Lower Yakima Valley Groundwater Management Area

Minority Report – December, 2018

Submitted by

To the Reader:

Everywhere in the world alfalfa enriches the soil by fixing and adding nitrogen - Unless you live in Yakima County.

According to the Lower Yakima Valley Groundwater Management Area (LYV GWMA) Report, alfalfa removes an average 236 pounds of nitrogen per acre per year from the soil, in our very special part of the world.

According to the LYV GWMA Advisory Committee (GWAC) the universally accepted laws of science do not apply to us. If the GWAC did not like the data we simply threw it out. The GWAC did not like the fact that nitrate levels in monitoring wells north of Outlook reached 160 mg/L, 180 mg/L or 234 mg/L (safe nitrate for drinking is < 10 mg/L) - so we ignored those samples.

The GWMA Plan, approved by a majority of the GWAC that included three major WA State agencies, is based on half-truths and outright falsehoods. It is a lesson in collusion and corruption.

Please read this Minority Report from the Friends of Toppenish Creek carefully. It is a best effort to relate the six year history of the Lower Yakima Valley Groundwater Management Area and to tell Washingtonians how $2.3 million tax dollars were spent.

Respectfully

The Friends of Toppenish Creek

Executive Summary

Friends of Toppenish Creek is a 501(C) 3 non-profit environmental group that has been part of the Lower Yakima Valley Groundwater Management Area (LYV GWMA) since the beginning in 2012.

> *Friends of Toppenish Creek is dedicated to protecting the rights of rural communities and improving oversight of industrial agriculture. FOTC operates under the simple principle that all people deserve clean air, clean water and protection from abuse that results when profit is favored over people. FOTC works through public education, citizen investigations, research, legislation, special events, and direct action.*

FOTC files this report because the LYV GWMA has failed to deliver on promises to reduce nitrates in groundwater. In 2010, according to *Lower Yakima Valley Groundwater Quality; Preliminary Assessment and Recommendations*, about 12% of wells in the LYV had nitrate levels above the safety standard of 10 mg/L. In the last round of GWMA sampling 20% of wells had nitrate levels above the standard.

Here are more specific reasons for a Minority Report:

1. The GWMA has not complied with the mandates in WAC 173-100-090(1) and WAC 173-100-100(6)

2. The dairy industry has maintained veto power over any and all GWMA actions. Advocates for dairy have controlled the agenda and marginalized other voices on the GWMA advisory committee (GWAC).

3. The GWMA leadership has failed to provide adequate research that is necessary in order for the GWAC to do the work. The GWMA has missed almost every deadline.

4. The GWMA gathered data and then, failed to analyze the data. The GWMA did no analysis of Deep Soil Sampling data, High Risk Well testing results, composting data, sampling of domestic wells and drains, or responses to a survey of public understanding.

5. GWMA contractors have not complied with the terms of their contracts. There were no consequences. A Nitrogen Availability Assessment was supposed to be the center piece of GWMA problem solving. It arrived 18 months late. The authors ignored bio-solids and waste water spray-fields, ignored the GWMA Deep Soil Sampling, ignored inputs from animals on pasture, ignored composting yards, failed to do a promised literature review and incorrectly stated that there is no leaching from alfalfa fields. They ignored nitrogen runoff to surface waters.

6. The GWMA has not addressed the impact of groundwater pollution on the health and well-being of the people who live in the Lower Yakima Valley. The GWAC has ignored Environmental Justice.

7. The GWMA has used up $2.3 million and left the program with no funds for implementation and no road map for how to obtain funds.

Background

In 2008 reporter Leah Beth Ward wrote a series of award winning reports entitled *Hidden Wells, Dirty Water* for the Yakima Herald Republic. Ward interviewed people who were afraid to drink water from their domestic wells and encountered difficulties when they went to authorities for information and assistance. She asked the U.S. Environmental Protection Agency (EPA) to investigate.

The EPA began sampling water in the area and convened meetings where residents and other stakeholders discussed ways to address the emerging problems. That group recommended formation of a GWMA and Yakima County asked to be designated as the lead agency in a 2011 *Request for Identification Lower Yakima Valley Groundwater Management Area.* Very few of the Goals and Objectives in that document have been achieved.

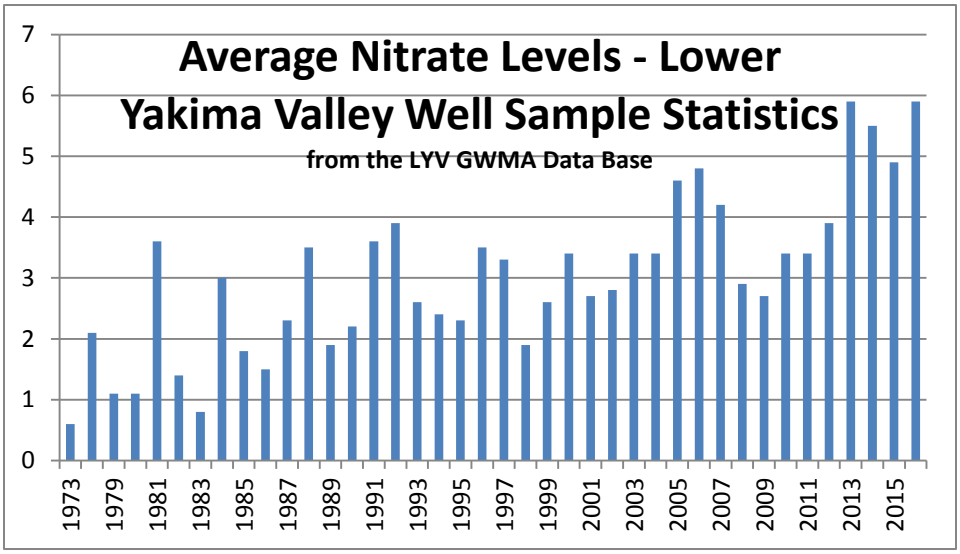
The Nitrate Problem

Nitrate contamination of groundwater is a world-wide problem that has grown over the last century due to an increasing population; man-made changes to the nitrogen cycle due to manufacture of chemical fertilizers; and an increase in confined animal feeding

operations. Washington State ranks 12th in the nation for the percentage of the land surface with groundwater nitrates > 5 mg/L. Nitrates pose a health risk to animals and to people, especially babies.

California, with severe water quality problems, spends millions of dollars every year on groundwater. There is no end in sight. In 2008 that state commissioned the University of California at Davis to study nitrates in drinking water. The LYV GWMA relied heavily on data from this comprehensive study while, at the same time, acknowledging that conditions in California and other impacted areas are different from those in the Yakima Valley.

In the Lower Yakima Valley the number of contaminated wells is increasing and the level of contamination is increasing. Here is a chart adapted from the GWMA Data Base that illustrates the trends:



(Since those readings are missing from the data base this graph does not include 2014 – 2016 well testing from a "dairy cluster" where 61% of domestic wells one mile down gradient had nitrate levels above the safety standard of 10 mg/L. and the highest reading was 234 mg/L.)

GWMA Actions

Early in the process the GWAC agreed upon the need for foundational work in order to analyze local issues. There was consensus on the importance of education and public outreach, a baseline survey of public understanding, an early Area Characterization, Deep

Soil Sampling, a Network of Groundwater Monitoring Wells, and a Nitrogen Loading Assessment.

Public Outreach: In 2013 Education and Public Outreach (EPO) created a public survey that was carried out by students from Heritage University. The EPO group worked with EPA's Pediatric Environmental Health Services Unit (PEHSU) on a program to inform new mothers in the valley about the risks from using well water to mix baby formula. The EPO group facilitated free well water testing for 460 homes, presented bi-lingual material at five health fairs, supported radio presentations in English and Spanish and purchased billboard space that advised people to have their well water tested.

Deep Soil Sampling: Deep Soil Sampling was performed in fall 2014, spring 2015, fall 2015 and spring 2016. Both Ecology and FOTC analyzed the data in 2017-2018 but these analyses were never shared with or accepted by the GWAC. For this data set FOTC found:

- There are differences between spring and fall deep soil testing results
- The range of values for alfalfa is huge and suggests a need for further study
- The range of values for hops is large and suggests a need for further study
- Over half of the fields planted in triticale are at medium to high risk for leaching nitrate to the groundwater
- Double cropping is associated with higher nitrate levels
- In this data set rill irrigation was more protective of the groundwater than sprinkler irrigation
- Application of liquid manure is significantly more likely to result in high nitrate levels than application of solid manures or commercial fertilizer.

High Risk Well Assessment: Between 2013 and 2016, on behalf of the GWMA, the Yakima Health District tested 460 domestic wells in order to better understand the prevalence of nitrate contamination of the aquifer. This High Risk Well study found:

- 59% of wells had nitrates from 0 to 5.0 mg/L
- 26% of wells had nitrates from 5.01 to 9.99 mg/L
- 15% of wells had nitrates from 10.0 to 35.0 mg/L

A survey of conditions at well sites that was supposed to accompany the High Risk Well Assessment was not completed.

Network of Monitoring Wells: Since 2013 the GWAC has studied plans for a network of purpose built monitoring wells. In January, 2017 the Pacific Groundwater Group signed a contract to oversee the installation of these wells. The county did not sign the contract until January, 2018. In early 2017 the U.S. Geological Survey signed a contract to sample those wells and test for nitrates. The terms of that contract have expired. As of October, 2018 there were no wells, no network and no plans for how to analyze the data if/when samples are collected. The GWAC discussed this topic over eight times during the past six years and repeatedly approved plans for groundwater monitoring.

Nitrogen Loading Assessment: The GWAC agreed on the need for a Nitrogen Loading Assessment, a mathematical approach to nitrogen balance in the target area, in order to determine the contribution from various sources and to prioritize response strategies. The Washington State Department of Agriculture (WSDA) and Yakima County agreed to complete an NLA for the GWMA with a due date of December, 2015.

The NLA did not arrive until April, 2017. By then it was renamed a Nitrogen Availability Assessment (NAA). WSDA and Yakima County did not follow the Scope of Work (SOW) for the study. Nitrogen inputs were missing for alfalfa fields, industrial spray fields, bio-solids and compost yards. Nitrogen runoff to the surface waters was ignored.

2017 Testing of Domestic Wells: Every two months during 2017 the USGS tested about 156 domestic wells and 24 agricultural drains in the target area on behalf of the GWMA. The data was shared with the GWAC but there was no evaluation. FOTC performed an analysis but our work was never discussed or approved by the GWAC.

Here are average nitrate levels for five areas in the GWMA:

- North of Wapato – 0.50 mg/L
- Wapato to Granger – 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

Proposed Solutions: In mid-2017 the GWMA leadership introduced over 250 proposed solutions to the nitrate problem, in spite of the fact that there was: no Area Characterization, no analysis of High Risk Well Testing, no analysis of the Deep Soil Sampling, no Nitrogen Loading Assessment and no Network of Monitoring Wells. Throughout the last half of 2017 the GWAC focused on refining this list.

FOTC finds the process to be very flawed. For example, the initial list contained seven strategies that target domestic septic systems but no strategies that targeted composting operations or atmospheric deposition of nitrogen.

GWMA Plan: The most recent GWMA timeline called for an approved plan by June, 2018. This would allow time for a State Environmental Policy Act (SEPA) review and public hearings on the plan before the GWMA contract expires in December, 2018. Once again, the deadline has passed.

For these reasons FOTC now offers an alternate GWMA Plan based on the last six years of work and our participation. We have included an important section entitled, *What Will Happen If We Do Nothing?* This is required by WAC 173-100-100(2). We suggest measureable goals and objectives along with a draft plan for evaluation. Please understand the limitations involved when a small group with few resources undertakes this work

Problem Definition

Between 12% and 20% of wells in the Lower Yakima Valley have nitrate levels > 10 mg/L. The problem is not evenly distributed across the valley. More wells in the southern portion of the GWMA target area are contaminated than those in the northwestern area. The highest groundwater nitrate concentrations are down gradient from dairies.

Contributing factors are groundwater flow, depth to groundwater, soil characteristics, weather patterns, housing density, disposal of industrial and municipal wastes, and agricultural practices including: crop types, irrigation practices, fertilization, maintenance of lagoons/ponds, volatilization from production areas and cropland.

In recent years the problem has expanded from shallow and aging domestic wells to deeper municipal wells. Since the early 2000's the City of Grandview has monitored nitrate levels in its municipal wells closely and has blended water from several wells in order to deliver safe drinking water. In 2013 the City of Mabton drilled a new $1.85 million well to replace older wells that were troubled with decreasing water pressure and elevated nitrates.

FOTC Analysis of the Problem

Area Characterization: The GWMA target area extends along the Yakima River Valley from Union Gap in the north to the Yakima/Benton County line in the east. The western border is the Yakima River/eastern boundary of the Yakama Reservation. The outermost occupied parcels, down gradient from the Rattlesnake Hills and the Horse Heaven Hills form the northern and southern borders.

Soil is mostly composed of rich sediments that include Touchet Beds, loess and thick alluvial sands and gravels, and significant thickness of Ellensburg Formation. Half of the target area lies in the Toppenish Sedimentary Basin and half in the Benton Sedimentary Basin. Rainfall averages seven inches per year.

Agriculture is the driving force behind the local economy. Irrigation from the Sunnyside and Roza Irrigation Districts serves about 96,000 acres of rich farmland. Major crops are apples, corn, triticale, grapes, alfalfa, cherries, mint, hops, wheat and asparagus. Since the late 1980's dairying has assumed an ever increasing importance in the agricultural community. Over the past twenty five years the number of milk cows has increased at a rate of almost 3,000 per year. Increases in land planted in corn and forage have accompanied this trend.

The population is about 70% Latino and is much younger than average for Yakima County or for the state. Many people are recent immigrants who speak English less than well. About 20% of the population lives below the poverty level and slightly over half have a high school diploma. Because the population is often non-mainstream and because pollution issues are prominent the potential for Environmental Injustice is high in the GWMA.

The Yakama Nation has highlighted the impact of climate change on the valley. The USGS has documented declining water tables in the basalt aquifers. Groundwater from shallow aquifers in the LYV flows toward the Yakima River and is a major contributor to instream flows that are protected by treaties. The Yakima River Basin Integrated Water Resource Management Plan is intensely involved in seeking solutions to problems caused by over-allocation of this precious and limited resource.

Knowledge Gaps: Based on GWMA discussions over the past five years, FOTC perceives the following knowledge gaps:

- Insufficient understanding and recognition of local public health issues
- Insufficient understanding of nitrogen volatilization from animal agriculture and cropland that leads to poorly characterized atmospheric deposition of reactive nitrogen and an unquantified impact on the nitrogen balance.
- Uncertainty about market impacts on agricultural practices in the area
- Insufficient understanding of the percentage of dairy manure that is composted and exported from the area
- Insufficient information about the amount of commercial fertilizer that is applied to GWMA cropland
- Uncertainty about the rate of nitrate leaching from pens, corrals and compost areas
- Insufficient education regarding movement of groundwater in the vadose zone
- Poor understanding surrounding the meaning of Environmental Justice

Regulatory Gaps: Based on GWMA discussions over the past five years, FOTC perceives the following regulatory gaps:

- The Dairy Nutrient Management Act does not authorize the WSDA Dairy Nutrient Management Program (DNMP) to enforce compliance with Dairy Nutrient Management Plans (NMPs)
- Washington State's Non-point Source Pollution Prevention Plan has not yet been approved by the EPA

- Yakima County's Voluntary Stewardship Program relies on the GWMA plan for data gathering and evaluation of agriculture in the LYV. If the GWMA plan is weak this will weaken our VSP.
- WAC 173-201A-020 requires Ecology to approve and list BMPs that protect waters of the state. This has not been done.
- There are no Total Maximum Daily Loads (TMDLs) for nutrients for the Lower Yakima River, in spite of the fact that nitrogen and phosphorous concentrations in agricultural drains have not declined in recent years.
- Environmental groups believe that the 2017 NPDES General Permit for Concentrated Animal Feeding Operations (CAFOs) is weak and does not protect waters of the state. Industry believes the permits are too costly for producers.
- WAC 173-350-220 is poorly enforced. As a result manure composting operations pollute the groundwater
- Under WAC 16-06-210 (29) reporting of the number of cows on a facility is so broad that efforts to control pollution from animal agriculture are impaired
- WAC 173-224-040 imposes lower fees on dairy CAFOs than it does on beef or other CAFOs
- There is no reporting of nitrogenous and other potentially toxic emissions from CAFOs
- There is no regulation of manure applications on non-dairy cropland
- Yakima County with 35% of all Washington milk cows has no CAFO ordinance.

What Will Happen If We Do Nothing? Groundwater quality in the LYV GWMA is worsening. Current efforts to address the problem are not working. If we do nothing different the future will bring falling aquifers with increasingly polluted water. Costs to future tax payers, our children, will escalate.

Goals & Objectives

FOTC believes that GWMA Goals and Objectives must be framed so that change can be measured. With this in mind we suggest the following:

Overarching Goal: Reduce Nitrates in Lower Yakima Valley Groundwater to Safe Levels of < 10 mg/L

Pollution prevention will be a guiding principle

1. Everyone who lives in the LYV will have access to safe and affordable drinking water. No one will pay more than 2% of their income for bottled water.

2. People who live in the Lower Yakima Valley will be engaged and involved in programs to reduce nitrates in groundwater

3. There will be no more "bureaucratic runaround". When people call authorities they will receive accurate and helpful information.

4. The LYV aquifers will show decreasing nitrate levels beginning in 2020. The aquifers will reach safe levels by 2040

5. Soil nitrate levels below the root zone on LYV cropland will be < 15 ppm

6. There will be no leaching of nitrate below animal pens & corrals, lagoons & ponds, or compost yards

7. Volatilization of nitrogen from production areas and cropland will be quantified and controlled

8. Costs for cleanup of the LYV aquifers will be borne by those who pollute

Summary

Agencies and stakeholders have attempted to turn around the trend toward increasing nitrates in LYV groundwater since the 1990's. Efforts to date, including the work of the LYV GWMA, have failed.

The largest contributor to groundwater nitrates in the LYV is animal agriculture, namely CAFO dairies. FOTC firmly believes that the most cost effective way to solve the nitrate problem is to control the number of cows in the area.

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Reasons for a Minority Report

1. The GWMA has not complied with the mandates in WAC 173-100-1090(1) or WAC 173-100-100(6).

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4. The GWMA gathered data and then, failed to analyze the data. The GWMA did no analysis of Deep Soil Sampling data, High Risk Well testing results, composting data, sampling of domestic wells and drains, or responses to a survey of public understanding.

5. GWMA contractors have not complied with the terms of their contracts. There were no consequences. A Nitrogen Availability Assessment, the center piece of the GWMA problem solving, ignored bio-solids and waste water spray-fields, ignored the GWMA Deep Soil Sampling, ignored inputs from beef feedlots and animals on pasture, ignored composting yards, failed to do a promised literature review and incorrectly stated that there is no leaching from alfalfa fields. The NAA ignored runoff to surface waters.

6. The GWMA has not addressed the impact of groundwater pollution on the health and well-being of the people who live in the Lower Yakima Valley. The GWAC has ignored Environmental Justice.

7. The GWMA has used up $2.3 million and left a program with no funds for implementation and no road map for how to obtain funds.

For documentation that supports these statements and further explanation, please go to page 193 of this report.

Nitrate Contamination of Groundwater, a World Wide Problem

Water is life. Groundwater is the source of drinking water for much of the world's population. Groundwater is essential for agriculture and industry. And groundwater has been and continues to be contaminated across the globe by human activity.

The most pervasive and most studied groundwater contaminant is a highly soluble compound with the chemical formula $-NO_3$, also called nitrate. Nitrate levels in groundwater have increased dramatically over the past century due, in large part, to advances in the manufacture of chemical fertilizers and changes in management of animal agriculture. (EPA, 2018c; Sutton et al, 2011)

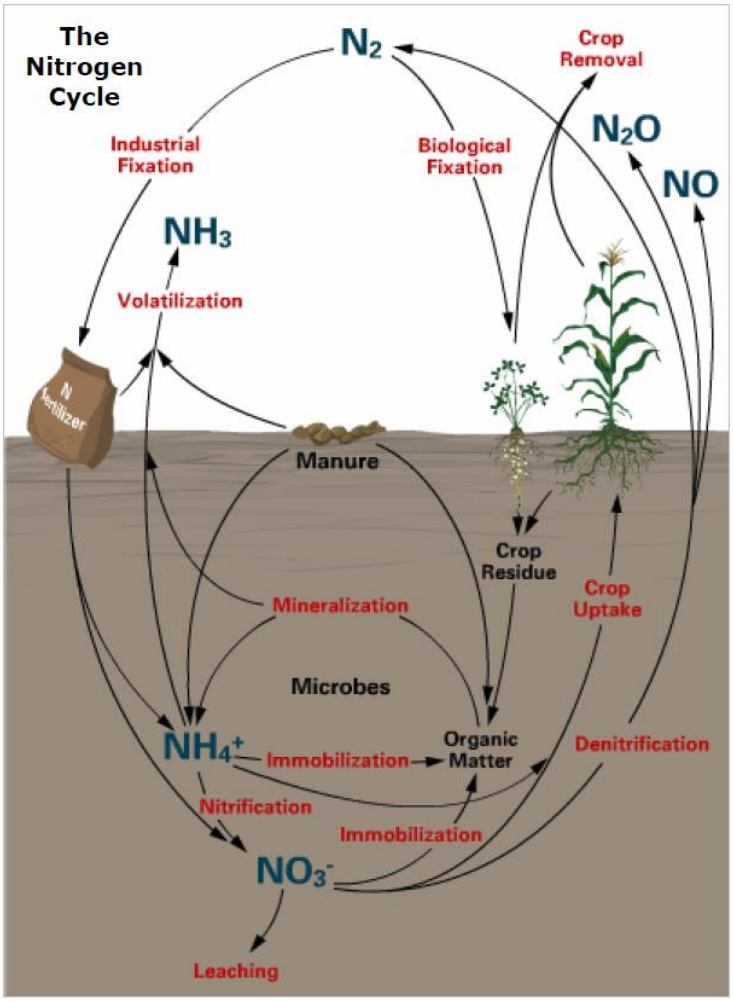
Fertilizer: Farmers have known for millennia that crops such as legumes and alfalfa enrich the soils and make it more productive. This happens because micro-organisms in the plant roots convert inert nitrogen, N_2, into nitrate that feeds plant growth.

Early in the 20^{th} century two chemists, Fritz Haber and Carl Bosch, discovered a way to do this in the laboratory. Industrialization of the process led to production of nitrate ammunitions that supported World Wars I and II. During peace time munitions factories were converted into fertilizer plants that support the dramatic growth of agriculture we see today. (Sutton et al, 2011)

As a result of human conversion of atmospheric N_2 into chemically and biologically reactive nitrogen the nitrogen cycle has been altered. We now have much more ammonia (NH_3), ammonium (NH_4), Nitrous Oxide (N_2O), Nitrite ($-NO_2$) and Nitrate ($-NO_3$) in the world than ever before. This leads to water pollution, especially where fertilizers are applied to the cropland. (EPA, 2011; Sutton et al, 2011)

To better understand the nitrogen cycle, please see the excellent Fact Sheet, *Nitrogen Basics – The Nitrogen Cycle*, from Cornell University Extension Service. (Attachment 31) The diagram below shows the many pathways involved in the Nitrogen Cycle.

Diagram 1. The Nitrogen Cycle



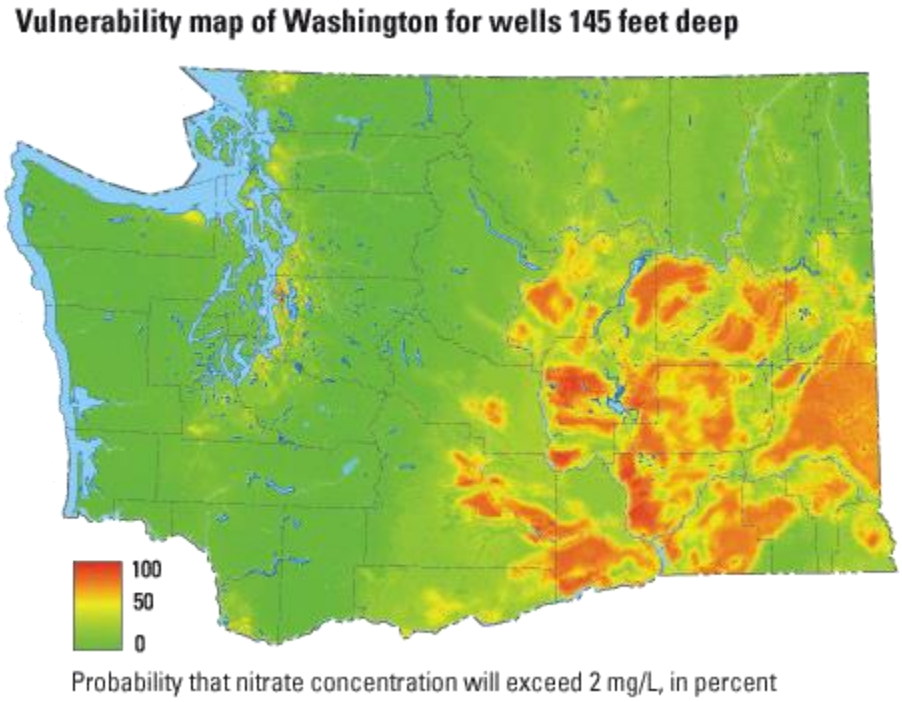
From Cornell University Extension Service: *Nitrogen Basics – The Nitrogen Cycle*

Animal Agriculture: Over the last 50 - 70 years agriculture has changed from a system of small family farms with multiple crops into a network of vertically integrated industries that supply the world with food. Many animals that supply meat, milk and fiber are now raised in concentrated animal feeding operations (CAFOs) where thousands are maintained on small acreages. This means that feed is delivered to the animals and waste products must be mechanically removed. This can be costly. Accumulation of hard to transport manures often leads to contamination of groundwaters. (PEW Commission, 2008; Kellogg et al, 2000) The frequent result is leaching of nitrates to groundwater in areas with intense agriculture. (Harter et al, 2012)

Nitrate Contamination of Groundwater in Washington State

Nitrate concentrations in the groundwater are elevated above background levels for much of Washington State. The USGS map below shows that most areas with elevated nitrates are east of the Cascades. Note that > 2 mg/L shows nitrate above background levels but it does not indicate a danger to human health. The EPA currently states that drinking water with N > 10 mg/L is unsafe for humans.

Map 1. At Risk Aquifers in Washington State



(Frans, 2008)

The WA State Dept. of Ecology has studied nitrates in groundwater since at least 1988 when the agency initiated the Agricultural Chemicals Pilot Study that included collection of nitrate data in Yakima County. (Erickson, 1990) Interest was high during this period and a number of studies followed soon after:

- Protecting Groundwater: A Strategy for Managing Agricultural Pesticides and Nutrients (Ecology, 1992)

- Effects of Leakage from Four Dairy Waste Storage Ponds on Ground Water Quality, Final Report (Erickson, 1994)
- Irrigation management practices to protect ground water and surface water quality State of Washington (Canessa & Hermanson, 1995)
- An Examination of Methemoglobinemia in Washington State (Shields, 1996)
- Creation of the Columbia Basin Groundwater Management Area in 1998

Ecology continued to work on the problem, mostly with studies in Whatcom County. (See Attachment 74 for a listing of Ecology Groundwater Studies) In 2014 the agency launched a *Nitrate Prioritization Project* that may create an easily accessible data base for groundwater nitrates in the state. (Morgan, 2014) The proposed goals of this project are to:

1. Delineate areas where high nitrates in groundwater occur.
2. Prioritize those areas by potential impact to people and resources.
3. Make information available to everyone.

At the current time there is no strategy in place for statewide nitrate surveillance. However the project has multiple conclusions and recommendations for refining and improving Washington's approach to the problem. (Morgan, 2014, pages 29 & 51)

On a national scale Washington and Kansas are tied for 12th place when looking at the percentage of state land surface with groundwater nitrates > 5 mg/L. Here is data for seriously impacted states (EPA, 2018e) (Also see Attachment 46)

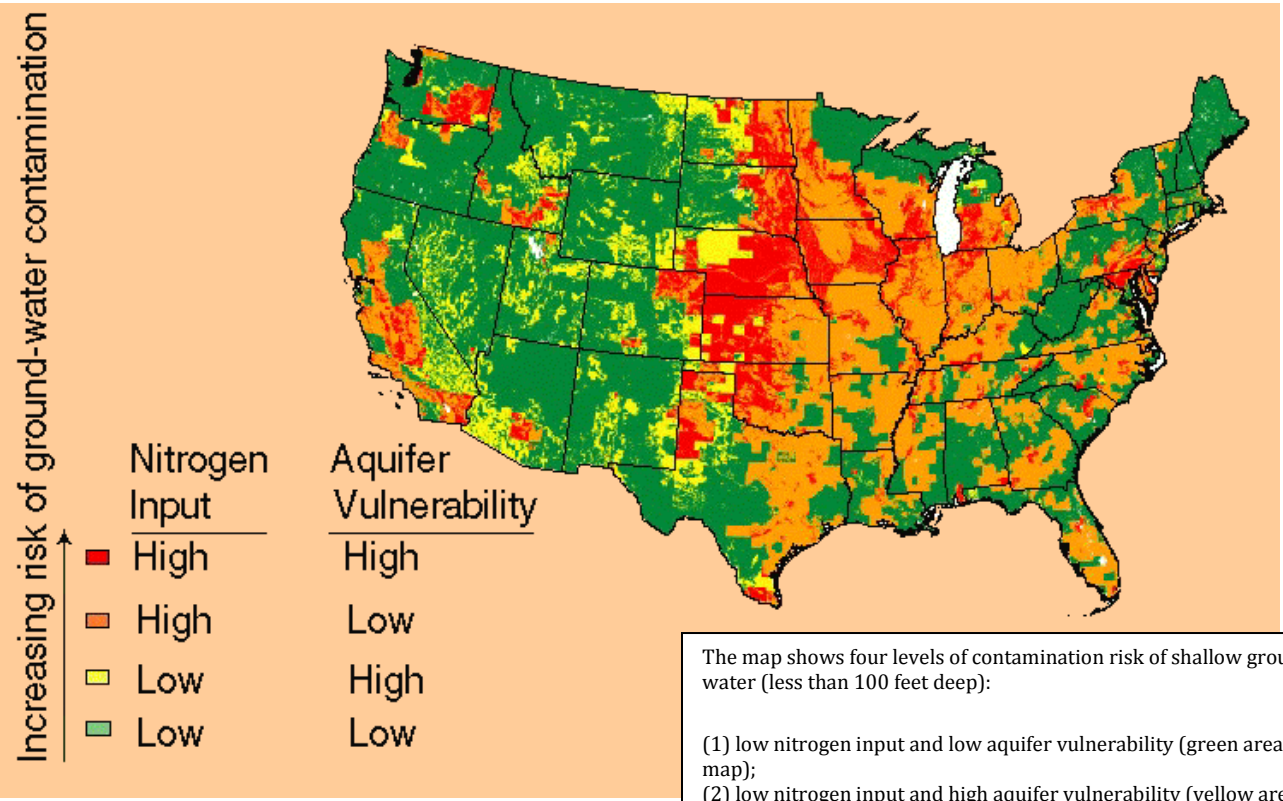
Table 1. Nitrate Pollution by State

State	Estimated Area in Square Miles with Nitrate > 5 mg/L	Estimated % of State Land Area with N > 5 mg/L	% of Population that Uses Groundwater for Drinking
Delaware	975.68	53%	10%
Maryland	2,673.76	28%	17%
Nebraska	13,417.82	17%	18%
Rhode Island	168.34	16%	8%
Louisiana	6,530.15	15%	12%
Massachusetts	950.97	12%	8%
Arizona	12,763.38	12%	4%
California	15,003.54	10%	7%

North Carolina	4,580.33	9%	26%
Florida	4,975.31	9%	10%
New Jersey	642.47	9%	11%
Washington	**5,325.51**	**8%**	**14%**
Kansas	6,306.98	8%	5%
Vermont	2,628.97	7%	30%
Pennsylvania	2,982.64	7%	20%
Texas	15,818.61	6%	10%
Michigan	3,253.68	6%	29%
Connecticut	275.68	6%	24%
Illinois	3,132.06	6%	9%
Idaho	4,256.00	5%	30%
Ohio	2,005.41	5%	17%

Another way to visualize the severity of the problem in Washington, compared to the rest of the nation is by mapping. Here is the situation in 1998, according to the USGS (Nolan et al, 1998)

Map 2. Nitrate Pollution across the Nation



The map shows four levels of contamination risk of shallow ground water (less than 100 feet deep):

(1) low nitrogen input and low aquifer vulnerability (green area on the map);
(2) low nitrogen input and high aquifer vulnerability (yellow area);
(3) high nitrogen input and low aquifer vulnerability (orange area); and
(4) high nitrogen input and high aquifer vulnerability (red area).

Impact on Human Health from Nitrates in Drinking Water

The EPA's Integrated Risk Information System is re-evaluating the current assessment of health risks due to nitrate and nitrite. The safety standard of 10 mg/L nitrate in drinking water may soon be lowered as a result. (U.S. EPA, 2017a: U.S. EPA 2017b; Walton, 2018)

This re-evaluation is due to more recent ongoing and evolving research that looks more closely at the ways that nitrate and nitrite impact physiology and body chemistry. Some studies have found significant effects from drinking water with nitrate levels between 5 and 10 mg/L. (Ward et al, 2005; WHO, 2016).

Health impacts from nitrates are interwoven with a series of bio-chemical reactions in the body. In brief: varying portions of ingested nitrate (NO_3) from food and water convert into nitrite (NO_2). When nitrite binds with hemoglobin in the blood stream the hemoglobin is less able to carry oxygen. Under certain conditions nitrite in the stomach converts into N-nitrosoamines which produce cancer. (ATSDR, 2017; IARC, 2010) Some studies show a positive relation between nitrate intake and certain cancers while others do not. (Ward et al, 2005; Walton, 2018)

Most of the nitrate that people take into our bodies comes from food, especially from leafy vegetables. Vitamin C in these vegetables reduces the conversion of nitrate to nitrite and N-nitroso amines. Vitamin C is a mitigating factor. (ATSDR, 2017; IARC, 2010)

ATSDR (2017) has established a Minimum Risk Level (MRL) of 4 mg/kg body wt. /day for nitrate. This means that a 220 pound adult (100 kg) should consume less than 400 mg (.014 ounces) of nitrate per day. This intake could come from a typical vegetarian diet that is high in leafy vegetables. (Note: 10 ppm nitrate-N/L = 45 ppm nitrate/L)

If an average adult drinks 2 liters of water per day here is the amount of nitrate intake:

- If nitrate N is 10 ppm (the safe standard) then nitrate in 2 liters = 90 mg
- If nitrate N is 20 ppm (double the safe standard) then nitrate in 2 liters = 180 mg
- If nitrate N is 30 ppm (triple the safe standard) then nitrate in 2 liters = 270 mg

Nitrate poisoning from food is rare, although very young children who have been fed large amounts of vegetables, such as carrot soup, have developed methemoglobinemia or blue baby syndrome. (Sanchez-Echaniz et al, 2001; Savino et al, 2006; Sernia et al, 1984)

Children under the age of six months are less able to tolerate nitrate and are susceptible to methemoglobinemia which may be life threatening. Health care providers have been aware of this problem since the 1940's. (Bosch, 1950; Walton, 1951; Comley, 1945; Comley 1987; Knobeloch et al, 2000) This occurs most often when formula is reconstituted using well water with high nitrate levels. Methemoglobinemia in babies may be confused with heart failure. The symptoms are the same.

There are case studies that relate spontaneous abortion to well water with high nitrates. (Manassaram et al, 2005; CDC, 1996). There is research that links birth defects to well water with high nitrates (Brender et al, 2004; Brender et al, 2013; Cedergren et al, 2002; Bukowski et al, 2001; Croen et al, 2001; Tabacova et al, 1993; Tabacova et al, 1998; Arbuckle et al, 1988; Dorsch et al, 1984).

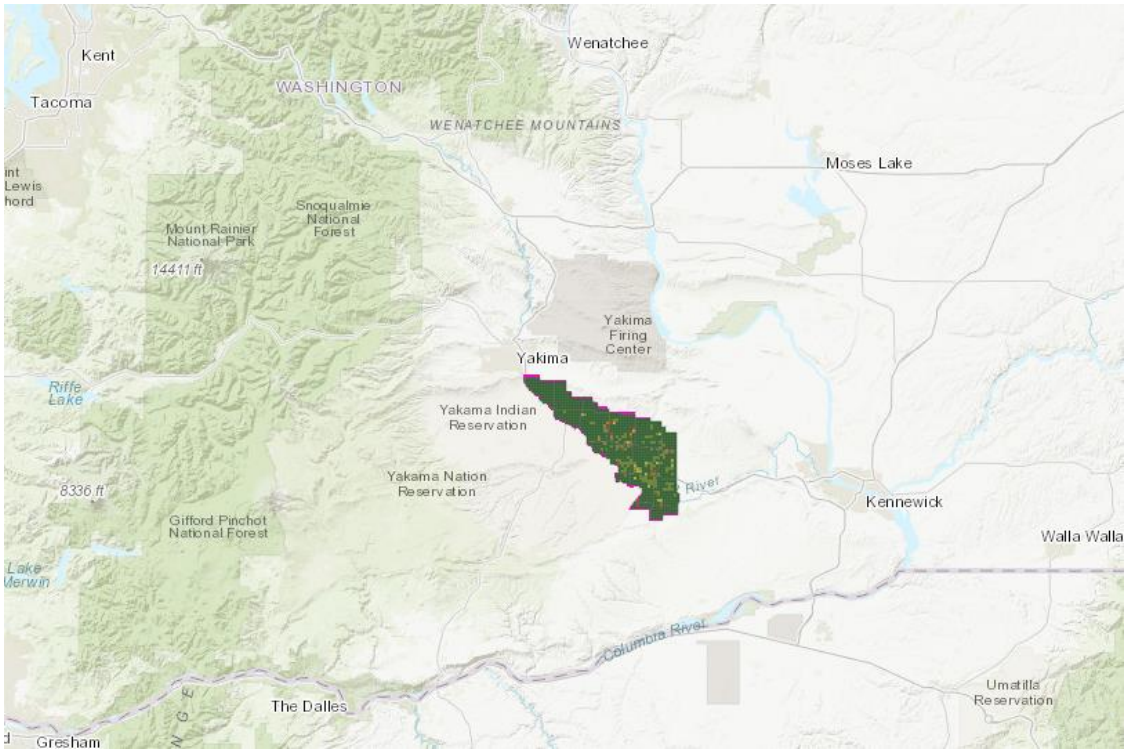
There is research that shows a positive relationship between elevated nitrates in drinking water and a number of chronic illnesses including thyroid disease, heart disease and diabetes. There is contradictory research. (Ward et al, 2004)

A study of healthy volunteers showed a significant increase in heart rate and a drop in blood pressure when the subjects received one time doses of sodium nitrite. (ATSDR, 2017) While this may or may not be beneficial, the point is that nitrate in drinking water has a physiological impact on humans.

GWMA History

The Lower Yakima Valley Groundwater Management Area (LYV GWMA) was formed in 2012 to address nitrate pollution in the highly productive and intensely farmed Lower Yakima Basin. The current boundaries for the LYV GWMA are shown in the map below; also available at http://arcg.is/1ie9mP

Map 3. Lower Yakima Valley GWMA



The southwestern boundary of the GWMA is the Yakima River and the coincident northeastern border of the Yakama Nation. The eastern boundary of the GWMA is the Yakima – Benton County line. The northern border and the short southern border were created by including parcels of land with wells that lie down gradient from the Rattlesnake Hills and the Horse Heaven Hills. (Yakima County, 2011b)

Brief Background

1990: Concerns about elevated nitrates and other contaminates in Eastern Washington groundwater date back to the 1980's. In 1990 the Washington State Dept. of Ecology

published the *Washington State Agricultural Chemicals Pilot Study*, available at https://fortress.wa.gov/ecy/publications/documents/9046.pdf that found high nitrate levels in Whatcom County and Franklin County but low levels in Yakima County. This study and others led to the 1998 designation of the Columbia Basin Groundwater Management Area for Franklin, Adams, Grant and Lincoln Counties.

1995: In 1995, with funding from the Clean Water Act Section 319, agricultural scientists Peter Canessa and Ronald Hermanson published research entitled *Irrigation Management Practices to Protect Groundwater and Surface Water Quality: State of Washington.* (Canessa & Hermanson, 1995) This document created a foundation for major improvement in irrigation management. Most of the best management practices (BMPs) from that study are still recommended today. In fact 39 of the 85 BMPs recommended by the GWMA Irrigated Ag Work Group came from this document.

1990 – 2002: Throughout the 1990's Yakima environmentalists led by the Community Association for the Restoration of the Environment (CARE) sounded the alarm regarding pollution of ground and surface waters from a growing dairy industry that was migrating from California to the Yakima Valley.

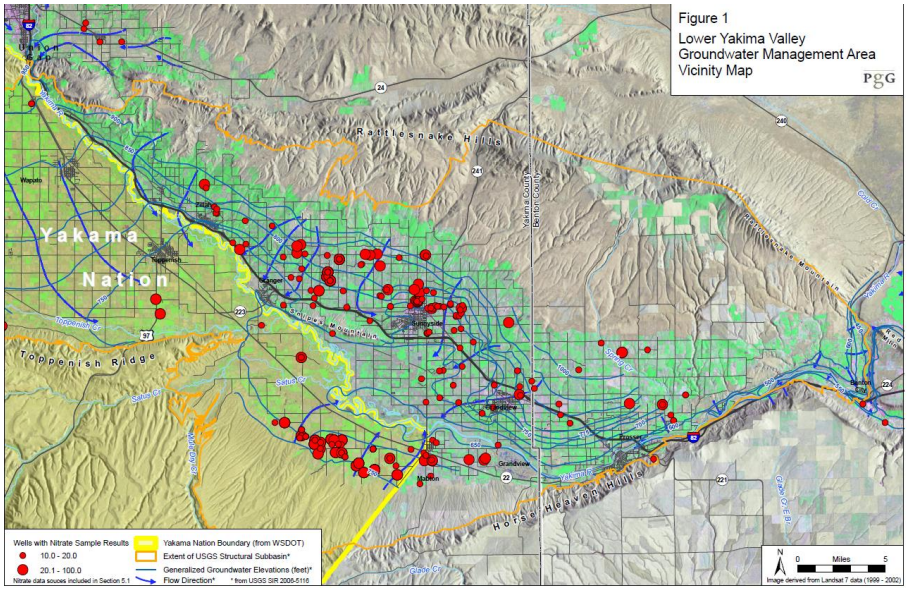
As the result of a court settlement, CARE and Henry Bosma funded a study entitled *Quality of Ground Water in Private Wells in the Lower Yakima Valley, 2001-02,* available at https://fortress.wa.gov/ecy/publications/documents/0210074.pdf This research, also known as the VIRE Study (Sell & Knutson, 2002), divided the LYV into Region I - the northwest and Region II - the southeast. A total of 249 domestic wells were tested. The VIRE study found no nitrates > 10 mg/L in wells from Region I. But 21% of the tested wells in Region II exceeded the standard. Mean values for chloride, ammonia and specific conductivity were significantly higher in Region II. Subsequent well water surveys find a similar pattern.

2008: In 2008 Leah Ward from the Yakima Herald Republic wrote an award winning series of articles entitled *Hidden Wells, Dirty Water* (Attachment 36) that cast a bright light on the problem. Ward asked for an investigation by the Environmental Protection Agency (EPA).

2010: In 2010 the EPA began studying Yakima groundwater contamination. The EPA studies are available at https://www.epa.gov/wa/lower-yakima-valley-groundwater The EPA initiated a collaborative process in which state and local agencies, EPA and the community looked at possible solutions. The result was a report, *Lower Yakima Valley Groundwater Quality: Preliminary Assessment and Recommendations,* available at https://fortress.wa.gov/ecy/publications/documents/1010009.pdf

The map below describes the results of well testing for nitrates that were available in 2010. Note that some of the wells had readings up to 100 mg/L nitrate.

Map 4. Nitrates in Wells – Lower Yakima Valley - 2010

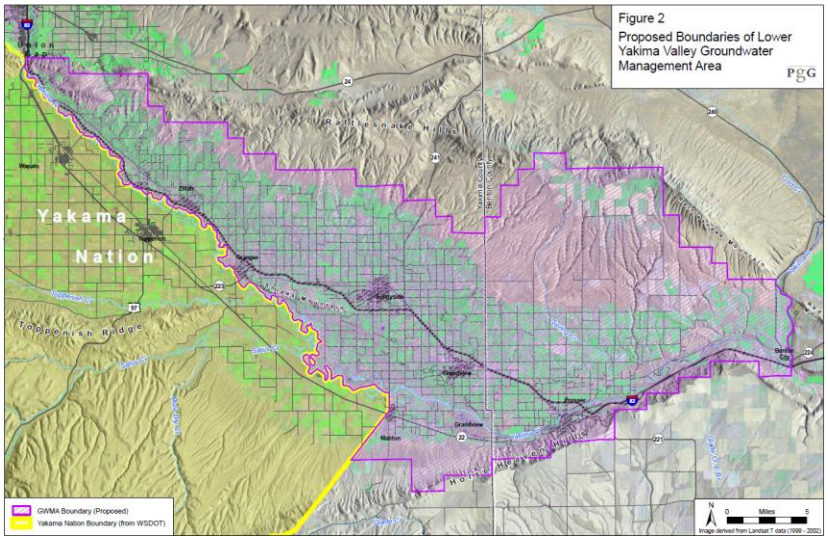


From LYV GWMA Request for Identification 201

The stakeholders recommended creation of a groundwater management area to address water quality problems in the valley. In 2011, as authorized by WAC 173-100-050, Yakima County submitted a *Request for Identification: Lower Yakima Valley Groundwater Area,* available at https://www.yakimacounty.us/DocumentCenter/View/2359/2011-Request-for-Identification-Lower-Yakima-Valley-Groundwater-Management-Area-PDF

2012: The LYV GWMA began meeting in mid-2012. At that time the target area included large parts of Benton County but excluded reservation lands. The Yakama Nation decided to pursue a reservation only project to address groundwater contamination.

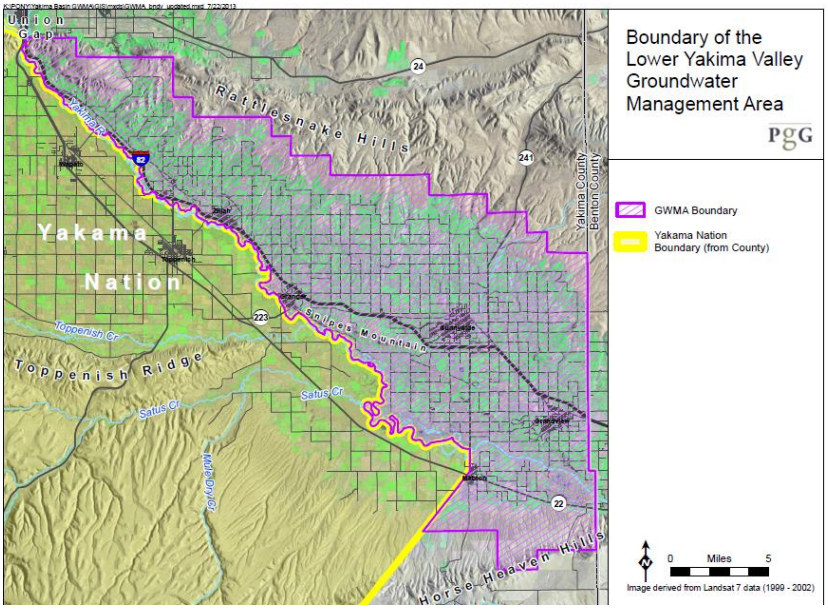
Map 5. The official map of the LYV GWMA in 2011-2012



From LYV GWMA Request for Identification 2011

2013: On April 10, 2013, Benton County filed a letter asking to withdraw from the LYV GWMA. On June 7, 2013 Ecology formally accepted this withdrawal. The GWMA boundaries were re-drawn as described in the map below.

Map 6.



Boundary of the Lower Yakima Valley Groundwater Management Area at
https://www.yakimacounty.us/DocumentCenter/View/1893/Groundwater-Management-Area-Boundary-Map-PDF

Highlights of GWMA Actions

2012: The first two meetings of the Groundwater Management Area Advisory committee (GWAC) in June and July of 2012 were devoted to familiarization with the prescribed processes, getting to know each other and development of guidelines for the work to follow.

2012-2013: The GWAC crafted a Work Plan between July 2012 and February 2013 that was then submitted to Ecology for approval. The submission included a projected budget for the GWMA and a plan for Education and Public Outreach.

2013: The GWAC discussed Goals and Objectives at five of the twelve 2013 meetings but the group did not progress beyond the measures described in the Work Plan. That plan identified objectives and related tasks for each of the seven work groups – Data Collection, Irrigated Agriculture, CAFO/Livestock, Residential Commercial, Industrial & Municipal (RCIM), Education & Public Outreach (EPO), Regulatory Framework, and Funding. The Work Plan is available at http://www.yakimacounty.us/598/Work-Plans

There was general agreement on the need for:

1. A survey of the public to assess understanding of the nitrate problem
2. A nitrogen loading assessment
3. A network of wells for groundwater monitoring
4. Deep soil sampling to evaluate the impact of various cropping practices.

Suggestions for a broader study of environmental impact and the impact on public health were rejected.

2013: Yakima County commissioned a study of Best Management Practices (BMPs) and a study of the relevant Regulatory Framework. Heritage University surveyed 130 homes in the valley to assess public awareness. These were all completed and presented to the GWAC in the last half of 2013. Data and Reports are available at http://www.yakimacounty.us/DocumentCenter/Home/View/8453 and http://www.yakimacounty.us/DocumentCenter/Home/View/8454

2014 – 2016: In the fall of 2014 the EPA presented to the GWAC the first round of results from their work with a cluster of five dairies in the LYV. The results are available at https://www.epa.gov/sites/production/files/2017-12/documents/lower-yakima-valley-groundwater-fact-sheet-december-2014.pdf

The GWAC and the Irrigated Agriculture Work Group (IAWG) spent nearly a year developing a plan for Deep Soil Sampling (DSS) that provided confidentiality for participants. DSS began with sampling in the fall of 2014, continued in the spring of 2015, fall of 2015 and ended in the spring of 2016. Results and FOTC analysis are attached. (Attachment 16, Attachment 17, Attachment 18, Attachment 23 & Attachment 24 (Data from DSS Spring 2016 is available at http://www.yakimacounty.us/541/Groundwater-Management-Area in Volume II))

2013 – 2017: Discussion and planning for a Nitrogen Loading Assessment (NLA) began in late 2013 and culminated in a plan designed to deliver a report in December 2015. WSDA accepted responsibility for the agricultural portion and Yakima County accepted responsibility for the RCIM portion. The report was delayed for nearly two years. The GWAC saw the first draft in April 2017. Members of the GWAC disagreed with the methods and conclusions. Comments were submitted and a responsive second draft was delivered in June 2018. The first and second drafts are attached as well as FOTC analysis. (Attachment 27, Attachment 30 & Attachment 32) As of July, 2018 WSDA has "finalized" and posted the report without GWAC approval.

2013 – 2017: In December 2013, the GWAC began the long process of developing a network of wells for groundwater monitoring. Over the next five plus years the GWAC discussed the project eleven times. In early 2017 the Pacific Groundwater Group signed a contract with Yakima County to oversee the installation of wells but the county did not sign the contract until January 2018. In early 2017 the United States Geological Survey (USGS) signed a contract with Yakima County to draw samples from the purpose built wells during 2017 but the wells were never drilled. As of October 2018 there was no network of purpose built monitoring wells. There is a 2017 project in which USGS sampled 156 domestic wells every two months. In that study 19.8% of the wells had nitrate levels above

10 mg/L. Results and FOTC analysis are attached. (Attachment 28) The numbers suggest, but do not prove, that the nitrate problem in the LYV may be worsening.

2014 – 2017: In June, 2014 Yakima County contracted with attorney Jim Davenport to advise the GWMA project. In July, 2017, based on his observations and participation, Mr. Davenport compiled a list of 260 potential Alternative Management Strategies for GWAC consideration. The GWAC met to discuss, edit and screen this list 10 times in 2017 and 4 times in 2018.

2015 – 2017: In July 2015 Ecology and Yakima County signed an interagency agreement modification that extended the GWMA deadline to September 2015. In November/December 2015 Ecology and Yakima County signed an interagency agreement that extended the GWMA deadline to December 2017. In January 2018 Ecology and Yakima County signed an amendment that extended the GWMA deadline to December 2018.

2018: In June 2018 Mr. Davenport presented to the GWAC a draft GWMA plan that included 54 Recommended Alternative Management strategies. FOTC dissatisfaction with the plan is the reason for this Minority Report. FOTC analysis of the selection process and the final product is attached. (Attachment 62, Attachment 63, Attachment 82)

Here is a tabular summary of the GWAC discussions.

Table 2. Topics from GWMA Meeting Agendas

Topic	2012	2013	2014	2015	2016	2017	2018
GWMA Programming							
Guidelines	2	2					
Time Frames/ Deliverables	1		2	3			
GWMA SOW/ Work Plan	6	4					
Budget		3	3		1		
Goals & Objectives		5				2	
Review Contracts & Agreements		1	5	1	3		2
Area Characterization					1	1	1
Inform the GWAC							
Informational Needs	2						

Yakima County Pilot Program		1					
Oregon GWMAs		1					
Overview of DNMP			1				
Nitrate Standards (EPA)			1				
Overview of Regulations			1		1		
Potential Requests to Legislature					2		
International Water Conference					1		
Alternative Management Strategies						1	
GIS Applications						3	1
Education & Outreach							
EPO Work Plan	3						
GWMA Outreach Materials		2					
Standardize Talking Points		1					
Billboards					1		
Research							
EPA Study	1	1					
USGS Research		1		1			
Heritage University Survey		1					
High Risk Well Assessment				1			
Nutrient Budget/NAA		2		2		4	
Deep Soil Testing		2	2	1			
BMP Study		1					
Data Collection/Modeling			1		2		
Groundwater Monitoring Plan			3	2	2	1	2
Solutions							
Alternative Strategies						10	4
Number of Meetings	7	12	8	5	6	14	4

Goals and Objectives for the GWMA

From Request for Identification Lower Yakima Valley Groundwater Management Area – June 2011

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. Progress towards identifying and reducing the sources of groundwater contamination will be evaluated by 2013 and shared with the public. Specific objectives are listed below.

DATA AND MONITORING

• Collect and incorporate existing nitrate and nitrogen data into a shared data management system or data sharing site to improve understanding of the sources and extent of contamination.

• Establish a monitoring program to identify sources of nitrate contamination and their relative importance.

• Establish and conduct long-term groundwater quality monitoring program and evaluate progress.

PROBLEM IDENTIFICATION

• Characterize the nature and extent of nitrate concentrations in Lower Yakima Valley groundwater.

• Identify and rank the sources of elevated nitrate in groundwater, with site-specific characteristics developed for "hot spots" as appropriate.

• Identify and describe activities contributing to groundwater contamination based on scientific data and evaluation. Scientific and other data will be shared among the partners to facilitate development of effective programs and strategies.

MEASURES TO REDUCE GROUNDWATER CONTAMINATION

• Develop effective and coordinated best management practices (BMPs) to address specific nitrate sources.

• Develop strategies for implementing best management practices such as technical assistance, education, ordinances and coordination with other regulatory and nonregulatory programs.

• Support enforcement of new and existing laws and ordinances.

EDUCATION

• Establish educational programs to promote the protection of groundwater quality and provide a forum for stakeholders to discuss nitrate reduction methods and improvement of groundwater quality. This will include culturally-appropriate education and outreach.

• Establish a clearinghouse for pertinent public health, environmental, and business information.

• Educate private well owners on water quality testing methods, frequencies, interpretation of results, and funding sources.

DRINKING WATER SYSTEMS

• Provide water quality and hydrogeologic data to assess needs and methods of expanding public water supplies, and provide a forum for initiation of these plans.

• Consider options to encourage appropriate expansion of public water supplies to areas that are currently dealing with contaminated private supplies.

• Assist residents whose supplies have been contaminated to access safe and reliable water supplies, using culturally-appropriate communications.

GENERAL

• Pollution prevention will be a guiding principle for all work done by the GWMA.

• Participation by the Yakama Nation will be requested and encouraged in a way that is consistent with their sovereignty.

• Participating agencies will maintain their regulatory authority using their own discretion as appropriate. They will also seek opportunities to coordinate actions and address regulatory gaps.

• The GWMA will seek sustainable funding sources to carry out its mission

Summary of Nitrate Water Studies in the Lower Yakima Valley

Yakama Reservation – Surface and Groundwater

Fretwell, M.O. & Yakama Tribal Council (1974) *Quality of Surface Water and Ground Waters, Yakama Indian Reservation.* United States Geological Survey, Report 77-128.

Nitrate concentrations >10 mg/l were observed in the Ellensburg formation of Ahtanum Creek; the Alluvium of the Toppenish Creek Basin. However, the conc. did not exceed 20 mg/l. High conc. were found in Satus Creek (Alluvium 170 mg/l) and 67 mg/l in the Ellensburg formation.

Agricultural Chemicals Study

Erickson, D., & Norton, D. E. (1990). *Washington State Agricultural Chemicals Pilot Study*. Washington State Department of Ecology, Environmental Investigations and Laboratory Services Program, Toxics Investigations/Ground Water Monitoring Section. Available at https://fortress.wa.gov/ecy/publications/documents/9046.pdf

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.

The Hornby Lagoon Study

Erickson, D. (1992). *Ground Water Quality Assessment, Hornby Dairy Lagoon, Sunnyside, Washington*. Washington State Department of Ecology, Environmental Investigations and Laboratory Services Program, Toxics, Compliance, and Ground Water Investigations Section. Available at http://yakimaco.us/GWMA/documents/library/92e23.pdf

Chloride concentrations in all wells downgradient of the main lagoon increased after the second and third quarters of monitoring (between four and ten months after the main lagoon received wastewater) probably due to leakage from the lagoon.

Yakama Reservation – Toppenish Creek

Payne, K. L., & Sumioka, S. S. (1994). *Selected water-quality data for the Toppenish Creek Basin, Yakima Indian Reservation, Washington, 1989* (No. 93-486). US Geological Survey; USGS Earth Science Information Center, Open-File Reports Section. Available at https://pubs.usgs.gov/of/1993/0486/report.pdf

> *Nitrite + nitrate nitrogen conc. Ranged from <0.1 mg/L to 9.3 mg/L in GW; and from <0.1 mg/L to 6.0 mg/L in SW samples.*

VIRE Study

Sell, R., & Knutson, L. (2002). *Quality of ground water in private wells in the Lower Yakima Valley, 2001-02*. Valley Institute for Research and Education. Available at https://fortress.wa.gov/ecy/publications/documents/0210074.pdf

> *A statistical analysis of the results of the chemical tests showed that the quality of groundwater was significantly better ($p<0.05$) in the northern portion of the study area (Region 1) than in the southern portion (Region 2). The communities of Buena, Parker, Toppenish, Wapato and Zillah are located in Region 1 and the communities of Granger, Grandview, Outlook, Mabton and Sunnyside are located in Region 2. None of the wells sampled in Region 1 exceeded the U.S. Environmental Protection Agency's maximum contaminant level (MCL) for nitrate+nitrite of 10 milligrams per liter whereas 21% of the wells in Region 2 exceeded this standard. Mean values for ammonia, chloride and specific conductivity were also significantly higher in Region 2*

EPA Study on the "Dairy Cluster"

Environmental Protection Agency (2016) Yakima Valley Dairies Consent Order. Available at https://www.epa.gov/wa/lower-yakima-valley-groundwater

> *Since the fall of 2013, the dairies have been collecting groundwater data each quarter from a network of 26 groundwater monitoring wells. The purpose of the monitoring well network is to assess the effect of nitrate source control actions taken by the dairies on nitrate concentrations in the groundwater.*

In the third quarter of 2013, the first quarter that the dairies conducted groundwater sampling, nitrate concentrations in seven of the downgradient wells were less than the MCL of 10 ppm; nitrate concentrations in 15 of the wells exceeded the MCL. The nitrate concentrations in the wells that exceeded the MCL ranged from 12 ppm to 166 ppm.

(EPA, 2014)

Two years later, in the third quarter of 2015, nitrate concentrations in seven of the downgradient monitoring wells were less than the MCL; nitrate concentrations in 14 of the wells exceeded the MCL; no sample could be taken from one groundwater monitoring well. The nitrate concentrations in the downgradient wells that exceeded the MCL ranged from 14 ppm to 180 ppm.

(EPA 2016)

Methemoglobinemia and Nitrates in South Central WA

VanDerslice, J. (2009). Final Report: Dose-Response of Nitrate and Other Methemoglobin Inducers on Methemoglobin Levels of Infants. National Center for Environmental Research WA State Department of Health. Olympia, WA. Retrieved from http://cfpub.epa.gov/ncer_abstracts/index.cfm/fuseaction/display.abstractDetail/abstract/5379/report/F

The results of this study provide evidence that exposure to nitrate from drinking water significantly and substantially increases the risk of an infant having physiologically elevated levels of methemoglobin. Furthermore, this risk is associated with intake levels above 0.5 mg NO3-N/kg day, approximately one-third of the RfD value.

CARE and Center for Food Safety (CFS) versus Cow Palace

All the important court documents from this landmark case are available at http://charlietebbutt.com/cases.html

In conclusion, this Court finds no genuine issue of material fact that Defendants' application, storage, and management of manure at Cow Palace Dairy violated RCRA's

substantial and imminent endangerment and open dumping provisions and that all Defendants are responsible parties under RCRA.

USGS Particle Tracking in LYV Groundwater

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. Available at https://pubs.er.usgs.gov/publication/sir20155149

The U.S. Geological Survey (USGS) recently completed a regional scale transient three-dimensional groundwater-flow model of the Yakima River Basin using MODFLOW-2000. . . . Of the 2,403 particles, the simulated path lines for 2,080 reached the water table within the 42-year simulation period, thus identifying the predicted recharge areas for those particles. The median horizontal straight-line distance was 13,194 feet between starting and ending locations for these particles and the median time-of-travel for particles that intersected the water table was 984 days. Well to water-table travel times for 75.4 percent of the particles were less than the average travel time of 3,749 days. Predicted recharge locations for all particles, including those that did not reach the water table in 42 years, were between 50 feet and 34 miles horizontal distance from their starting locations, with a median distance of less than 3 miles away.

GWMA Research

Heritage University Survey:

In 2013 the GWMA contracted with Heritage University to survey the people of the GWMA target area in order to learn how well this population understands problems associated with nitrates in groundwater and the GWMA process.

Results:

1. 69% of households were aware of potential health risks related to drinking water with high levels of nitrate
2. Slightly over half of those surveyed had their well water tested
3. 4% believed that someone in their home had become ill from drinking their well water
4. 42% had heard of the GWMA
5. 33% were interested in participating in a more in-depth well assessment survey
6. There was a high correlation between being aware of nitrate issues and having well water tested for nitrates.
7. There was a statistical difference between home owners and renters regarding awareness of nitrate issues with drinking water. Renters are not as well informed as home owners.
8. 71% of renters were comfortable asking landlords to test well water and 29% were not.
9. There was a statistical difference between home owners and renters regarding awareness of the Lower Yakima Valley Ground Water Management Area. Renters are not as well informed as home owners.
10. 43% of those with Spanish surnames purchase bottled water compared to 15% of those with non-Spanish surnames. There was no statistical difference in risks for those with Spanish surnames and those without.

(See Third Quarterly Report, 2013 and Attachment 20)

Survey of Health Care Providers:

In 2013 the GWMA contracted with the Yakima Health District to survey 600 health care providers in Yakima County regarding their understanding of nitrates in drinking water and associated health risks.

Results: No surveys were returned

PgG Summary of Water Studies in the GWMA Target Area

In 2013, on behalf of the GWMA, the Pacific Groundwater Group accessed all known well testing in the GWMA target area and summarized the results. PgG created a data base with 7,790 locations for public and private wells. PgG found sampling results for 2,532 of the wells since 1978 and calculated a mean nitrate level of 5.8 and a median level of 4.7 for all tests.

On page 7 this report summarized the results of all known well testing in the Lower Yakima Valley between 1975 and 2014. It appears that nitrate levels are increasing. The Pacific Groundwater Group notes that the high numbers from 2010 may be due to an increase in testing of shallower wells.

Table 3. Nitrate Levels in GWMA Target Area by Year: 1975-2014

Date Range of Well Samples	Number of Wells (n)	Mean Nitrate[1]	Median Nitrate[1]	Standard Deviation[1]
1975 to 1979	4	1.45	1.10	1.66
1980 to 1984	51	3.48	1.70	4.10
1985 to 1989	40	3.33	1.80	3.63
1990 to 1994	76	3.52	2.60	3.89
1995 to 1999	69	4.06	3.90	3.29
2000 to 2004	295	6.36	4.00	8.56
2005 to 2009	90	4.74	4.44	3.60
2010 to 2014	323	13.51	11.50	11.17

[1] nitrate mg/L

PgG looked at trends by year and by well depth and then looked at trends for 46 wells that had more than 10 samples. Because many of these are public wells they tend to be deeper wells. Using the Mann-Kendall trend test the study found 7 wells with increasing nitrate levels and 9 with decreasing nitrate levels. All seven worsening wells are in the VIRE

Region II. (Note: FOTC disagrees with the selection of the Mann-Kendall test and believes that the Seasonal Mann-Kendall test is more appropriate).

See Pacific Groundwater Group (2013) *Potential groundwater monitoring stations Yakima groundwater management area.* LYV GWMA Fourth Quarterly Report 2013, page 200. Available at http://www.yakimacounty.us/DocumentCenter/Home/View/8454

Deep Soil Sampling: Between the fall of 2014 and the spring of 2016 the South Yakima Conservation District (SYCD) and Landau Associates conducted Deep Soil Sampling on 175 properties in order to evaluate the extent of nitrate leaching up to 6 ft below the land surface. The survey gathered data about cropping patterns, fertilization history and irrigation practices.

Table 4. Results: Averages for Spring and Fall Soil Sampling, LYV GWMA, 2014 - 2016

Seasonal Averages	1 Ft #N/Acre	2 Ft #N/Acre	3 Ft #N/Acre	4 Ft #N/Acre	5 Ft #N/Acre	6 Ft #N/Acre	Total #N/Acre	Ammonia #N/Acre	Organic Matter
Fall (N = 93)	135.33	89.55	107.95	78.75	101.52	87.26	531.78	22.7	2.01%
Spring (N = 82)	68.39	104.7	114.94	95.57	96	64.92	448.41	23.8	2.13%

1. According to Ecology's Adaptive Management Plan (page 23) in the 2017 National Pollutant Discharge General Permit for Concentrated Animal Feeding operations risks for nitrate leaching are:
    a. Low risk = 15 parts per million or 55 lbs/acre at the 2 foot level
    b. Medium risk = 15 – 30 ppm or 55 to 110 lbs/acre at the 2 foot level
    c. High risk = 30 – 45 ppm or 110 to 165 lbs/acre at the 2 foot level
    d. Very high risk = > 45 ppm or 165 lbs/acre at the 2 foot level
2. There is significant leaching of nitrate below the root zone on cropland in the GWMA target area
3. There are differences between spring and fall deep soil testing results

4. There was unequal coverage of the various combinations of irrigation practices, crop types and leaching factors.
5. Sixty five of 175 samples or 37% fell into the category of sprinkler irrigation, 2.5 ft to 4 ft crops and moderately high to high Ksat
6. There were fields with extreme values that would ideally be re-tested.
7. The range of values for alfalfa is huge and suggests a need for further study
8. The range of values for hops is large and suggests a need for further study
9. Over half of the fields planted in triticale are at medium to high risk for leaching nitrate to the groundwater
10. Double cropping is associated with higher nitrate levels
11. In this data set rill irrigation is more protective of the groundwater than sprinkler
12. Application of liquid manure is significantly more likely to result in high nitrate levels than application of solid manures or commercial fertilizers.

(See Attachments 16, Attachment 17, Attachment 18 & Attachment 24)

High Risk Well Sampling: Between 2013 and 2016 the Yakima Health District tested 460 domestic wells in the GWMA target area in order to better understand the prevalence of nitrate contamination of the aquifer.

Table 5. Results of High Risk Well Testing

Nitrate Ranges	Count: Phase I + Phase II	Percent
0 to 5.0 mg/L	100 + 172 = 272	59%
5.01 to 9.99 mg/L	44 + 76 = 120	26%
10.0 to 35.0 mg/L	28 + 40 = 68	15%
Total	172 + 288 = 460	100%

(See Third Quarterly Report 2013, page 128 & First Quarterly Report 2016, page 139)

A survey of well heads and site conditions should have accompanied the water testing. FOTC submitted a public records request for that data in 2018. There were no completed surveys.

Nitrate Levels in Lagoon Effluent: In 2010 the EPA tested lagoon effluent for nitrogen content as part of research on the dairy cluster. At a later date the SYCD calculated nitrogen concentrations for this source based on owner testing from about 20 LYV dairies.

Results: Nitrogen concentrations in Yakima Valley lagoon effluent were higher than concentrations published for dairies in the UC Davis report (Viers et al, 2011).

Table 6. Comparison of Lagoon Nitrogen Concentrations

	EPA	SYCD	Combined
Sample Size	15	23	38
Minimum mg/L	290	180	180
Q1 mg/L	1000	355	455
Median mg/L	1400	768	1028
Mean mg/L	1212	949	1054
Mode mg/L	1200	336	1200
Q3 mg/L	1600	1092	1401
Maximum mg/L	1800	3633	3632
Standard Deviation	492	802	702

(See Attachment 32, *Estimated Nitrogen Available for Transport in the Lower Yakima Valley Groundwater Management Area,* Appendix B, page 85)

Nitrates below Pens, Corrals and Compost Yards: In 2015 a local team performed deep soil testing beneath pens, corrals and compost yards on several LYV operations. Although the methods lacked QA/QC protocols the results are helpful. (mg/kg = parts per million)

Table 7. Results of DSS in Pens & Corrals

Depth in pen (ft)	0	1	2	3	4	5	6
Minimum (mg/kg NO_3-N)	22.6	21.8	10.6	8.3	6.1	6.5	3.8
Maximum (mg/kg NO_3-N)	962.6	409.7	199.2	186.5	109.6	93.4	124.7
Average (mg/kg NO_3-N)	273.3	165.9	98.5	71.2	45.7	36.7	36.4
Median (mg/kg NO_3-N)	118.6	153.8	89.9	63.6	38	29.6	17.1
Standard Deviation (mg/kg NO_3-N)	308.6	115.3	54.5	45.9	31.1	26.4	36.8

(See Attachment 32, *Estimated Nitrogen Available for Transport in the Lower Yakima Valley Groundwater Management Area,* page 18; Attachment 13, Attachment 14, & Attachment 15)

Table 8. Results of DSS in Compost Yards

Site	Surface	1 Ft	2 Ft	3 Ft	4 Ft	5 Ft	6 Ft
1C1	364.0	116.3	95.6	82.6	31.1	15.4	15.6
1C2	292.7	49.8	24.5	28.6	27.1	21.0	19.8
5C1	159.0	118.8	133.8	225.0	153.9	116.7	28.0
2Cl	139.0	1.3	6.3	1.0	3.2	1.9	8.5
2Cu	649.4	30.0	2.2	36.9	150.0	175.1	151.5
4C1	48.3	164.5	226.1	216.9	222.5	132.1	59.1
6C	123.2	73.5	34.7	24.7	17.7	9.1	
Ave (ppm)	253.7	79.2	74.7	88.0	86.5	67.3	47.1
Range	48.3-649.4	1.3-164.5	2.2-226.1	1-216.9	3.2-222.5	1.9-175.1	8.5-151.5

(See Attachment 32, *Estimated Nitrogen Available for Transport in the Lower Yakima Valley Groundwater Management Area,* page 18; Attachment 13, Attachment 14, & Attachment 15)

Nitrate Loading Assessment/Nitrogen Availability Assessment: In 2015 the GWMA approved research to compile a Nitrogen Loading Assessment for the GWMA target area. The final product, delivered in 2018, was a Nitrogen Availability Assessment. (Note: The Friends of Toppenish Creek and others question the validity of some conclusions from that study. The NAA has not been approved by the GWAC)

These are the estimated contributions from major nitrate sources at the medium range according to the NAA.

1. Irrigated Agriculture – 64%
2. Lagoons – 19%
3. Pens – 12%
4. All Septic Systems – 2%
5. Atmospheric Deposition – 2%
6. Residential Fertilizer – 1%
7. Small Farms – 0%

(See Attachment 32, *Estimated Nitrogen Available for Transport in the Lower Yakima Valley Groundwater Management Area,* page 72 & Attachment 27)

These are the estimated contributions from major nitrate sources at the medium range according to an FOTC refinement of the data. (See Attachment 61)

1. Irrigated Agriculture: 61%
2. Lagoons: 17%
3. Pens: 11%
4. Atmospheric Deposition: 4%
5. Compost 3%
6. Septics: 2%
7. Bio-solids: 1%

2017 Sampling of Wells and Drains: In 2017 the United States Geological Survey (USGS) sampled 156 domestic wells and 24 drains for the LYV GWMA. According to Huffman, (2018)

> *The average nitrate concentration for groundwater samples was 6.1 mg/L as nitrogen. Concentrations of nitrate averaged 5.5 mg/L in drain site samples. The 10 mg/L maximum contaminant level (MCL) established by the EPA for drinking water was exceeded by 20 percent of samples from wells*

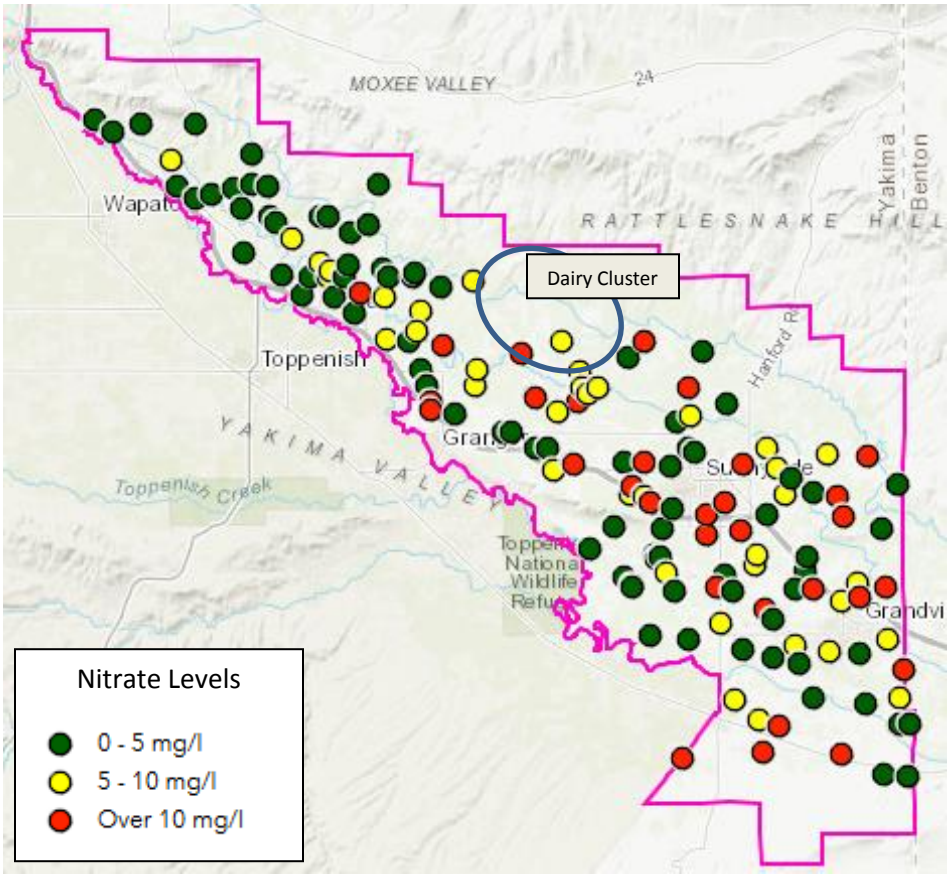
Here is a summary of FOTC analysis of the data gathered by USGS

1. Average nitrate levels for five well groupings are:
    A. North of Wapato – 0.50 mg/L
    B. Wapato to Granger – 4.00 mg/L
    C. Granger to Sunnyside – 8.62 mg/L
    D. Sunnyside to Mabton – 5.11 mg/L
    E. South of Mabton – 6.45 mg/L
2. Wells near the Yakima River had lower nitrate levels than those farther from the river
3. Wells in the area studied by the WA Agricultural Chemicals Pilot Project continue to have low nitrate levels

4. There was no overall correlation between well depth and nitrate levels
5. Drains in the northwestern study area had low nitrate levels
6. The highest drain nitrate levels were found in the area between Sunnyside and Mabton
7. Average nitrate levels in drains ranged from 0.01 mg/L to 13.07 mg/L

(See Attachment 28)

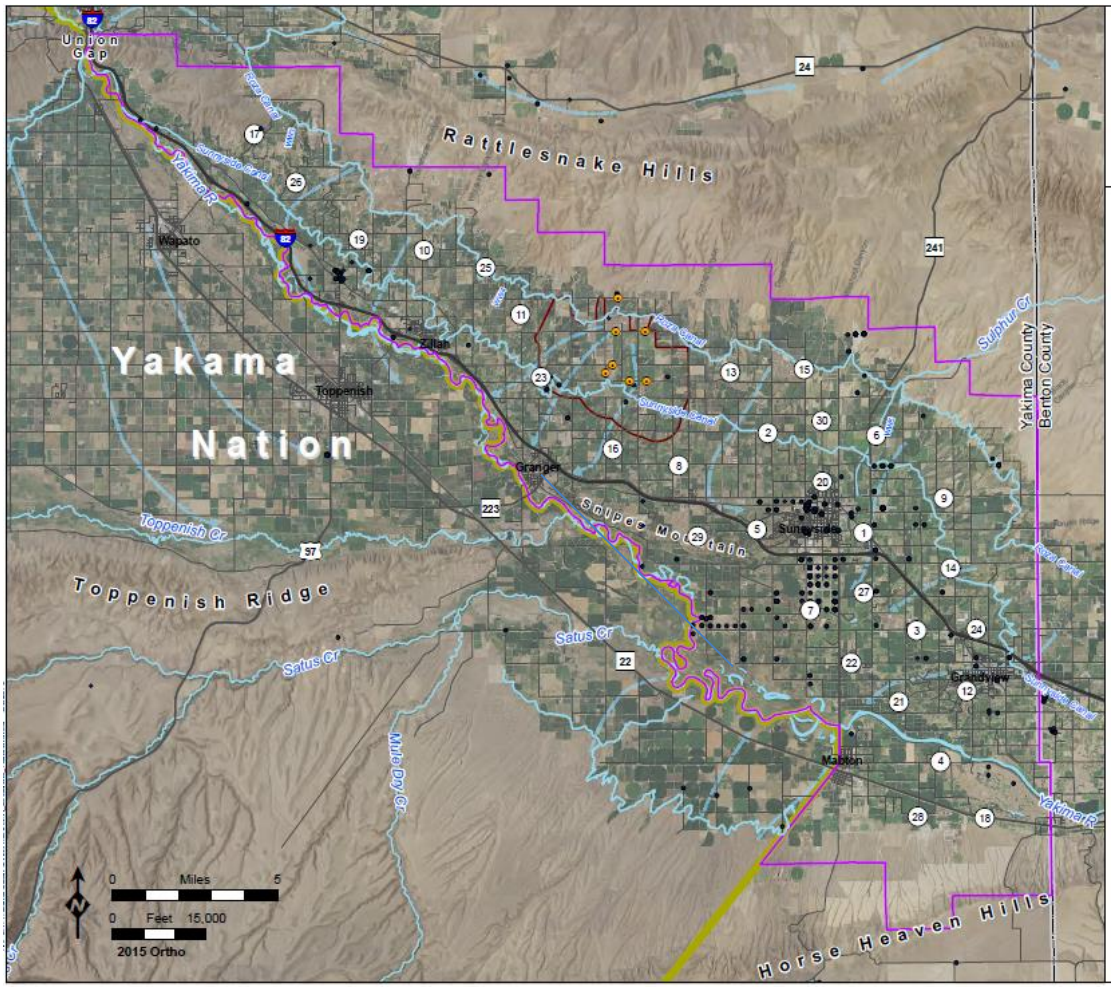
Map 7. Results of the 2017 USGS Domestic Well Testing



Source: Yakima County GIS mapping for the GWMA at http://arcg.is/1ie9mP

Planning a Network of Monitoring Wells: Since 2013 the GWAC has studied plans for a network of purpose built monitoring wells. The GWAC has approved a network of 30 purpose-built monitoring wells that capture "first waters" to be evenly spaced across the GWMA target area. See the map below for proposed well locations.

Map 8. Proposed Network of Purpose Built Wells - 2016



Pacific Groundwater Monitoring Group (2016) Ambient Monitoring Network Report in Fourth Quarterly GWMA Report 2016. Available at http://www.yakimacounty.us/DocumentCenter/Home/View/13094

Both the GWAC and the Data Work Group spent much time on this study. The original approved 2013 plan (Pacific Groundwater Group, 2013g) listed these monitoring objectives:

1. *Fill spatial data gaps*
2. *Monitor hot spots*
3. *Track increasing concentration trends*
4. *Measure basin-wide average concentration*
5. *Monitor common water supply aquifers*
6. *Measure effects of current and future practices*
7. *Address health risks*

At their October 12, 2016 meeting the Data Work Group was told that not all objectives could be met with existing funds. The work group narrowed down the list to "basin wide average concentrations" and "hot spots". The largest known hot spot is the dairy cluster.

The most recent proposed network addresses only one of these objectives - to measure basin wide average concentrations. As of October 2018 there were no monitoring wells and no plan for analysis. There are no proposed monitoring wells on the dairy cluster.

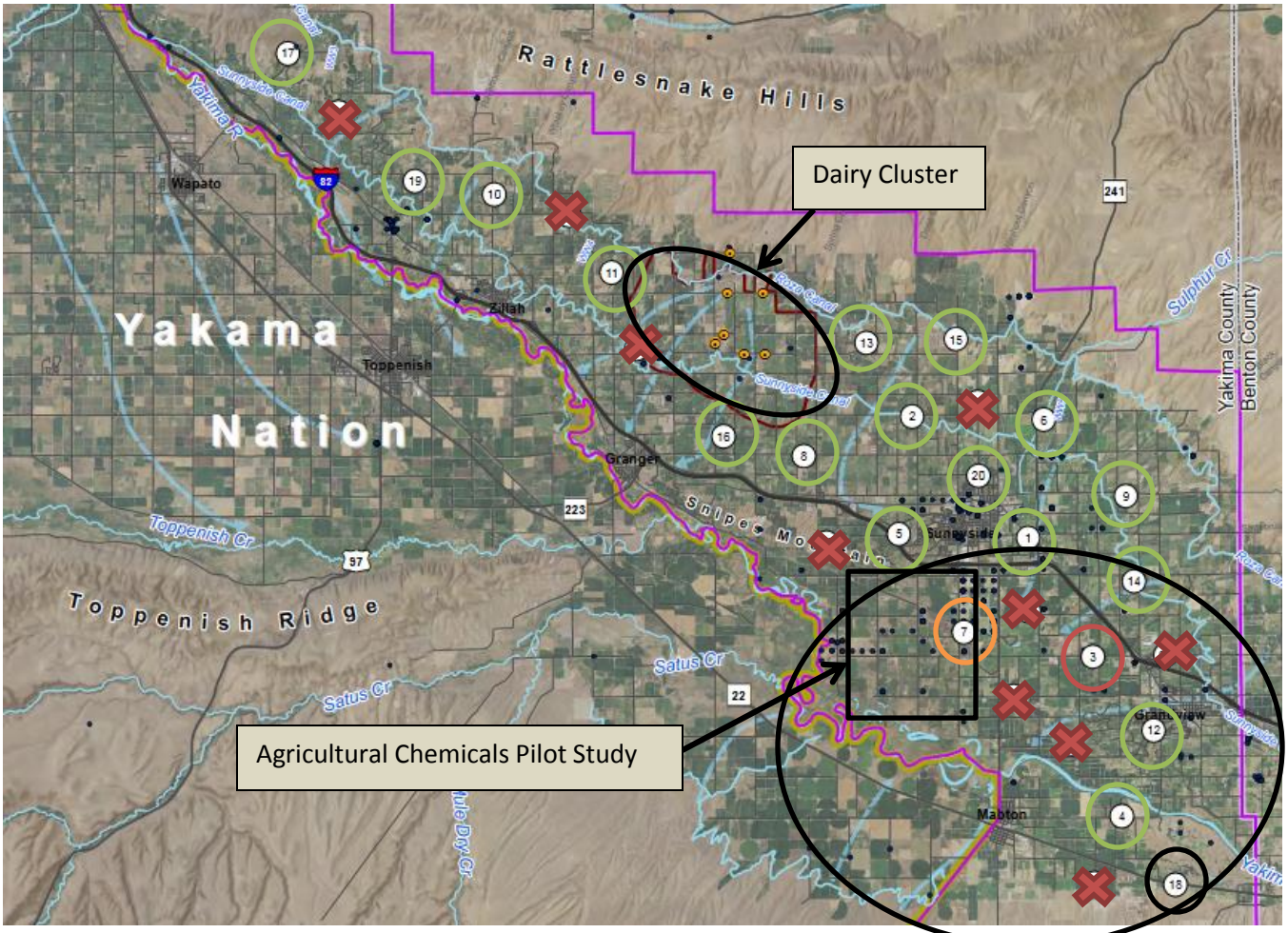
Recent contracts and requests for bidding indicate that the network will contain < 20 wells. (First Quarterly Report, 2018; Yakima County, 2018e) This is insufficient to adequately monitor water quality in the 273 square mile GWMA target area. For comparison, Ecology utilized a network of 28 monitoring wells in the 150 square mile Sumas Blaine aquifer. (Carey, 2017; Redding, 2011)

The only criteria for site selection in the planned GWMA network is equidistance on a two dimensional map. (LYV GWMA, 2014 ff) There was no selection based on elevation, geology, soil types, depth to groundwater, proximity to the river, hydrologic class, drainage class, proximity to cities, or proximity to various sources of pollution.

To illustrate the difficulties when there are too few wells, consider the 100 square mile southern section of the GWMA target area. In the original plan there would have been 11 monitoring wells. The reduction in number leaves 6 monitoring wells for an area that is not homogeneous. 1 site is somewhat well drained, 3 sites are well drained, 1 site is excessively well drained, 1 site is somewhat well drained/well drained. Only one site (#7) lies near the

area where the Agricultural Chemicals Pilot Study was performed. FOTC has repeatedly requested re-testing in this area.

Map 9. Soil Drainage Categories for Purpose Built Wells



GWMA Education and Outreach

Goals: The Education and Public Outreach Work Group began early in the GWMA process with an ambitious plan for engaging stakeholders and the community.

EPO Goals and Objectives

The GWMA Education and Public Outreach Plan will inform and educate the public about nitrate groundwater contamination and its health and environmental impacts, promote GWMA activities, and encourage engagement in the process by the community and key stakeholders.

Overarching Objectives

The overarching objectives developed to carry out the plan goals include:

1. Educating at-risk audiences about the risks of elevated nitrate to human health and how to protect themselves from that risk;

2. Informing audiences about the GWAC planning process; and

3. Inviting participation in the development of the GWMA program

(See Fourth Quarterly GWMA Report, 2012, page 113)

Actions: In 2017 the EPO group presented a list of the work group accomplishments, paraphrased here:

2013

1. Created a logo for the GWMA
2. Public Awareness Survey conducted by students from Heritage University – 136 completed surveys
3. Sent nitrate information to healthcare providers
4. Presentation to the Central Washington Family Residency program
5. Presentation on Spanish language radio, "Connect with your Government"
6. Presentation to the Community Advisory Board for El Proyecto Bienestar
7. Launched website

2014

1. News Release about GWMA accomplishments
2. Launched Phase I of the High Risk Well Assessments
3. Partners with the University of Washington/EPA Pediatric Environmental Health Services Unit to create a "New Moms" campaign that provides information to local maternity units
4. Created a Power Point with standardized information for presentations about the GWMA (English only)
5. Created a two year budget for EPO:
    a. Abandoned Wells and Septic System Maintenance $76,000
    b. Educational Outreach Campaigns $54,000
    c. Wellhead Risk Assessment Surveys-Phase 2 $100,000
    d. Redesign and Maintain GWMA Website $12,000
    e. Community Outreach Surveys $25,000

    (A request to hire a community outreach worker was rejected by the GWAC)
6. Released results of High Risk Well Assessments
7. Distributed 2,000 "New Mom" Flyers

2015

1. Rebuilt GWMA web site
2. Launched Phase II of the High Risk Well Assessments

2016

1. January and March Press Releases re High Risk Well Assessments
2. Completion of Phase II High Risk Well Assessments
3. Bi-lingual presentations to Sunnyside Work Force Clients
4. Talk Show participation on English and Spanish radio shows
5. Paid advertisements on English and Spanish radio
6. Editorial by Chairman Rand Elliott in English and Spanish newspapers
7. EPO participates in five Health Fairs – bilingual. Distributed nitrate test strips

8. First bilingual “Test Your Well” Billboard goes live

2017

1. Second bilingual billboard
2. “What You Can Do To Protect Your Well Water” campaign
    a. 12,000 flyers in Sunnyside Daily Sun News
    b. 10,700 flyers in El Sol
    c. March KIT radio interview with Commissioner Rand Elliott
    d. April KDNA radio presentation with Andres Cervantes and Ignacio Marquez

Early in the GWMA process the EPO developed a list of evaluation tools to determine success of the work

1. Number of new participating agencies
2. Number of face to face meetings
3. Number of Fact Sheets developed
4. Number of Talking Points/Presentations developed
5. Number of outreach recommendations received and implemented
6. Amount/character of audience feedback
7. Number of e-mail contacts received
8. Number of updates sent via e-mail
9. Number and character of comments, suggestions and praise
10. Number of agency/organization requests to be involved in GWMA
11. Structured interviews with key stakeholders to measure understanding of issues, involvement with GWMA

This evaluation has not been done.

Deficiencies: Efforts to inform the public about the risks of nitrates in well water have been thorough and ongoing. Efforts to tell people about the causes of groundwater contamination and proposed actions to remediate the problem were minimal.

There is no doubt that dairies are one leading cause of the pollution. Because other potential sources are not well characterized the industry successfully argued that dairy should not be the only target. Because EPO was cautioned not to talk about dairies information has been deliberately vague. This is not conducive to problem solving.

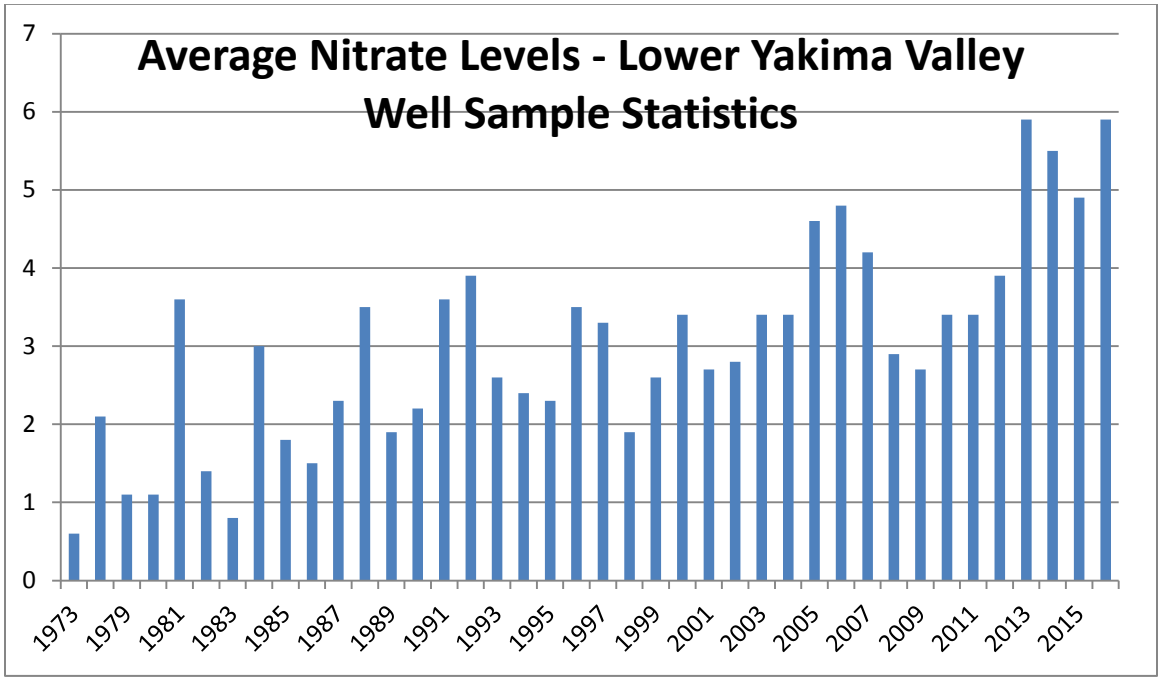
Two women of color from Radio KDNA volunteered to serve on the EPO work group. They spent a great deal of time working with a professor from the University Of Washington School Of Public Health on a project that would bring ten graduate students to the valley to assist the GWMA with public outreach. A dairywoman on the GWAC organized resistance to the plan and defeated the project. Why? She did not like the text book for the class, *Fresh Fruit, Broken Bodies,* which chronicled the experience of a physician and anthropologist who traveled with a group of Oaxacan farmworkers on their journeys from California to Washington.

There is a huge knowledge gap in the community. Many of the terms used in GWMA discussions are acronyms based on technical or legal language. It will be difficult for the community to evaluate the GWMA plan without some preliminary education. FOTC has asked the GWMA to develop a campaign to teach people the meaning of terms such as agronomic rates, vadose zone, and groundwater flow. In 2017 FOTC put together some short suggested bilingual flyers to help with this effort. The suggestion never made it to the EPO work group agenda.

Problem Definition – Nitrate Contamination of Groundwater in the LYV

Studies of nitrates in LYV groundwater over the past decades demonstrate an increase in the percentage of nitrate contaminated wells and levels of contamination. Studies vary in size and design so they cannot be directly compared with any accuracy. However, Yakima County has provided a summary of well sampling since 1973 from the GWMA Data Base. This is one way to look at the LYV groundwater nitrate trends.

Chart 1. Average Nitrate Levels in the Lower Yakima Valley - 1973 to 2015



From Appendix N: Lower Yakima Valley Groundwater Program, August, 2018

(Since the readings are missing from the data base this graph does not include 2014 – 2016 well testing from a "dairy cluster" where 61% of domestic wells one mile down gradient had nitrate levels above the safety standard of 10 mg/L. and the highest reading was 234 mg/L.)

Local Impact: Nitrate in Municipal Wells

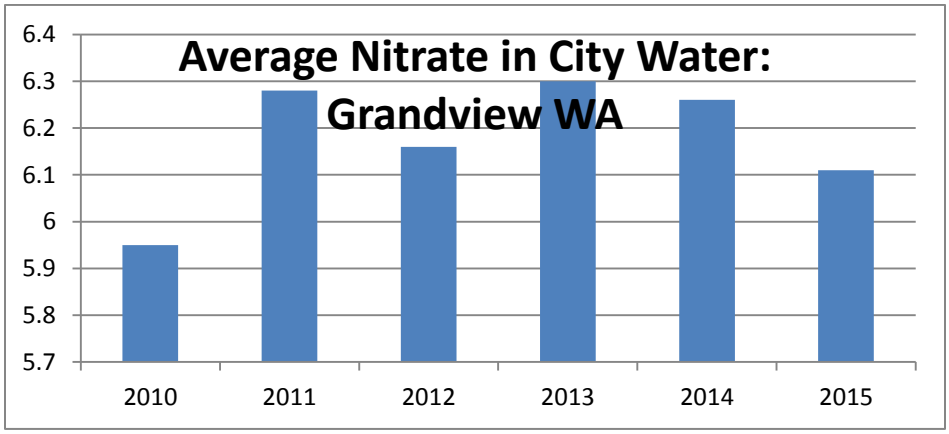
1. ***Rural home owners:*** If all impacted homeowners with contaminated wells purchase bottled water at a cost of $1.20 per gallon per day per person the total is over $1 to $1.75 million per year. (Approximately 20,000 people live outside the cities and towns and 12% to 20% of wells are contaminated or at risk). (Attachment 26 & Attachment 67)

2. ***In 2008 the Outlook Elementary School*** spent $48,000 to drill one new well and then another in order to provide nitrate free drinking water for the students. (Attachment 36)

3. ***In 2013 the City of Mabton*** began drilling a new well at a projected cost of $1,850,000. Two of the city's old wells were no longer producing at high enough pressures due to age and a falling aquifer. A third well had very high nitrate levels and the water from that well had to be blended with water from others in order to meet safety standards for human use. (Attachment 57 & Attachment 64)

4. ***The City of Grandview*** has deep municipal wells. Their wells tap the basalt aquifer. (Grandview, 2016) Water from a nitrate contaminated well is blended with water from the others in order to achieve safe nitrate concentrations. The average nitrate level in samples taken from Grandview municipal wells has been around 6 ppm since at least 2010. (WA State Dept. of Health, 2018b; Environmental Working Group, 2018)

Chart 2. Average Nitrate Levels in Grandview City Water



From the Environmental Work Group Tap Water Data Base at https://www.ewg.org/tapwater/system-contaminant.php?pws=WA5328970&contamcode=1040#.W2W4msIh2M8

5. ***In 2010-2011 Yakima County*** provided water treatment systems for 161 LYV households in a Nitrate Treatment Pilot Program. The WA State Dept of Health provided $395,200 in funding. The county spent $264,085 and returned the remainder. (Yakima County, 2011c)

6*.* ***In November 2014*** the WA State Dept. of Health offered Yakima County $148,000 to deliver water treatment for LYV residents. Yakima County declined the opportunity.

7**.** ***Since 2014 dairies under a consent order with the EPA*** have provided reverse osmosis to homes with elevated nitrates one mile down gradient from their operations. (EPA, 2014)

8**.** ***Since 2015 dairies under a consent decree from the Ninth Circuit Court*** have provided reverse osmosis to homes with elevated nitrates three miles down gradient from their operations. (See CARE and CFS versus Cow Palace, Tebbutt Law, 2015)

One Confirmed Source – Groundwater Pollution from Dairies:

More intense monitoring: The GWMA studies have not clearly determined the relative contribution from various sectors of the agricultural community. Because concentrated animal feeding operations face well-known challenges in managing manures there are regulations in place to protect the waters of the state from this potential source of pollution. (RCW 90.64 – Dairy Nutrient Management Act). There is monitoring in place that makes it easier to pinpoint leaching of nitrates from fields controlled by dairies. This source is significant.

Dairies in Washington State are required to have nutrient management plans (NMPs). There is no requirement for them to follow their plans but they are required to keep records. (WSDA DNMP, 2016 & 2017) One of the underpinnings of the dairy nutrient management program is twice annual soil sampling to determine 1. How much nitrogen is already available in the soil prior to application of fertilizers and manures, and 2. How much of the available nitrogen was taken up by plants during the growing season and how much remains with a potential for leaching to groundwater.

Agronomic Rates & Soil Testing: When manures and fertilizers are applied only in amounts needed by the crops they are applied at agronomic rates. This is a legal term that is used to distinguish acceptable agricultural practices from actions that pollute and violate state and federal rules and regulations.

Soil testing is often used to decide whether or not applications are agronomic. (WA State Dept of Ecology, 2017a & 2017b) However, Ecology also states:

> *In excessively drained soils with irrigation or high precipitation, soil nitrate testing is not likely to be informative, either as an indicator of overloading, or as an indicator of risk of groundwater contamination, due to the rapid removal of potential nitrate contamination from the root zone.* (Morgan, 2014)

Agronomic Rates in the Yakima Valley: In 2016 WSDA sent a report to the legislature entitled, *Implementation of Nutrient Management Training Program for Farmers.* (WSDA DNMP, 2016) The agency stated that dairies in Yakima County control over 28,000 acres of cropland. In 2014 there were problems with excess nutrients on 11.9% of those acres. In 2016 there were problems on 6.6% of those acres. Much, probably most, of this improvement can be attributed to the remediation work that was done by the "dairy cluster" in cooperation with the EPA. The 11.9% rate for Yakima County in 2014 was over three times worse than the state average and the 6.6% rate for 2016 was twice the state average. (WSDA DNMP 2016, p. 9)

EPA Consent Agreement: Since 2013 the EPA has been working with a cluster of Yakima dairies where 61% of down-gradient domestic wells have nitrate levels > 10 mg/L. EPA's 2016 report, *Yakima Valley Dairies Consent Order Update,* says:

> *The Consent Order states that the three dairies must maintain soil nitrate at the 2–foot (12' – 24") depth below 45 parts per million (PPM). This level was selected because at the time the Consent Order was signed, it was consistent with the level that was used by the State of Washington with regard to dairies in the context of their Nutrient Management Plans.*

> *In accordance with the Consent Order, the three dairies have sampled soil in their 34 application fields twice a year: post-harvest sampling is done at the 1-foot, 2-foot, and 3-foot depths in the fall, and pre-plant sampling is done at the 1-foot and 2-foot depths each spring. In fall 2013, 20 of the dairies' 34 application fields exceeded 45 ppm at the 2–foot depth. Two years later, in fall 2015, the number of fields exceeding 45 ppm at the 2-foot depth was reduced to nine.* (EPA, 2016, page 2)

Litigation: In 2015, in CARE and Center for Food Safety versus Cow Palace, Judge Thomas Rice from the 9th Circuit Court of Appeals found that dairies in the cluster had failed to follow their NMP's and that:

> *Defendants' application, storage, and management of manure at Cow Palace Dairy violated RCRA's substantial and imminent endangerment and open dumping provisions and that all Defendants are parties under RCRA.*
>
> (Tebbutt Law, 2015)

Testimony in that case revealed that the dairies:

1. Applied manures to cropland at greater than agronomic rates
2. Ignored weather conditions when applying manures and calculating application rates
3. Did not take post-harvest samples in the spring time when double cropping
4. Failed to take into account post-harvest nitrogen residuals when calculating application rates
5. Failed to calculate application rates based on realistic crop yields
6. Failed to take samples from applied manures and greatly underestimated the nitrogen content of applied manures
7. Over-estimated volatilization rates
8. Failed to keep records of irrigation practices
9. Set unreasonably high crop yield and removal goals
10. Allowed manure seals in lagoons to dry and crack
11. Failed to maintain compacted clay liners for lagoons

(Expert Testimony of Dr. Byron Shaw, Expert Testimony of David Erickson, at http://charlietebbutt.com/cases.html)

Relevant National and Worldwide Research:

The ability to produce nitrogen fertilizers on an industrial scale has transformed agriculture worldwide and made it possible to feed a world population that has grown from 1 billion in 1804 to 3 billion in 1960 to 6 billion in 1999. The current population is about 7.5 billion and that number is expected to reach 9 billion in 2054. (United Nations, 1999)

This major advance has changed the nitrogen cycle. Major consequences are:

1. *Approximately doubled the rate of nitrogen input into the terrestrial nitrogen cycle, with these rates still increasing;*
2. *Increased concentrations of the potent greenhouse gas N_2O globally, and increased concentrations of other oxides of nitrogen that drive the formation of photochemical smog over large regions of Earth;*
3. *Caused losses of soil nutrients, such as calcium and potassium, that are essential for the long-term maintenance of soil fertility;*
4. *Contributed substantially to the acidification of soils, streams, and lakes in several regions*
5. *Greatly increased the transfer of nitrogen through rivers to estuaries and coastal oceans.*
6. *Increased the quantity of organic carbon stored within terrestrial ecosystems;*
7. *Accelerated losses of biological diversity, especially losses of plants adapted to efficient use of nitrogen, and losses of the animals and microorganisms that depend on them; and*
8. *Caused changes in the composition and functioning of estuarine and nearshore ecosystems, and contributed to long-term declines in coastal marine fisheries.*

(Vitousek et al, 1997)

Sources of nitrogen emissions are combustion and burning of fossil fuels, agriculture and biological nitrogen fixation. Agriculture is the largest source and animal agriculture is the largest component within that category. Transformation of organic nitrogen from manures into ammonia and nitrate takes years and differs from the more rapid utilization of nitrogen from chemical fertilizers. (Reis et al, 2016; Sutton et al, 2011, EPA, 2011; Gruber & Galloway, 2008; Liu et al, 2010).

There are parts of the world with an excess of nitrogen and parts of the world such as sub-Saharan Africa with insufficient nitrogen. This situation provides an opportunity for developing countries and areas that have only been farmed in recent times to proactively manage the nitrogen balance. (Reis et al, 2016) The Yakima Valley has been intensively farmed for just over 100 years.

How much reactive nitrogen can the world handle in a sustainable manner? Stefan et al (2015) have estimated that we currently produce 2 ½ times the amount of reactive nitrogen that would allow us to continue to live as we are accustomed. International policy changes are recommended to avoid environmental crises that will force change upon us. (Sutton et al, 2011; Vitousek et al, 1997)

Animal agriculture is a major part of farming in the Yakima Valley and is enmeshed in the global economy (Ryan Dumas, 2018a; Ryan Dumas, 2018b). Policy changes across the globe will impact our local economies. FOTC believes that analysis of potential and likely environmental regulations, evolving markets and externalization of costs should be part of the GWMA analysis. (See Paulot & Jacob, 2014)

GWMA Conclusions:

In general the LYV GWMA advisory committee agrees that agriculture is the leading cause of nitrate pollution. The group agrees that the largest potential source is leaching of nitrate from cropland when fertilizers and manures are applied in amounts that exceed the needs of plants, or when unforeseen events inhibit plant uptake.

The GWAC agrees that other sources are manure lagoons, pens and corrals, composting yards, industrial waste management, application of bio-solids to cropland, atmospheric

deposition, commercial and residential septic systems, small and hobby farms and application of residential fertilizers. The GWAC has not officially ranked these sources. There is a big difference between potential nitrogen inputs and actual leaching to groundwater. For example, 100 tons of nitrogen on 500 acres is more likely to reach the groundwater than 100 tons of nitrogen on 5,000 acres.

The 2018 Nitrogen Availability Assessment, *Nitrogen Available for Transport, Yakima Valley GWMA,* provides estimates of the potential amounts of N from each source (page 72) and FOTC has refined those estimates as seen below (Attachment 30 & Attachment 61)

Table 9. Available Contribution to Nitrate Pollution by Source

Nitrogen Availability Assessment	**Friends of Toppenish Creek**
Irrigated Agriculture – 64%	Irrigated Agriculture - 61%
Lagoons – 19%	Lagoons - 17%
Pens – 12%	Pens - 11%
All Septic Systems – 2%	Atmospheric Deposition - 4%
Atmospheric Deposition – 2%	Compost - 3%
Residential Fertilizer – 1%	Septics - 2%
Small Scale Farms – 0%	Bio-solids - 1%

An appropriate plan to address nitrate leaching will allocate resources and target efforts to those sources that cause the most pollution. The NAA estimate is a reasonable starting point with a few qualifiers. FOTC believes:

1. Atmospheric deposition causes over 4% of the problem because this source applies nitrogen to all 175,000 acres of the GWMA target area and not just the 74,000 designated for atmospheric deposition in WSDA calculations.
2. Lagoons and ponds with synthetic liners do not pose the same risk to the groundwater as those with clay liners.

3. NAA estimated risk from residential fertilizer is inappropriately high because the authors assumed that all applied residential fertilizer is available for leaching. We disagree. The fact that lawns are green demonstrates plant uptake of fertilizers.
4. The NAA estimate of nitrogen available for transport attributed to some crops is inaccurate.
5. Loss of nitrogen in runoff to surface waters should be addressed.
   (Attachment 61)

The GWAC agrees that agricultural practices are the leading cause of nitrates in LYV groundwater. To date those practices are not well characterized except for dairy.

Human Behavior:

A next step in describing the problem requires answers to the question, "Why do people do what they do?" Possible answers include:

1. Ignorance – most people have historically been unaware of the problem

2. Peer pressure – people imitate the action of those around them

3. Economics – well fertilized fields produce larger crops. Fertilizer is expensive.

4. Lack of regulation - no laws prevent excessive application of fertilizers/manures

And this leads to several interrelated approaches for influencing decision-making:

1. Education and Outreach

2. Influence Public Opinion

3. Analyze the Market Place – profit and loss

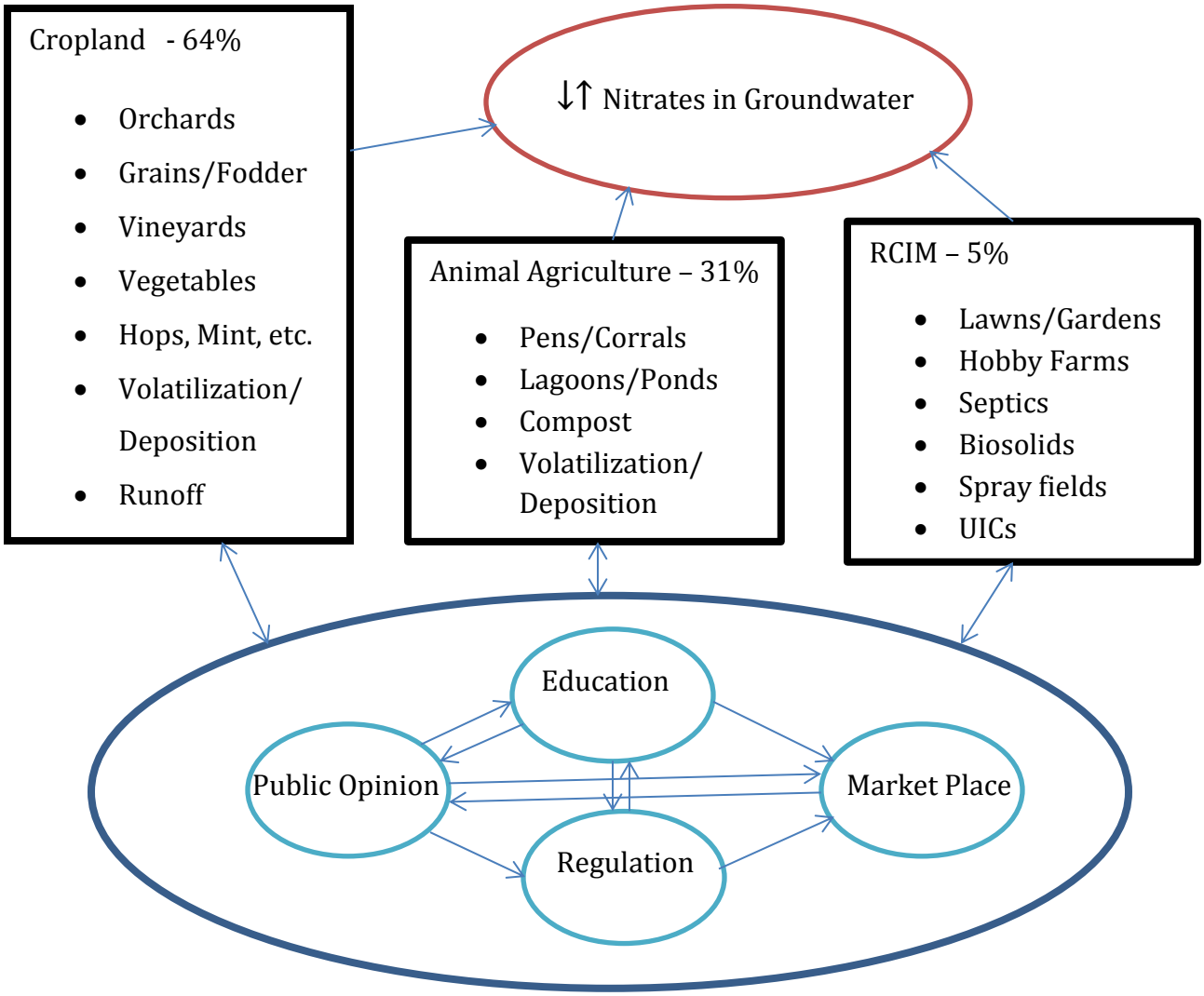
4. Implement appropriate regulation – incentives and penalties

(These hypotheses are based on discussions within the GWMA Irrigated Agriculture Work Group)

The conceptual framework below maps connections between human motivators, behaviors and the resulting impact on nitrates in groundwater.

Relationships between actions, sources of pollution, & nitrate levels in groundwater

Diagram 2.



Analysis of the Problem

Area Characterization

Here is an overview of the Lower Yakima Valley GWMA target area and Yakima County.

Hydrogeology from *Lower Yakima Valley GWMA Request for Identification (2011)*:

> *Lower Yakima Valley is the valley surrounding the Yakima River between Union Gap and Benton City. On the north it is bounded by the Rattlesnake Hills, and on the south it is bounded by the Horse Heaven Hills and Toppenish Ridge. Politically it is composed of unincorporated Yakima County, the Yakama Nation reservation, and the Cities of Benton City, Prosser, Grandview, Mabton, Sunnyside, Granger, Zillah, Toppenish and Wapato. Land and water use is dominated by agriculture on and off the reservation.*
>
> *Groundwater in the LYV originates as precipitation, infiltration from streams, and from irrigation and stock water that infiltrates into the ground from canals, fields and spray fields. Infiltration of septic tank effluent and stock water overflow also recycles water locally and results in groundwater recharge. Annual precipitation ranges from about 6 to 9 inches, while groundwater recharge is estimated to range from 7 to over 25 inches per year in irrigated areas and an inch or less in unirrigated areas (Vaccaro and Olsen, 2007,). With much of the land in the LYV used for irrigated agriculture, local recharge rates are significantly higher than precipitation due to the application and leakage of irrigation water.*
>
> *Recharge water may be contaminated by human activities. After recharge, the groundwater and possible contaminants move laterally and vertically toward wells, drainage ditches, and the Yakima River and its tributaries. The US Geological Survey has mapped shallow groundwater flow paths.*
>
> *If not intercepted by wells, shallow groundwater generally moves toward the Yakima River and its tributaries from the uplands on both sides of the valley. Where the river water level is lower than the adjacent groundwater elevation, groundwater will flow*

into the river from both sides. In these cases the river is a hydrologic boundary for shallow groundwater and shallow groundwater does not pass to the other side of the river. However, the boundary effect depends on the relative elevations of the river and groundwater; therefore, changes in recharge, pumping, river level changes, and the basin-and-ridge geology of the valley affect the boundary relationship. USGS research suggests that in some river reaches in some seasons, the groundwater level is lower than the river and the river therefore loses flow to the ground. In those cases the river may not be a regional hydrologic boundary (groundwater may move laterally below the river). Finally, deeper aquifers are less influenced by the river than are shallow aquifers.

Drinking water supplies in LYV are met primarily by wells that pump groundwater. Individual domestic wells tap permeable portions of a surficial sedimentary aquifer, while most municipal wells tap deeper aquifers in basalt (lava bedrock) and sedimentary inter bed layers that underlay the sediments.

Shallow layers of the sedimentary aquifer (less than ~100 ft below ground) may not be overlain by protective (low permeability) layers (ie: they may be "unconfined") whereas deeper layers of the sedimentary aquifer and the basalt aquifers are usually overlain by protective layers (ie: they are "confined"). Confined aquifers are usually deeper and are more protected by low permeable layers than are unconfined aquifers; however, they may nonetheless be subject to contamination by human activities. In the case of LYV, the Preliminary Assessment Report of 2010 identified that wells up to 300 feet deep were much more likely to contain groundwater with nitrate concentration above the MCL of 10 mg/L than were deeper wells. Because of the slow movement of groundwater, deeper aquifers may become contaminated in the future, and take more time to recover after reductions in nitrogen loads.

Deeper wells in the area are generally completed in lower portions of the sediments and in the Columbia River Basalts (bedrock aquifer) and interbed layers. Some wells completed in basalt are shallower than wells completed in sediments due to differences

in sediment thickness. The basalt aquifer is generally semi-confined and is composed of numerous distinct aquifers present in zones between the basalt flows. The extent of connection between the basalt aquifers at different interflow zones is documented in recent and pending published reports (Vaccaro et al, 2009) by the USGS. Most municipal and irrigation wells are completed in the deeper sedimentary and bedrock aquifers.

Map 10: **Map of the Yakima Basin from Hydrogeologic Framework of Sedimentary Deposits in Six Structural Basins, Yakima River Basin, Washington by Jones, Vaccaro & Watkins, 2006**

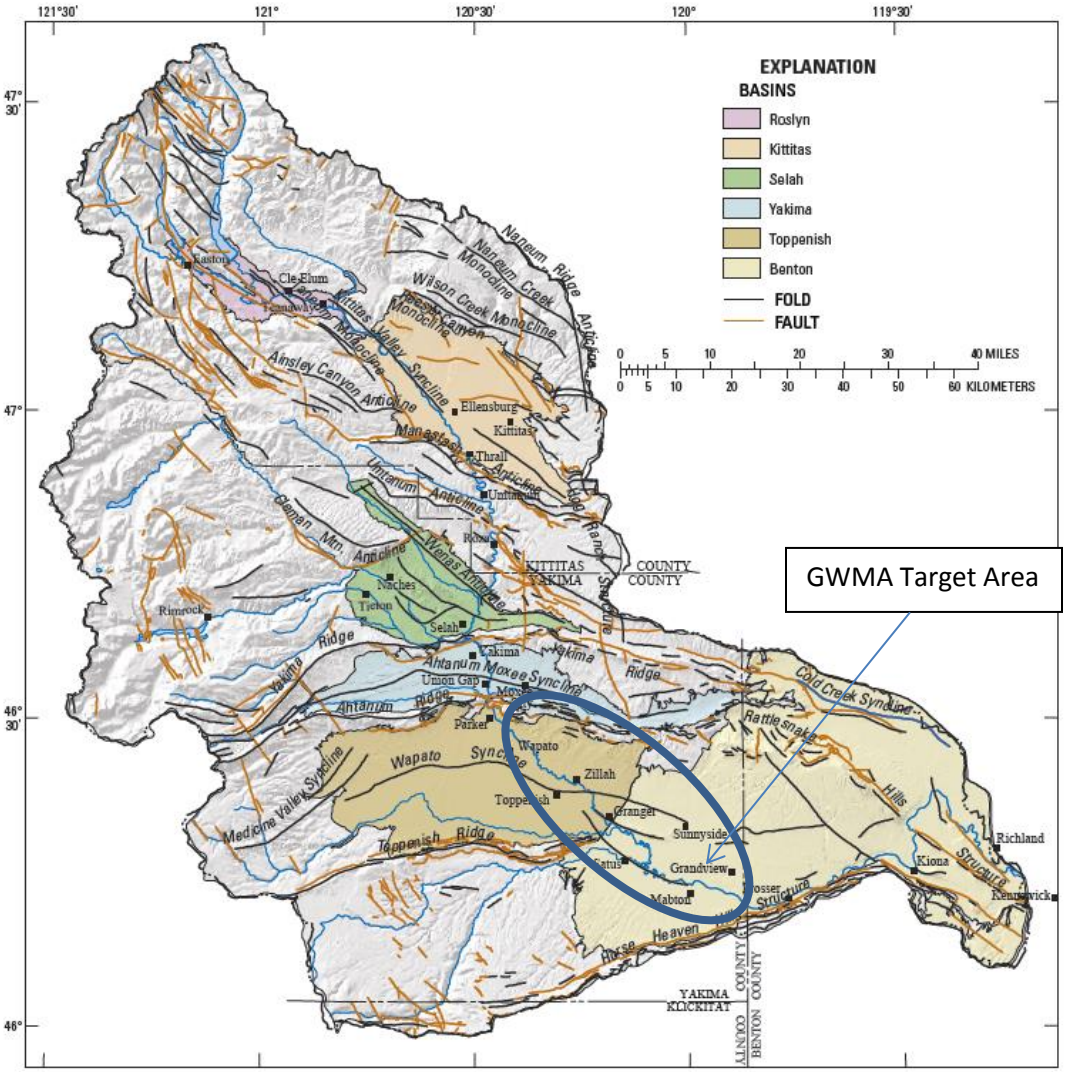


Figure 7. Structure delineating six sedimentary basins, Yakima River Basin, Washington.

Geology from the EPA study, *Relation between Nitrate in Water Wells and Potential Sources in the Yakima Valley, WA (2013)*

The Toppenish and Benton Basins consist of fine- and coarse-grained sediments overlying a sequence of three major basalt flows. The structural setting for the study area is created by bounding ridges such as the Rattlesnake Mountains, Ahtanum Ridge, Toppenish Ridge, and Horse Heaven Hills. The uppermost basalts of the Saddle Mountain Unit of the Columbia River Basalt Group are typically exposed in these upland ridges. This unit averages more than 500 feet thick. The underlying Wanapum unit averages 600 feet thick. These units are separated by the Mabton Interbed, with an average thickness of 70 feet.

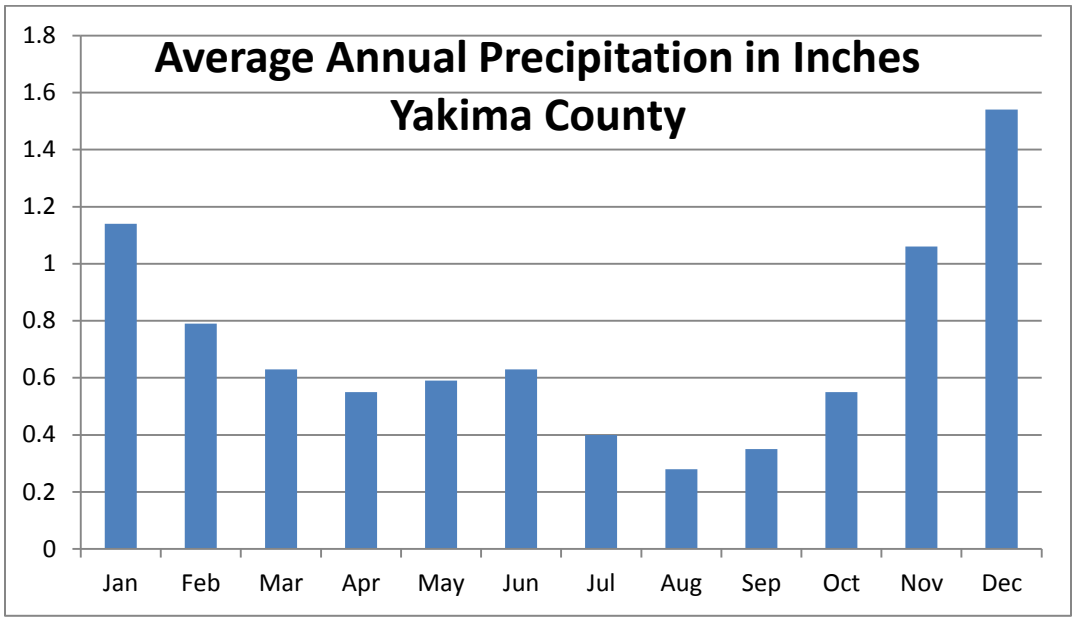
The valley is filled with a variety of sediments that pinch out along the flanks of the ridges. These sediments include Touchet Beds, loess and thick alluvial sands and gravels, and significant thickness of Ellensburg Formation. The thickness of these sedimentary units decreases from an average of more than 500 feet in the Toppenish Basin to less than 200 feet in the lower Benton Basin.

Water is found in fractures and interbeds formed of clinkers, permeable lava, lake deposits or paleo-soils and may occur at significant depths in the upland ridges, such as Horse Heaven Hills, and especially in the basalts. The water table is found at shallower depths as the valley is approached from these ridges. Near the Yakima River, it may be less than 10 feet to water, especially during the irrigation season.

The Lower Yakima Valley is filled with sediments shed by the ridges at the margins of the study area and those deposited in the valley bottom by the Yakima River. These sediments have an internal structure that strongly controls groundwater movement. As the water moves through these sediments, it tends to follow preferential flow paths composed of coarser sediments.

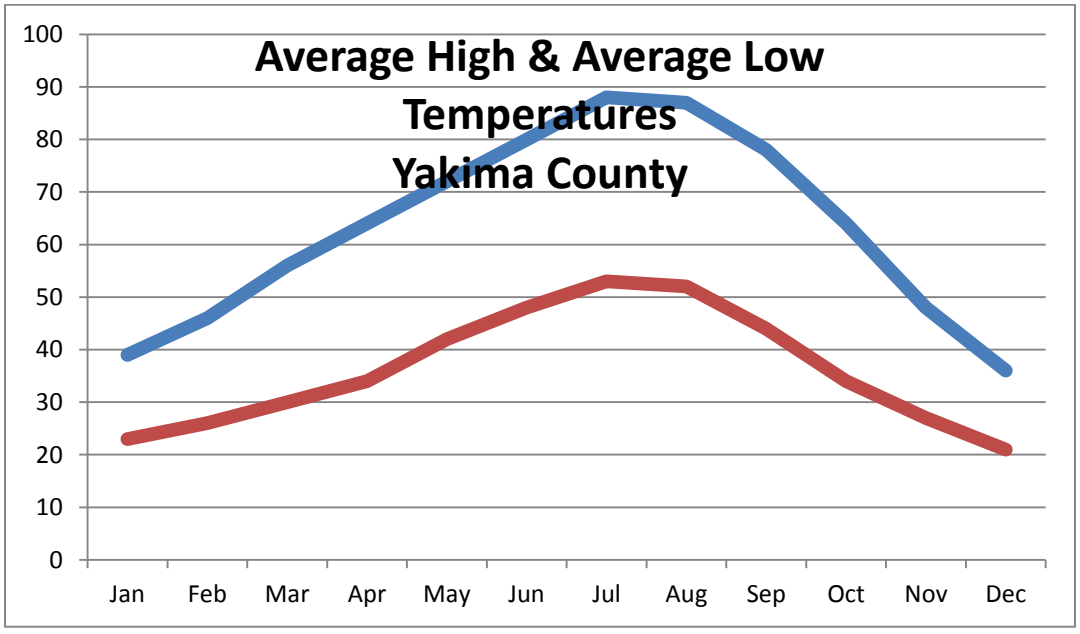
. **Climate and Weather from *U.S. Climate Data- 2018***

Chart 3.



Temperatures for Yakima County

Chart 4.



Soils and Land Use from the Natural Resources Conservation Service (2018)

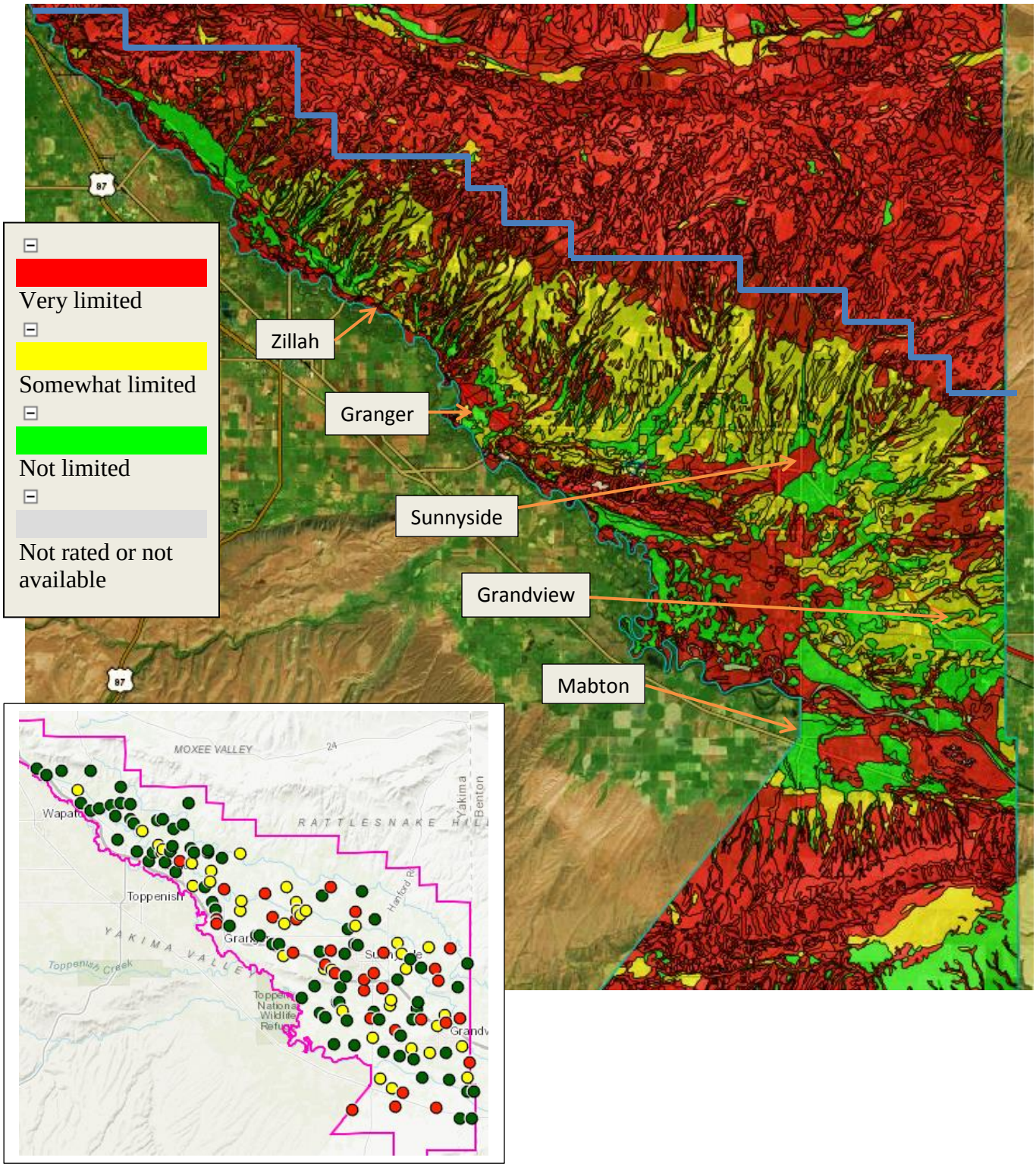
Web Soil Survey (WSS) provides soil data and information produced by the National Cooperative Soil Survey. It is operated by the USDA Natural Resources Conservation Service (NRCS) and provides access to the largest natural resource information system in the world. NRCS has soil maps and data available online for more than 95 percent of the nation's counties and anticipates having 100 percent in the near future. The site is updated and maintained online as the single authoritative source of soil survey information.

Soil surveys can be used for general farm, local, and wider area planning. Onsite investigation is needed in some cases, such as soil quality assessments and certain conservation and engineering applications
https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm

The Natural Resource Conservation Service has mapped and described the soils in the LYV. As an example consider mapping of risks for application of manures, food wastes, bio-solids and irrigation waste water to the land. Criteria for ratings include: depth to saturated zone, filtering capacity, adsorption, drought, slow water movement, strongly contrasting textural stratification, depth to bedrock, slope, cobble content, large stones on the surface, runoff, acidity, depth to cemented pan, sodium content, leaching, salinity, and flooding.

The NRCS map of the LYV below shows areas that are appropriate for land application of waste water by irrigation and contiguous areas that are very limited. *Results of the Recent 2017 USGS Domestic Well Testing,* Map 7, are superimposed on the NRCS map to facilitate discussion of the implications for the GWMA target area. Further application of the NRCS Soil Survey data to the Yakima Valley is available in Attachment 66.

Map 11. Natural Resources Conservation Services – Soil Mapping – Disposal of Waste Water by Irrigation



Economy from WA State Employment Security *Yakima County Profile (2017)*

In Yakima County, total covered employment increased from 93,988 in 2004 to 111,538 in 2016, a 17,550 job and 18.7 percent expansion during this twelve-year period. Of the 22 NAICS sectors mentioned earlier, there were five major sectors/industries that accounted for 65.4 percent of all jobs countywide in 2004. The same "Top Five" accounted for 70.9 percent of all covered employment countywide twelve years later, in 2016. Hence, the Yakima County economy was not a tremendously diverse economy in 2004 and QCEW employment data indicate it has become somewhat less diverse by 2016. In 2016; agriculture provided 28.1 percent, health services 13.7 percent, local government 12.0 percent, retail trade 9.6 percent and manufacturing 7.5 percent of total covered employment countywide. In 2004; agriculture provided 21.3 percent, local government 13.0 percent, health services 11.6 percent, manufacturing 9.8 percent and retail trade 9.7 percent of total covered employment. Hence, there was some repositioning within the "Top Five" rankings of job-providing sectors during this twelve-year period (i.e., from 2004-2016), as follows:

- *Employment in agriculture, forestry and fishing (where the vast majority are in agriculture) jumped 56.4 percent (from 20,057 jobs in 2004 to 31,361 in 2016) as agriculture strengthened its "Number One" position during this twelve-year period (or 13 years, inclusive). The agricultural sector will likely continue to expand in the near future, according to an article entitled "New Industry Coming to Sunnyside Will Bring 200 New Jobs" published in the New Vision website on 19 June 2017 The article states: "Ostrom Mushroom Farms, located in Olympia, WA, and the Port of Sunnyside have announced that the company will be opening a new farm in Sunnyside. . . Ostrom has been growing mushrooms since 1928 and employs 300 growers, pickers, and packers at their Olympia farm. The mushrooms are handpicked daily, refrigerated, and shipped fresh to consumers all over the Pacific Northwest, Alaska, and Hawaii. . . When in full production, Ostrom will create over 200 new jobs and be one of the*

largest employers in the County." Certainly this is good economic news for the local agricultural industry.

- *Local government registered a 9.3 percent employment upturn (from 12,209 jobs in 2004 to 13,350 in 2016) but it moved downwards in the "Top Five" ranking; from the second largest industry employment-wise in 2004 to the "Number Three" position by 2016.*
- *Health services registered a strong 39.7 percent expansion (from 10,914 jobs in 2004 to 15,252 in 2016) improving its ranking from the third largest industry countywide in 2004 to the "Number Two" position by 2016.*
- *Manufacturing employment in Yakima County decreased 8.8 percent (from 9,181 jobs in 2004 to 8,369 in 2016) and this sector/industry slipped from the "Number Four" to the "Number Five" position in the "Top Five" rankings between 2004 and 2016. Why? Durable goods manufacturing took some hits in the decade from 2000-2010. Layoffs were particularly severe in transportation equipment manufacturing (i.e., closures at Chinook Trailwagons and Western RV) and in lumber and wood products (i.e. the Yakima Resources closure). Nondurable goods manufacturing was not immune to layoffs either as food processing/manufacturing shed jobs when Del Monte closed their asparagus cannery in Toppenish. However, annual QCEW employment data show that although Yakima County's manufacturers "troughed" at 7,470 jobs in 2010, this subsector has generally been on an uptrend since then. Specifically, manufacturing employment rose to 7,869 in 2011, ebbed to 7,813 in 2012, expanded to 8,222 in 2014, virtually stalled at 8,216 jobs in 2014 before advancing to 8,279 jobs in 2015 and to 8,369 in 2016. These data indicate a slow, but not steady, resurgence in Yakima County's manufacturing employment since 2010. Following are examples of some manufacturing subsectors that have shown promise, and/or stability, in recent years:*
    - *Food manufacturing (NAICS 311) provides more jobs than any other manufacturing subsector in Yakima County. It provided 2,874 jobs across Yakima County in 2010 (which was the "trough" of the recent recession in terms of its effect on total covered employment). The*

number of food manufacturing jobs accelerated to 3,129 in 2011 before settling in the 3,000-job range from 2012 through 2016.

- *Plastics and rubber product manufacturing (NAICS 326) has escalated slowly and steadily from 1,102 jobs in 2009 to 1,391 in 2016, a 289 job and 26.2 percent upturn. Clearly this is a local subsector that has found a "niche" here in the Yakima Valley. This upturn from calendar year 2019 (674 jobs) to 2016 (905 jobs) equates to 18 more paper manufacturing jobs (up 4.5 percent) in this five-year period.*
- *In 2009 the number of fabricated metal product manufacturing (NAICS 332) jobs bottomed out at 674, but this subsector has generally been in a growth mode ever since. By 2016 it provided 905 positions, equating to 231 additional jobs, a strong 34.3 percent employment rise. Clearly, fabricated metal product manufacturing has been faring well here in Yakima County during this seven-year period (2009 through 2016).*
- *Machinery manufacturing (NAICS 333) progressed from 473 jobs in 2010, to 502, in 2011, to 539 in 2012, to 573 in 2013, stabilized at 602 jobs in 2014 and 2015, and then rose to 617 in 2016. Hence, from 2010 through 2016 this subsector tallied 144 more jobs, a healthy 30.4 percent employment gain during this six-year period. This subsector will likely continue to grow in 2017, according to a 20 June 2017 article entitled "Pro West Mechanical Expands, Plans to Add 40 New Employees" The article states, "The company was diversifying by adding new services while growing their industrial spray painting and finishing business – and this was in addition to expanding their original metal fabrication, manufacturing, and assembly services."*

- *Retail trade increased employment by 17.4 percent (from 9,145 jobs in 2004 to 10,732 in 2016) raising its ranking from the fifth-largest job providing industry/sector countywide in 2004 to the "Number Four" position by 2016.*

Agriculture

Based entirely on statistics from the USDA National Agricultural Statistical Service numbers FOTC observes some trends for Yakima County over the 25 years from 1987 to 2012:

1. The number of farms decreased by 26%

2. The land in farms increased by 10%

3. The average farm size increased by 49%

4. Irrigated cropland decreased by 9% (Decrease from 2007 to 2012 needs explanation)

5. The market value of all farm products increased by 230%

6. Average market value per farm increased by 346%

7. Market value of crops increased by 243%

8. Market value of livestock increased by 209%

9. Total farm expenses increased by 230%

10. Expenses per farm increased by 345%

11. Number of beef cows decreased by 41%

12. Number of milk cows increased by 396%

13. Land in grain corn increased by 166%

14. Land in corn silage increased by 94% from 2002 to 2012

15. Land in vegetables decreased by 67%

16. Number of orchards decreased by 53%

17. Land in orchards decreased by 8%

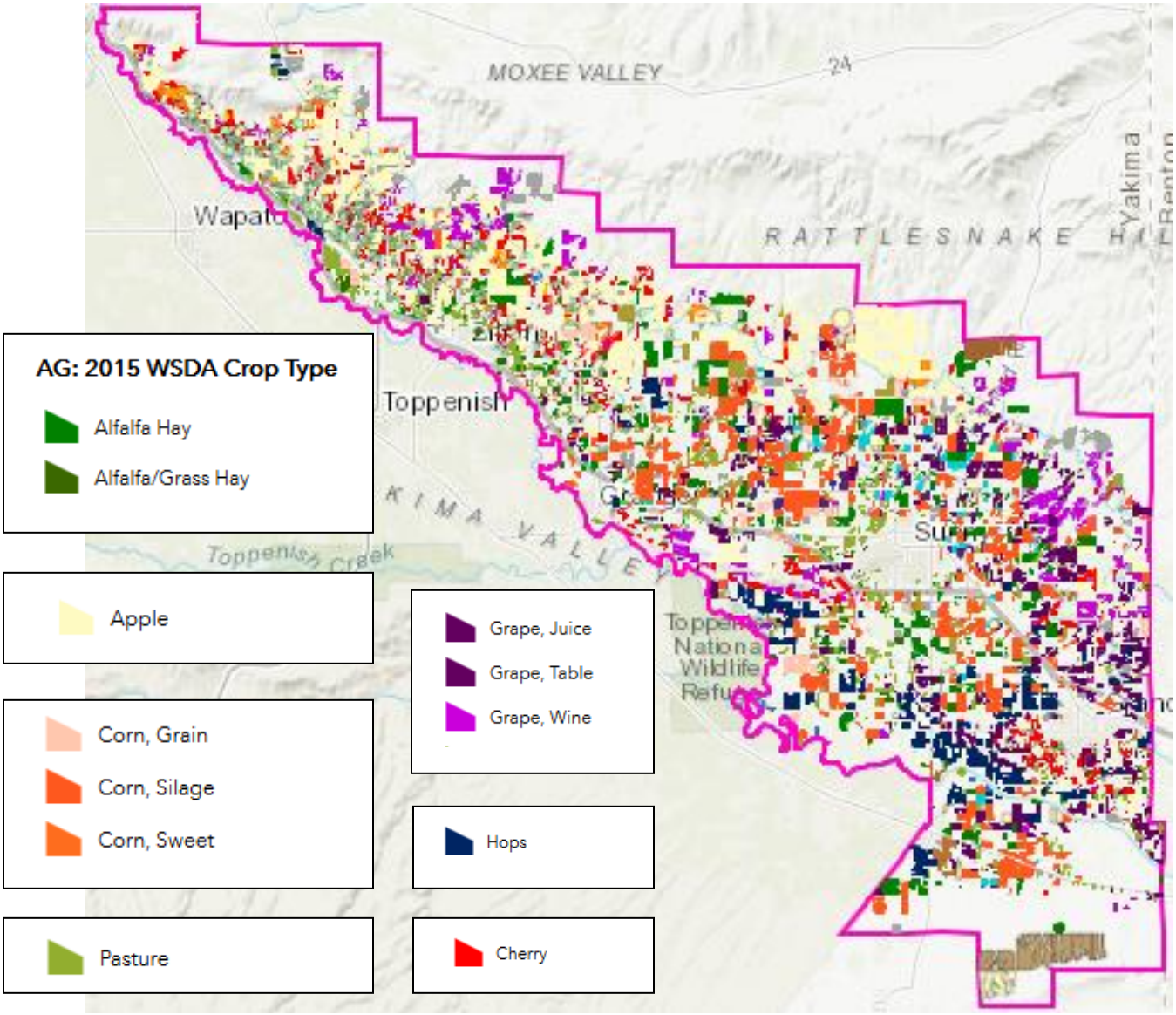
The numbers indicate a shift in cropping patterns away from fruits and vegetables, away from beef cattle, and toward milk production and growing animal feed. Orchards still occupy about half of the irrigated farmland and the number of vineyards is likely increasing. USDA data for grapes and hops is limited.

Yakima County Agricultural Trends from the National Agricultural Statistics Service

Table 10.

Yakima County Statistics	1987	1992	1997	2002	2007	2012
Farms	4,239	3,651	3,365	3,730	3,540	3,143
Land in Farms (acres)	1,612,399	1,639,965	1,682,961	1,678,984	1,649,281	1,780,498
Average Farm Size (acres)	380	449	500	450	466	566
Irrigated Cropland (acres)	247,313	256,508	277,589	269,127	267,566	224,386
Market Value All Farm Products	498,067,000	689,734,000	873,495,000	843,871,000	1,203,806,000	1,645,510,000
Average per Farm ($)	117,496	188,916	259,582	226,239	340,058	523,549
Market Value of Crops ($)	311,621,000	470,771,000	580,897,000	508,254,000	787,459,000	1,069,497,000
Market Value of Livestock ($)	186,445,000	218,963,000	292,598,000	335,617,000	416,347,000	576,013,000
Total Farm Production Expenses	411,259,000	545,701,000	643,211,000	725,281,000	857,111,000	1,358,478,000
Expenses per Farm ($)	97,064	149,466	191,148	193,666	242,122	432,223
Cattle & Calves Inventory	183,908	210,679	191,064	230,275	212,762	258,663
Beef Cows	25,969	29,171	31,755	22,866	28,594	15,414
Milk Cows	25,161	34,703	51,050	67,343	89,575	99,532
Grain Corn (acres)	8,629	10,379	12,680	13,644	16,755	14,303
Corn Silage (acres)				16,440	25,047	31,879
Hay, alfalfa, green chop (acres)	35,971	35,766	43,848	54,413	52,295	36,849
Vegetables (acres)	22,060	19,356	18,479	15,077	10,051	7,305
Number of Orchards	2,366	2,034	1,805	1,809	1,470	1,101
Land in Orchards (acres)	95,690	96,859	109,940	99,834	95,351	87,607
Government Payments ($)				10,501,000	4,705,000	5,804,000
Number of Farms Receiving Payments				735 (20%)	325 (9%)	360 (11%)
From USDA National Agricultural Statistics Service at https://www.agcensus.usda.gov/index.php						

Map 12. WSDA map of crops for ~ 96,000 acres of irrigated land in the LYV in 2015



Commodity	Acreage in the GWMA (2015)
Apple	17,333
Corn Silage	16,778
Triticale	10,780 (Double Cropped with Corn)
Grape (Juice	10,257
Alfalfa	7,989
Pasture	6,731
Cherry	6,336
Hops	5,961
Grape (wine)	5,126

Population

Highlights from the U.S. Census American Fact Finder:

1. The LYV population has grown at a faster rate than Yakima County as a whole

2. Households in the LYV are larger than those for the state or the county

3. There is a wide range of median household incomes for zip codes in the LYV

4. Per capita income in the LYV is significantly lower than Yakima County as a whole

5. Average age in the LYV is lower than that for Yakima County or for Washington State

6. Slightly over 50% of people who live in the LYV have graduated from high school compared to 73% for Yakima County and 91% for Washington State

7. Less than 10% of the people who live in the LYV have college degrees compared to 15% for the county and 34% for the state

8. Poverty levels by zip code in the LYV vary from slightly to 50% higher than those for Yakima County as a whole. They are over 50% higher than those for the state as a whole

9. The percentage of people living below the poverty level in the LYV has decreased between 2000 and 2016, except for the zip code that includes Grandview

10. The percentage of the population that is white, not Latino decreased between 2000 and 2016

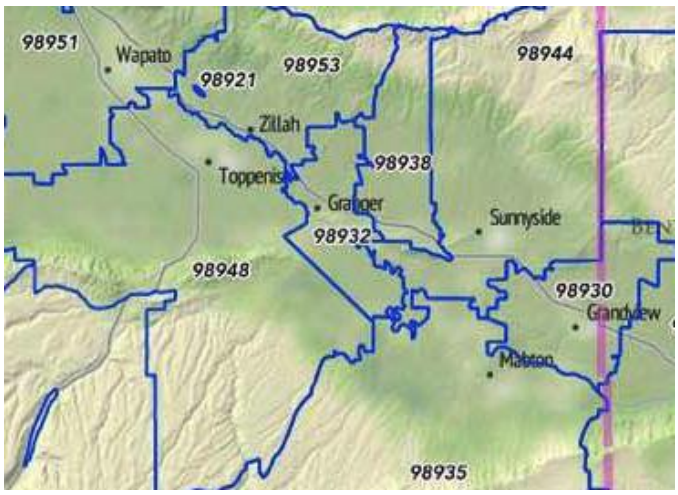
11. The percentage of the population that is Latino has increased by over ten percentage points between 2000 and 2016

12. Over 65% of the population in the LYV speaks a language other than English

13. About a quarter of the people in the LYV do not have health insurance

Map 13.

Lower Yakima Valley Zip Codes



Population Demographics adapted from the U.S. Census *American Fact Finder*

Table 11.

	Zip 98932	Zip 98930	Zip 98935	Zip 98938	Zip 98944	Zip 98953	Yakima Co.	WA State
Population								
2018	5,079	16,599	3,364	3,518	16,407	6,936	250,193	7,405,743
2010	5,032	15,252	4,190	2,177	15,922	6,681	243,237	6,724,545
2000	4,182	12,919	3,885	1,992	13,905	6,079	222,581	5,894,121
2018 minus 2000	897	3,680	-521	1,526	2,502	857	27,612	1,511,622
% Change	21%	28%	-13%	77%	18%	14%	12%	26%
Ave HH Size	3.88	3.45	3.91	5	3.71	3.01	3.04	2.57
Median HH Income	$44,929	$38,936	$45,276	$75,451*	$37,975	$61,267	$45,700	$62,848
Per Capita Income	$13,253	$14,497	$14,011	$18,832	$16,121	$22,276	$20,653	$32,999
Under Age 18	37%	37%	32%	39%	39%	32%	30%	22%
% HS Diploma	58%	57%	52%	38%	52%	79%	73%	91%
% Bachelor's Degree	3%	9%	5%	8%	8%	15%	15%	34%
Individuals < Poverty	31%	22%	20%	19%	24%	8%	21%	13%
% < Poverty 2000	34%	20%	28%	28%	30%	19%	20%	11%
% White Alone	18%	20%	16%	34%	15%	67%	43%	69%
% White 2000	26%	40%	27%	47%	25%	66%	57%	79%
% Latino	78%	80%	81%	65%	84%	41%	49%	13%
% Latino 2000	69%	59%	72%	51%	73%	32%	36%	8%
Language other than English at home	72%	66%	71%	78%	65%	23%	40%	19%
W/O Health Insurance	24%	24%	25%	28%	23%	31%	13%	7%
Data from the U.S. Census - American Fact Finder at https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml								

* Access the web site for the American Fact Finder to better understand this figure

Environmental Justice from *Lower Yakima Valley Groundwater Quality (2010)*

Environmental justice is defined by the EPA as "the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies." This report concludes that a lack of coordination amongst agencies with limited authorities for addressing groundwater conditions in the Lower Yakima Valley has led to confusion amongst members of the public about their options for addressing environmental concerns in the area. This, in itself, represents an environmental justice concern. Additionally, the demographic conditions of the Lower Yakima Valley transposed against the conditions of groundwater pollution create inequities of representation and communication regarding solutions for people to protect themselves from groundwater pollution.

Part of our shared goal is to see that all persons have access to safe drinking water supplies. This includes incorporating environmental justice considerations into the water quality improvement process to ensure that all communities have the same degree of protection from environmental and health hazards.
Attention to environmental justice concerns is necessary because actions to improve water quality that adequately protect the general population, may not always protect discrete segments of the population. Communities face different levels of environmental harms and risks depending on cultural practices, diet, and where they live, work, and play. Further, higher-risk populations, communities with environmental justice concerns, and disadvantaged groups, often face barriers in trying to address concerns within their communities. Such environmental justice concerns are particularly relevant for rural communities, and in this case a predominantly agricultural based community. The following are potential obstacles to public participation and factors that result in differential risks among vulnerable communities:

- *Competing priorities and multiple challenges*

• Lack of personal or community resources (e.g., financial, information, political experience)

• Inadequate access to infrastructure such as housing, utilities, communication, and transportation

• Language barriers (non-English speaking or non-fluency)

• Cultural or other barriers to participation in government processes

• Residents who are not property owners (e.g., tenants and agricultural workers)

• Cumulative risks from exposure to multiple sources of pollution

Climate Change from the *Yakama Nation Climate Change Adaptation Plan (2016)*

The climate is changing in the Pacific Northwest. The average annual temperature increased by 1.3 °F between 1895 and 2011. We have seen changes in the mountains; over the last century, nearly all of the glaciers in Washington State have retreated. Agricultural conditions have changed as well. The number of frost-free days has increased by more than a month, on average, and the growing season has lengthened accordingly. We are seeing changes in our rivers and streams. Peak stream flows are coming earlier in the year than they used to in many locations, and late summer stream flows are declining. These changes are consistent with what we expect to see based on regional projections of climate change, although natural variability also continues to play an important role in what we experience from year to year.

In 2015, the city of Yakima had the warmest June on record, and the Columbia River was the warmest it has been since 1950. Approximately one-quarter of a million salmon died, reportedly because of warm water and resulting diseases. Wildfires brought "unhealthy" and "very unhealthy" air quality conditions to the communities of Toppenish, White Swan, and Yakima. While the high temperatures and drought that we experienced in 2015 cannot be fully attributed to climate change, given the aforementioned role of natural variability and the influence of El Niño, recent

experiences give us a picture of what we are likely to experience more often in the future as the climate continues to change.

There are a number of scenarios that scientists use to project what might happen as a result of climate change. The scenarios make different assumptions about future greenhouse gas emissions. However, all of those scenarios project further warming in this century: between 4.3 to 5.8 degrees F warmer on average in Washington State by the 2050s compared to the 1950-1999 period. In the Yakima Basin, average summer temperatures are expected to be 83 to 90 degrees by mid-century, depending on what choices are made— locally, regionally, and globally—that affect the trend of greenhouse gas emissions. Those would be the averages; our hottest summer days will likely be even hotter than what we are used to.

When it comes to rain and snow, precipitation projections are uncertain. Climate scientists currently anticipate only slight increases in average annual precipitation, with more of that precipitation coming in the winter and in heavier downpours. Meanwhile, the Yakima Basin is a temperature-sensitive system, so warmer temperatures will mean less snow and more rain. We expect to see increasing winter flows and decreasing summer flows in the rivers. We also expect to see peak stream flows occurring four to nine weeks earlier in the 2080s than what we are used to seeing today. Snowmelt runoff already happens two to three weeks earlier than it did historically in many streams in the Pacific Northwest.

State of the Aquifers from *Approaches for Assessing Ground-Water Availability under Competing Demands and Climate Change – 2008, Bachman, Ely & Vaccaro*

Many areas of the American West struggle with the allocation of diminishing water supplies between growing municipal and agricultural demands. In the Pacific Northwest, surface water supplies are additionally stressed by in-stream flow requirements mandated for the protection of endangered salmonid species. In the Yakima River Basin in Washington State, where river and stream flows primarily are

derived from winter snowpack in the mountains, surface-water supplies are fully allocated in wet years and over-allocated in dry years.

Tribal water rights from the 1800s supersede irrigation or municipal rights in the basin, and ongoing litigation to discern the influence of ground-water pumping on surface-water flows led to U.S. Geological Survey involvement in a comprehensive assessment of ground water.

In the Yakima River Basin:

- *In areas of heavy pumping, head declines of greater than 150 feet have been measured*
- *Groundwater users must pay for additional power to pump from greater depths*
- *Lowered water tables likely increase capture of water from streams*
- *Climate Models indicate warming temperatures, which will reduce recharge over the next 20, 50, and 80 years*
- *More precipitation will be in the form of rain rather that snow resulting in increased winter runoff and reduced late-spring and summer runoff*
- *Endangered Species Act mandates protection of three listed salmonid species*
- *2 species already extirpated from the basin*
- *Minimum flow requirements during spawning season conflict with irrigation season*

Clarification: In general there are two types of aquifers in the LYV: shallow unconfined aquifers in the alluvium and deeper, confined basalt aquifers. At some point in time a bureaucratic decisions was made and the GWMA began to focus only on the shallow aquifer. This decision was not made by the GWAC.

Due to recharge from irrigation the shallow aquifers are mostly stable. The deeper aquifers are receding at a rate of approximately 2.9 ft per year. (WA State Dept. of Ecology, 2018d)

Characterization Summary

The Lower Yakima Valley is one of the most productive agricultural areas in the United States. This distinction is due to deep fertile soils, long sunny days and a large system of irrigation canals that tap the Yakima River.

The population of the GWMA target area is about 50,000 and approximately 80% Latino. The median household income is comparable to that for Yakima County as a whole but the per capita income is lower. The percentage of people who live below poverty has decreased over recent years to approximately 20%. Education levels lag and much of the population speaks English less than well. Environmental Justice is a concern when pollution and limited opportunities for community engagement are on the table.

There are about 96,000 acres of irrigated cropland in the GWMA target area. Leading crops are apples, corn, triticale, grapes, alfalfa, cherries and hops. Over the past three decades the dairy industry has quadrupled in size in the area. There are about 100,000 milk cows in the LYV with about the same number of supporting livestock – dry cows, heifers and calves. Currently about a third of crops are grown to provide feed for animal agriculture.

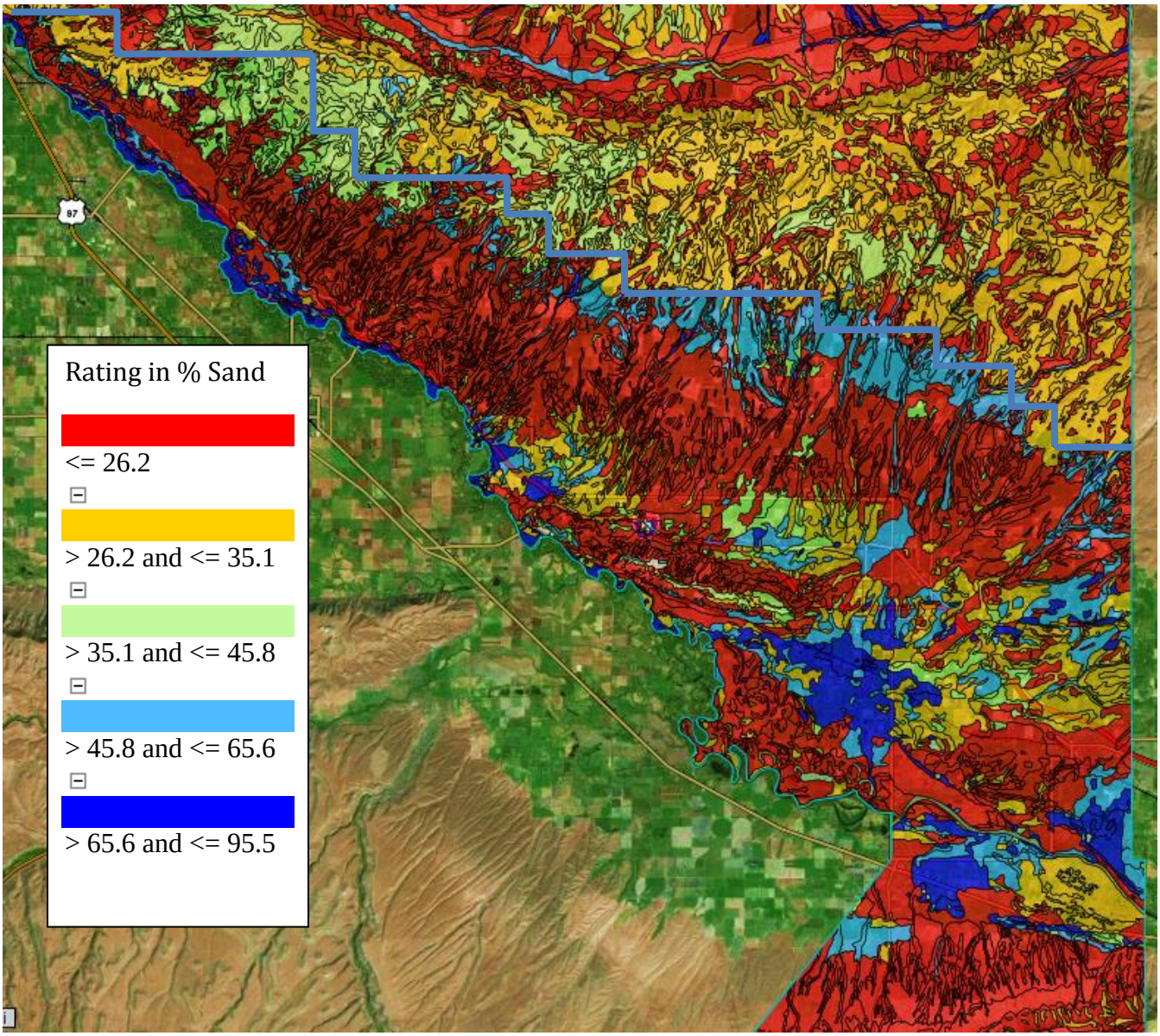
Global warming has begun to change agriculture in the LYV as well as the way we live and work. The growing season begins earlier, there are more frost free days, snow pack is decreasing, and drought years are more frequent. We experience more forest and range fires. This creates opportunities for invasive species that threaten native plants. Any plan for addressing groundwater must consider global warming as well as the consequences of declining aquifers.

Differences in Sub Areas of the GWMA

Comparing areas with very low nitrate levels in groundwater

The LYV GWMA target area is not homogeneous. Nitrate levels in groundwater range from 0 to 240 mg/L. Depth to groundwater ranges from a few feet to several hundred feet. Soils range from poorly drained to excessively drained. Crops range from apples to zucchini squash. These factors all impact nitrate flows. Here is an illustration from Attachment 66.

Map 14 - NRCS Mapping of Sand Percentages in LYV Soils



The GWMA should have performed a more in depth comparison and analysis of the major factors that impact nitrate in groundwater. We did not.

To illustrate what needs to be done FOTC has performed a summary comparison of four areas in the GWMA where nitrate levels were < 1 mg/L in the 2017 USGS well survey. Data sources are the Yakima County GIS mapping at http://arcg.is/1ie9mP, the NRCS Soil Survey at https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx and USGS well water data at maps.waterdata.usgs.gov.

Map 15 – Low Nitrate Areas

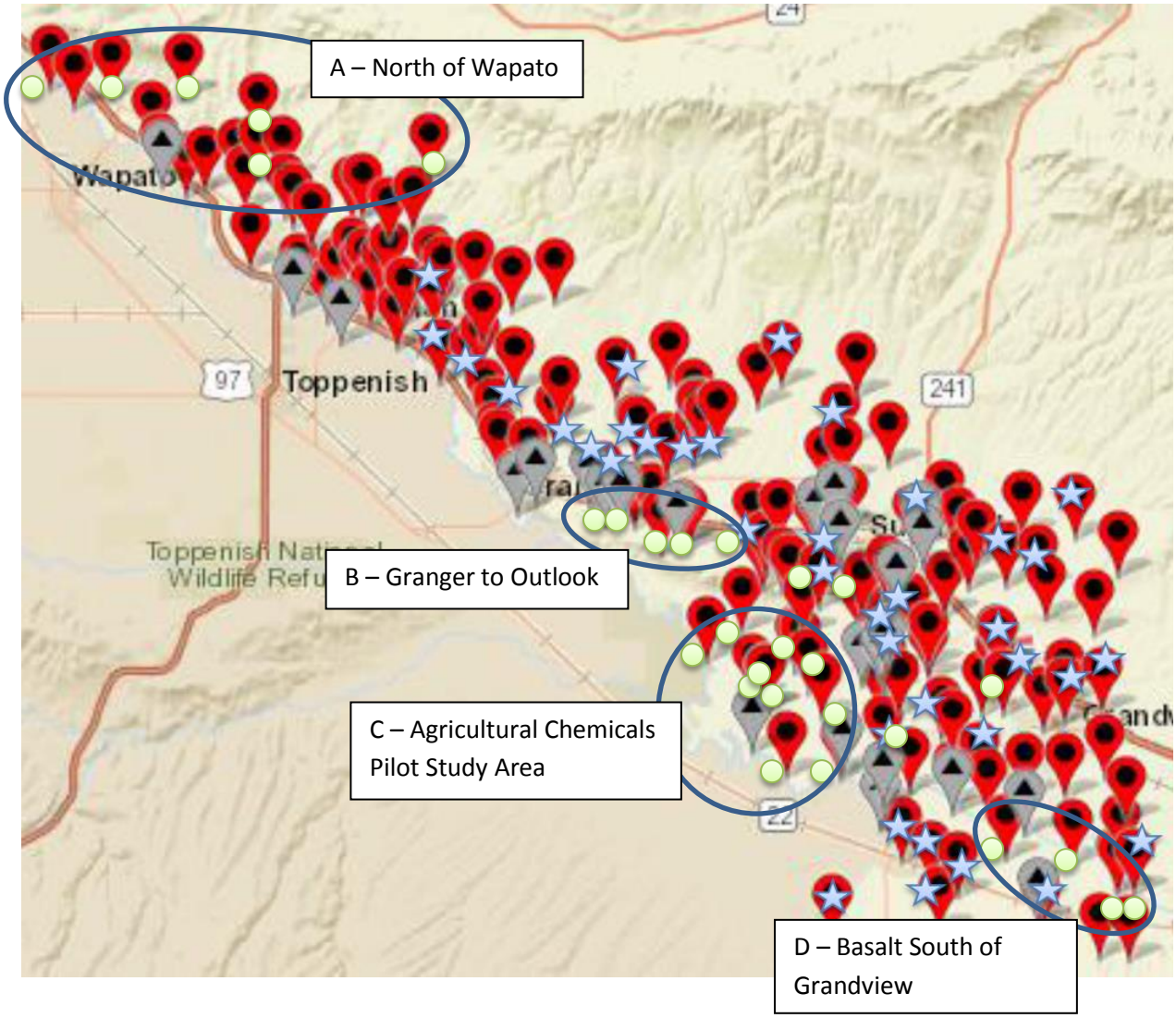


Table 12 – Characteristics of Low Nitrate Areas

Sub-Area		Soils	Crops	CAFO's	Well Depth	Water Table
A		Silt Loams	Fruit	No	Deep 200 - 600 ft	25 - 100 ft, Some > 100
B		Sandy Loam	Corn	Yes	Around 200 ft	Mostly 15 - 25 ft
		Silt Loam	Alfalfa			
		Fine Sandy Loam	Grapes			
			Pasture			
C		Loamy Fine Sand in NE	Corn	Yes	< 100 ft	15- 25 ft, and
		Silt Loam in SW	Hops			25 – 100 ft
			Alfalfa			
D		Starbuck Silt Loam	None	No	Around 150 ft	25 – 100 ft
		Starbuck Rock Outcrop				

Summary of possible reasons for low nitrate levels in these samplings:

A: Deep Wells. More recent agriculture.

B: Wells are drilled into a deeper aquifer? Snipes Mountain lies directly to the south. Groundwater flow makes a 90 degree turn to the east when it reaches Snipes Mountain.

C. The water table is very shallow and the wells are < 100 ft deep. Impact of sandy soils and proximity to the Yakima River.

D. Basalt formation and no cropland.

More study is required to describe the contributors to nitrate in LYV groundwater and the pathways in diverse sections of the target area.

Projection of Water Use Needs in the LYV

Groundwater in the LYV supplies the needs of municipalities, private homeowners, industry, crops, animal agriculture, instream flows and recreation. Demand currently exceeds supply. According to USGS (Bachman, 2008) groundwater pumpage in the entire Yakima Basin increased from 40,000 acre feet in 1960 to 190,000 acre feet in 2000.

- *In areas of heavy pumping, head declines of greater than 150 feet have been measured*
- *Ground-water users must pay for additional power to pump from greater depths*
- *Lowered water tables likely increase capture of water from streams*

Here are predicted changes in LYV groundwater demand for the next 25 years.

Needs of people: Human demands will increase by ~ 28% over 25 years

We assume that the population of the GWMA target area is 50,000. This is based on the sum of populations for zip codes 98930, 98932, 98935, 98938, 98944 and 98953 for 2018 in the *U.S. Census American Fact Finder.* This is a crude estimate. Parts of zip codes 98930, 98932, 98935 and 98944 lie outside Yakima County and parts of zip code 98951plus two smaller zip codes lie within the GWMA target area.

We used growth rates for Yakima County from the WA State Office of Finance & Management (2018). We calculate that the average person uses 100 gallons of water per day (USGS, 2018). This results in demand for about 1,386,200 more gallons per day for domestic use by the year 2045.

Table 13. Projected Population and Water Needs

Year	Population	Growth Rate Over Five Years	Gallons per Day
2015	50,000	5%	5,000,000
2020	52,500	5%	5,250,000
2025	55,125	5%	5,512,500
2030	57,881	4%	5,788,100
2035	60,196	3%	6,019,600
2040	62,002	3%	6,200,200
2045	63,862		6,386,200

Industry: Change in Demands Uncertain

According to the most recent *WA State Employment Security Yakima County Profile,* the Lower Yakima Valley is expected to experience growth in food processing and related industries. We are unable to provide reasonable estimates of the impact this growth will have on groundwater usage.

Instream flows: Challenges

The relationship between groundwater and instream flows is well established. (Vaccaro et al, 2009; USGS 2018) Depletion of the aquifers results in reduced return flow to surface waters. In the Lower Yakima Valley improved irrigation methods such as drip irrigation and lining canals result in decreased groundwater re-charge and decreased groundwater return flow to the rivers and streams.

According to Ecology (2016) during the 2015 drought:

> *The drought was directly responsible for widespread fish die-offs and impacts to wildlife. Hundreds of thousands of Columbia/Snake River Basin sockeye salmon perished in July. There was confirmed mortality of 182 sturgeon, most were large, breeding sized fish, in the Columbia River. Widespread reports of fish strandings occurred throughout the state, including federally-listed species such as bull trout. Also, more than 1.5 million juvenile salmon, steelhead, and rainbow trout died at 11 Washington hatcheries due to drought conditions.*

There is a legal mandate to maintain instream flows in Washington State. (Hirst, 2016)

The Yakima River Basin Integrated Water Resource Management Plan (YRBWEP) is looking at new and innovative ways to store water for irrigation. Periods of time with extra surface water do not always coincides with the periods of highest crop needs. The YRBWEP is studying storage in LYV groundwater. (USBR, 2017) This would impact water levels in the aquifer and return flow to the river.

Crops:

Based on analysis of statistics for Yakima County from the USDA National Agricultural Statistical Service (NASS) for the period between 1987 and 2012 here are some trends:

1. The land in farms increased by 10%
2. Irrigated cropland decreased by 9%
3. Land in grain corn increased by 166%
4. Land in corn silage increased by 94% from 2002 to 2012
5. Land in vegetables decreased by 67%
6. Land in orchards decreased by 8%

There is increasing acreage in corn and decreasing acreage in vegetables and tree fruits. Changes in apple production to smaller trees and drip irrigation provide for increased production with less water and less acreage. (DeVaney, 2018) Most hop and grape fields have changed to drip irrigation.

Nitrogen Available for Transport Lower Yakima GWMA 2018, page 91, provided data for *Water Duty* or the amount of water required on average for the major crops in the LYV. Here is a summary of that data in gallons per day by crop:

Table 14. Water Duty for Major LYV Crops

Crop	Average Water Duty (in/acre)	Gal/Acre/Day	Acres	Gallons/Day
Nectarine/Peach	40.42	2959.8	843	2,495,121
Pear	39.85	2917.8	3,331	9,719,299
Pasture	37.89	2774.1	6,731	18,672,307
Alfalfa Hay	35.87	2626.7	7,989	20,984,380
Mint	34.87	2553	1,418	3,620,084
Cherry (see notes)	30	2196.6	6,336	13,917,730
Apple (see notes)	30	2196.6	17,333	38,073,867
Hops	29.89	2188.6	5,961	13,045,990
Silage Corn	28.55	2090.2	16,778	35,069,340
Field Corn (Grain)	28.55	2090.2	1,166	2,437,171
Triticale (double crop)	28.55	2090.4	10,780	22,534,964

Grape (juice)	26.51		1940.4	10,257	19,902,273
Grape (Wine)	26.51		1941.1	5,126	9,949,937
Wheat	23.29		1705.3	1,283	2,187,903
Totals				95,332	212,610,366

Most of the demand is met with surface water. During periods of drought farmers are permitted to use emergency wells and withdraw from the groundwater.

According to the Roza Irrigation District (nd):

> *1992 through 1994: The longest sustained drought period in the history of the district occurred. Water supplies were critically curtailed, with supplies of only 58%, 67%, and 37% respectively. The 37% supply in 1994 was the worst water shortage ever experienced by the district. The accumulative effect of short water supplies damaged permanent crops causing financial hardship on growers and the district.*

During the most recent 2015 drought, 45 emergency drought wells were used in the Roza Irrigation district. (McClain et al, 2016). Statewide Ecology issued 76 emergency drought permits in that year and 60 were in the Central WA Region. (Anderson et al, 2016). Climatologists predict more frequent drought years and this will no doubt impact groundwater storage and emergency pumping.

Animal Agriculture: At current growth rates groundwater demand will double in 25 years

Data from the National Agricultural Statistics Service that describes changes in LYV animal agriculture since 1987 shows a steady growth in the number of milk cows and a decline in the number of beef cattle. The number of milk cows has increased by almost 3,000 cows per year and the number of beef cows has decreased by about 420 head per year.

Table 14. Numbers of Cattle & Calves in Yakima County 1987 - 2012

	1987	1992	1997	2002	2007	2012
Cattle Population						
Cattle & Calves	183,908	210,679	191,064	230,275	212,762	258,663
Beef Cows	25,969	29,171	31,755	22,866	28,594	15,414
Milk Cows	25,161	34,703	51,050	67,343	89,575	99,532
Change over five years						
Cattle & Calves		26,771	-19,615	39,211	-17,513	45,901
Beef Cows		3,202	3,584	-8,889	5,728	-13,180
Milk Cows		9,542	16,347	16,293	22,232	9,957
Average change every five years				**Average change per year**		
Cattle & Calves		14,951		2,990		
Beef Cows		-2,111		-422		
Milk Cows		14,874		2,974		

With these numbers in mind we can predict an increase of about 2,900 head of cattle per year and associated increase in water consumption. Here we estimate 50 gallons per day per milk cow on average and 10 gallons per animal per day on average for other bovines. (Institute of Agriculture and Natural Resources, 2016; Dairy Herd Management, 2011)

Table 15. Predicted Cattle Populations in Yakima County and Water Needs

	# Milk Cows	Gal per day		# Other Cattle	Gal per day		Total Gallons/day
		50 gal/cow			10 gal/head		
2012	99,532	4,976,600		159,131	1,591,310		6,567,910
2017	114,406	5,720,300		174,082	1,740,820		7,461,120
2022	129,280	6,464,000		189,033	1,890,330		8,354,330
2027	144,154	7,207,700		203,984	2,039,840		9,247,540
2032	159,028	7,951,400		218,935	2,189,350		10,140,750
2037	173,902	8,695,100		233,886	2,338,860		11,033,960
2042	188,776	9,438,800		248,837	2,488,370		11,927,170
2047	203,650	10,182,500		263,788	2,637,880		12,820,380

The amount of groundwater required for animal agriculture will likely increase over the coming years. Wells for animal agriculture are commonly drilled into the deeper basalt aquifers. At the current rate of increase in cattle numbers water needs could double in 25 years. There is no legal limit on the amount of water that producers can withdraw to water livestock based on a recent interpretation of RCW 90.44 by the WA State Supreme Court in Five Corners Family Farms versus the State of Washington. (Find Law, 2011)

Gaps in Knowledge & the GWMA Work

1. Public Health: At the beginning of the GWMA discussions, Friends of Toppenish Creek asked the group to consider a community health assessment for the LYV. This would have provided a baseline understanding of population health and a foundation for measuring the impact of nitrate reduction on health.

The GWAC was not receptive and preferred to focus simply on reducing nitrates in groundwater. Chairman Rand Elliott observed that reducing nitrates in the drinking water would automatically improve public health and measuring the impact was unnecessary. (LYV GWMA, Dec. 12, 2012 meeting of the GWAC)

Since 2012, we have moved from a goal of reducing nitrates within five years to stating that it will take decades to see improvements. Detrimental health effects will be ongoing for a generation. Research demonstrates increased nitrate related risks for certain cancers, reproductive problems, chronic health effects and increased morbidity/mortality among infants who drink formula made from well water. (See Attachment 29)

Rates for congenital anomalies and developmental delay are higher for Yakima County than Washington State (YVMH, 2013, Virginia Mason Memorial, 2016). Rates for pre-term births are consistently higher than the state average (WA DOH, 2018). Hospitalizations for cardiac events, COPD and asthma are higher than the state average (WA DOH, 2018). The contribution of nitrates in drinking water to these conditions in the LYV is unknown.

In terms of standard of living and access to health care, Yakima County is a poor county. Services that are taken for granted in more affluent parts of the state are simply not available to us. (Attachment 67) The tables below compare public health services in Yakima County to those in other large Washington Counties:

Chart 5 – Public Health Expenditures

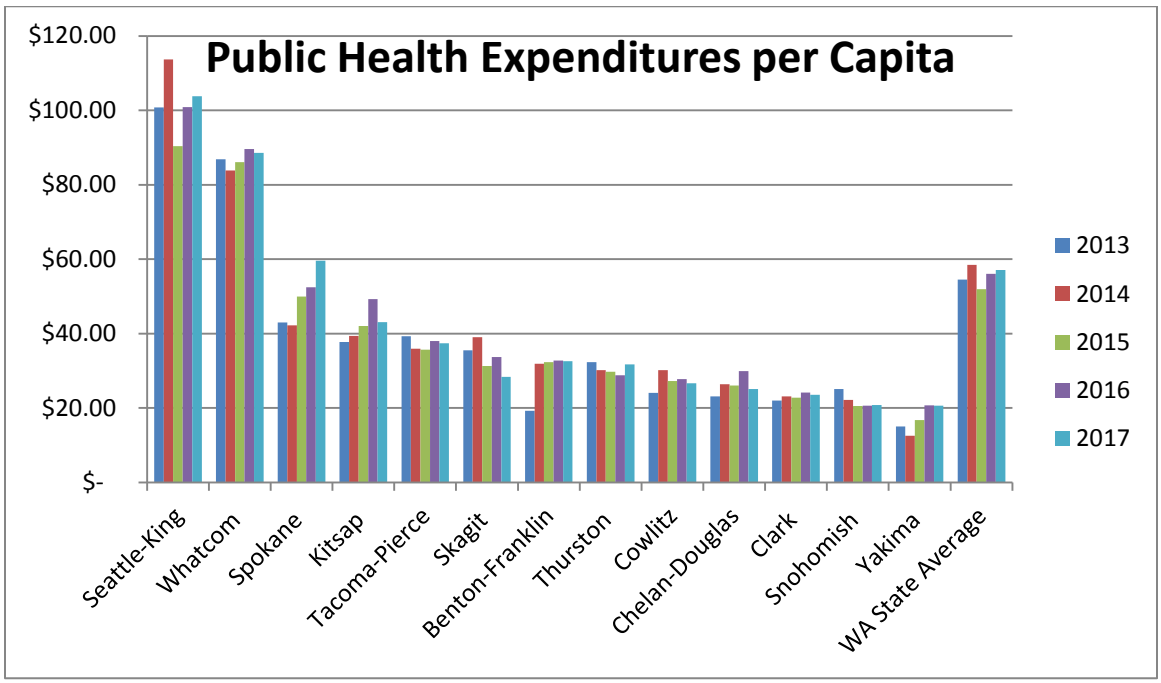
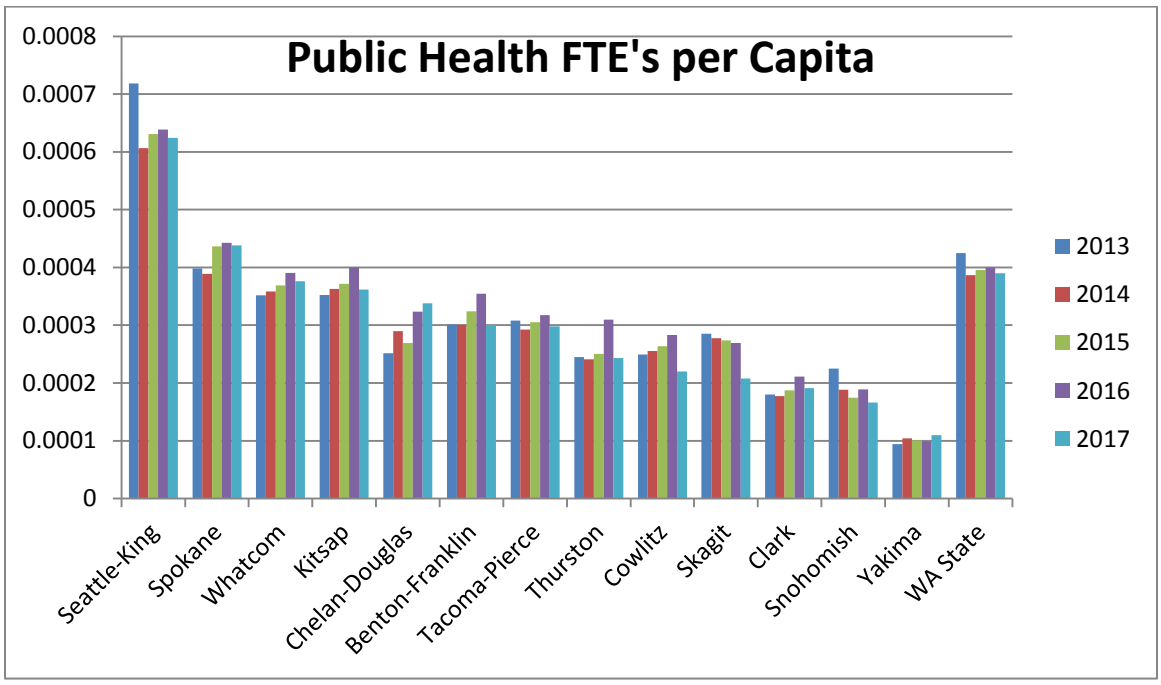


Chart 6 - Public Health FTE's per Capita



Currently methemoglobinemia or blue baby syndrome is a reportable condition in Yakima County. To our knowledge there is no requirement to test methemoglobin levels

when babies present with signs and symptoms which can mimic other conditions. We do not know the level of physician awareness.

A 2009 study of methemoglobinemia and nitrates in drinking water by the WA State Dept. of Health (VanderSlice, 2009) found:

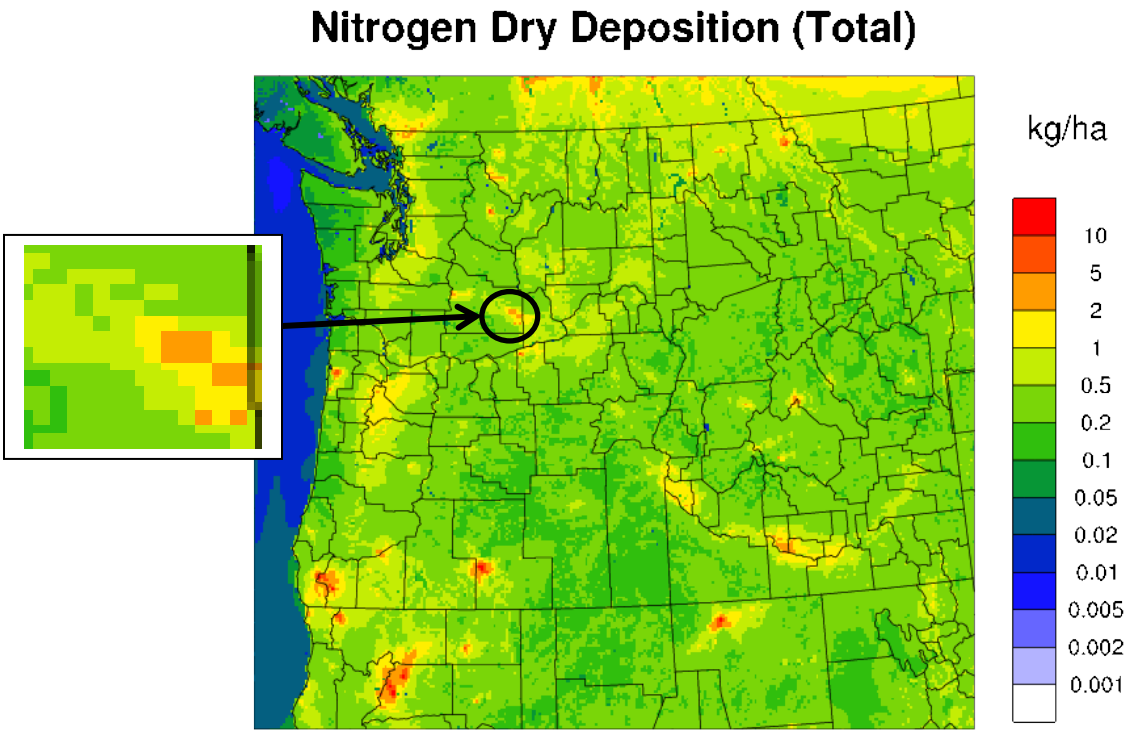
> *The results of this study provide evidence that exposure to nitrate from drinking water significantly and substantially increases the risk of an infant having physiologically elevated levels of methemoglobin. Furthermore, this risk is associated with intake levels above 0.5 mg NO3-N/kg day, approximately one-third of the RfD value. Overall, about 4 percent of the infants had this level of exposure, and it occurred uniformly from 1 to 5 months of age. In this sample, virtually all infants (94.1%) who were given water containing nitrate above 5 mg/L NO3-N had exposures above 0.5 mg/kg day.*

2. Atmospheric Deposition: Atmospheric deposition of nitrogen occurs when nitrogenous compounds that are emitted from traffic, forest fires, combustion, cropland and animal feeding operations falls back to earth and deposits on the land surface. These nitrogenous compounds are called reactive nitrogen. Reactive nitrogen includes nitrite (-NO_2), nitrate (NO_3), nitrous oxide (N_2O), ammonia (NH_3) and ammonium (-NH_4) that are part of the nitrogen cycle. Ammonia and ammonium are re-deposited on the land surface through wet and dry deposition. (Sutton et al, 2011) Approximately 13% of emitted nitrogen redeposits on the land where it originated. (Personal conversation, Dr. Ranil Dhammapala, November 2018)

Washington State University administers a program entitled AIRPACT V that models atmospheric deposition for Washington, Oregon and Idaho on a monthly basis. The results of that modeling predict atmospheric deposition of around 8 lbs nitrogen per acre in the Lower Yakima Valley which is significantly higher than the 2.05 lbs per acre in the WSDA Nitrogen Availability Assessment. (See Attachments 70 and 71)

Below is a map from the WSU AIRPACT V program for the month of August, 2018, available at http://lar.wsu.edu/airpact/monthly_depo_ap5.php (One kg/ha equals 0.89 lbs per acre)

Map 16 – Atmospheric Deposition August 2018



3. Economic Impact: Throughout the GWMA discussions various participants have informed the GWAC that economic factors are a major driving force for decision making. Suggestions to fund an economic analysis have been rejected. The Friends of Toppenish Creek performed a simple study that shows significant costs for the people who live in the Yakima Valley plus significant costs for growers and producers who must address groundwater pollution. (See Attachment 26) This document could be a starting point for further research.

Experts say it is easier and less costly to prevent pollution than to clean up a polluted aquifer. We know that California is currently spending millions upon millions to address severe groundwater pollution in the Central Valley. (Harter et al, 2012; King et al, 2012; Canada et al, 2012) This is a serious warning for Washington State.

We suggest there is a knowledge gap regarding the total costs of groundwater pollution in the LYV and that an economic impact analysis is appropriate in order to minimize cost of prevention and mitigation. It is impossible to analyze and address a problem without accurate measurements.

Our best estimates indicate that the impacted people of the LYV spend over $1 million per year in order to obtain safe drinking water. (Attachment 26)

4. Manure Export: Agricultural experts on the GWAC have repeatedly stated that 50% to 70% of manures produced in LYV dairies are exported as compost. (Attachment 54) Friends of Toppenish Creek have no reason to doubt these statements. However, scientific rigor requires documentation. There is a gap in proving this assumption and a need to quantify the amount of manure and compost that is exported from the target area in order to refine estimates of nitrogen balance. This information could be gathered by survey work or by a reporting mandate for composters under RCW 70.95.

***5*. Commercial Fertilizer:** The study, *Estimated Nitrogen Available for Transport in the Lower Yakima Valley Groundwater Management Area,* (WSDA, 2018) describes the difficulties involved in obtaining estimates regarding purchase and application of commercial fertilizer in the GWMA target area. Sales are reported on a statewide basis but not at county wide or zip code specific levels. More precise data would allow more accurate calculations of nitrogen balance. This information could be gathered by survey work or by a reporting mandate for wholesalers under RCW 15.54.325.

6. NRCS Monitoring: The Natural Resource Conservation Service funds conservation projects and practices across Washington State. According to Bonda Habets (2015) from the Spokane office the NRCS does not monitor the impact of these grants beyond the funding period. Thus it is difficult to evaluate the long term benefits of NRCS programs.

7. Release of nitrate from organic nitrogen: The GWMA Nitrogen Availability Assessment states on page 31:

> *This organic nitrogen will mineralize over time, making more nitrogen available for plant growth for several years after the initial application. The actual nitrogen available in the first and subsequent years depends on the nitrogen source, weather and temperature conditions, and the breakdown rate of the organic matter containing*

the nitrogen. WSDA did not attempt to account for these nuances of nitrogen availability from different sources

And on page 36:

Previously, practice has been to allow for a minimum of 20 lbs N/ac per % organic matter; however, based on recent soil testing data in the Yakima Valley it appears that the contribution from organic matter should be increased from 20 lbs N/ac to 35-50 lbs N/ac per 1% organic matter when the fields have a history of manure applications.

WSDA does not reference the specific research to support this latter assertion. It would be prudent to locate definitive research or to conduct and publish LYV studies that quantify the amount of nitrogen available from breakdown of organic matter.

8. Nitrogen Balance for Alfalfa Fields: The nitrogen budget proposed in the GWMA Plan severely underestimates the contribution of alfalfa to nitrogen availability.

Below is a table from page 44 of the *Estimated Nitrogen Available for Transport in the Lower Yakima Valley Groundwater Management Area*, the GWMA's NAA. This table states that alfalfa removes large amounts of nitrogen from the soil. This may be true when alfalfa is used to lower nitrogen levels in fields where fertilizer and manures have been over applied. It is certainly not universally true.

Table 15. One year's worth of inputs and outputs for the top 15 crops in the GWMA

Commodity	Acreage	Sum of inputs and outputs for one year (lb N/ac-yr)		
		Low	Medium	High
Apple	17,333	-5	64	165
Corn (silage)	16,778	-156	47	242
Triticale	10,780	-92	13	250
Grapes (juice)	10,257	15	105	142
Alfalfa	7,989	-322	-214	-46
Pasture	6,731	-143	-47	62
Cherry	6,336	27	78	156
Hops	5,961	-41	99	113
Grapes (wine)	5,126	40	67	102
Pear	3,331	-1	65	119
Mint	1,418	-166	46	102
Wheat	1,283	-36	44	113
Corn (grain)	1,166	-4	148	284
Asparagus	854	58	130	156
Peach/Nectarine	843	12	54	104

There is no evidence of over application across the entire GWMA target area. In fact growers point out that fertilizer is expensive and is applied only as needed. In the majority of cases growers are aware of nitrogen fixation and manage their land accordingly.

The source for the GWMA Plan estimate is *Nutrient Management Guide for Dryland and Irrigated Alfalfa in the Inland Northwest* by Koenig et al (2009) who state:

> *Fortunately, alfalfa obtains most of the nitrogen it needs from the atmosphere through a symbiotic association with rhizobia (Sinorhizobium meliloti) bacteria that inhabit nodules in the alfalfa root system. Successful conversion of atmospheric nitrogen to a form usable by alfalfa ("fixation") depends on the presence of rhizobia in soil or inoculated seed, suitable soil pH (discussed above), and nutrient availability—particularly molybdenum, copper, and cobalt (discussed later).*
>
> *Rhizobia require a source of energy (carbohydrate) from alfalfa. This comes at some cost to the plant, so alfalfa preferentially uses ammonium- and nitrate-nitrogen in the soil, if available, rather than fixing its own nitrogen. Nitrogen fixation is, however, a very cost-effective way to obtain nitrogen. Given the high nitrogen content of alfalfa (Table 1), fertilizing stands with nitrogen is seldom economical. For long-term production, correcting the underlying problem that is limiting fixation or shifting to non-legume (grass) production is normally more economical than fertilizing alfalfa with nitrogen.*
>
> *Alfalfa is deep-rooted and drought-tolerant, making it well-suited for nitrogen uptake. The crop is commonly used to dispose of waste nitrogen from a variety of industries. At 50–70 lb per ton of hay, alfalfa removes more nitrogen than almost any other crop. When nitrogen is supplied via wastewater or manure, alfalfa preferentially absorbs nitrogen from the soil rather than fixing it from the atmosphere. A reasonable nitrogen application rate for disposal situations is 80% of the nitrogen removed by the hay crop. Fertilizing alfalfa with nitrogen may increase nitrate in the hay, so monitoring is helpful to curtail this problem if necessary.*

Other nitrogen balance studies state that alfalfa adds to nitrogen loading:

1. The Lower Umatilla Basin Groundwater Management Area estimated 45 lb/acre nitrogen remained in the soil profile on alfalfa fields at the end of the season. (Grondin et al, 1995, page I-40)
2. The comprehensive study of groundwater in the Tulare Lake Basin and the Salinas Valley by the University of California at Davis estimated that 2.4% of leaching to groundwater in that area was from alfalfa cropland. (Viers et al, 2012, page 11)
3. In the Sumas Blaine aquifer, about 2% of on-ground nitrogen loading comes from legumes. (Almasri, 2007, pager 277)
4. In the Mississippi Basin, legumes (alfalfa and soybeans) contribute over a million metric tons of nitrogen input every year. (Goolsby and Battaglin, 1997)

Closer to home, the GWMA Deep Soil Sampling found extreme variability in nitrate levels on LYV fields. This sampling clearly shows nitrate leaching from some alfalfa fields in the area.

The table below describes 7 fields where only alfalfa was grown for at least four years. (There were 27 fields in the DSS where alfalfa was grown for some of the preceding four years but other crops were grown on that land as well.) (Please note the higher levels of organic matter in these fields compared to the GWMA average of 2.17 %.)

Table 18 – Nitrate Levels in DSS Alfalfa Fields

Field ID	1 FT	2Ft	3 Ft	4 Ft	5 Ft	6 Ft	Total	Ammonia	Organic
2044	29	152	457	623	706	409	2376	31	3.4
2045	29	4	20	22	13	31	119	25	2.37
2047	113	466	913	951	626	242	3321	21	3.11
2073	36	35	31	38			140	27	2.42
2074	75	55	68	97	94	26	415	26	2.51
4152	25	106	319	279	256	219	1204	26	2.63
4153	17	9	21	21	5	10	83	17	2.62
Averages	46.29	118.14	261.29	290.14	283.33	156.17	1094	24.7	2.72

It is incorrect to state that alfalfa cropland in the LYV does not contribute to the problem of nitrates in groundwater. It is inappropriate to look at agriculture as a whole using only the dairy perspective.

9. Vegetative Buffers: According to the EPA (Helmers et al, 2008)

> *Buffers and filter strips are areas of permanent vegetation located within and between agricultural fields and the water courses to which they drain. These buffers are intended to intercept and slow runoff thereby providing water quality benefits. In addition, in many settings they are intended to intercept shallow groundwater moving through the root zone below the buffer.*

Vegetative buffers reduce runoff of nitrate, phosphate and other pollutants into surface waters. The size of buffers is an ongoing source of disagreement between environmentalists and growers who see buffers as land lost to production. (Wasserman, 2016)

Current extent, cost and benefits of vegetative buffers in the GWMA target area have not been accurately measured. Buffers have not been included in recommended ways to reduce nitrate pollution to the ground and surface waters. Sequestration of nitrate in buffers hs not been measured or estimated.

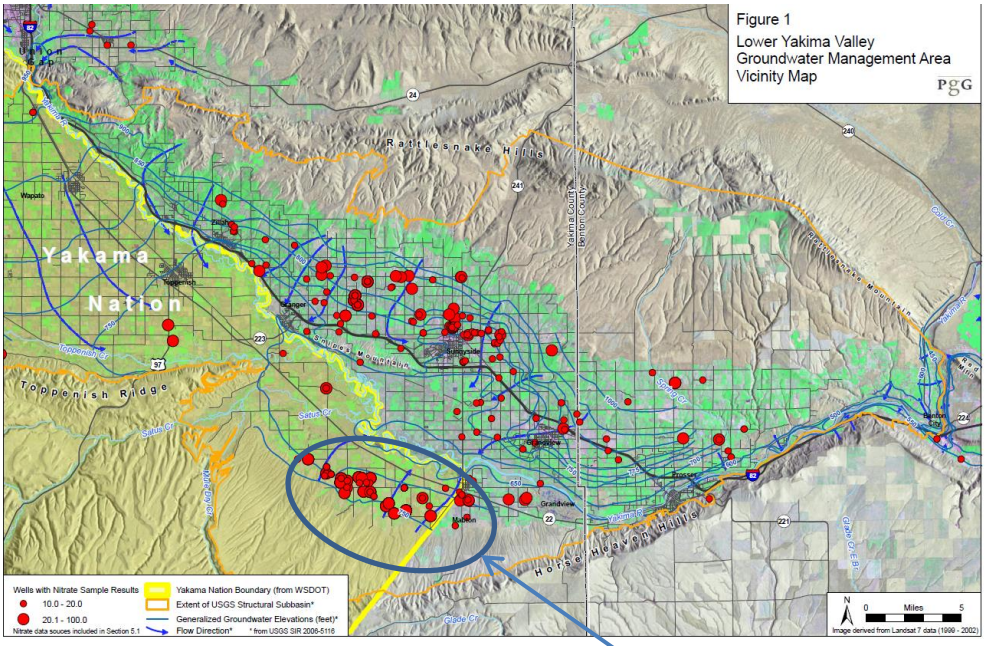
According to the Roza-Sunnyside Joint Board of Control (2010) current recommendations for buffers surrounding irrigation waterways in the LYV are 20 feet. This is almost half the size of the buffer widths recommended by advocates for salmon. Those who worry about fish habitat recommend buffers that are 35 to 50 feet wide. (Wasserman, 2016; EPA 2018)

10. Data sharing between the Yakama Nation and the LYV GWMA: The Yakama Nation is a sovereign government while the LYV GWMA is a temporary project designed to address a specific problem. The Yakama Nation has sent a representative to almost every meeting of the GWAC. He has actively participated in several work groups. The Yakama Nation has chosen to address nitrate problems on the reservation using a separate process, one that does not require public information sharing.

Early investigations demonstrated extensive nitrate contamination of the groundwater in parts of the Yakama Reservation surrounding Satus Creek. Ground water in this area flows in a north and north-easterly direction and eventually reaches the Yakima River. The aquifer here is shallow and water from the reservation travels to non-reservation land.

We suggest a need for sharing of data gathered on the Yakama Reservation with the LYV GWMA. This would require nation to nation agreements.

Map 4. Nitrates in Wells Lower Yakima Valley - 2010



11. Leaching from pens, corrals and compost yards: Multiple small data sets clearly demonstrate leakage of nitrate and ammonia to the vadose zone beneath pens, corrals and compost areas. Some stakeholders from the agricultural community question the reliability of this data. The WSDA chose not to estimate leakage from compost areas in their Nitrogen Availability Assessment (Attachment 32, page 13), in spite of the fact that 2015 WSDA research showed elevated nitrate levels below compost areas (Attachments 13, Attachment 14 & Attachment 15).

Table 8. Nitrate Levels beneath LYV Compost Yards - 2015

Compost Yards		**Nitrate - mg/kg**						
Site	Surface	1 Ft	2 Ft	3 Ft	4 Ft	5 Ft	6 Ft	7 Ft
1C1	364.0	116.3	95.6	82.6	31.1	15.4	15.6	8.3
1C2	292.7	49.8	24.5	28.6	27.1	21.0	19.8	
5C1	159.0	118.8	133.8	225.0	153.9	116.7	28.0	8.5
2Cl	139.0	1.3	6.3	1.0	3.2	1.9	8.5	
2Cu	649.4	30.0	2.2	36.9	150.0	175.1	151.5	
4C1	48.3	164.5	226.1	216.9	222.5	132.1	59.1	
6C	123.2	73.5	34.7	24.7	17.7	9.1		
Average	253.7	79.2	74.7	88.0	86.5	67.3	47.1	8.4
Range	48.3-649.4	1.3-164.5	2.2-226.1	1-216.9	3.2-222.5	1.9-175.1	8.5-151.5	8.3-8.5

With these concerns in mind, it is important to conduct high quality studies that assess movement of nitrogen beneath production areas with different soil types, hydrogeology and histories.

12. Environmental Justice (EJ): The majority of the people who live in the LYV are people of color. Due to language barriers, Yakima County has been under a court order to publish voting materials in both English and Spanish since 2004. (U.S. Dept. of Justice, 2004) The best available information says that a quarter of the LYV population speaks English less than well. (U.S. Census, 2018)

FOTC believes that the GWMA leadership and many members of the GWAC do not understand the foundation for Environmental Justice, the risks of not implementing EJ, or the benefits of implementing EJ. This is evidenced by the fact that Environmental Justice was never referenced in the GWAC meetings and never discussed by the GWAC. Translation from English to Spanish does not equate to communicating in "culturally appropriate" ways. (See Attachment 67 for Economic Impact on Poor Families)

13. Movement of Water and Nitrates in the Vadose Zone: Since the beginning of the GWMA work some stakeholders have made "legacy nitrates" part of the conversation. This

term describes nitrates that have remained in the vadose zone as the result of fertilization that dates back to the 1950's. The amount or distribution of "legacy nitrates" in the GWMA target area has not been quantified. (Vadose zone = area between land surface & aquifers)

International experts on changing nitrogen cycles have attempted to quantify the amount of nitrogen sequestered in typical vadose zones. (Ascott et al, 2017) They argue that conventional nitrogen budgets are incomplete. There are inputs and outputs, but nitrogen also accumulates in "sinks" such as the vadose zone. The amount of nitrogen storage varies depending on travel time, depth to groundwater, soil porosity, years of farming and recharge. In areas that have been cultivated for centuries there are steady states in which inputs may equal outputs. Patterns of nitrogen movement are different in more recently farmed locations compared to regions that have been farmed for centuries.

Ascott et al (2017) state:

> *Storage of nitrate in the vadose zone is one of a number of temporary catchment retention processes such as storage in soil organic matter, subsoils, land not in agricultural production, the riparian zone and in rivers. These possible nitrogen stores and how they change through time (eg, N release through mineralisation of soil organic matter) should also be compared with storage in the vadose zone to determine whether they are significant enough to be incorporated into future nutrient budgets. In combination, these processes will result in substantial delays in the impacts of changes in agricultural management practices on groundwater and surface water quality.*

Some GWMA stakeholders maintain that not all nitrates that leach below the root zone ultimately reach the aquifer. (Attachment 42) They propose that nitrification and denitrification take place and this decreases the impact on the groundwater. Others (Shaw, 2015) state that denitrification is minimal in the well drained soils of the LYV

It is instructive to look at deep soil sampling from LYV operations. Here are the results of DSS with a Geoprobe in the soils beneath a LYV dairy compost yard. Observe that nitrate concentrations in the pore water are very high.

Table 19. Soil and Pore Water Testing Beneath a LYV Compost Yard

Boring ID		Soil							Pore water
		Moisture content		Concentration (C_t)					Concentration (C_w)
	Interval (ft)	Weight (%)	θ_w (-)	Chloride (mg/kg)	Phos (mg/kg)	Ammonia (mg/kg)	Nitrate (mg/kg)	TKN (mg/kg)	Nitrate (mg/L)
DA-SB-02	0-1	20.4	0.388	404	95	12	158	896	775
	1-2	17.3	0.329	243	58	21	72	560	416
	2-3	12.4	0.236	407	14	13	76	448	613
	3-4	11.4	0.217	303	4	8	43	280	377
	4-5	13.8	0.262	374	4	11	160	224	1,159
	5-6	12.7	0.241	320	2	9	252	56	1,984
	6-7	14.6	0.277	282	3	104	403	112	2,760
	7-8	15.1	0.287	257	4	6	466	112	3,086
	8-9	15.2	0.289	220	3	5	464	112	3,053
	9-10	13.8	0.262	150	3	5	322	112	2,333
	10-11	16.9	0.321	324	47	8	226	672	1,337
	13-14	17	0.323	236	3	5	88	224	518
	14-15	20.4	0.388	299	4	4	36	168	176
	15-16	19.8	0.376	247	4	5	29	168	146
	16-17	14.6	0.277	150	8	5	19	336	130
	17-18	13.6	0.258	236	14	5	30	336	221
	18-19	5.9	0.112	87	3	4	11	112	186
	19-20	7.8	0.148	66	2	4	11	168	141
DA-SB-03	0-1	14.4	0.274	135	97	8	43	168	299
	1-2	15.5	0.295	135	31	4	19	560	123
	2-3	14.9	0.283	191	21	4	82	336	550
	3-4	12.5	0.238	303	34	3	117	504	936
	4-5	12.8	0.243	285	2	3	113	224	883
	5-6	13.9	0.264	326	8	3	175	224	1,259
	6-7	17.1	0.325	341	7	4	216	224	1,263
	7-8	17.8	0.338	294	15	4	217	280	1,219
	8-9	13.9	0.264	130	5	4	93	224	669
	9-10	17.6	0.334	119	3	5	117	672	665
	10-11	21.9	0.416	148	4	5	214	168	977
	11-12	20.2	0.384	143	4	2	221	168	1,094
	12-13	19.6	0.372	152	3	4	256	168	1,306
	13-14	17.1	0.325	142	3	7	237	168	1,386
	14-15	19.8	0.376	158	3	5	242	168	1,222
	15-16	17.8	0.338	109	4	4	162	112	910
	16-17	13.5	0.257	89	4	4	101	112	748
	17-18	12	0.228	68	11	5	80	224	667
	18-19	9.1	0.173	86	7	5	98	224	1,077
	19-20	5.5	0.105	0	2	5	46	112	836

From Second Supplemental Report *Community Association for Restoration of the Environment, Inc. and Center for Food Safety, Inc. v. George & Margaret, LLC, George DeRuyter & Son Dairy, LLC, D & A Dairy, and D & A Dairy, LLC.* (Attachment 65)

Farming is relatively recent in the LYV going back about 150 years. The soils are mostly well drained to very well drained. Depth to groundwater is not great due in part to recharge from irrigation.

There are well accepted models that could be applied (UC Davis, 2018; Nolan 2010; Ascott et al, 2017). The USGS has begun work to model the flow of groundwater in the Lower Yakima Valley (Bachman, 2015) and finds that 86% of groundwater reaches the water table within 42 years of application to the land surface, and "Well to water-table travel times for 75.4 percent of the particles were less than the average travel time of 3,749 days."

There are serious conversations within the Yakima Basin Integrated Plan about storing water in the LYV groundwater during periods of high surface water flow, for use later in the year when flows are low and irrigation needs are high. (Personal conversations YRBWEP LYV Groundwater Work Group, Sept. 11, 2018). Sites for groundwater storage must be evaluated for capacity, expected losses, cost to store and cost to retrieve the water. Is there nitrogen in the vadose zone that would leach to the aquifers as a side effect from such a project? That is a worthy question.

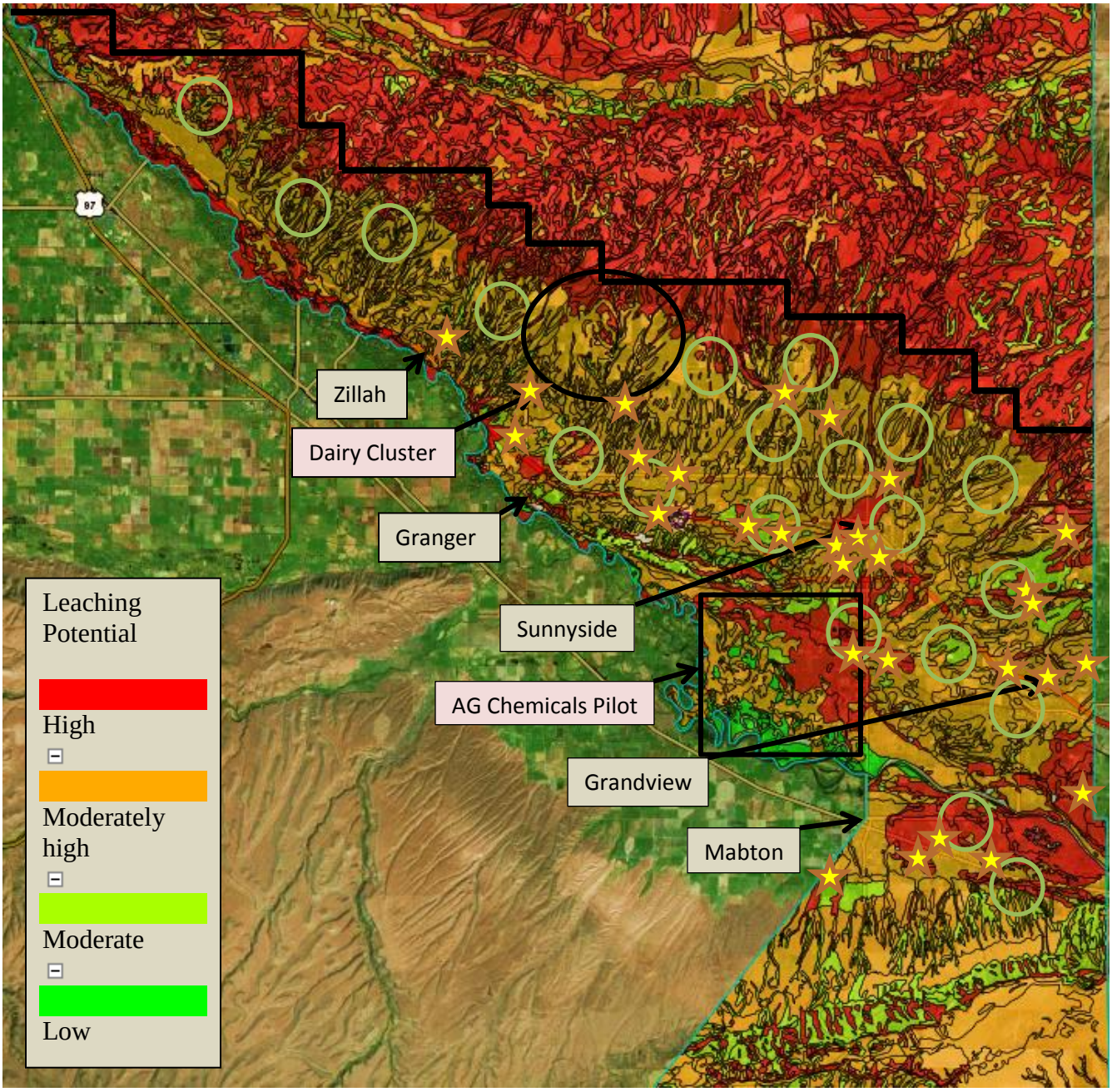
In summary, irrigation has modified groundwater storage in the LYV. Changes in irrigation practices and water storage will impact groundwater flows in the near future. Some nitrogen is sequestered in LYV vadose zones and it would be helpful to model and quantify this process. Due to soil properties and a shallow water table the amount of nitrogen in the vadose zones is not as large as the amounts from regions with deep water tables or poor drainage.

14. Nitrate Leaching for Various Soils in the GWMA:

Soil and groundwater nitrate levels vary across the GWMA. Contributing factors are hydraulic conductivity, soil properties, depth to groundwater, groundwater flow patterns, cropping patterns, and irrigation practices. (See Attachment 66) Nitrate leaching potential is calculated by interpreting the impact from: mean annual precipitation; water travel time through the profile; available water capacity; depth to the water table; slope gradient adjusted for the hydrological soil group; and potential evapotranspiration. (NRCS 2018)

Most of the GWMA target area has leaching potentials in the moderately high and high categories. This information must be part of the long term GWMA program. The map below shows leaching potentials, wells with high nitrates in 2017 and proposed monitoring wells.

Map 17. NRCS Leaching Potentials in the GWMA Target Area

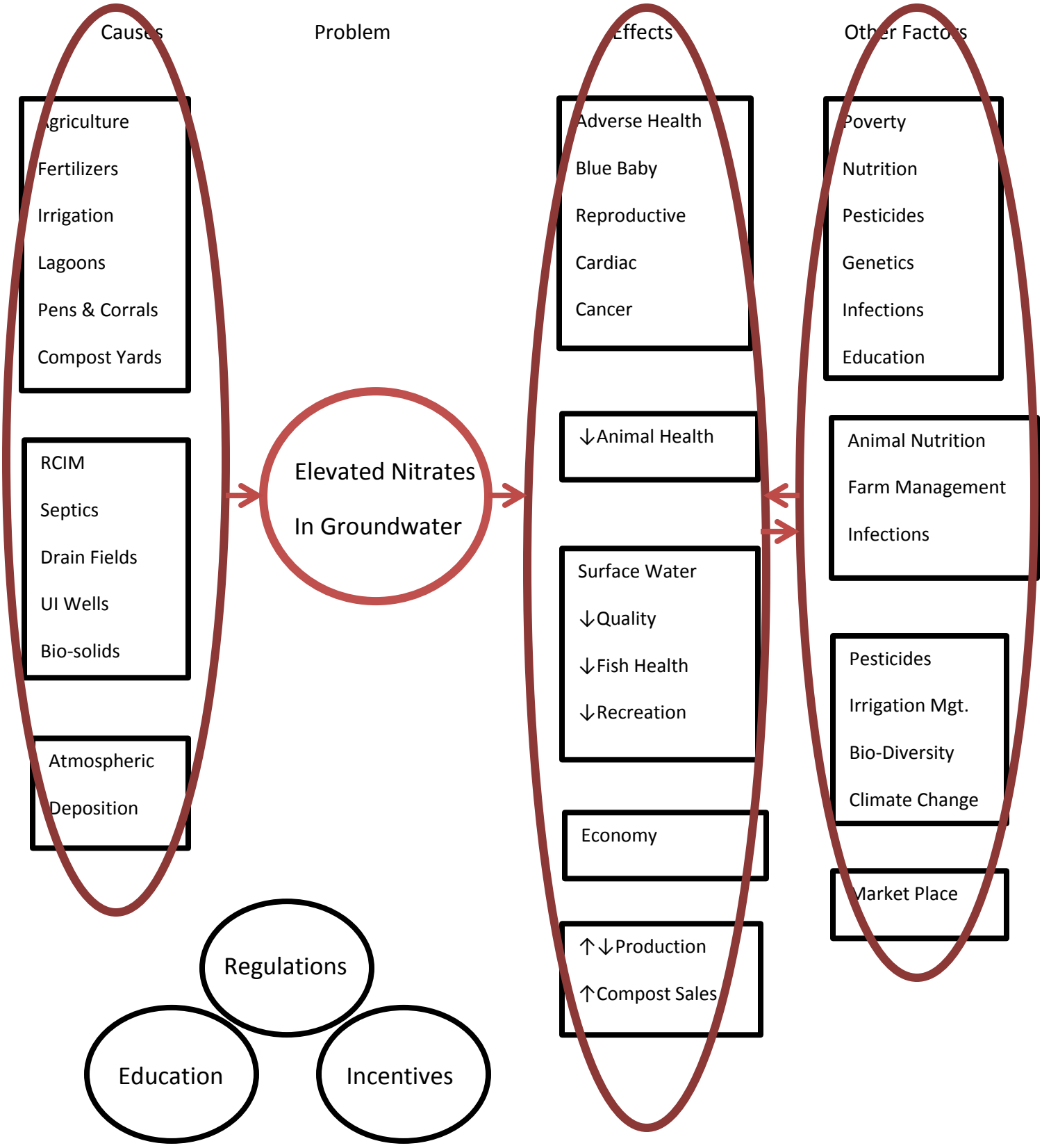


High Nitrate USGS Test Well = ★ Proposed Monitoring Wells = ○

16. Comprehensive Data Base - Central Repository for Analysis of Relevant Data:
FOTC believes that many environmental, economic and public health issues in the LYV are interconnected. We favor robust data gathering and expert analysis of the many causes and effects. In order to do this we need a central repository of relevant data. The GWMA made a timid start, in our opinion. Much more work is needed. (See GWMA Evaluation Plan on page 146 of this Minority Report)

The proposed model below shows potential causes, effects and unanticipated consequences related to elevated groundwater nitrate. This model can be used to identify sources and contributing factors and choose the most effective targets for interventions.

Diagram 3. **Conceptual Model for a Data Base**



Gaps in Regulations

1. Chapter 90.44.050 RCW allows animal agriculture to withdraw unlimited amounts of groundwater for livestock. This law was enacted long before concentrated animal feeding operations came into existence. As a result factory farms can withdraw millions of gallons of water per day while neighbors must ration water and drill deeper and deeper wells.

2. The Dairy Nutrient Management Act (DNMA) does not authorize penalties when dairies do not follow their Nutrient Management Plans (NMPs). Dairies in Washington State must have NMP's in place but there is no requirement for them to follow these plans. Large dairies in Yakima County have ignored their NMP commitments and have polluted the groundwater, often at very high rates. (Tebbutt Law, 2016) And non-enforcement sits at the very center of these dairy related pollution problems in the LYV

In the fall of 2017 David Bowen from Ecology advised the GWAC that the appropriate way to achieve a modification of WA State laws is to write a white paper on a topic and submit it to the appropriate state agency. FOTC followed his advice and wrote a draft letter recommending enforcement of NMP commitments. (See Attachment 33) The draft letter was never brought to the table for GWAC discussion.

3. Non-point source pollution: In order to qualify for section 319 grant funding under the Clean Water Act, Washington must have a plan for controlling non-point source pollution. Work on a plan has stagnated for some time and Washington's plan for control of non-point source pollution has not yet been approved by the EPA. Ecology is currently working on a plan to address non-point sources that will prove acceptable. This draft plan includes the LYV GWMA project as one tool for monitoring and controlling non-point sources. (Rau, 2015)

In *Washington's Water Quality Management Plan to Control Nonpoint Sources of Pollution* Ecology (Rau, 2015) says on page 101:

> *WSDA has been heavily involved with the nitrate groundwater contamination issues in the lower Yakima valley for over a decade. Recent work on the groundwater*

management area (GWMA) included staffing the technical committees and committing resources through an interagency agreement to conduct a comprehensive nitrogen loading assessment. Completion of this assessment will allow members of the GWMA to focus nitrogen management actions on land uses that contribute excess nitrogen most significantly to degradation of groundwater quality in the area.

And on page 112:

In 2011, the Lower Yakima Valley GWMA was formed to address nitrate contamination in groundwater. The GWMA is a response to the elevated nitrate levels found in the Lower Yakima Valley which often exceed the state groundwater standard of 10.0 mg/L. The goal of the Lower Yakima Valley GWMA is to reduce nitrate contamination concentrations in groundwater below state drinking water standards.

Yakima County requested that Ecology recognize the GWMA and provide assistance for helping reduce the nitrate level in the groundwater. Tasks include:

- *Data collection, monitoring and analysis.*
- *Public education and outreach.*
- *Problem identification.*
- *Potential measures or practices for reducing groundwater contamination.*

There is no GWMA Nitrogen Loading Assessment and the most recent Nitrogen Availability Assessment has not been approved. This promised step toward meeting EPA approval of a Non-Point Source Pollution Prevention Plan is in jeopardy.

4. The Yakima County Voluntary Stewardship Work Plan (2017) relies on the LYV GWMA plan to fulfill VSP obligations in the area. The VSP agricultural viability aim on page 89 is to:

Support actions that benefit groundwater quality and agricultural viability

And the associated activity on pages 89 & 98 is to:

Support Lower Yakima Valley Groundwater Management Area (LYGWMA) group outcomes

Under Section 8.1 – Monitoring Tools, the VSP states:

> *In addition to parameters with specific thresholds identified in Appendix G, the Work Group will also consider available monitoring information and trends (e.g., groundwater data collected through the LYGWMA process) to ensure that the Work Plan's goals and benchmarks continue to be consistent with the latest understanding of ecological functions, potential impairments, agricultural practices, and opportunities for critical area protection or enhancement or enhancement of agricultural viability.*

If, as seems likely, the GWMA plan fails to provide monitoring of LYV groundwater quality with a method for evaluating the effectiveness of prevention strategies, then the VSP will lose this tool for evaluation of their program.

5. WAC 173-201A-020 requires Ecology to approve Best Management Practices (BMPs) for protection of Washington waters. To date there is no listing of Ecology approved BMPs.

The history of Ecology's efforts to comply with the law goes back, at least, to 2009 when the department tried to provide clarity for livestock producers on what they were expected to do to protect waters of the state. Ecology developed a guide entitled, *Clean Water Practices for Livestock Grazing,* designed to "satisfy both the legal definition of BMPs and the compliance requirements for nonpoint sources of pollution, as defined by water quality regulations." (Western Environmental Law Center, 2016, page 24).

Some conservations districts and the WA Association of Conservation Districts saw this as an Ecology intrusion into their domain, in spite of the fact that it is a requirement in the law. Since that time the conservation districts have argued that NRCS standards should be used as official BMPs and Ecology has argued that the NRCS standards are guidelines that do not meet the criteria needed for enforcement. ." (Western Environmental Law Center, 2016, page 24). There are currently no Ecology approved BMPs in Washington State.

6. Total Maximum Daily Loads (TMDLs) have not been fully developed for the Lower Yakima River. Specifically there are no TMDLs for nutrients.

Testing of drains in the GWMA target area clearly show significant discharge of nitrogen and phosphate to the river from cropland. (Attachment 28) The Roza Sunnyside Joint Board of Control has conducted research that shows declining concentrations of most major pollutants in the drains and wasteways except for nitrogen. (Zuroske, 2009) Ecology has calculated annual land surface nitrate loading that exceeds 200 kg/km^2/yr for Spring Canyon, Deep Canyon and Sunnyside that lead to high discharge of nutrients to the Yakima River (Whiley, 2015).

If we had TMDLs for nitrogen and phosphorous in place there are regulatory mechanisms that could be used to monitor and address discharge by irrigated parcel. The irrigation districts currently do this for turbidity and total suspended solids. (Roza-Sunnyside Joint Board of Control, 2010)

7. The Memorandum of Understanding between Ecology and the WSDA (Ecology, 2011) is cumbersome and unwieldy with many opportunities for mis-interpretation and mis-application. An outsider needs a road map to navigate the > 70 points of decision-making that specify whether Ecology or WSDA is in charge of a given situation. This MOU is Washington's attempt to comply with the Clean Water Act as it applies to animal agriculture. To our knowledge it has never been approved by the EPA.

In addition it is functionally impossible for the WSDA to adequately perform the inspections allocated to them by the MOU, at least for the lands east of the Cascades where 60% of Washington dairy cows are housed. There is one dairy inspector for Eastern Washington, in spite of the fact that the legislator provided funding for an additional inspector in 2015. (WA State Dairy Nutrient Management Program 2016 & 2017)

LYV residents have filed complaints with WSDA DNMP and those complaints have not been investigated for days, until after the evidence had been flushed away. (Attachment 75)

8. NPDES Permit for CAFOs: State law requires Ecology to issue a new National Pollutant Discharge Elimination System (NPDES) permit for CAFOs every five years. The 2006 permit expired in 2011 and Ecology did not begin constructing a new one until 2015.

The NPDES permit for CAFOs that was issued in early 2017 was challenged before the WA State Pollution Control Hearing Board (PCHB) by the WA State Dairy Federation, the Washington Farm Bureau and a coalition of seven environmental groups. Concerns are detailed at http://www.eluho.wa.gov/Decision/Search_Cases Closing arguments can be seen by video at the City of Yakima website: http://205.172.45.10/CablecastPublicSite/show/8763?channel=1

The WA Dairy Federation (WDF) and the WA Farm Bureau (WFB) argued:

1. Ecology has changed depth to groundwater requirements by measuring from the bottom of lagoon liners instead of the top.
2. The Economic Impact Analysis did not adequately account for all costs of compliance with the NPDES permit for CAFOs
3. The plan underestimates the costs of soil sampling
4. The permits do not provide for a stable and predictable business climate

Ecology disagrees.

Environmental Groups argued:

1. Without groundwater monitoring it is impossible to determine effluent limitations for groundwater
2. The NPDES permits for CAFOs violate Washington's anti-degradation requirements
3. The permits violate Washington's AKART (all available known and reasonable technology) requirements for lagoon construction.
4. The permits violate the anti-backsliding provision of the Clean Water Act

Ecology disagrees.

The PCHB found in favor of Ecology on all counts except #1 for the WDF and WFB above. Both industry and the environmental groups are appealing this decision.

In the meantime only 23 of the 450 plus dairies in Washington State are covered by NPDES permits, the approved way to manage pollution from concentrated animal feeding operations. In Yakima County only 5 out of approximately 60 dairies are covered by an NPDES permit. These five have chosen the State Only General Permit that does not fall

under the Clean Water Act, does not address discharge to surface waters and has no provisions for citizen enforcement. (WA State Dept. of Ecology, 2018) Since regulators must prove discharge to waters of the state in order to require an NPDES permit (Ecology 2017a) and there is no groundwater monitoring it is difficult to bring dairies into the program.

9. WAC 173-350-220 provides guidance for management of composting facilities, including composting of manures. Section (1) (b) provides exemptions for certain operations that process agricultural wastes, manure and bedding from zoos and bulking agents. These operations must secure exemptions from Ecology and must report monitoring and record keeping to local health districts. Based on the results of public records requests FOTC believes that manure composting operations in the Yakima Valley are not complying with the law. In PRR responses Ecology stated that only one dairy in the LYV has applied for an exemption and the Yakima Health District had annual reports from only one LYV dairy. (Documents available on request)

In addition, the South Yakima Conservation District has stated in a meeting of the GWMA Regulatory Work Group that it is acceptable to compost on bare ground. Dan DeGroot, a member of the GWAC and a dairyman, stated that Ecology told him compaction from movement of vehicles was sufficient to prevent discharge to the aquifer. (LYV GWMA Regulatory WG Meeting, November, 2016)

No agency appears to take responsibility for groundwater pollution related to composting, in spite of the fact that leaching from compost yards is well-documented. (Attachments 13, Attachment 14 & Attachment 15)

10. Tax on Water: Since 2017 Washington residents have been required to pay a tax on bottled water. (WA Dept. of Revenue, 2017). There are very cumbersome exemptions for people areas such as the LYV where there is no readily available source of potable water. These exemptions are not well publicized and it would be cost prohibitive to publicize them.

Being forced to purchase water when groundwater is unsafe and the responsible agencies do nothing is already an unacknowledged tax. Addition of an official tax is a cruel abuse of low income people who have no way to complain.

A reasonable change to the law is an exemption for entire communities when nitrates in groundwater exceed 10 mg/L for > 10% of domestic wells. This would require changes to RCW 82.12, RCW 82.32, RCW 82.04, and RCW 82.14

11. WAC 16-06-210 (29) states:

> *Under RCW 42.56.610 and 90.64.190, information identifying the number of animals; volume of livestock nutrients generated; number of acres covered by the plan or used for land application of livestock nutrients; livestock nutrients transferred to other persons; and crop yields in plans, records, and reports obtained by state and local agencies from dairies, animal feeding operations, and concentrated animal feeding operations not required to apply for a National Pollutant Discharge Elimination System permit is disclosable in the following ranges:*

For simplicity only the ranges for dairy heifers are provided here:

> *(c) Number of animals: Dairy heifers*
> *1 to 49*
> *50 to 149*
> *150 to 299*
> *300 to 999*
> *1,000 to 1,999*
> *2,000 to 2,999*
> *3,000 to 3,999*
> *4,000 and above*

These ranges are so large that a citizen who wishes to investigate potential for pollution cannot make reasonable calculations about manure production and availability of cropland for manure disposal. Citizens have the right to protect ourselves from pollution and WAC

16-06, as currently written makes it very difficult to exercise that right by accessing accurate data. (Barton, 2017; Wishart, 2017)

12. WAC 173-224-040 Permit fee schedule provides the following fees for NPDES permits for concentrated animal feeding operations (CAFOs):

Concentrated Animal Feeding Operation – Fee per Year	2018	2019
a. < 200 Animal Units	264.00	279.00
b. 200 - < 400 Animal Units	663.00	700.00
c. 400 - < 600 Animal Units	1,327.00	1,401.00
d. 600 - < 800 Animal Units	1,990.00	2,101.00
e. 800 Animal Units and greater	2,657.00	2,805.00
Dairies $.50 per Animal Unit not to exceed $1,776.00 for FY 2018 and $1,875.00 for FY 2018 & beyond		

Thus a dairy with 400 animal units would pay $200 per year instead of the $663 per year that a beef operation pays. A dairy with 800 animal units would pay $1,600 per year instead of the $2,657 per year that a beef operation would pay. A 1,000 head dairy would pay the same permit fees as a 10,000 head dairy. This does not seem fair to us and validates our fears that policy makers favor larger businesses and certain forms of agriculture, especially dairy, over others.

13. Reporting of emissions from CAFOs. Based on simple estimates of average emissions from cows it is easy to show that the amounts of ammonia and other hazardous compounds emitted by CAFOs would trigger reporting requirements if they came from warehouses or factories. (See WAC 173-460). However, recent federal legislation rejects reporting requirements under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the Emergency Planning & Community Right-to-Know Act (EPCRA). (EPA, 2018) Thus people in Yakima County have great difficulty calculating an accurate Nitrogen Balance.

14. Reporting of manure applications to non-dairy fields. Under RCW 90.64, the Dairy Nutrient Management Act (DNMA), dairymen must report the amount of manure applied to fields under their control, along with the nutrient content of the manures. If manure is sold

to a neighboring farmer and applied to land not controlled by the dairy there is no requirement or mechanism for monitoring the amount of application, timing of application or nutrient content. There is no requirement for soil testing on non-dairy cropland.

15. Yakima County Code: With 35% of all dairy animals housed in Yakima County, there is a great need for a clear definition of confined animal feeding operations and appropriate regulations to address public health issues associated with this form of animal agriculture. (See further discussion under Viable Alternative Solutions, page 128)

The Yakima County Code requires permits for new construction. Concentrated animal feeding operations (CAFOs) are allowed in agriculture zoned areas under a Type II administrative review. (See 19.14.010 Allowable Land Use Table. (Yakima County, n.d.))

There is a LYV dairy with a NMP that was approved in 1995 and updated in 2013. The dairy currently has about 3,000 milk cows. In 2017, in order to make certain capital improvements, construction permits from Yakima County were needed. The permit application revealed that the CAFO had never obtained the appropriate land use permits. The dairy simply started as a small operation and gradually added cows.
Here is an excerpt from the permit application:

> *The castle grove dairy is a concentrated animal feeding operation (CAFO) in the AG land use zone. Chapter 15 of YCC requires a Type II review and a conditional use permit. Prior to this set of capital improvements, castle grove has not needed to obtain these land use permits.*
>
> *It is not uncommon for dairies in Yakima Valley to be operating without the proper land uses permits. Many dairies began as small operations and grew to CAFO status without triggering a review by the Yakima County Planning Department. But when capital improvement require building permits, the building permits force the land use permits.* (See Attachment 56)

To be clear, in 2017 there was at least one large dairy in Yakima County that had never applied for or received the proper land use permits to operate as a CAFO.

Ecological Perspective/Sustainability - Everything is Connected

It is important to listen to the people on the ground. Farmers, and others, are dependent on weather, people, insects, microbes, research and politics. Sooner or later one more gallon of water will overtop a dike, leading to a flood of family homes, leading to an illness that causes a mother to lose her job, and so on ad infinitum. It is in everyone's best interests to watch out for each other. There is a lot to contemplate. Actions have consequences.

There is a member of the gWAC who tells a great story about seeing the whole picture.

> *There was an intelligent and affluent man who had the opportunity to buy a very large acreage in an area that was well suited for growing wine grapes. The man chose the perfect variety; planned to cover his land with this type of grapes and make a huge profit.*
>
> *The story teller gently pointed out that there was one major flaw in the plan. All the grapes would ripen at the same time and it is impossible to bring in a thousand pickers for just a few days of work.*

Jon DeVaney from the WA State Tree Fruit Association tells audiences that one of the strengths of agriculture in the Yakima Valley is a diversity of crops. Because of the variety of apples planted here harvest lasts from late July to after Thanksgiving. (DeVaney, 2018)

Change in one part of the valley has a ripple effect in other areas. If we take actions to reduce nitrate in groundwater we need to look at the side effects from our actions. For example:

1. Is it cost effective; is it reasonable to make all farmers test their soils?
2. Do certain subsidies help one set of farmers and make competing harder for others?
3. How does runoff impact the fish population?
4. If we spend public monies on nitrates does that mean less funding for our schools?
5. Should we improve water quality at the expense of air quality?
6. Does poor air quality affect the crops? The forests? Our lives?
7. Who bears the burden when cities and towns must drill new and deeper wells

Special Issues

Some issues are hard to classify but nevertheless important. These discussions are introduced here.

Discrimination/Marginalization: Prior to the first GWMA meeting the Friends of Toppenish Creek set up a meeting between Commissioner Rand Elliott and three women of color from Radio KDNA. The hope was that one of the three would be invited to sit on the GWMA advisory committee. The Commissioner never arrived. He forgot to put the meeting on his calendar. There was no invitation.

At the March, 2013 meeting of the GWAC, a citizen, a man of color, asked for help because manure from a neighboring dairy was flowing onto his property and contaminating his septic field. He was referred to the Yakima Health District and that agency subsequently condemned his home.

In the fall of 2014 FOTC and two Latina leaders from El Proyecto Bienestar introduced a professor from the University Of Washington School Of Public Health to the GWMA Education and Public Outreach Work Group. The group worked with her to develop a project in which graduate students from the university would assist the GWMA EPO to investigate abandoned wells. Two dairy members from the EPO argued against the project and convinced the GWAC to reject it.

On April 23, 2015 the GWMA Regulatory Work Group met at the Conference Room for District Court Probation Offices in Yakima. Friends of Toppenish brought a videographer to tape the meeting. The videographer happened to be a young Yakama woman. When she went to use the rest room the Yakima County staff told her she could not use the facilities. She then walked down the street to use the restroom at McDonalds. Although the GWAC and Yakima County were informed about the incident there was no effort to make contact and no apology.

On October 20, 2016 Ecology and the Dept of Health provided a one hour “Groundwater Primer” and demonstration of groundwater flow using a sand tank. FOTC asked to have this

demonstration provided in Spanish. The answer was “yes” but that demonstration never took place.

In the fall of 2017 and the spring of 2016 FOTC and a representative from the Latino Community Fund met with the Yakima County Director of Public Services twice to explain why the GWMA should pursue a project to educate the Spanish speaking community about basic groundwater concepts such as “agronomic rates”, “groundwater flow”, “vadose zone”, etc. FOTC put together some proposed informational leaflets in Spanish. The suggestion was never even put on the EPO agenda for discussion.

The GWMA Livestock/CAFO BMPs are not really BMPs:

WAC 173-200-020(5) defines

> *"Best management practices" or "BMPs" mean schedules of activities, prohibitions of practices, maintenance of procedures, and other management practices, to prevent or reduce the pollution of groundwaters of the state. BMPs also include treatment requirements, operating procedures and practices to control plant site runoff, spillage or leaks, sludge or water disposal, or drainage from raw material storage.*

This is a legal definition that is used to enforce the chapter 90.48 RCW, the Water Pollution Control Act and chapter 90.54 RCW, the Water Resources Act of 1971.

NRCS Conservation Practices are voluntary guidelines designed to advise growers and producers how to best promote conservation. NRCS Conservation Practices are not BMP’s and are not designed for regulation. (NRCS, nd)

The GWMA CAFO/Livestock Work Group chose to recommend the NRCS standards in place of BMP’s. It is incorrect to label them as BMP’s.

Tale of Two Lagoons

In Snohomish County the Tulalip Indian Tribe has partnered with dairymen and power plants to develop a manure digester that transforms effluent from thousands of cows into

electricity and keeps the nutrients out of the Skykomish/Snohomish River. The digester breaks even financially but the water is protected. (Northwest Indian Fisheries Commission, 2009; personal communication Darryl Williams, 2017)

In the Yakima Valley there is a private manure digester, financed in large part by public monies, that is being re-fitted to produce bio-gas, again using public monies. The rationale for abandoning the original plan is that producing electricity was not sufficiently profitable for the dairy. (Fletcher, 2014)

Our point is that goals are important. The goal of making money requires a different mindset than the goal of protecting the waters.

Bureaucratic Inefficiency. Several years ago, some of the local people on the GWAC observed that the process was moving very slowly. One of the bureaucrats from Olympia joked that "At least it means job security". (Some people are paid for their work on the GWMA, others are not.). At the rate we are going the aquifers of the LYV will not recover.

Here is a timeline for major events regarding regulation of discharges to water of the state by dairies in Washington:

1992: Stakeholders develop "Protecting Groundwater: A Strategy for Managing Agricultural Pesticides and Nutrients"

1998: Passage of RCW 90.64 the Dairy Nutrient Management Act. Inspections are done by Ecology

2002: Close to 100 dairies are under NPDES permits. There are 7 inspectors

2003: Inspections turned over to WSDA. Number of inspectors reduced to 2 ½

2004: WSDA notes that only 15% of producers are keeping records

2005: Water quality issues in the Yakima Valley brought up through complaints

2006: Ecology issues a new NPDES permit for CAFO's

2008: "Hidden Wells, Dirty Water" published in the Yakima Herald Republic

2009: Legislation makes it a violation of the statute not to keep records

2010: Legislation establishes a penalty for not keeping records

2011: CAFO NPDES permit expires

2012: The LYV GWMA begins. The goal is to reduce nitrates in the groundwater within five years.

2015: Ecology begins work on a new CAFO NPDES permit. There has been no permit in place for four years.

2015: WSDA informs the legislature of the need to enforce dairy nutrient management plans. No action is taken.

2017: A new CAFO NPDES permit is issued. Less than 25 dairies statewide are under permit.

2018: The LYV GWMA has not yet approved a plan. Reducing nitrates in groundwater "will take decades".

(See Attachment 74 & Attachment 76 for more details)

What Will Happen if We Do Nothing?

Based on the above Characterization of the LYV GWMA target area, along with trends from the U.S. Census and the National Agricultural Statistics Service there are potential outcomes and/or scenarios of what the LYV will look like in 25 years if we do nothing different.

Water Quantity

Assumptions/predictions/estimates for the next 22 - 24 years are:

1. At current rates the population will increase at about 1% per year from a current estimate of 50,000 to 62,002 in the year 2040.
2. Demand for water for humans will increase from 5 million gallons per day in 2015 to 6.20 million gallons per day in 2040.
3. Most of the people will live in the smaller cities. About a third will be < 18 years of age. The poverty level will be higher than the state or the county level as a whole and the educational level will be lower than the state or the county level as a whole.
4. There will be a need for about 8,000 more jobs, assuming a 60% rate of participation in the labor force (U.S. Census, 2018)
5. Land in farming will stay about the same and land under irrigation will stay about the same at 96,000 to 99,000 acres. (McClain, 2015)
6. The number of farms will decrease by 1% per year – for Yakima County as a whole from 3,143 in 2012 to 2,200 in 2042
7. Farms will continue to enlarge. (Already two very large dairies in the LYV are owned by out of state investors.)
8. Land in grapes and hops may increase. (Attachment 42, page 3) (We do not have hard data from USDA.}
9. If the amount of land in orchards continues to decrease at a rate of .32% per year the land in apples will decrease from the current level of 17,333 acres to 15,990 in 2042
10. If the amount of land in orchards continues to decrease at a rate of .32% per year the land in cherries will decrease from the current level of 6,336 acres to 5,845 acres in 2042

11. The GWMA target area cannot sustain the present rate of increase of 6.6% per year for land planted in grain corn or 9.4% per year for land planted in corn silage. At this rate, in 25 years, the amount of land planted in corn would exceed the total irrigated acreage for the GWMA target area.
12. At current rates of change, by the year 2042 there will be 248,837 cows and calves, plus 188,776 milk cows in Yakima County, mostly in the LYV. The demand for water for cows will increase from 11,544,510 gallons per day in 2012 to 23,003,330 gallons per day in 2042.
13. In the next 25 years demand for groundwater will change:
    a. Increased demand for people – about 1.38 million more gallons per day (LYV)
    b. Increased demand for animals – about 11.5 million more gallons per day (All of Yakima County)
    c. Improved efficiency due to methods such as drip irrigation and canal lining will reduce demand and reduce recharge
    d. Increased demand for irrigation water due to double cropping
    e. Increased demand for emergency groundwater withdrawals due to increased frequency of drought years
    f. In many parts of the GWMA target area water tables will decline

Although the shallow, unconfined aquifers in the LYV remain stable at this time, the deeper basalt aquifers are declining at an average rate of 2.19 ft per year, according to Ecology (2018d)

Water Quality:

When the GWMA first met in 2012 the best estimates said that about 12% of domestic wells in the LYV had nitrate levels > 10 mg/L. (Attachment 2) The GWMA asked the Pacific Groundwater Group (PgG) to explore these numbers in more depth. Their study *Potential Groundwater Monitoring Stations Yakima Groundwater Management Area* (See First

Quarterly GWMA Report, 2014, page 100/162) found steadily increasing levels of nitrates in the area, based on analysis of all well water testing grouped by years.

Table 3. Nitrate Levels and Trends in the GWMA Target Area: 1975 - 2014

Date Range	Number of Wells	Mean Nitrate	Median Nitrate	Standard Deviation
1975 -1979	4	1.45	1.1	1.66
1980 - 1984	51	3.48	1.7	4.1
1985 - 1989	40	3.33	1.8	3.63
1990 - 1994	76	3.52	2.6	3.89
1995 - 1999	69	4.06	3.9	3.29
2000 - 2004	295	6.36	4	8.56
2005 - 2009	90	4.74	4.44	3.6
2010 - 2014	323	13.51	11.5	11.17

For readers who are unfamiliar with statistical analysis half of the numbers in a data set are above the median and half are below. This means that for the studies done between 2010 and 2014 half of the samples had nitrates > 11.5 mg/L.

This observation is not definitive. In 2017 the GWMA contracted with the USGS to sample 156 voluntarily submitted domestic wells in the target area. That study found 19.7% of wells had nitrate levels > 10 mg/L. (Huffman, 2018) In the GWMA High Risk Well Assessment 15% of wells had nitrate levels > 10 mg/L. In any case, water quality appears to be worsening in the LYV.

The GWAC has intuitively assumed that the most impacted aquifers are the shallower aquifers. This is not totally true. (See Attachment 28) The study, *Potential Groundwater Monitoring Stations Yakima Groundwater Management Area,* found data from 22 GWMA area wells that are deeper than 1,000 feet. Four of these wells or 18% had maximum nitrate levels > 10 mg/L.

One way to understand the rise in nitrate levels is to analyze “hot spots” or areas with very high nitrate levels. At this point in time the most visible and best studied “hot spot” in the

area is a “dairy cluster” that is under consent decree with the Environmental Protection Agency for remediation. This is an approximately 12 square mile area north of the unincorporated community of Outlook. There are five dairies in the cluster and they house about 24,000 animals. Initial well water testing down gradient from the cluster found that 61% of domestic wells had nitrate levels > 10 mg/L. (EPA Region X, 2014 & 2016)

Since 2013 the EPA has been working with the dairies on implementing best management practices designed to improve water quality. Part of this work involves quarterly testing of water from a system of 23 monitoring wells. This ongoing study will assess the impact of BMP’s for animal agriculture and cropland. (EPA Region X, 2014 & 2016)

The 2016 EPA Progress Update stated:

> *In the third quarter of 2013, the first quarter that the dairies conducted groundwater sampling, nitrate concentrations in seven of the downgradient wells were less than the MCL of 10 ppm; nitrate concentrations in 15 of the wells exceeded the MCL. The nitrate concentrations in the wells that exceeded the MCL ranged from 12 ppm to 166 ppm.*
>
> *Two years later, in the third quarter of 2015, nitrate concentrations in seven of the downgradient monitoring wells were less than the MCL; nitrate concentrations in 14 of the wells exceeded the MCL; no sample could be taken from one groundwater monitoring well. The nitrate concentrations in the downgradient wells that exceeded the MCL ranged from 14 ppm to 180 ppm.*

Remediation of aquifers near “hot spots” does not happen quickly. There are at least six other areas in the LYV GWMA target area with high concentrations of dairies and milk cows. The WSDA Dairy Nutrient Management Program has been in place since the late 1990’s and appears unable to prevent the related groundwater pollution.

<u>Groundwater quality in the LYV GWMA is worsening. Current efforts to address the problem are not working. If we do nothing different the future will bring falling aquifers with increasingly polluted water.</u>

Worst Case Scenario – Concentrated Animal Feeding Operations take over the Lower Yakima Valley

Data from the National Agricultural Statistics Service indicates a 25 year trend toward more dairy cows (see above) and more land planted in forage crops.

Table 20. Percentage of Land by Crop Type in Yakima County

Crop Type		1987	1992	1997	2002	2007	2012
Grain Corn		3%	4%	5%	5%	6%	6%
Total Forage – Corn Silage, Alfalfa, Hay		15%	14%	16%	26%	29%	30%
Vegetables		9%	8%	7%	6%	4%	3%
Orchards		39%	38%	40%	37%	36%	39%
Other		34%	36%	32%	26%	25%	22%

If these trends continue we could see a community defined by concentrated animal feeding operations (CAFOs). The adverse consequences to communities from CAFOs have been clearly documented in other parts of the country. (PEW Commission, 2008; American Public Health Association, 2003; National Association of Local Boards of Health, 2010)

Number and Size of Dairies: In the 2016 *WSDA Dairy Nutrient Management Program Implementation of Nutrient Management Training Program for Farmers Report to the Legislature,* the agency stated that Yakima County had 69 dairies in 2014 and 62 dairies in 2016. (WSDA, 2016) This is a decrease of about 3.5 dairies per year. WSDA (2017) also states that, during the 43 years from 1969 to 2012, the number of dairies in Yakima County decreased from 301 to 97, a loss of 4.7 dairies per year.

If the LYV loses 4 dairies per year we would predict no dairies at all in the LYV in 25 years. At a decrease of 2 dairies per year there would be 12 dairies remaining in 25 years. These are no longer family farms where the children help with the work after school and show calves at the county fair. These are factory farms where each cow has a number and lives or dies based on how much milk she produces.

Number of Milk Cows: If trends continue (and this is a big if) there will be ~189,000 milk cows in the GWMA target area in 25 years. This equates to 12 mega dairies with ~15,000 cows per dairy.

Change in Land Usage: This approximate doubling of dairy cow numbers would increase the acreage in pens and compost to 5,200 acres and lagoon acreage to well over 420 acres. (WSDA, 2018) In order to feed this number of animals the land in corn silage and forage must approximately double.

There are well documented benefits from agricultural diversity including the ability to better manage soils, enhanced disease/pest resistance, agility in a fluid market place, protection of the environment, and protecting bio-diversity in general. Historically, the Yakima Valley has been well-known for and benefited from a diversity of crops. (DeVaney, 2018) Planting more land in corn reduces these benefits.

Adverse Side Effects: Some of the adverse side effects from an increase in CAFOs are:

1. Increased withdrawal of groundwater
2. Increased groundwater pollution assuming that the regulatory climate is unchanged
3. Increased nitrogenous and other emissions to the ambient air (Rotz, 2004)
4. Decreased employment opportunities (Community Attributes Inc, 2015, pp 7 & 8)
5. Depressed local economy (PEW Commission, 2009)
6. Increased adverse health impacts (American Public Health Association 2003; National Association of Local Boards of Health, 2010)
7. Decreased quality of life (PEW Commission, 2009)

Future Costs of Drinking Water Treatment for Rural Areas & Municipalities

Known methods of addressing nitrate pollution of drinking water include:

- Connecting smaller water systems with nearby larger water systems
- Consolidating smaller waters systems into larger regional water systems
- Installing groundwater community treatment

- Drilling new wells
- Blending sources
- Providing and maintaining point of use treatment for households

(Harter et al, 2012)

Drinking water costs for rural populations that are impacted by nitrate pollution are high and are increasing across the nation. For example:

Harter et al (2017) devoted Technical Report 7 to analysis of drinking water supply options in central California. This comprehensive study concluded that

> *The overall cost of providing nitrate-compliant drinking water to the currently affected population in the Tulare Lake Basin and Salinas Valley is estimated to be about $20 million per year for the short-term and about $36 million per year for the long-term. Roughly $17 to $34 million per year of this estimate is for community public water system users for the short- to long-term, respectively, and about $2.5 million is for providing and maintaining point-of-use treatment for household self-supplied or local small water system users. To put this funding need in perspective, the overall costs correspond to $80 to $142 per year per susceptible person, $5 to $9 per study area irrigated acre per year, or $100 to $180 per ton of fertilizer nitrogen applied, for the short- to long-term, respectively.*

Vedachalam, Mandelia and Heath (2018) studied three municipal water treatment sites in Iowa and Illinois in order to estimate treatment costs for bringing nitrate levels down to drinking water standards. At these sites, less costly options such as blending high nitrate water with low nitrate water were no longer viable. This study emphasized that lowering nitrate levels in the groundwater is more cost effective than removing nitrate through water treatment. The study found

> *Capital expense is a significant component of the overall cost of nitrate treatment at the three utilities. Amortized capital cost of the treatment unit outweighed annual operations and maintenance (O&M) costs, except in Des Moines, which experienced*

heavy use of its treatment unit, especially in the latter half of the study period. A review of capital cost data from 10 other locations, in addition to the three study utilities, showed a scale effect: the cost per unit volume at the largest utility was orders of magnitude lower than that at much smaller ones. This suggests that smaller utilities face an undue burden of nitrate pollution in drinking water sources. A lack of robust data precluded any conclusions on O&M costs, but limited data from Des Moines and Decatur showed that in years when influent nitrate levels were the highest, the utilities spent 9 percent and 4 percent, respectively, of their overall operating budget on nitrate treatment.

Consider the small town of Pretty Prairie, Kansas, population 650. That town has embarked on a $2.4 million project to remove nitrates that are double the safe standard. The town's annual budget is $1.2 million. (Walton, 2017)

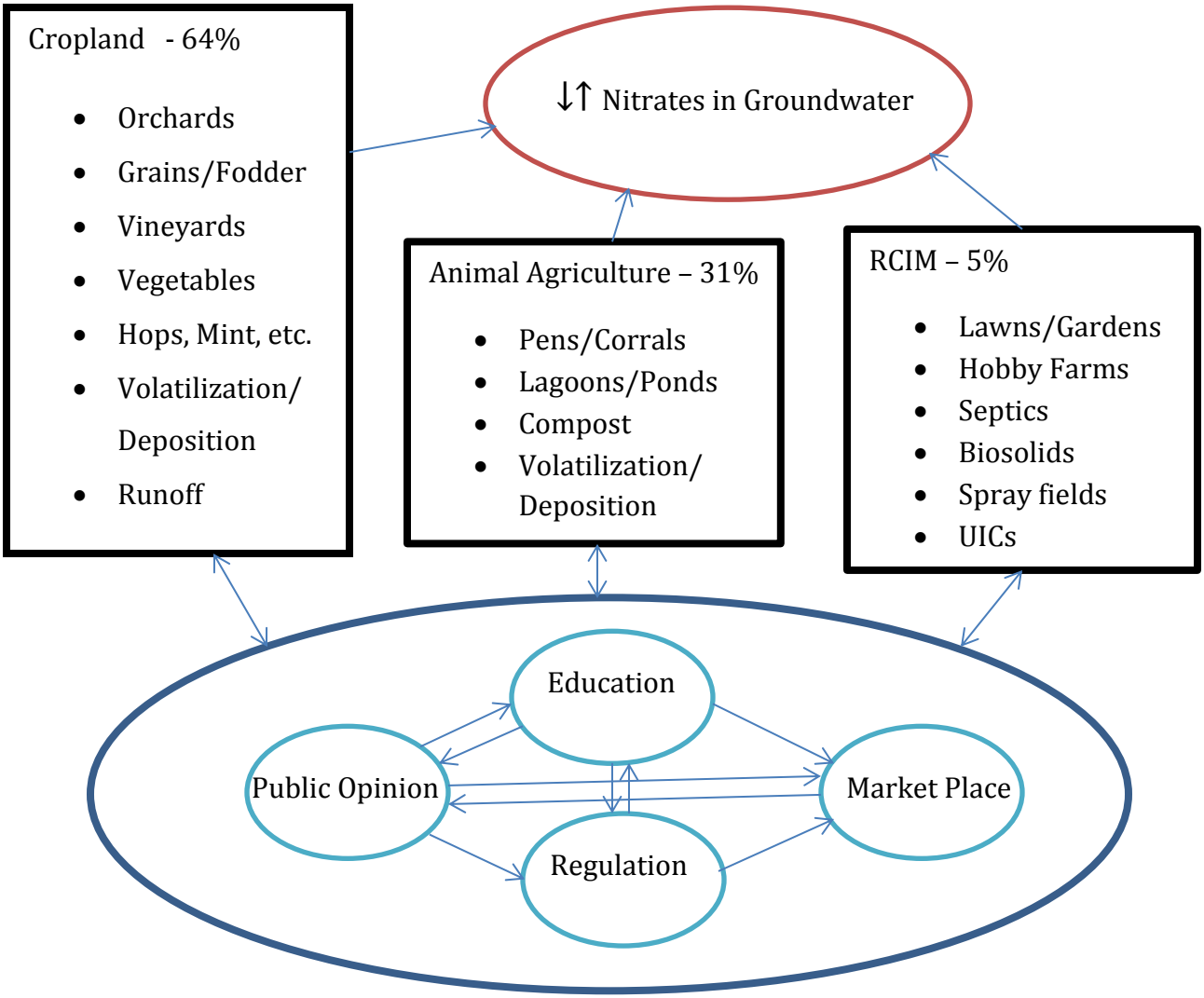
In the LYV Grandview is already blending water in order to deliver drinking water with safe nitrate levels. The City of Mabton and the Outlook Elementary School have been forced to drill new wells. (Attachment 36 & Attachment 57) FOTC estimates that vulnerable people in the LYV spend over $1 million per year on bottled water (Attachment 26).

Costs to the tax paying public will increase significantly if LYV municipalities are required to install reverse osmosis treatments. "Building a treatment facility can cost a mid-sized city $10 million to $15 million." (Walton, 2018)

Water Quantity and Quality Goals

To review, here is the conceptual framework from page 66 - *Relationships between sources, nitrate pollution of groundwater and solutions*

Diagram 2.



It is odd for a single stakeholder to propose goals and objectives. But FOTC will make some suggestions for Water Quality Goals based on the above understanding of relationships.

Overarching Goal: Reduce Nitrates in Lower Yakima Valley Groundwater to Safe Levels of < 10 mg/L

Pollution prevention will be a guiding principle

1. Everyone who lives in the LYV will have access to safe and affordable drinking water. No one will pay more than 2% of their income for bottled water.

2. People who live in the Lower Yakima Valley will be engaged and involved in programs to reduce nitrates in groundwater

3. There will be no more "bureaucratic runaround". When people call authorities they will receive accurate and helpful information.

4. The LYV aquifers will show decreasing nitrate levels beginning in 2020. The aquifers will reach safe levels by 2030

5. Soil nitrate levels below the root zone on LYV cropland will be < 15 ppm

6. There will be no leaching of nitrate below animal pens & corrals, lagoons & ponds, or compost yards

7. Volatilization of nitrogen from production areas and cropland will be quantified and controlled

8. Costs for cleanup of the LYV aquifers will be borne by those who pollute

Currently Available Management Strategies

Best Management Practices: In 2013 the GWMA contracted with HDR Engineering to compile a summary of recommended best management practices (BMPs) for irrigated cropland; livestock operations; turf grass and urban landscaping; industrial and municipal land application of wastewater, sewer leakage and septic systems. Those BMPs are available in Attachment 37. Many have been promoted for years and many have delivered impressive results. For example BMPs for irrigation management have been implemented in the LYV and the result is reduced runoff, reduced turbidity in runoff and reduced total suspended solids in runoff. (Roza-Sunnyside Joint Board of Control, 2010) NRCS promotes these practices and others through cost sharing and incentives.

Recommended conservation practices for dairies have been shared and encouraged by the WSDA Dairy Nutrient Management Program with an annual budget over $600,000 (WSDA, 2018) and the South Conservation District with an annual budget of $247,000. (WA CC, 2018)

Public Health: The Yakima Health District with an annual budget of $6 million has a mandate to address, among other things:

1. Water and Vector-borne Disease Services
2. Solid and Hazardous Waste Services
3. Waste Water Treatment Services

The WA Dept of Health inspects and regulates public water systems and waste water management systems. The WA State Dept of Ecology is responsible for water quality, waste and toxics in the state. Ecology has authority over NPDES permits, abandoned wells, underground injection control wells, implementation of the CWA (with delegation of dairy policy to WSDA), composting operations, regulation of bio-solids, and industrial waste water treatment.

Zoning: Yakima County has authority under the State Environmental Policy Act, the Subdivisions Act, the Growth Management Act and Local Project Review to control zoning in the county for the benefit of present and future generations.

Promising Alternative Strategies

The above strategies have been ongoing for decades. While important, these strategies were not sufficient to prevent contamination of the LYV aquifers with nitrates.

FOTC will use this section of our Minority Report to re-introduce some potential Alternative Strategies that are likely to deliver positive results.

1. High Tech Modeling of Nitrate Flows in the LYV

In 2013 the United States Geological Survey presented a plan to the GWAC that would have created a model of nitrogen flow in the LYV. This model would help growers, producers, policy makers and advocates better understand the impact of various practices and take measures to prevent further pollution and mitigate ongoing pollution.

The GWAC turned to other options and never returned to the discussion of technological solutions. FOTC strongly recommends a revisit to this modeling. See Attachment 72 for a more in-depth description of the USGS proposal.

2. Soil Moisture Testing

Growers who attended various work group meetings have been unanimous in their praise of the benefits gained by using soil moisture sensors. These same people have asked for assistance incorporating various software packages into a useable on-farm program. FOTC strongly recommends allocation of public funds to increase the use of soil moisture sensors and to facilitate on-farm use of computerized programs that improve farming efficiency.

3. Ecology's Nitrate Prioritization Project

In 2016 Ecology published a document entitled *Washington Nitrate Prioritization Project.* The paper concluded with clear and valuable recommendations for developing a statewide program to address the problem of groundwater contamination. Other western states including Idaho, California and Oregon have groundwater quality programs in place, while Washington struggles with naive GWMA advisory groups that necessarily start from scratch and try to re-invent the wheel with each new endeavor.

FOTC believes that a well-funded and well-staffed state directed program could provide each GWMA with the tools needed for success. There would be a central data base, information sharing in real time, and a framework for cooperation between agencies and the public. (Morgan, 2016)

4. Revision of the Dairy Nutrient Management Act RCW 90.64

Proposed Addition:

RCW 90.64.027 Dairy nutrient management plan non-compliance

(1) A dairy shall be out of compliance with a nutrient management plan if:

(a) Elements to fully implement the plan are not in place eighteen months after plan submission

(b) At any time actions described in the nutrient management plan are not being implemented as described

(2) The WSDA Dairy Nutrient Management Program and Dairy Inspectors shall report instances when dairies are out of compliance to the Department

(a) The Department shall consult with the non-compliant dairy and determine whether the non-compliance endangers waters of the state. If the non-compliance potentially causes pollution of the waters of the state the dairy shall take immediate actions to implement the nutrient management plan and shall immediately apply for a National Pollutant Discharge General Permit for Concentrated Animal Feeding Operations

(b) If the non-compliance does not potentially cause pollution of the waters of the state the dairy shall have thirty days to work with the conservation district and return to compliance. If compliance is not achieved in thirty days the dairy shall immediately apply for a National Pollutant Discharge General Permit for Concentrated Animal Feeding Operations

(3) A dairy farm that is determined to be out of compliance is subject to the provisions of this chapter and to the enforcement provisions of chapters 43.05 and 90.48 RCW, including civil penalties levied under RCW 90.48.144. (See Attachment 33)

5. CAFO Regulation at the Local Level: Here is a proposed Yakima County Ordinance that will address issues related to CAFO water pollution.

Proposed Ordinance – Chapter 19.37 Regulation of Concentrated Animal Feeding Operations

Whereas RCW 36.32.120 provides that Yakima County Commissioners may (7) make and enforce, by appropriate resolutions or ordinances, all such police and sanitary regulations as are not in conflict with state law; and

Whereas RCW 36.32.120 provides that the Yakima County Commissioners (10) have power to declare by ordinance what shall be deemed a nuisance within the county; and

Whereas RCW 70.05.060 provides a local board of health with the power to (2) supervise the maintenance of all health and sanitary measures for the protection of the public health within its jurisdiction; and

Whereas RCW 70.05.060 provides a local board of health with the power to (3) enact such local rules and regulations as are necessary in order to preserve, promote and improve the public health and provide for the enforcement thereof; and

Whereas RCW 70.05.060 provides a local board of health with power to (4) provide for the control and prevention of any dangerous, contagious or infectious disease within the jurisdiction of the local health department; and

Whereas RCW 70.05.060 provides a local board of health with power to (5) provide for the prevention, control and abatement of nuisances detrimental to the public health; and

Whereas RCW 70.05.060 provides a local board of health with power to (7) establish fee schedules for issuing or renewing licenses or permits or for such other services as are authorized by the law and the rules of the state board of health: PROVIDED, That such fees for services shall not exceed the actual cost of providing any such services; and

Whereas concentrated animal feeding operations in Yakima County have been found to contaminate the groundwater downgradient from pens, corrals, lagoons, ponds and cropland where manures are applied in excessive amounts; and

Whereas manure lagoons without synthetic liners are known to leak, and

Whereas some concentrated animal feeding operations in Yakima County have been found to ignore the standards of practice agreed to in their nutrient management plans; and

Whereas elevated levels of bacteria and nitrates in groundwater are known to endanger the public health

Now, therefore, be it ordained by the Board of County Commissioners of Yakima County, Washington, as follows:

Definitions (To be added to Chapter 19.01.070):

Agricultural Composting: means composting of agricultural waste as an integral component of a system designed to improve soil health and recycle agricultural wastes. Agricultural composting is conducted on lands used for farming.

Agricultural Wastes: means wastes on farms resulting from the raising or growing of plants and animals including, but not limited to, crop residue, manure from herbivores and nonherbivores, animal bedding, and carcasses of dead animals.

Agronomic Rate: means the application rate (dry weight basis) that will provide the amount of nitrogen or other critical nutrient required for optimum growth of vegetation, and that will not result in the violation of applicable standards or requirements for the protection of ground or surface water as established under chapter 90.48 RCW, Water pollution control and related rules including chapter 173-200 WAC, Water quality standards for groundwaters of the state of Washington, and chapter 173-201A WAC, Water quality standards for surface waters of the state of Washington.

Animal Units (AU): A unit of measurement for calculating the number of animals on a concentrated animal feeding operation. One AU approximately equals 1,000 lbs of live animal weight. One AU equals:

a) 1.0 beef feeder or slaughter animal
b) 0.5 horse
c) 0.7 dairy cow
d) 1.1 jersey cow
e) 2.5 swine weighing over 55 lbs
f) 15 swine under 55 lbs
g) 10 sheep

h) 10 goats
i) 50 ducks
j) 50 turkeys
k) 100 chickens
l) an equivalent animal type and weight that has a similar amount of manure produced as one of the animal unit categories set forth in the definition of animal unit above

Animal Waste: Any animal excrement, animal carcass, feed waste, animal water waste, or any other waste associated with animals.

Animal Waste Water: Any animal excreta, any liquid which comes into contact with any manure, litter, bedding or other raw material or intermediate or final material or product used in or resulting from the production of animals or products directly or indirectly used in the operation of a CAFO, or any spillings or overflow from animal watering systems, or any liquid used in washing, cleaning or flushing pens, barns, or manure pits, or any liquid used in washing or spraying to clean animals, or any liquid used for dust control on the premises of a CAFO.

Compost Categories are:

a) Compost IA - Agricultural wastes, manure and bedding from zoos, bulking agents. Greater than 25 cubic yards with no upper limits when only agricultural wastes, manure and bedding from zoos, and bulking agents are processed on-farm, or on-site for zoos.
b) Compost IB - Agricultural wastes, yard debris, bulking agents. Greater than 25 but no more than 1,000 cubic yards of agricultural wastes and bulking agents on-farm at any one time, and up to 50% of organic materials on-farm can be yard debris.
c) Compost IC - Yard debris, crop residues, manure and bedding, bulking agents. Greater than 25 but no more than 500 cubic yards of material on-site at any one time, not to exceed 2,500 cubic yards processed in a calendar year.

d) Compost ID – All organics feedstocks. Greater than 25 but no more than 250 cubic yards of material on-site at any one time, not to exceed 1,000 cubic yards in a calendar year.
e) Compost II – All organic feedstocks. No more than 5,000 gallons or 25 cubic yards of material on-site at any one time.

Composted material: means organic solid waste that has undergone biological degradation and transformation under controlled conditions designed to promote aerobic decomposition at a solid waste facility in compliance with the requirements of this chapter. Composting is a form of organic material recycling. Natural decay of organic solid waste under uncontrolled conditions does not result in composted material.

Composting: means the biological degradation and transformation of organic solid waste under controlled conditions designed to promote aerobic decomposition. Natural decay of organic solid waste under uncontrolled conditions is not composting.

Composting Yard: Any area where manure is composted

Confinement Building: Any structure that:

a) Has a full or partial roof supported by columns or walls and that is used for the housing or enclosure of animals, or
b) Anything that is constructed or erected, the use of which requires location on the ground or attachment to something having location on the ground or attachment to something having location on the ground and that is used or designed for housing or enclosure of animals

Confinement Lot: Any area of land that is fenced or enclosed, and that is used to confine animals.

Dry Handling Waste: Manure (urine or feces), litter, bedding, or feed waste from animal feeding operations.

Land Apply/Application: The process of putting manure, litter, process wastewater, or other organic by-products on to a field to provide nutrients for crop growth.

Livestock: Cattle, sheep, swine, poultry, and other animals or fowl, which are being produced primarily for use as food or food products for human consumption.

Manure Compost: Composting is the controlled aerobic biological decomposition of organic matter into a stable, humus-like product called compost. It is essentially the same process as natural decomposition except that it is enhanced and accelerated by mixing organic waste with other ingredients to optimize microbial growth. Classifications are:

a) Class IA - Agricultural wastes, manure and bedding from zoos, bulking agents. Greater than 25 cubic yards with no upper limits when only agricultural wastes, manure and bedding from zoos, and bulking agents are processed on-farm, or on-site for zoos.
b) Class IB - Agricultural wastes, yard debris, bulking agents. Greater than 25 but no more than 1,000 cubic yards of agricultural wastes and bulking agents on-farm at any one time, and up to 50% of organic materials on-farm can be yard debris.
c) Class IC - Yard debris, crop residues, manure and bedding, bulking agents. Greater than 25 but no more than 500 cubic yards of material on-site at any one time, not to exceed 2,500 cubic yards processed in a calendar year.
d) Class ID – All organics feedstocks. Greater than 25 but no more than 250 cubic yards of material on-site at any one time, not to exceed 1,000 cubic yards in a calendar year.
e) Class II – All organic feedstocks. No more than 5,000 gallons or 25 cubic yards of material on-site at any one time.

Manure Storage Area: Any area where manures are stockpiled and stored for more than 30 days.

Populated Area: Any circular area inscribed by a radius of 1,442 feet and a circumference of 9,059 feet (such area including not more than approximately one hundred fifty (150) acres and having at least ten (10) occupied dwellings/establishments, which area is not on CAFO property, as measured in a straight line from the nearest occupied dwelling/establishment to the nearest CAFO confinement building, confinement lot, or other confinement area, or waste handling facility.

Waste Treatment Lagoon (Also known as Livestock Lagoon): A waste treatment impoundment made by constructing an embankment and/or excavating a pit or dugout.

19.37.010 Classification of Concentrated Animal Feeding Operations:

a) A Class IA CAFO is one that has a capacity of at least seven thousand 7,000 AU.
b) A Class IB CAFO is one that has a capacity between three thousand (3,000) AU and six thousand nine hundred ninety-nine AU (6,999) inclusive.
c) A Class IC CAFO is one that has a capacity between one thousand (1,000) AU and two thousand nine hundred and ninety-nine (2,999) AU inclusive.
d) A Class II CAFO is one that has a capacity of at least six hundred (600) AU, but less than one thousand (1,000) AU.
e) A Class III CAFO is one that has a capacity of at least three hundred (300) AU, but less than six hundred (600) AU.

19.37.020 Permit Requirements for CAFOs:

19.37.021. No CAFO shall be constructed, operated, used, or established within Yakima County unless a CAFO permit has been issued by the Yakima County Code Enforcement. To apply for a Yakima County Permit the CAFO shall submit to the County Code Enforcement a plan showing the location of the proposed facility, the number of proposed animal units, the proposed method and locations of animal waste disposal and the name and address of the owner of the proposed CAFO as well as the name and address of the owner of the land

on which the CAFO will be located, if different from the owner of the CAFO. In such case, if the County Code Enforcements determines that the proposed CAFO complies in every respect with the terms of this Chapter, then the Code Enforcement shall issue a CAFO permit.

19.37.022. Prior to filing an application to acquire a CAFO permit, the owner or operator of any concentrated animal feeding operation shall provide the flowing information to County Code Enforcement and to all adjoining property within two miles of the CAFO boundaries

a) The number of animals anticipated at such facility by type of animal;
b) The waste handling plan and general layout of the facility
c) The location and number of acres of such facility;
d) Name, address, telephone number and registered agent for further information as it relates to the permit
e) The location of all leased properties and acreage where the CAFO proposes to land apply manures (see section 19.37.0311)

19.37.023. At least one public hearing shall be held by the county before approving any CAFO permit. Such public hearing may be continued from time to time and additional hearings may be held.

19.37.024. It shall be a violation of this chapter and unlawful for any person to operate a CAFO without first obtaining a CAFO permit from Yakima County

19.37.025. It shall be a violation of this chapter and unlawful for any person to operate a CAFO with a number of Animal Units in excess of the number specified in the permit issued by Yakima County.

19.37.026. It shall be a violation of this chapter and unlawful for any person to apply animal waste or animal waste water in a manner inconsistent with the requirements of this chapter.

19.37.030 Rules Applicable to All CAFOs;

19.37.031. The proposed CAFO shall be in compliance with all provisions of this chapter

19.37.032. No lagoon shall be constructed, operated or established unless it is designed, inspected, and approved by a Civil Engineer licensed in the State of Washington

19.37.033. All Livestock Feedlots, Compost yards and Livestock Lagoons shall be designed in such a manner as to avoid degrading the quality of surface or groundwaters.

19.37.034. All Livestock Feedlots, Composting yards and Livestock Lagoons shall be designed in such a manner as to avoid degrading air quality. In no event shall the concentration of gases at the boundary of the land resulting from the operation of a Livestock Lagoon or Livestock Feedlot exceed the following levels:

Gas	Maximum Allowable Concentration	Exposure Period
Carbon Dioxide (CO_2)	5,000 parts per million (ppm)	Not applicable
Ammonia (NH_3)	5 ppm	Not applicable
Hydrogen Sulfide (H_2S)	10 ppm	2 hours
Methane (CH_4)	1,000 ppm	Not applicable
Carbon Monoxide (CO)	35 ppm	1 hour

19.37.035. The applicant shall demonstrate that the soils on the premises, including a soil-plant filter area, are suitable for and compatible with the proposed CAFO with respect to Livestock Lagoons, Compost Yards and the application of liquid, slurry or solid animal waste onto or into the soil on the premises. Further, no animal waste from a Livestock Lagoon shall be applied when soils are water saturated, frozen, or covered with snow, or when other soil conditions would result in waste runoff.

19.37.036. The Livestock Feedlot, Compost Yard or Livestock Lagoon shall at all times be operated in compliance with any required local, state or federal permits, licenses or other approvals and in compliance with all applicable state and local laws and regulations.

19.37.037. The CAFO shall own or lease one acre of land for each 4 AU of capacity. This requirement may be modified so that a CAFO can house more animals if the manures and/or compost from the extra animals are exported from the facilities and documentation of the export is provided. The applicant shall provide a nutrient management plan that addresses environmental monitoring and reporting, including nitrogen, phosphorous and potassium levels in the soil. In the case of dairy operations a WSDA or Conservation District approved nutrient management plan will suffice.

19.37.038. Animal waste and animal waste water shall not be applied to land with a slope greater than 10%.

19.37.039. Animal waste shall be injected, knifed or incorporated into the soil within 36 hours of application. There shall be no application of animal waste or animal waste waters within five hundred (500) feet of an occupied dwelling/establishment which existed prior to the date the CAFO was constructed. This rule shall not apply to occupied dwellings/establishments owned by the CAFO.

19.37.0340. Animal waste and animal waste water shall not be applied within five hundred (500) feet of any sink hole, or well or spring or other water supply or one hundred (100) feet from any stream (including intermittent streams). This rule shall not apply to waste lagoons on the CAFO property, but shall apply to all other wells, water supplies, streams, ponds, lakes, springs, and sink holes on the CAFO property. No Feedlot or Livestock Lagoon shall be located within a Floodplain.

19.37.0341. If the applicant or the operator of a CAFO does not own all of the land which will be used for the spreading of animal waste and waste water, the applicant shall provide an enforceable lease, easement, or other written agreement as part of the application for a CAFO permit. The length of the agreement shall be such that the CAFO has adequate time to make other alternative arrangements in the event that the existing lease, easement or other written agreement cannot be renewed. Such proof must annually be provided to the commission on the anniversary of the issuance of the permit.

19.37.0342. Any person selling, giving, purchasing, receiving or dispensing animal waste within Yakima County will be held responsible for full compliance with the Yakima CAFO ordinance.

19.37.040. Setback Requirements:

19.37.041. Setbacks from other CAFOs

a) No Class IA CAFO shall be located within one and one-half mile of any Class IA or Class IB CAFO
b) No Class IA CAFO shall be located within one mile of any other Class IC, Class II CAFO or Class III CAFO.
c) No Class IB, Class IC, Class II CAFO or Class III CAFO shall be located within one mile of any Class IB CAFO.
d) No Class IC, Class II CAFO or Class III CAFO shall be located within three quarters (3/4) mile of any Class IC CAFO.
e) No Class II CAFO or Class III shall be located within one-half (1/2) mile of any Class II CAFO or Class III CAFO
f) These distances shall be measured from the nearest point of one CAFO's confinement or waste containment system to the nearest point of another CAFO's confinement or waste containment system.

Setback Distances	Class IA	Class IB	Class IC	Class II
Class IA	1.5 miles	1.5 mile	1 mile	1 mile
Class IB	1.5 mile	1 mile	1 mile	1 mile
Class IC	1 mile	1 mile	¾ mile	¾ mile
Class II	1 mile	1 mile	¾ mile	½ mile
Class III	1 mile	1 mile	¾ mile	½ mile

19.37.042. The following minimum buffers are required between Feedlots, Compost yards or Livestock lagoons and any public building or occupied dwelling/establishment:

a) For a Class II, Class III and Class IC CAFO, two thousand (2,000) feet;
b) For a Class IB CAFO, three thousand (3,000) feet; and
c) For a Class IA CAFO four thousand (4,000) feet.

Size of CAFO	Minimum Distances from Occupied Dwelling/Establishment
Class IA	4,000 ft
Class IB	3,000 ft
Class IC	2,000 ft
Class II	2,000 ft
Class III	2,000 ft

19.37.043 Setbacks shall not apply to occupied dwellings/establishments owned by the CAFO or to dwellings not in existence at the time of issuance of the Yakima County CAFO permit.

19.37.044. No CAFO shall be located within two miles of an incorporated area. The two mile distance shall be measured from the outermost boundary of the production area – pens, barns, corrals, lagoons and manure storage areas – to the nearest border of the incorporated area.

19.37.045. No CAFO shall be located within one-thousand (1,000) feet of the property line or within one-thousand (1,000) feet of any public use area or conservation area. The distance shall be measured from the outermost boundary of the production area – pens, barns, corrals, lagoons and manure storage areas – to the nearest border of the public use or conservation area.

19.37.046. No Class IA, IB, IC, II or Class III CAFO shall be located within one (1) mile of a populated area. The distance shall be measured from the outermost boundary of the production area – pens, barns, corrals, lagoons and manure storage areas – to the nearest border of the populated area.

19.37.050. Groundwater Testing & Monitoring

19.37.051. Every concentrated animal feeding operation in Yakima County with more than 600 animal units shall install monitoring wells to measure changes to water quality in the underlying aquifers. One well shall be upgradient and the remainder shall be downgradient. Sample shall be collected semi-annually and tested for bacteria, chloride, total dissolved solids, ammonia, nitrate plus nitrite, total phosphorous, chemical oxygen demand, and total organic carbon. Groups of CAFOs in close proximity to one another can create a ground water monitoring network. The numbers of monitoring wells shall be:

a) Class IA – six (6) wells plus one more well for each 2,000 additional cows above 9,000
b) Class IB – five (5) wells
c) Class IC – four (4) wells
d) Class II – three (3) wells

19.37.052. Selection of well sites shall be done by the CAFO operator in consultation with experts from the WA State Dept. of Ecology

19.37.060. Financial Guarantees

19.37.061. No permit for a Class IA, IB, IC, or II CAFO shall be issued unless adequate security has been furnished to ensure proper cleanup and disposal as required below:

19.37.062. A cash, surety bond or irrevocable letter of credit shall be furnished to the Yakima County Treasurer for any manure storage system. A manure storage system may include one or more lagoons at any single CAFO. If the bond is a surety bond, the surety shall be approved by the County Commission and found to be of reputable character and financially sound with respect to the obligation incurred. The bond shall be furnished before construction and during the operating period. The bond shall remain with the County treasurer until the operator has complied with all Federal, State and Local laws in operation of the facility and until the prompt clean up and proper disposal of any waste

improperly handled or disposed of at the facility and restoration of the premises upon which the facility operated. If a cash bond is posted, all interest earned thereon shall become part of the bond subject to terms and conditions, including the condition of release. The County Commission shall give approval before release of the bond.

19.37.070. Variance: Where, due to an extraordinary or exceptional situation or condition of a specific piece of property, the strict application of the Ordinance would result in peculiar and exceptional difficulties to, or an exceptional and demonstrable undue hardship upon, the owner of the property as an unreasonable deprivation of use as distinguished from the mere grant of a privilege, the County Commission may authorize, as part of the application for a CAFO permit, a variance from the strict application so as to relieve said demonstrable difficulties or hardships, provided the relief can be granted without substantial detriment to the public good and without substantially impairing the intent, purpose, and integrity of the regularities, standards and criteria established in this Ordinance.

19.37.080. Application of Ordinance: A CAFO in existence at the time of the enactment of this Ordinance is exempt from its terms and conditions, so long as the operating conditions do not change. A CAFO already in existence that increases AUs, increases waste production, or changes waste management practices must obtain a new CAFO permit before making changes and must comply with the Ordinance within three (3) months of permit approval.

19.37.090. Administrative Fees:

19.37.091. No application for approval of a Yakima County CAFO permit shall be accepted until the applicant has paid all processing fees as set forth below. Fees paid shall be non-refundable except as provided in section 19.37.094 below.

19.37.092. The fee amount shall not exceed the amount needed to recover the cost of inspection, investigation and review of the proposed application. The fee amounts are based upon the anticipated costs of review, inspection and investigation. The fee amounts have taken into consideration the need for special investigative services including geological inspections, hydrologic inspections, groundwater monitoring, soils evaluation, and other unique costs of a scientific or technical nature associated with the processing of the application. For purposes of this Ordinance the initial administrative fee amounts shall be as follows:

Classification of CAFO	Initial Fee
Class IA	$10,000
Class IB	$5,000
Class IC	$2,500
Class II	$2,000
Class III	$1,500

In the event the cost to the county exceeds the above amounts, the additional cost will be assessed to the applicant with a maximum fee of twice the administrative fee listed above.

19.37.093. There shall be established with the County Treasurer an escrow fund, for each application for a Yakima County CAFO permit, for the purposes of reimbursing the county for services rendered in connection with administration of this Ordinance. Said escrow account shall include the proceeds of project review fees established pursuant to this section. The funds contained in said escrow account shall be used solely to reimburse the county for actual costs associated with administration of this Ordinance, for actual services rendered for investigation, administration and processing of a county CAFO permit including costs associated with the retaining and compensation of experts on scientific and technical issues associated with the application, and costs associated with public hearings. The County Treasurer shall disburse payments based upon billings supplied by Code Enforcement and approved by the County Commissioners.

19.37.094. The applicant for a county CAFO permit may apply to the county for a credit against the fee previously paid in the event that a portion of the costs of review and processing is duplicative, pursuant to the standards of applicable case law or statutes then in effect. After the approval, conditional approval or denial of a CAFO permit the County Treasurer shall refund to the applicant any unexpended or unencumbered balance of the escrow account established pursuant to this section for said application.

19.37. 100 Violation of Ordinance. Any person violating this Ordinance shall be subject to punishment by imprisonment or fine as provided by law. Each day a person operates a CAFO in violation of this Ordinance, and each time a person applies animal waste or animal waste water in a manner inconsistent with the requirements of this Ordinance, shall be considered a separate offense.

19.37.110. Severability. The chapters, sections, paragraphs, sentences, clauses, and phrases of Ordinance 97.37 are severable, and if any phrase, clause, sentence, paragraph, or section of this ordinance shall be declared unconstitutional or otherwise invalid by the valid judgement or decree of any Court of competent jurisdictions, such unconstitutionality or invalidity shall not affect any of the remaining phrases, clauses, sentences, paragraphs, or sections of this Ordinance since the same would have been enacted by the Board of County Commissioners without the incorporation in the Ordinance of any such unconstitutional or invalid phrase, clause, sentence, paragraph or section.

6. An ACT relating to creating a task force on hazardous air emissions from confined animal feeding operations

BE IT ENACTED BY THE LEGISLATURE OF THE STATE OF WSHINGTON:

NEW SECTION. Sec.1. (1) A task force on hazardous air emissions from confined animal feeding operations and manure composting operations is established, with members as provided in this subsection.

(a) The governor shall appoint seven members, who must include a representative from the following:

(i) The department of ecology;

(ii) The department of health

(iii) The department of agriculture;

(iv) A state association of counties;

(v) An academic research institution

(vi) A state agricultural association

(vii) A state environmental organization

(b) The task force shall choose its chair from among its membership. The department of ecology shall convene the initial meeting of the task force.

(2) The task force shall review the following issues:

(a) The most expedient and accurate way to estimate emissions of hazardous air pollutants – ammonia, hydrogen sulfide, particulate matter, fine particulate matter, oxides of nitrogen, nitrous oxide, methane, volatile organic compounds (n-Propanol, Ethyl Acetate, iso-propanol, Acetaldehyde, Methanol, n-Propyl acetate, 2-butanone, Toluene, phenol, 2-butanol, Benzene, Hexanal, Dimethyl sulfide, acetic acid, Pentanol, 1-Butanol, Heptanal, 4-Methyl-phenol, 2-pentanone, Benzaldehyde) – from confined feeding operations and manure composting operations

(b) The pathways that hazardous air pollutants follow when they leave confined animal feeding operations or manure composting operations

(c) A dose response impact on human health due emissions of hazardous air pollutants from confined animal feeding operations and manure compost operations

(d) The impact on global warming from emissions of hazardous air pollutants from confined animal feeding operations and manure compost operations

(e) The relationship between air pollution and water pollution in terms of the nitrogen balance in communities where the department of ecology regulates nutrients under the Clean Water Act

(3) Staff support for the task force must be provided by the department of ecology.

(4) The task force must report its findings and recommendations to the governor and the majority and minority leaders of the two largest caucuses of the house of representatives and the senate by December 31, 2019.

(5) This section expires June 30, 2020.

7. Request for Ecology to Review WAC 173-100 - Groundwater Management Areas

In Washington State protection of groundwater quality is achieved through implementation of WAC 173 – 100: Groundwater Management Areas and Programs. There is room for improvement.

> *The purpose of this chapter is to establish guidelines, criteria, and procedures for the designation of groundwater management areas, subareas or zones and to set forth a process for the development of groundwater management programs for such areas, subareas, or zones, in order to protect groundwater quality, to assure groundwater quantity, and to provide for efficient management of water resources for meeting future needs while recognizing existing water rights. The intent of this chapter is to forge a partnership between a diversity of local, state, tribal and federal interests in cooperatively protecting the state's groundwater resources.*

The guidelines for formation and developing a groundwater management area or GWMA are spelled out clearly in the law. There is no accountability built in to the code. There are no consequences when a groundwater management area committee does not complete the

mandated work which is what happened in the Lower Yakima Valley over the past six years.

WAC 173 – 100 – 160 states:

> *The department of ecology shall initiate a review of the rules established in this chapter whenever new information, changing conditions, or statutory modifications make it necessary to consider revisions.*

FOTC strongly suggests that the conditions are ripe for a revision of WAC 173 – 100 because the LYV GWMA:

1. Did not create an advisory committee with a broad spectrum of stakeholders
2. Failed to gather input from minority populations in the LYV
3. Failed to analyze the relevant data in order to determine the etiology of groundwater contamination in the LYV
4. Failed to compel compliance with contracts
5. Ignored the impact of contaminated drinking water on public health
6. Failed to estimate historical and current rates of groundwater use and purposes
7. Failed to define the extent of the problem caused by each source of pollution
8. Allowed publication of an inaccurate, incomplete and misleading estimate of nitrogen availability in the area
9. Failed to develop a monitoring system for evaluating the effectiveness of the program as required by WAC 173-100
10. Failed to develop a process for the periodic review and revision of the groundwater management program as required by WAC 173-100
11. Wasted $2.3 million in tax payer monies designated to address and reverse groundwater pollution in the LYV.

FOTC believes that a lack of consequences encouraged the GWMA leadership and advisory committee to ignore the codes designed to protect groundwater in Washington State. FOTC believes that revision of WAC 173 – 100 that adds consequences for non-compliance to the code is in order.

Here are suggested measures that will potentially improve the implementation of WAC 173 – 100.

1. Each GWMA shall employ a science officer with expertise in water science to oversee the plan development. He/she shall be responsible for maintaining scientific standards and accepted principles of scientific research during the program development.
2. The first three meetings of each GWMA shall be dedicated to education of the advisory committee on:
    a. WAC 173-100
    b. Applicable federal, state, Indian and local water laws
    c. Principles of project development and committee work
    d. Principles of groundwater flow
    e. Ecological connections between ground and surface water; groundwater and the ambient air
    f. Basic tenets of public health
    g. Principles of Environmental Justice
3. Ecology shall develop a curriculum that facilitates this preliminary education of the committee
4. Every meeting of each GWMA advisory group and work group shall be recorded and the recordings shall be stored and maintained for a period of five years after completion of each GWMA program.
5. In areas where over 10% of the community speaks a language other than English at home or speaks English less than well, the meeting summaries shall be translated into the commonly used language and made available to that population.
6. Every six months each active GWMA shall publish a report to the public that is written in commonly used language and clearly describes the GWMA activities.
7. There shall be a well-defined plan for periodic, formative annual evaluation throughout the program development. Ecology shall approve or disapprove each evaluation.

a. Each evaluation and report shall include a statement of the GWMA goals and objectives with a description of GWMA advisory committee actions that address and achieve those goals and objectives
b. Every year each member of the GWMA advisory committee shall submit a report of the actions taken by that individual stakeholder to promote the GWMA goals and objectives
c. There shall be a publicly disseminated attendance record for GWMA meetings and work group meetings for each member of the advisory committee

8. Every action by any GWMA advisory committee shall be approved or disapproved by a vote of the members in attendance and that vote shall be recorded.
9. The Washington State Department of Health and local health jurisdictions shall ensure that their representative understands the principles of public health and the physiological effects of contaminated water on the human body.
10. The Washington State Department of Health and local health jurisdictions shall ensure that their representatives educate each GWMA advisory committee regarding the impact of contaminated drinking water on the affected population.
11. Each GWMA shall complete an analysis of the economic impacts of groundwater pollution on the targeted communities
12. There shall be an annual audit of expenditures for each GWMA. Failure to spend funds appropriately using accepted accounting practices shall cause classification of a GWMA as non-compliant. Non-compliance requires:
    a. Hiring a finance officer to oversee all expenditures
    b. Prompt notification of the public regarding causes for non-compliance
    c. Department of Ecology review of the work done by GWMA leadership and replacement of responsible program leaders as appropriate
13. There shall be a process by which citizens can request a review of GWMA activities by Ecology at any time during a GWMA program

A Monitoring System for Evaluating the Effectiveness of the Program

In order to effectively monitor progress it is necessary to have clear and measureable goals and objectives. The potential objectives and proposed actions below are based on the vision of a small group and do not carry the weight of consensus. However, they are worthy of consideration.

Overarching Goal: Reduce Nitrates in Lower Yakima Valley Groundwater to Safe Levels of < 10 mg/L

Pollution prevention will be a guiding principle

1. Everyone who lives in the LYV will have access to safe and affordable drinking water. No one will pay more than 2% of their income for bottled water.

Objective 11: Reduce the number of domestic wells with nitrate levels > 10 mg/L by 5% per year until all domestic wells provide safe drinking water

Action 111: Implementation of GWMA Plan

Action 112: Implement a system for annual monitoring of domestic well water. Ongoing free well water testing will increase community engagement and facilitate data collection.

Objective 12: People with contaminated domestic wells will receive free drinking water until their well water is safe to drink

Action 121: Drill deep public wells at 2 – 3 locations in the LYV, (Cost $50,000 - $75,000) or

Action 122: Provide public faucets connected to municipal water systems (Cost $20,000)

Evaluation:

- Analysis of data from domestic well monitoring system
- Number of times people draw water from the public system

2. People who live in the Lower Yakima Valley will be engaged and involved in programs to reduce nitrates in groundwater

Objective 21: Over 90% of the people who live in the Lower Yakima Valley will understand the pathways and process that contaminate groundwater in the area

Action 211: Ongoing outreach and education with periodic updates on groundwater in the LYV

Action 212: Annual community surveys that include understanding of groundwater ($25,000 per year)

Objective 22: Over 20% of adults in the LYV will participate in surveys and focus groups that address ways to protect the groundwater

Action 221: Hire dedicated staff to create study materials, meet with small groups, inform and educate (Cost $100,000 per year)

Action 222: Annual community surveys that include understanding of groundwater

Evaluation:

- Annual public survey
- Number of focus groups
- Number of focus group participants
- Pre and post surveys

3. There will be no more "bureaucratic runaround". When people call authorities they will receive accurate and helpful information.

Objective 31: The Yakima Health District, Yakima Public Works and Ecology will create a small task force to develop a flow chart and information sheet that informs the public where to call for assistance with water pollution issues and related health concerns. (Cost $10,000)

Objective 32: The document produced will be shared with groups that meet the public regarding health, environment, agriculture, commerce and real estate.

Evaluation:

- Include access/satisfaction question in annual public surveys

4. The LYV aquifers will show decreasing nitrate levels beginning in 2020. The aquifers will reach safe levels by 2030

Objective 41: Growers will observe the 4 R's – Right product, Right source, Right timing and Right location.

Action 411: Hire dedicated staff to create study materials, meet with small groups, inform, educate and gather feedback (Cost $100,000 annually)

Action 412: Annual surveys that include understanding of 4 R's

Objective 42: Growers will optimize efficiency of irrigation systems and practices

Action 421: Hire dedicated staff (WSU?) to create study materials, meet with small groups, inform, educate and gather feedback

Action 422: Annual surveys that include irrigation practices and results

Objective 43: Producers will either line pens, corrals, lagoons, ponds and compost areas or they will monitor groundwater downgradient from these production areas

Action 431: Hire dedicated staff (SYCD?) to create study materials, meet with small groups, inform, educate and gather feedback ($100,000 annually)

Action 432: Annual surveys that include producers' feedback and groundwater testing

Evaluation (Cost $70,000 annually)

- Analysis of results from domestic well testing
- Analysis of water testing from municipal wells
- Results from monitoring wells on the "Dairy Cluster"
- Analysis of samples from promised system of purpose built wells
- Annual grower surveys
- Annual producer surveys
- Number of lagoons, ponds, pens, corrals, compost areas that are lined
- Analysis of samples from monitoring wells down gradient from lagoons, ponds, pens, corrals, compost areas

5. Soil nitrate levels below the root zone on LYV cropland will be < 15 ppm

Objective 51: Soil testing will become routine practice in the LYV

Action 511: Hire dedicated staff (WSU?) to create study materials, meet with small groups, inform, educate and gather feedback

Action 512: Annual surveys that include grower feedback and soil testing results

Action 513: Discounts on soil testing for participation in studies

Objective 52: Growers will value their role in protecting the groundwater

Action 521: Awards for protecting the environment

Action 522: Annual surveys that include grower feedback

Evaluation:

- Analysis of soil test data base
- Analysis of grower feedback

6. There will be no leaching of nitrate below animal pens & corrals, lagoons & ponds, or compost yards

Objective 61: Producers will understand the risks of nitrate leaching from pens, corrals, lagoons, ponds and compost areas

Action 611: Hire dedicated staff (SYCD?) to create study materials, meet with small groups, inform, educate and gather feedback

Objective 62: Producers will either line pens, corrals, lagoons, ponds and compost areas or they will monitor groundwater downgradient from these production areas

Action 621: Change RCW 90.64 to require implementation of nutrient management plans. Require implementation of NMPs or application for an NPDES CAFO General Permit

Evaluation:

- Number of lagoons, ponds, pens, corrals, compost areas that are lined
- Analysis of samples from monitoring wells down gradient from lagoons, ponds, pens, corrals, compost areas

7. Volatilization of nitrogen from production areas and cropland will be quantified and controlled

Objective 71: Create a state level task force to address this problem (Cost $10,000)

Action 711: Agree on a system for estimating and/or measuring nitrogen emissions from CAFO's and cropland in the LYV (Cost $50,000)

Action 712: Estimate the impact on public health and the environment from agricultural emissions (Cost $50,000)

Action 713: Create a task force to find ways to minimize these emissions (Cost $10,000)

Action 714: Create a task force to find ways to protect public health (Cost $10,000)

Action 715: Incorporate agricultural emissions into WA State Climate Change policy. This will shine a light on our role in global warming.

Evaluation

- Success in creating a plan for modeling or measuring
- Analysis of the data from the model or testing
- Analysis of health impacts
- Analysis of impacts on global warming

8. Costs for cleanup of the LYV aquifers will be borne by those who pollute

Objective 81: Craft a local ordinance that places a limit on cows per acre, identifies polluting CAFOs and requires a CAFO bond to cover any cleanup costs.

Action 811: Add staff at the county level to monitor nitrate levels in groundwater near CAFOs and to enforce the Yakima County Code (Cost $100,000 covered by fees)

Objective 82: Levy fines for dairies that do not comply with nutrient management plans.

Action 821: WSDA and Ecology to coordinate

Evaluation:

- Passage of regulations
- Analysis of data gathered from implementation of the permitting programs

When evaluation of these goals and objectives is combined with readily available studies that evaluate the effects of nitrate water pollution along with studies of contributing factors, we have a robust data base for discussion of LYV environmental, community and economic well-being. Note that only the leading causes of nitrate pollution were addressed.

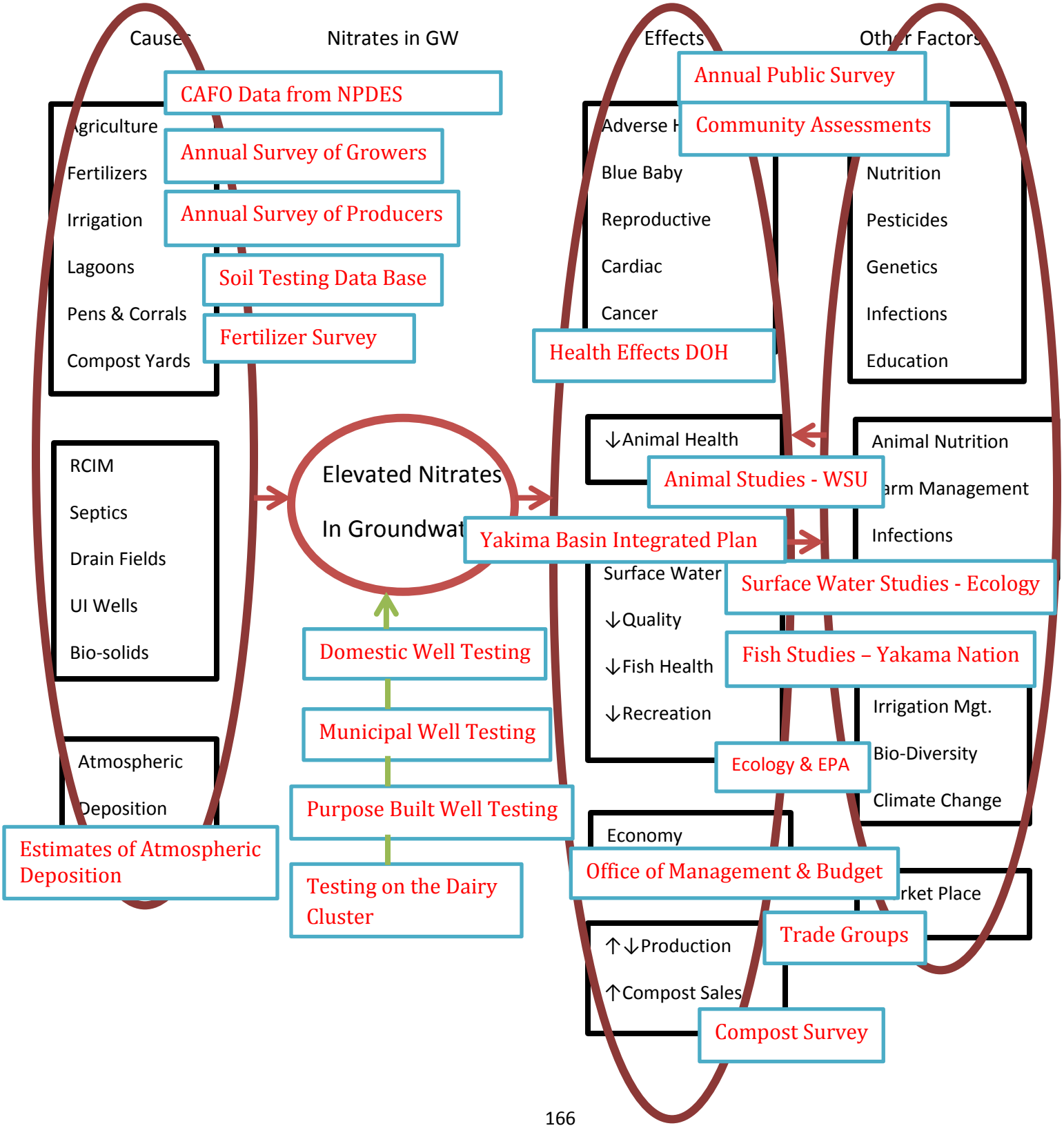
Please look at the list of evaluation tools below and the conceptual model that follows. (See Attachment 73 for a description of recommended programs and tools)

Table 21. Potential Evaluation Tools LYV GWMA

Evaluation of GWMA Data	**Evaluation of Other Factors**
Annual Public Survey • Knowledge of groundwater • Environmental Concerns • Satisfaction with access to agencies and level of response • Water related health • Understand strategies to improve the aquifers Annual Survey of Growers • Understanding of groundwater N • Implementation of BMPs • Irrigation Management • Soil Test Results • NASS Annual Survey of Producers • Implementation of BMPs • Soil Testing • Groundwater Testing • Understanding of groundwater N • NASS Analysis of soil testing data base Results from domestic well testing Results of water testing from municipal wells Results from monitoring wells on the "Dairy Cluster" Analysis of samples from purpose built wells CAFO data from regulatory agencies Estimates of nitrogen emissions and atmospheric deposition	Health Effects – DOH • Rates for Infectious Disease • Cancer Statistics • Washington Tracking Network • Maternal Child Statistics • Farmworker Health • CHARS (Hospital Data) • BRFSS (Behavior Survey) Animal Health – WSU, UW One Health Surface Water • Monitoring of drains • TMDL monitoring by Ecology • Fish Studies by the Yakama Nation • Studies from the Yakima Basin Integrated Plan (YRBWP) Watershed – Studies by the Yakima County Voluntary Stewardship Program Economy – Employment Security, WA State Office of Management and Budget Production – Trade Groups Crop Values – WSDA, Trade Groups Compost Sales – Survey Community Assessments • Virginia Mason Memorial • Astria Health • Opportunities Industrialization Center Tools • SPARROW (Surface Water) • USGS GW MODFLOW (GW Flow) • HYDRUS (Vadose Zone) • SSURGO (NRCS Soils)

Conceptual Model for Evaluation

Diagram 4.



A Process for the Periodic Review and Revision of the Groundwater Management Program

There is a grave need for someone to take responsibility to ensure follow through on recommended solutions to the problem of elevated nitrates in LYV groundwater, whether those recommendations come from the GWAC as a whole, from FOTC, or from other stakeholders.

Here is an example of the tragedy that occurs when no one pays attention:

Beginning in 1989 Ecology convened a group of stakeholders who worked on *Protecting Groundwater: A Strategy for Managing Agricultural Pesticides and Nutrients.* In 1992 that group published a summary of their findings.

The Overview of the Strategy developed by that group says:

> *While there is evidence of contamination of ground water by pesticides and nutrients, the focus of this Strategy is on protection of ground water, rather than remediation. The Strategy identifies and supports activities and programs to prevent contamination, and will allow both the agricultural community and involved agencies to make best uses of resources. We have an opportunity to implement a strong program of protection that will meet the needs of the state both to safeguard the quality of its waters and to enhance the long-term viability of agriculture. In many cases, what the Strategy is advocating is not new. The state is already undertaking many of the activities recommended by this Strategy. The Strategy provides a common focus for the agencies and organizations involved, and sets up a mechanism to guide the development of programs.*

Twenty five years later, with water quality in the LYV worsening, no one is checking to see which strategies from 1992 were effective, which were implemented and which were not. The LYV GWMA could easily cut and paste this "hope for the future" into our final GWMA plan and no one would notice that it is old work.

Suggestion: FOTC suggests a review of the plan every five years, with a requirement to consider the multiple data sets listed in Table 18. FOTC suggests that the Review Committee should consist of representatives from:

- The U. Environmental Protection Agency
- The U.S. Geological Survey
- The Yakama Nation
- The WA State Dept. of Ecology
- The WA State Dept of Agriculture
- The WA State Dept. of Health
- Yakima County
- The Yakima County Health District
- The Roza Sunnyside Joint Board of Control
- The South Yakima Conservation District
- The Yakima Valley Farmworker Clinics
- The Yakima Valley Farm Bureau
- A Local Environmental Group
- Five citizens with letters of support from the community
- An attorney with expertise in environmental and water law
- A data analyst

This group would evaluate progress based on well-defined criteria that includes well water testing. This group would write a progress report to the Governor and the Legislature. Failure to meet goals and objectives must trigger a strong regulatory response. Regulators must have authority to impose sanctions against those who continue to pollute.

Regulatory Review

Federal:

Clean Water Act: 33 U.S.C. §1251 et seq. (1972)

Clean Water Act Section 303(d): Impaired Waters and Total Maximum Daily Loads (TMDLs)

Clean Water Act, Section 402: National Pollutant Discharge Elimination System

Safe Drinking Water Act 42 U.S.C. §300f et seq. (1974)

Emergency Planning & Community Right-to-Know Act (EPCRA) 42 U.S.C. §11001 et seq. (1986

Resource Conservation and Recovery Act (RCRA) 42 U.S.C. §6901 et seq. (1976)

Comprehensive Environmental Response, Compensation, and Liability Act (Superfund) 42 U.S.C. §9601 et seq. (1980)

Important Note: There are recent changes in CERCLA and EPCRA Reporting Requirements for Air Releases of Hazardous Substances from Animal Waste at Farms

Winters Doctrine

Clean Air Act 42 U.S.C. §7401 et seq. (1970)

Title VI of the Civil Rights Act of 1964 42 U.S.C. § 2000d Et Seq.

Executive Order 12898 - Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations

Executive Order 13132 – Federalism

State of Washington:

RCW 90.03 Water Code

RCW 90.48.010 Water Pollution Control Act

RCW 90.54 Water Resources Act

RCW 90.44 Regulation of Public Groundwaters

Hirst decision

RCW 90.82 Watershed Planning Act

RCW90.64 Dairy Nutrient Management Act

RCW 43.05Technical Assistance Programs

RCW 70.85 Solid Waste Management

Public Trust Doctrine

RCW 7.48.305 Agricultural activities and forest practices—presumed reasonable and not a nuisance (Right to Farm)

RCW 36.70a Growth Management Act

RCW 36.70A.700 Voluntary Stewardship Program

RCW 26.25.010 Tribal Sovereignty

RCW 42.30 Open Public Meetings Act

Local Ordinances:

Yakima County Code

Yakima County Code Title 6.22 Rights of Farmers

Yakima County Code Title 16A Critical Areas

Yakima County Code Title 16C Critical Areas

Yakima County Code Title 19 Unified Land Development Code

Yakima County Code Title 19.25 Sewer and Water

Description of Purpose- Rules & Regulations

Federal:

Clean Water Act: 33 U.S.C. §1251 et seq. (1972)

https://www.epa.gov/laws-regulations/summary-clean-water-act

> *The Clean Water Act (CWA) establishes the basic structure for regulating discharges of pollutants into the waters of the United States and regulating quality standards for surface waters. The basis of the CWA was enacted in 1948 and was called the Federal Water Pollution Control Act, but the Act was significantly reorganized and expanded in 1972. "Clean Water Act" became the Act's common name with amendments in 1972.*
>
> *Under the CWA, EPA has implemented pollution control programs such as setting wastewater standards for industry. EPA has also developed national water quality criteria recommendations for pollutants in surface waters.*
>
> *The CWA made it unlawful to discharge any pollutant from a point source into navigable waters, unless a permit was obtained. EPA's National Pollutant Discharge Elimination System (NPDES) permit program controls discharges. Point sources are discrete conveyances such as pipes or man-made ditches. Individual homes that are connected to a municipal system, use a septic system, or do not have a surface discharge do not need an NPDES permit; however, industrial, municipal, and other facilities must obtain permits if their discharges go directly to surface waters.*

Clean Water Act Section 303(d): Impaired Waters and Total Maximum Daily Loads (TMDLs)

https://www.epa.gov/tmdl

> *EPA's 303(d) Program assists states, territories and authorized tribes in submitting lists of impaired waters and developing TMDLs. A TMDL establishes the maximum amount of a pollutant allowed in a waterbody and serves as the starting point or planning tool for restoring water quality.*

Clean Water Act, Section 402: National Pollutant Discharge Elimination System

https://www.epa.gov/cwa-404/clean-water-act-section-402-national-pollutant-discharge-elimination-system

> *National Pollutant Discharge Elimination System (NPDES) Program - Establishes an effluent permit system for point source (e.g., pipe, ditch, sewer) discharges of pollutants into waters of the U.S. The NPDES permit system requires those permitted to maintain records and report on the amount and nature of discharged effluent waste components. The stormwater program is a part of the NPDES program and is designed to reduce or eliminate the discharge of contaminated stormwater into waters of the U.S. The program requires the following stormwater discharges to be covered by an NPDES permit:*
>
> - *discharge associated with industrial activity*
> - *discharge from a large or medium municipal separate storm sewer system, or*
> - *discharge which EPA or the state/tribe determines contributes to a violation of a water quality standard or which is a significant contributor of pollutants to waters of the United States*

Safe Drinking Water Act 42 U.S.C. §300f et seq. (1974)

https://www.epa.gov/laws-regulations/summary-safe-drinking-water-act

> *The Safe Drinking Water Act (SDWA) was established to protect the quality of drinking water in the U.S. This law focuses on all waters actually or potentially designed for drinking use, whether from above ground or underground sources.*
>
> *The Act authorizes EPA to establish minimum standards to protect tap water and requires all owners or operators of public water systems to comply with these primary (health-related) standards. The 1996 amendments to SDWA require that EPA consider a detailed risk and cost assessment, and best available peer-reviewed science, when developing these standards. State governments, which can be approved to implement these rules for EPA, also encourage attainment of secondary standards (nuisance-*

related). Under the Act, EPA also establishes minimum standards for state programs to protect underground sources of drinking water from endangerment by underground injection of fluids.

Emergency Planning & Community Right-to-Know Act (EPCRA) 42 U.S.C. §11001 et seq. (1986)

https://www.epa.gov/laws-regulations/summary-emergency-planning-community-right-know-act

Authorized by Title III of the Superfund Amendments and Reauthorization Act (SARA), the Emergency Planning & Community Right-to-Know Act (EPCRA) was enacted by Congress as the national legislation on community safety. This law is designed to help local communities protect public health, safety, and the environment from chemical hazards.

To implement EPCRA, Congress requires each state to appoint a State Emergency Response Commission (SERC). The SERCs are required to divide their states into Emergency Planning Districts and to name a Local Emergency Planning Committee (LEPC) for each district.

Broad representation by fire fighters, health officials, government and media representatives, community groups, industrial facilities, and emergency managers ensures that all necessary elements of the planning process are represented.

Resource Conservation and Recovery Act (RCRA) 42 U.S.C. §6901 et seq. (1976)

https://www.epa.gov/laws-regulations/summary-resource-conservation-and-recovery-act

The Resource Conservation and Recovery Act (RCRA) gives EPA the authority to control hazardous waste from the "cradle-to-grave." This includes the generation,

transportation, treatment, storage, and disposal of hazardous waste. RCRA also set forth a framework for the management of non-hazardous solid wastes. The 1986 amendments to RCRA enabled EPA to address environmental problems that could result from underground tanks storing petroleum and other hazardous substances.

HSWA - the Federal Hazardous and Solid Waste Amendments - are the 1984 amendments to RCRA that focused on waste minimization and phasing out land disposal of hazardous waste as well as corrective action for releases. Some of the other mandates of this law include increased enforcement authority for EPA, more stringent hazardous waste management standards, and a comprehensive underground storage tank program.

Comprehensive Environmental Response, Compensation, and Liability Act (Superfund)
42 U.S.C. §9601 et seq. (1980)

https://www.epa.gov/laws-regulations/summary-comprehensive-environmental-response-compensation-and-liability-act

The Comprehensive Environmental Response, Compensation, and Liability Act -- otherwise known as CERCLA or Superfund -- provides a Federal "Superfund" to clean up uncontrolled or abandoned hazardous-waste sites as well as accidents, spills, and other emergency releases of pollutants and contaminants into the environment. Through CERCLA, EPA was given power to seek out those parties responsible for any release and assure their cooperation in the cleanup.

EPA cleans up orphan sites when potentially responsible parties cannot be identified or located, or when they fail to act. Through various enforcement tools, EPA obtains private party cleanup through orders, consent decrees, and other small party settlements. EPA also recovers costs from financially viable individuals and companies once a response action has been completed.

EPA is authorized to implement the Act in all 50 states and U.S. territories. Superfund site identification, monitoring, and response activities in states are coordinated through the state environmental protection or waste management agencies.

The Superfund Amendments and Reauthorization Act (SARA) of 1986 reauthorized CERCLA to continue cleanup activities around the country. Several site-specific amendments, definitions clarifications, and technical requirements were added to the legislation, including additional enforcement authorities. Also, Title III of SARA authorized the Emergency Planning and Community Right-to-Know Act (EPCRA).

Winters Doctrine

http://nationalaglawcenter.org/wp-content/uploads/assets/crs/RL32198.pdf

Although the federal government has authority to regulate water, it typically defers to the states to allocate water resources within the state. The federal government maintains certain federal water rights, though, which exist separate from state law. In particular, federal reserved water rights often arise in questions of water allocation related to federal lands, including Indian reservations.

Indian reserved water rights were first recognized by the U.S. Supreme Court in Winters v. United States in 1908. Under the Winters doctrine, when Congress reserves land (i.e., for an Indian reservation), Congress also reserves water sufficient to fulfill the purpose of the reservation.

Clean Air Act 42 U.S.C. §7401 et seq. (1970)

https://www.epa.gov/laws-regulations/summary-clean-air-act

The Clean Air Act (CAA) is the comprehensive federal law that regulates air emissions from stationary and mobile sources. Among other things, this law authorizes EPA to

establish National Ambient Air Quality Standards (NAAQS) to protect public health and public welfare and to regulate emissions of hazardous air pollutants.

One of the goals of the Act was to set and achieve NAAQS in every state by 1975 in order to address the public health and welfare risks posed by certain widespread air pollutants. The setting of these pollutant standards was coupled with directing the states to develop state implementation plans (SIPs), applicable to appropriate industrial sources in the state, in order to achieve these standards. The Act was amended in 1977 and 1990 primarily to set new goals (dates) for achieving attainment of NAAQS since many areas of the country had failed to meet the deadlines.

Section 112 of the Clean Air Act addresses emissions of hazardous air pollutants. Prior to 1990, CAA established a risk-based program under which only a few standards were developed. The 1990 Clean Air Act Amendments revised Section 112 to first require issuance of technology-based standards for major sources and certain area sources. "Major sources" are defined as a stationary source or group of stationary sources that emit or have the potential to emit 10 tons per year or more of a hazardous air pollutant or 25 tons per year or more of a combination of hazardous air pollutants. An "area source" is any stationary source that is not a major source.

For major sources, Section 112 requires that EPA establish emission standards that require the maximum degree of reduction in emissions of hazardous air pollutants. These emission standards are commonly referred to as "maximum achievable control technology" or "MACT" standards. Eight years after the technology-based MACT standards are issued for a source category, EPA is required to review those standards to determine whether any residual risk exists for that source category and, if necessary, revise the standards to address such risk.

Important Note: CERCLA and EPCRA Reporting Requirements for Air Releases of Hazardous Substances from Animal Waste at Farms https://www.epa.gov/epcra/cercla-and-epcra-reporting-requirements-air-releases-hazardous-substances-animal-waste-farms

Due to legislative changes in the Consolidated Appropriations Act, 2018 (Omnibus Bill), "air emissions from animal waste at a farm" are exempt from reporting under CERCLA. On May 2, 2018, the D.C. Circuit Court of Appeals issued its mandate vacating the 2008 final rule. However, farms will remain exempt from the CERCLA reporting requirements as a result of the FARM Act. Additionally, these types of releases do not need to be reported under EPCRA.

Title VI of the Civil Rights Act of 1964 42 U.S.C. § 2000d Et Seq.

https://www.justice.gov/crt/fcs/TitleVI-Overview

Title VI, 42 U.S.C. § 2000d et seq., was enacted as part of the landmark Civil Rights Act of 1964. It prohibits discrimination on the basis of race, color, and national origin in programs and activities receiving federal financial assistance. As President John F. Kennedy said in 1963:

Simple justice requires that public funds, to which all taxpayers of all races [colors, and national origins] contribute, not be spent in any fashion which encourages, entrenches, subsidizes or results in racial [color or national origin] discrimination.

If a recipient of federal assistance is found to have discriminated and voluntary compliance cannot be achieved, the federal agency providing the assistance should either initiate fund termination proceedings or refer the matter to the Department of Justice for appropriate legal action. Aggrieved individuals may file administrative complaints with the federal agency that provides funds to a recipient, or the individuals may file suit for appropriate relief in federal court. Title VI itself prohibits intentional discrimination. However, most funding agencies have regulations implementing Title VI that prohibit recipient practices that have the effect of discrimination on the basis of race, color, or national origin.

Executive Order 12898 - Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations 59 FR 7629; February 16, 1994

https://www.epa.gov/laws-regulations/summary-executive-order-12898-federal-actions-address-environmental-justice

> *Executive Order (E.O.) 12898 - Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations - was issued by President William J. Clinton in 1994. Its purpose is to focus federal attention on the environmental and human health effects of federal actions on minority and low-income populations with the goal of achieving environmental protection for all communities.*
>
> *The E.O. directs federal agencies to identify and address the disproportionately high and adverse human health or environmental effects of their actions on minority and low-income populations, to the greatest extent practicable and permitted by law. The order also directs each agency to develop a strategy for implementing environmental justice. The order is also intended to promote nondiscrimination in federal programs that affect human health and the environment, as well as provide minority and low-income communities access to public information and public participation.*
>
> *In addition, the E.O. established an Interagency Working Group (IWG) on environmental justice chaired by the EPA Administrator and comprised of the heads of 11 departments or agencies and several White House offices.*

Executive Order 13132 – Federalism

https://www.epa.gov/laws-regulations/summary-executive-order-13132-federalism

> *Executive Order (E.O.) 13132 - Federalism - was issued by President William J. Clinton in 1999. The E.O.'s objective is to guarantee the Constitution's division of governmental responsibilities between the federal government and the states. It furthers the policies of the Unfunded Mandates Reform Act.*

To the extent practicable and permitted by law, the Agency cannot promulgate two types of rules unless we meet certain conditions as described below. The two types of rules are:

1. *rules with Federalism Implications (FI), substantial direct compliance costs on state and local (S/L) governments, and not required by statute, and*
2. *rules with FI and that preempt S/L law.*

FI is defined as having substantial direct effects on states or local governments (individually or collectively), on the relationship between the national government and the states, or on the distribution of power and responsibilities among the various levels of government.

The Agency cannot promulgate the first type of rule unless we:

- *provide funds necessary to pay direct compliance costs of the S/L governments, or*
- *early in the process before promulgation, consult with elected S/L officials or their representative national organizations.*

We cannot promulgate the second type unless we consult with elected S/L officials or their representative national organizations early in the process before promulgation.

For these two types of rules, we also must:

- *adhere to the fundamental principles in §2 of the E.O. and comply, to the extent permitted by law, with the general policymaking criteria in §3 of the E.O.;*
- *provide in a separate preamble section a federalism summary impact statement;*
- *make available to the Office of Management and Budget any written communications from S/L officials; and*
- *for final rules subject to E.O. 12866 review, include certification from EPA's Designated Federalism Official stating EPA has met E.O. requirements.*

State of Washington:

RCW 90.03 Water Code
http://app.leg.wa.gov/rcw/default.aspx?cite=90.03

> *It is the policy of the state to promote the use of the public waters in a fashion which provides for obtaining maximum net benefits arising from both diversionary uses of the state's public waters and the retention of waters within streams and lakes in sufficient quantity and quality to protect instream and natural values and rights. Consistent with this policy, the state supports economically feasible and environmentally sound development of physical facilities through the concerted efforts of the state with the United States, public corporations, Indian tribes, or other public or private entities. Further, based on the tenet of water law which precludes wasteful practices in the exercise of rights to the use of waters, the department of ecology shall reduce these practices to the maximum extent practicable, taking into account sound principles of water management, the benefits and costs of improved water use efficiency, and the most effective use of public and private funds, and, when appropriate, to work to that end in concert with the agencies of the United States and other public and private entities.*

RCW 90.48.010 Water Pollution Control Act
http://app.leg.wa.gov/RCW/default.aspx?cite=90.48.010

> *It is declared to be the public policy of the state of Washington to maintain the highest possible standards to insure the purity of all waters of the state consistent with public health and public enjoyment thereof, the propagation and protection of wild life, birds, game, fish and other aquatic life, and the industrial development of the state, and to that end require the use of all known available and reasonable methods by industries and others to prevent and control the pollution of the waters of the state of Washington. Consistent with this policy, the state of Washington will exercise its powers, as fully and as effectively as possible, to retain and secure high quality for all waters of the state. The state of Washington in recognition of the federal government's interest in the quality of the navigable waters of the United States, of which certain*

portions thereof are within the jurisdictional limits of this state, proclaims a public policy of working cooperatively with the federal government in a joint effort to extinguish the sources of water quality degradation, while at the same time preserving and vigorously exercising state powers to insure that present and future standards of water quality within the state shall be determined by the citizenry, through and by the efforts of state government, of the state of Washington.

RCW 90.54 Water Resources Act

http://app.leg.wa.gov/RCW/default.aspx?cite=90.54

It is the purpose of this chapter to set forth fundamentals of water resource policy for the state to insure that waters of the state are protected and fully utilized for the greatest benefit to the people of the state of Washington and, in relation thereto, to provide direction to the department of ecology, other state agencies and officials, and local government in carrying out water and related resources programs. It is the intent of the legislature to work closely with the executive branch, Indian tribes, local government, and interested parties to ensure that water resources of the state are wisely managed.

RCW 90.44 Regulation of Public Groundwaters

http://app.leg.wa.gov/RCW/default.aspx?cite=90.44&full=true

This chapter regulating and controlling groundwaters of the state of Washington shall be supplemental to chapter 90.03 RCW, which regulates the surface waters of the state, and is enacted for the purpose of extending the application of such surface water statutes to the appropriation and beneficial use of groundwaters within the state.

Hirst decision – Ecology Statement

https://ecology.wa.gov/Water-Shorelines/Water-supply/Water-rights/Case-law/Hirst-decision

A 2016 Washington State Supreme Court decision changed how counties decide to approve or deny building permits that use wells for a water source.

In the Whatcom County vs. Hirst, Futurewise, et al. decision (often referred to as the "Hirst decision"), the court ruled that the county failed to comply with the Growth Management Act requirements to protect water resources. The ruling required the county to make an independent decision about legal water availability.

Streamflow restoration

Washington State has a new streamflow restoration law in response to the "Hirst decision." The law, Engrossed Substitute Senate Bill 6091, was passed on Jan. 18, 2018, and signed by Gov. Inslee the next day.

'Hirst decision' background

We protect rivers and streams across the state by creating instream flow rules, which set the amount of water necessary for protecting fish, wildlife, and recreation. In 1985, we adopted an instream flow rule for the Nooksack River (WAC 173-501) in Whatcom County. This rule closed most streams in the watershed to new water right permits but allowed landowners to use permit-exempt wells in most of the area. Whatcom County's development regulations followed our instream flow rule.

A reliable, year-round supply of water is necessary for new homes or developments. Before the Oct. 6, 2016, court decision, many counties relied on our determination about whether year-round water was available. The court decision changed that. Counties had to make their own decisions about whether there was enough water, both physically and legally, to approve any building permit that would rely on a well.

In response to the decision, several counties severely restricted approvals of subdivisions and building permits for houses relying on permit-exempt wells. Some counties required permit applicants to pursue expensive hydrogeological study before building.

Key points of the decision

- *Science has shown that rivers and streams are generally connected to groundwater. In the decision, the Washington State Supreme Court said that water is not legally available if a new well would impact a protected river or stream, or an existing senior water right.*
- *If a county determined that water was not legally available for a new use, the county would not be able to approve a building permit — even if a well was already drilled.*

RCW 90.82 Watershed Planning Act
http://apps.leg.wa.gov/rcw/default.aspx?cite=90.82&full=true

The purpose of this chapter is to develop a more thorough and cooperative method of determining what the current water resource situation is in each water resource inventory area of the state and to provide local citizens with the maximum possible input concerning their goals and objectives for water resource management and development.

It is necessary for the legislature to establish processes and policies that will result in providing state agencies with more specific guidance to manage the water resources of the state consistent with current law and direction provided by local entities and citizens through the process established in accordance with this chapter.

RCW90.64 Dairy Nutrient Management Act
http://app.leg.wa.gov/rcw/default.aspx?cite=90.64

The legislature finds that there is a need to establish a clear and understandable process that provides for the proper and effective management of dairy nutrients that affect the quality of surface or ground waters in the state of Washington. The legislature finds that there is a need for a program that will provide a stable and predictable business climate upon which dairy farms may base future investment decisions.

The legislature finds that federal regulations require a permit program for dairies with over seven hundred head of mature cows and, other specified dairy farms that directly discharge into waters or are otherwise significant contributors of pollution. The legislature finds that significant work has been ongoing over a period of time and that the

intent of this chapter is to take the consensus that has been developed and place it into statutory form.

*It is also the intent of this chapter to establish an inspection and technical assistance program for dairy farms to address the discharge of pollution to surface and ground waters of the state that will lead to water quality compliance by the industry. A further purpose is to create a balanced program involving technical assistance, regulation, and enforcement with coordination and oversight of the program by a *committee composed of industry, agency, and other representatives. Furthermore, it is the objective of this chapter to maintain the administration of the water quality program as it relates to dairy operations at the state level.*

It is also the intent of this chapter to recognize the existing working relationships between conservation districts, the conservation commission, and the department of ecology in protecting water quality of the state. A further purpose of this chapter is to provide statutory recognition of the coordination of the functions of conservation districts, the conservation commission, and the department of ecology pertaining to development of dairy waste management plans for the protection of water quality.

RCW 43.05 Technical Assistance Programs

http://app.leg.wa.gov/rcw/default.aspx?cite=43.05&full=true

The legislature finds that, due to the volume and complexity of laws and rules it is appropriate for regulatory agencies to adopt programs and policies that encourage voluntary compliance by those affected by specific rules. The legislature recognizes that a cooperative partnership between agencies and regulated parties that emphasizes education and assistance before the imposition of penalties will achieve greater compliance with laws and rules and that most individuals and businesses who are subject to regulation will attempt to comply with the law, particularly if they are given sufficient information. In this context, enforcement should assure that the majority of a regulated community that complies with the law are not placed at a competitive disadvantage and that a continuing failure to comply that is within the

control of a party who has received technical assistance is considered by an agency when it determines the amount of any civil penalty that is issued.

RCW 70.85 Solid Waste Management

http://apps.leg.wa.gov/RCW/default.aspx?cite=70.95

The purpose of this chapter is to establish a comprehensive statewide program for solid waste handling, and solid waste recovery and/or recycling which will prevent land, air, and water pollution and conserve the natural, economic, and energy resources of this state.

Public Trust Doctrine

https://ecology.wa.gov/Water-Shorelines/Shoreline-coastal-management/Shoreline-coastal-planning/Shoreline-laws-rules-and-cases/Public-Trust-Doctrine

The Public Trust Doctrine is a legal principle derived from English Common Law. Under this doctrine, the waters of the state are a public resource owned by and available to all citizens equally for:

- *Purposes of navigation*
- *Conducting commerce*
- *Fishing*
- *Recreation and similar uses*

The Public Trust Doctrine trust is not invalidated by private ownership of the underlying land. The doctrine limits public and private use of tidelands and other shoreline areas to protect the public's right to use the waters of the state.
The Public Trust Doctrine does not allow the public to trespass over privately-owned uplands to access the tidelands. It does, however, protect public use of navigable water bodies below the ordinary high water mark.

Protecting the public trust is a duty of Washington. The state Shoreline Management Act is

one of the primary means by which this duty is carried out. The doctrine requires a careful evaluation of the public interest served by any proposed action

RCW 7.48.305 Agricultural activities and forest practices—presumed reasonable and not a nuisance (Right to Farm)
https://app.leg.wa.gov/rcw/default.aspx?cite=7.48.305

(1) Notwithstanding any other provision of this chapter, agricultural activities conducted on farmland and forest practices, if consistent with good agricultural and forest practices and established prior to surrounding nonagricultural and nonforestry activities, are presumed to be reasonable and shall not be found to constitute a nuisance unless the activity or practice has a substantial adverse effect on public health and safety.

(2) Agricultural activities and forest practices undertaken in conformity with all applicable laws and rules are presumed to be good agricultural and forest practices not adversely affecting the public health and safety for purposes of this section and RCW 7.48.300. An agricultural activity that is in conformity with such laws and rules shall not be restricted as to the hours of the day or day or days of the week during which it may be conducted.

(3) The act of owning land upon which a growing crop of trees is located, even if the tree growth is being managed passively and even if the owner does not indicate the land's status as a working forest, is considered to be a forest practice occurring on the land if the crop of trees is located on land that is capable of supporting a merchantable stand of timber that is not being actively used for a use that is incompatible with timber growing. If the growing of trees has been established prior to surrounding nonforestry activities, then the act of tree growth is considered a necessary part of any other subsequent stages of forest practices necessary to bring a crop of trees from its planting to final harvest and is included in the provisions of this section.

(4) Nothing in this section shall affect or impair any right to sue for damages.

RCW 36.70a Growth Management Act
http://apps.leg.wa.gov/RCW/default.aspx?cite=36.70a

The legislature finds that uncoordinated and unplanned growth, together with a lack of common goals expressing the public's interest in the conservation and the wise use of our lands, pose a threat to the environment, sustainable economic development, and the health, safety, and high quality of life enjoyed by residents of this state. It is in the public interest that citizens, communities, local governments, and the private sector cooperate and coordinate with one another in comprehensive land use planning. Further, the legislature finds that it is in the public interest that economic development programs be shared with communities experiencing insufficient economic growth.

RCW 36.70A.700 Voluntary Stewardship Program
http://app.leg.wa.gov/RCW/default.aspx?cite=36.70A.700

(1) The purpose of chapter 360, Laws of 2011 is to establish the voluntary stewardship program as recommended in the report submitted by the William D. Ruckelshaus Center to the legislature as required by chapter 353, Laws of 2007 and chapter 203, Laws of 2010.

(2) It is the intent of chapter 360, Laws of 2011 to:

(a) Promote plans to protect and enhance critical areas within the area where agricultural activities are conducted, while maintaining and improving the long-term viability of agriculture in the state of Washington and reducing the conversion of farmland to other uses;

(b) Focus and maximize voluntary incentive programs to encourage good riparian and ecosystem stewardship as an alternative to historic approaches used to protect critical areas;

(c) Rely upon RCW 36.70A.060 for the protection of critical areas for those counties that do not choose to participate in this program;

(d) Leverage existing resources by relying upon existing work and plans in counties and local watersheds, as well as existing state and federal programs to the maximum extent practicable to achieve program goals;

(e) Encourage and foster a spirit of cooperation and partnership among county, tribal, environmental, and agricultural interests to better assure the program success;

(f) Improve compliance with other laws designed to protect water quality and fish habitat; and

(g) Rely upon voluntary stewardship practices as the primary method of protecting critical areas and not require the cessation of agricultural activities.

RCW 26.25.010 Tribal Sovereignty

https://app.leg.wa.gov/rcw/default.aspx?cite=26.25.010

The legislature recognizes that Indian tribes are sovereign nations and the relationship between the state and the tribe is sovereign-to-sovereign.

RCW 42.30 Open Public Meetings Act

http://app.leg.wa.gov/rcw/default.aspx?cite=42.30

The legislature finds and declares that all public commissions, boards, councils, committees, subcommittees, departments, divisions, offices, and all other public agencies of this state and subdivisions thereof exist to aid in the conduct of the people's business. It is the intent of this chapter that their actions be taken openly and that their deliberations be conducted openly.

The people of this state do not yield their sovereignty to the agencies which serve them. The people, in delegating authority, do not give their public servants the right to decide what is good for the people to know and what is not good for them to know. The people insist on remaining informed so that they may retain control over the instruments they have created

Local Ordinances:

Yakima County Code

http://www.codepublishing.com/WA/YakimaCounty/

Yakima County Code Title 6.22 Rights of Farmers

A farm operation shall not be found to be a public or private nuisance if the farm or farm operation conforms to generally accepted agricultural and management practices.

Yakima County Code Title 16A Critical Areas

Title 16A establishes policies, standards, and other provisions pertaining to development of designated critical areas. Stream corridors, flood hazard areas, water resource and wetland areas, and wildlife habitat areas constitute part of Yakima County's critical areas. These areas are of special concern to the people of Yakima County and the state of Washington because they are environmentally sensitive lands which comprise an important part of the county's natural resource base.

Yakima County Code Title 16C Critical Areas

Title 16C establishes policies, standards, and other provisions pertaining to development within designated critical areas regulated under the provisions of the Growth Management Act (RCW 36.70A), and development regulated under the National Flood Insurance Program and RCW 86.16. Additional purpose and intent for the protection of critical areas is provided in the chapter on each subject. Stream corridors, frequently flooded areas, wetlands, critical aquifer recharge areas, geologically hazardous areas and fish and wildlife habitat areas constitute Yakima County's critical areas. These areas are of special concern to the people of Yakima County and the state of Washington because they are environmentally sensitive lands, or hazardous areas, which compose an important part of the county's natural resource base.

Yakima County Code Title 19 Unified Land Development Code

No development shall occur nor shall any building or other structure be constructed, erected, repaired, improved, altered, enlarged, moved, removed, converted, or demolished; nor shall any use or occupancy of premises within the County be commenced or changed; nor shall any condition of or upon real property be caused or maintained, after the effective date of this Title, except as authorized by this Title and

in conformity and full compliance with conditions established. It is unlawful for any person, firm or corporation to erect, construct, establish, move into, alter, enlarge, use or cause to be used, any buildings, structures, improvements or use of premises contrary to this Title. Where this Title imposes greater restrictions than those imposed or required by other rules, regulations or ordinances, this Title shall control.

Yakima County Code Title 19.25 Sewer and Water

This Chapter is intended to:

(1) Further the public health, safety and welfare by providing clear rules for when and how connection to public sewer and water is required or prohibited;

(2) Ensure that all required sewer and water connections and improvements are consistent with, and implement applicable goals and policies of, the Comprehensive Plan and this Chapter;

(3) Require development inside Urban Growth Areas to connect to available regional sewer and area-wide public water supply systems, and provide for full future extension of such services where they are presently unavailable to serve such development, in order to efficiently convert the land to urban uses within the 20 year planning period;

(4) Provide for expansion of existing regional sewer and area-wide water supply systems as a cost-effective means for infrastructure development;

(5) Prioritize use of community on-site sewage disposal systems, as defined in Section 19.01.070, when service from a regional sewer system is not available within Urban Growth Areas or the service area of a County sewer system or sewer district;

(6) Prioritize use of public water supplies from existing satellite utility systems and facilitate their use in all areas when service from an area-wide public water supply system is not available;

(7) Provide a framework for the future location of facilities to assist developers and property owners in design of their projects;

(8) Provide consumer protection for future third party purchasers of developed properties by requiring applicants to invest in site improvements such as dry-line sewer and double plumbing dry side sewer connections to reduce costs of connecting to regional sewer systems when they become available;

(9) Minimize the cost of such improvements to the taxpayers of this County and State; and

(10) Provide specific standards consistent with RCW 58.17.110 and 19.27.097 that will ensure that an adequate source of potable water will be provided prior to development approval.

Relevant Agencies & Organizations

- Yakama Nation
- U.S. Bureau of Reclamation
- U.S. Geological Survey
- U.S. Environmental Protection Agency
- U.S. Natural Resources Conservation Service
- WA State Dept. of Ecology
- WA State Dept. of Agriculture
    - Dairy Nutrient Management Program
    - Natural Resources Assessment Section
    - Commodity Commissions
- WA State Dept of Health
- WA State Dept of Fish and Wildlife
- Yakima County
    - Health District
    - Voluntary Stewardship Program
    - Water Conservancy Board
    - Yakima County Extension Service
- City of Grandview
- Port of Grandview
- City of Granger
- City of Mabton
- City of Sunnyside
- Port of Sunnyside
- Roza Irrigation District
- Sunnyside Irrigation District
- Roza Sunnyside Joint Board of Control
- South Yakima Conservation District
- Yakima Valley Conference of Governments
- Washington State University
- University of Washington
- Heritage University
- WA State Farm Bureau
- WA State Dairy Federation
- Community Association for the Restoration of the Environment
- Concerned Citizens of the Yakama Reservation
- Friends of Toppenish Creek
- Yakima Valley Farmworkers Clinics
- Neighborhood Health Services
- Astria Health Care
- Virginia Mason Memorial
- Northwest Communities Educational Center/Radio KDNA
  (See Attachment 69 for Stakeholder Descriptions)

Reasons for a Minority Report in Detail

Reason I - Does not comply with WAC 173-100

WAC 173-100-090(1) states:

> *The groundwater advisory committee shall be responsible for overseeing the development of the groundwater management program; reviewing the work plan, schedule and budget for the development of the program; assuring that the program is technically and functionally sound; verifying that the program is consistent with this chapter and with the respective authorities of the affected agencies; and formulating and implementing a public involvement plan.*

The official December 2018 proposed GWMA Plan is not technically and functionally sound. The basic analysis of causes is flawed because it:

1. Underestimates nitrogen leaching from alfalfa fields
2. Underestimates atmospheric deposition of reactive nitrogen
3. Ignores the "dairy cluster"
4. Ignores nitrogen leaching from composting operations
5. Ignores nitrogen inputs from application of bio-solids
6. Ignores industrial spray fields
7. Ignores runoff to surface waters

The program is not consistent with the authority of at least one affected agency

1. Washington State Department of Agriculture
   Recommended Alternative 41 says that WSDA *will Identify and support opportunities, including education research institutions for private, public and industry investment in technology and management of fertilizers and manures, including separation of solid and liquid wastes. (17 – WSDA)* and *construct GWMA administrative program.*

WSDA does not have authority under Chapter 43.23 RCW DEPARTMENT OF AGRICULTURE to construct a GWMA administrative program. WSDA does not have the expertise to design or construct such a program that would implement WA State Water Policy. The stated cost is $10 million to come from the WSDA Capital Budget. The GWMA does not have control over the WSDA capital budget.

2. Yakima Health District
   Recommended Alternative 2 says that YHD will *collect data from Ambient Groundwater Monitoring Wells. (42 – Yakima Health District)* and
   Study short-term seasonal variations in nitrate concentrations over next year or two and address effects of changes in nutrient application over the agricultural cycle. Study long-term trends that develop over several years to track whether time-based performance objectives are being met.

While YHD may have the authority, YHD does not have the requisite staff with sufficient expertise to study long-term trends and track whether objectives are being met. How can YHD demonstrate expertise when time based performance objectives have not been defined; when there is no plan for analysis of data from monitoring wells?

Experts from EPA, WSDA and Ecology state that the impact of changes in nutrient applications does not show up in the groundwater for a longer period of time than two or even several years.

In order to complete this task YHD would have to collect more data than just water samples. YHD would have to track the impact due to changes in nutrient management, etc. Funding of $20,000/year is insufficient to develop a survey instrument and gather data that the WSDA has not been able to acquire.

YHD does not have a good track record doing data gathering and survey work. See Reason for Minority Report IIIB, IV3, and V5. The YHD only has a staff of 27.7 FTE's and has other significant, important and mandatory tasks necessary to provide public health for a county of 250,000 people.

WAC 173-100-100(6) states:

Each program shall include, as appropriate, the following:

6(a) A detailed work plan for implementing each aspect of the groundwater management strategies as presented in the recommendations section.

6(b) A monitoring system for evaluating the effectiveness of the program;

6(c) A process for the periodic review and revision of the groundwater management program.

The GWM Plan is not consistent with WAC 173-100-100 (6). The plan lacks all three of these components. See Attachment 62, Attachment 63 and Attachment 82 for more details.

Reason II – Unbalanced Advisory Committee

In Brief: The dairy industry has maintained veto power over any and all GWMA actions. Advocates for dairy have controlled the agenda and marginalized other voices on the GWAC.

In the early years of the GWMA Charlie McKinney from Ecology oversaw the program development and selection of stakeholders. The Yakima Farm Bureau chose Steve George to represent them. Helen Reddout was one of three environmentalists on the GWAC.

Mrs. Reddout asked Mr. McKinney why Stuart Turner was chosen to participate. According to Mr. McKinney, Steve George had suggested that Mr. Turner could represent the fertilizer industry. Mrs. Reddout replied that Mr. Turner had no connections to fertilizer groups. Instead he was employed by the WA Dairy Federation and worked for several local dairies. Mr. George is likewise employed by the dairy federation. Mr. McKinney maintained the importance of bringing agriculture to the table and held out a promise of adding a second Hispanic representative and someone to speak for Environmental Justice. These last two additions did not happen. (Attachment 38)

GWAC Composition and Actions: There are six members of the GWAC who vote as a block to support the interests of the dairy industry. With six votes this block has vetoed every proposal that might adversely impact that special interest group. The block consists of:

- Yakima Farm Bureau – the farm bureau representative has been employed by the Dairy Federation for many years
- Yakima Dairy Federation
- Agronomist – this representative is employed by several LYV dairies
- WSDA – there have been several representatives from this agency. They all work directly with the WSDA Dairy Nutrient Management Program
- South Yakima Conservation District – this representative administers the dairy nutrient management program for SYCD and spends most of her time working with dairymen
- Community Representative II – this representative is, in fact, the wife of a dairyman

Some of the actions that this group has blocked include:

1. Consideration of the impact of cows per acre on water quality in Yakima County
2. Consideration of local regulation of concentrated animal feeding operations (CAFOs)
3. A technical workshop on Environmental Justice
4. Hiring an education and outreach worker to improve community engagement
5. Incorporation of LYV studies done by the EPA into the GWMA plan
6. A presentation on environmental law from a University of Washington professor of environmental law with 50 years of expertise on the subject.
7. A presentation on air emissions of nitrates in the LYV by the Dept. of Ecology
8. Analysis of the impact of nitrates on public health in Yakima County
9. Collaboration with the USGS on groundwater analysis in the LYV
10. Collaboration with the University of Washington School of Public Health
11. Approval of a listing of best management practices (BMPs) for animal agriculture. Natural Resource Conservation Service (NRCS) guidelines were substituted instead
12. Economic analysis of the impact of groundwater pollution on the LYV

A lack of diversity on the Groundwater Advisory Committee has allowed this group to focus almost entirely on the needs of the dairy industry while ignoring the needs of the people in the Lower Yakima Valley who rely on groundwater for drinking, the needs of fish in the polluted Lower Yakima River and the ecological consequences of nitrogen imbalance.

Background: The Lower Yakima Valley Groundwater Management Area (LYV GWMA) Request for Identification proposed a Groundwater Management Area Advisory Committee (GWAC) with 21 members. The actual number has ranged from 20 to 23. Benton County withdrew from the LYV GWMA in 2013 and this caused a re-configuration of the GWAC with the addition of three members from the community. The environmental group Community Association for the Restoration of the Environment (CARE) withdrew from the GWAC in 2014 and a representative from Heritage University joined in 2015. The U.S. Geological Survey withdrew in 2014 and returned in 2016.

Most of the GWMA work has been done by a GWAC that consisted of 22 representatives:

1. Yakama Nation
2. Yakima County
3. Yakima Health District
4. Yakima Farm Bureau
5. Yakima Dairy Federation
6. An Agronomist
7. Friends of Toppenish Creek
8. Concerned Citizens of the Yakama Reservation
9. South Yakima Conservation District
10. Port of Sunnyside
11. Washington State Department of Agriculture
12. Washington State Department of Health
13. Washington State Department of Ecology
14. Washington State University
15. United States Geological Survey

16. Environmental Protection Agency
17. Roza-Sunnyside Irrigation District
18. Hispanic Representative
19. Farmer – Irrigated Agriculture
20. Community Representative I
21. Community Representative II
22. Heritage University

Regarding decision making the GWMA Operating Guidelines state (page 4):

> *"Areas of agreement" on groundwater management plan elements will be developed by seeking consensus. Consensus has been reached when everyone agrees they can accept moving forward with the recommendation and will support the recommendation, and after every effort has been made to meet the interests of all members. If consensus cannot be reached, the decision will be made by a majority vote, with a majority requiring a minimum of 75% of those members or alternates present (assuming a quorum is present.) In those instances where agreement cannot be reached, the reasons for the disagreement will be noted in the project record and the dissenting voters may include a minority report. When a minority report is filed, a primary author will be identified for the purpose of representing the minority's viewpoint in discussions with the media.*

Here are the agenda topics for GWMA discussion from 2012 to 2018. Note the absence of public health, minority group concerns and environmental justice.

Table 2. GWMA Agenda Topics

Topic		2012	2013	2014	2015	2016	2017	2018
GWMA Programming								
Guidelines		2	2					
Time Frames/ Deliverables		1		2	3			
GWMA SOW/ Work Plan		6	4					

Budget			3	3		1		
Goals & Objectives			5				2	
Review Contracts & Agreements			1	5	1	3		2
Area Characterization						1	1	1
Inform the GWAC								
Informational Needs		2						
Yakima County Pilot Program			1					
Oregon GWMA			1					
Overview of Dairy NMP				1				
Nitrate Standards (EPA)				1				
Overview of Regulations				1		1		
Potential Requests to Legislature						2		
International Water Conference						1		
Alternative Management Presentation							1	
GIS Applications							3	1
Education & Outreach								
EPO Work Plan		3						
GWMA Outreach Materials			2					
Standardize Talking Points			1					
Billboards						1		
Research								
EPA Study		1	1					
USGS Research			1		1			
Heritage University Survey			1					
High Risk Well Assessment					1			
Nutrient Budget/NAA			2		2		4	
Deep Soil Testing			2	2	1			
BMP Study			1					
Data Collection/Modeling				1		2		
Groundwater Monitoring Plan				3	2	2	1	2
Solutions								
Alternative Strategies							10	4
Number of Meetings		7	12	8	5	6	14	4

Respect:

The official GWMA Plan states on page ix:

> *The diversity of the committee members' interests often made for contentious discussions, but the members were committed to resolving the issues and continued to participate, and were usually respectful.*

The Friends of Toppenish Creek have not felt respected during the past six years. We have endured a great deal of acrimony and, in our opinion, unfair treatment. See Attachment 84 for documentation.

Reason III – Missed Deadlines and Bungled Research

In Brief: The GWMA leadership has failed to provide research that is necessary in order for the GWAC to do the work. The GWMA has missed almost every deadline.

A. Missed GWMA deadlines include:

1. Submission of GWMA Work Plan by Dec. 31, 2012
2. Completion of GWMA Plan by June 30, 2015
3. Completion of GWMA Plan by Sept. 30, 2015
4. Completion of GWMA Plan by Dec. 31, 2017
5. Almost none of the deadlines in the Timeline from the Feb. 2013 GWMA Work Plan were met. We calculate that about 84 out of 219 tasks from the Work Plan have been completed as of June 15, 2018 (Attachment 34)
6. Almost none of the deadlines in the 1-29-2015 GWMA Timeline were met.
7. Approval of a Final Plan by June, 2018

B. Inadequate Research & Analysis: It is impossible for an advisory group to function without reliable information that is shared in a timely manner. Problems related to delivery of important research include:

1. The GWAC acknowledged early in the process that an Area Characterization is essential for scientific study of nitrate pollution. The GWAC received proposed tables of contents for an Area Characterization in March 2013 and June 2015,

nothing else. An incomplete Draft Area Characterization was finally delivered in March 2018. As of October, 2018 it had not been approved.

2. At the beginning of the GWMA Yakima County hired a hydrogeologist to lead the effort. The hydrogeologist left in mid-2013 and was not replaced. Thus the GWMA was left without scientific leadership for the next five years.
3. There was no follow up survey after a 2013 baseline assessment of public awareness regarding groundwater pollution and the LYV GWMA that was done by Heritage University. Consequently we do not know whether GWMA activities have improved public understanding of the problem.
4. In March 2015 Yakima County and WSDA signed a contract to deliver a Nitrogen Loading Assessment that is needed in order for the GWAC to evaluate contributions of nitrate to groundwater from various sources. The study was due on Dec. 31, 2015 with the possibility of a two month extension. But in fact the study was not delivered until April 2017. It was no longer a Nitrogen Loading Assessment (NLA) but morphed into a Nitrogen Availability Assessment (NAA). It still has not been approved by the GWAC because several groups have questioned the accuracy of the information. For example:
    a. The Scope of Work for the project was ignored
    b. There is no assessment of the contribution from bio-solids
    c. There is no assessment of the contribution from spray fields used by waste water treatment plants
    d. The authors promised to hold meetings with local farmers and conduct local surveys. Instead they conducted telephone interviews with a few managers, crop advisors and fertilizer salesmen. A single consultant spoke for:
        i. 81% of the surveyed alfalfa acreage
        ii. 85% of corn silage acreage
        iii. 78% of juice grape acreage
        iv. 80% of hops acreage
        v. 90% of mint acreage
    e. There was no comparison of the NAA results with the GWMA Deep Soil Sampling as promised

f. Nitrogen inputs from farm animals on pasture or beef feedlots were ignored
g. There was no literature review for leakage from manure lagoons as promised
h. Nitrogen leakage from composting areas (> 500 acres in the GWMA target area) was omitted
i. The study incorrectly stated that 77% of nitrogen availability from irrigated cropland comes from apple orchards
j. The study stated that the average apple orchardist applies 60 lb of nitrogen per acre at the beginning of the season and there are 90 LBs of nitrogen per acre on the land at the end of the season.
k. The study incorrectly stated that nitrogen from alfalfa fields does not leak below the root zone. The GWMA DSS clearly showed otherwise.
l. The study ignored nitrogen runoff to surface waters.

5. The GWAC began developing plans for a network of monitoring wells in 2013. As of October, 2018 none of these wells had been drilled. Here is a history of GWAC actions related to purpose built monitoring wells:
    a. Draft Potential Groundwater Monitoring Stations December 3, 2013 (4th Quarter Report 2013, page 200/236)
    b. Potential Groundwater Monitoring Stations document December 3, 2013 (1st Quarter Report 2014, page 90/162)
    c. Interim Final Groundwater Monitoring Plan Version 7 (4th Quarter Report 2014, page 82/157)
    d. Pacific Groundwater Group (PgG) Agreement with Yakima County for "Monitoring Well Network Design" dated December 8, 2015 (4th Quarter Report 2015, page 68/76)
    e. PgG Technical Memorandum "Draft Ambient Groundwater Monitoring Network Location Selection Method" dated March 18, 2016 (1st Quarter 2016, page 104/143)
    f. PgG's report "Draft Lower Yakima Valley GWMA Proposed Ambient Groundwater Monitoring Network June 8, 2016 (2nd Quarter Report 2016, page 152/211)

g. GWMA Ambient Monitoring Network Report for Final Approval (4th Quarter Report 2016, page 98/170)
h. Recommendation regarding Groundwater Monitoring from Data Work Group (4th Quarter Report 2016, page 160/170)
i. January 2017 the Pacific Groundwater Group signs a contract to facilitate installation of groundwater monitoring wells in the GWMA target area. Yakima County did not sign the contract until January 2018 and did not inform the GWAC.
j. When Ecology presented the conceptual idea of a groundwater monitoring plan to the GWAC in 2016 they said there would be 35 to 40 wells. The signed contract says there will likely be less than 20. (1st Quarterly Report 2018, page 394/398)
k. As of October, 2018 no monitoring wells had been drilled. There is no plan for analyzing any data we gather.

6. The GWMA conducted Deep Soil Sampling from the fall of 2014 to the spring of 2016. There was no plan for data analysis. In 2017 Ecology provided an analysis and Friends of Toppenish Creek provided another. Neither of these analyses has been shared or discussed in a meeting of the GWAC.

7. The Yakima Health District conducted High Risk Well testing of 460 domestic wells in the GWMA target area. The project included a two page survey related to the home owner's well and water supply. The results of those surveys have never been shared with the GWAC nor analyzed.

8. In 2017 the U.S. Geological Survey tested approximately 156 domestic wells every other month as requested by the GWMA program. There was no plan for data analysis. The Friends of Toppenish Creek performed a basic analysis of the data but that study has not been accepted by the GWAC or included in the GWMA Report.

C. Final Report*:* In late 2017 the GWMA was given an extension until Dec. 31, 2018 for completion of a plan. The GWAC committed to twice monthly meetings in order to accomplish this. To date there were meetings in February (1), March (1), April (1), May (2), June (1), August (1) and December (1).

1. In order to complete a plan the GWAC needs:
    a. Area Characterization
    b. Problem Definition
    c. Goals and Objectives
    d. Listing of Alternative Solutions
    e. Listing of Recommended Alternative
    f. Implementation Strategies

2. The GWAC received a draft document with a partial Area Characterization in March, 2018. The other components of the plan were missing.

3. The GWAC missed a June 30, 2018 deadline for completion of the GWMA plan. A draft document presented on June 21, 2018 prompted many concerns. Edits were requested and the draft plan was sent back for a re-write.

4. If the Goals and Objectives from the GWMA Work Plan are used for the final plan, there are some serious deficiencies. Unfulfilled objectives from the Request for Identification include:
    a. Establish a monitoring program to identify sources of nitrate contamination and their relative importance
    b. Establish and conduct long-term groundwater quality monitoring program and evaluate progress
    c. Establish educational programs to promote the protection of groundwater quality and provide a forum for stakeholders to discuss nitrate reduction methods and improvement of groundwater quality. This will include culturally-appropriate education and outreach

d. *Provide water quality and hydrogeologic data to assess needs and methods of expanding public water supplies, and provide a forum for initiation of these plans*
e. *Consider options to encourage appropriate expansion of public water supplies to areas that are currently dealing with contaminated private supplies*
f. *Assist residents whose supplies have been contaminated to access safe and reliable water supplies, using culturally-appropriate communications*
g. *The GWMA will seek sustainable funding sources to carry out its mission*

5. In February, 2013, in order to achieve 100% GWAC support for the GWMA Work Plan a section on public health was added to the plan. That section reads:

Immediate Public Health Needs

Approximately 75,000 persons reside within the Lower Yakima Basin area. Of that amount, it is estimated that about 25,000 residents (34% of the population) obtain their drinking water from private wells. Water quality testing conducted by various entities during the last twenty years shows that up to twenty percent of the private drinking water wells may exceed drinking water standards for nitrate. Accordingly, a conservative calculation indicates that upwards of 1,800 private wells within the area may exceed nitrate drinking water standards.

The GWAC recognizes and supports the primary long-term goal of the GWMA to reduce concentrations of nitrate in groundwater to below Washington State drinking water standards in order to protect the health and safety of the residents of the Lower Yakima Basin, The GWAC believes, based on similar efforts within the State of Washington and the Nation, that fulfillment of this goal will undoubtedly take many years to achieve. The GWAC is very concerned about the public health effects nitrates may have on the existing residents during this period of time. Accordingly, the GWAC will work with Federal, State, and Local governments to immediately seek funding and implement programs to provide clean drinking water to the residents of the Lower Yakima Basin.

In fact there was no follow-through. The LYV GWMA has done nothing to access programs to help the residents of the LYV access clean drinking water. In fact, in 2014 Yakima County

returned to the state $150,000 that was awarded to help private home owners access safe drinking water. In fact, the 2017 survey of 156 wells by U.S.G.S., found that 19.7% of the wells exceeded the safe standard of 10 mg/L nitrate. This suggests no decrease in nitrate pollution of LYV aquifers as a result of GWMA activity.

6. According to the GWMA Guidelines which are derived from WAC 173-100-100:

GWAC members will:

- *Review technical information and analyses to understand the scope of the problem, and potential approaches to the problem and their impact on the community.*
- *Serve as a liaison to the public and/or their agencies (as appropriate) by networking effectively outside the GWAC with people or groups with similar interests to provide broad input to the discussions.*
- *Bring a valuable and informed perspective, and contribute useful information to the process.*
- *Work collaboratively, constructively and creatively to help develop the groundwater management program.*
- *Attend meetings consistently. If an organization seat (member or alternate) is not represented at two consecutive meetings, the member will receive a reminder notification and a warning about absences. If an organization seat (member or alternate) is not represented for three consecutive meetings, the GWAC will consider whether to ask the Department of Ecology to vacate the seat and seek to refill it with a new representative from the same constituency group who will participate consistently.*
- *Come to meetings prepared (do the homework).*
- *Be willing and able to commit time and energy to the development of the groundwater management program.*
- *Abide by the ground rules.*

Yakima County will:

- *Provide available and newly developed information on data and monitoring, problem identification, measures to reduce groundwater contamination and education.*
- *Provide draft and/or final technical analyses to inform GWAC discussions.*
- *Support the GWAC in their decision-making.*
- *Prepare a work plan, schedule and budget for the development of the program.*
- *Support the GWAC's responsibilities as liaison to the public and/or their agencies by providing information in a timely fashion to allow for GWAC*

It is impossible for the GWAC to comply with these requirements without adequate information. At this late point in time there is no:

a. Nitrogen Loading Assessment
b. High Risk Well Assessment Analysis
c. Groundwater Monitoring Network
d. Detailed plan for implementing recommended solutions

As of February, 2018 this is a best estimate of task completion for the GWMA Work Groups. (See Attachment 34)

Table 22. Task Completion

1.0 Data Collection, Characterization, Monitoring	36 Tasks, 17 Completed
2.1 Livestock & CAFO – Yards, corrals, lagoons, manure field application	54 Tasks, 11 Completed
2.2 Irrigated Agriculture	50 Tasks, 25 Completed
3.0 Regulatory Framework	26 Tasks, 15 Completed - 10 Poorly Done & incomplete
4.0 Education and Outreach	32 Tasks, 26 Completed - 10 Poorly Done
5.0 Funding	21 Tasks, None Completed
Total	219 Tasks, 94 Complete, 20 Poorly Done

Reason IV - No Analysis of Research

In Brief: The GWMA gathered data and then, failed to analyze the data. The GWMA did no analysis of Deep Soil Sampling data, High Risk Well testing data, composting data, sampling of domestic wells and drains, or responses to a survey of public understanding.

1. Heritage Survey: In 2013 the GWMA contracted with Heritage University to conduct a survey of private well owners in the LYV in order to obtain a baseline assessment of how much people knew about nitrate contamination of the groundwater and the purpose of the LYV GWMA. Survey results were presented to the GWAC in September 19, 2013. The survey and results are available in the 3rd Quarter GWMA report for 2013.

Members of the GWAC reasonably assumed that the survey would be done by random sampling. This was not the case. Yakima County chose the homes to be surveyed. When community representatives asked the Education and Public Outreach (EPO) work group (WG) how many of the bilingual surveys were conducted in Spanish the work group leaders did not know.

The EPO WG presented the following tallies to the GWAC:

A. 69% (94) households are aware of the potential health risks associated with drinking water with high levels of nitrate.
B. Over half of those surveyed had their private wells tested for nitrate
C. 4% (6) households believed that someone in their home had become ill from drinking well water
D. 42% (57) of households had heard of the GWMA
E. 33% (45) households were interested in more in-depth well testing

There was no analysis of the data. Friends of Toppenish Creek subsequently performed a lengthy statistical analysis (Attachment 20) that was never shared with the GWAC. That analysis found:

A. In two of the major zip codes, 98944 - Sunnyside & 99350 - Prosser, less than half of those surveyed test well water for nitrates.

B. There is a statistical difference between home owners and renters regarding awareness of nitrate issues with drinking water. Renters are not as well informed as home owners.
C. 71% of renters were comfortable asking landlords to test well water and 29% were not.
D. There is a high correlation between being aware of nitrate issues and having well water tested for nitrates.
E. 43% of those with Spanish surnames purchase bottled water compared to 15% of those with non-Spanish surnames. There was no statistical difference in risks for those with Spanish surnames and those without.

There are no subsequent surveys to determine whether the GWMA work has improved public understanding of groundwater pollution in the LYV.

2. Deep Soil Sampling: On July 15, 2014 Yakima County contracted with the South Yakima Conservation District to administer a Deep Soil Sampling (DSS) study. The GWAC spent an extraordinary amount of time and effort to bring this project together in a way that protects the anonymity of farmers who were willing to volunteer their fields for testing.

Purposes of the DSS were:

1) Providing baseline data regarding the nitrogen content (nitrate, ammonium, and organic matter) of soils underlying a variety of soil, crop, and irrigation systems that represent a cross-section of agricultural activities.
2) Provide an initial assessment of current nitrogen and water management practices in place today and in the past.
3) Provide information regarding availability of soil nitrogen to crops.
4) Provide the foundation for a technically based education program.
5) Provide information about project design, practical realities, time requirements and costs that can be used in developing subsequent project scopes.

The GWAC reviewed a draft DSS Plan in late 2013 (See 4th Quarter GWMA Report 2013) and approved a final DSS plan in April 2014 (See 2nd Quarter Report 2014). The plan called for a distribution of samples across three parameters – soil type (revised to leaching potential), cropping type (revised to root depth) and irrigation types. There were 3 to 4 divisions within each category. This resulted in between 36 and 96 possible combinations. The plan called for sampling of the most common combinations and the GWAC agreed that this would provide sufficient data for an initial evaluation.

These stated objectives were not achieved. The final collection of 175 samples contained:

A. 15 categories or combinations of parameters. (5 of the 15 had only one sample).
B. 40% of the samples were in the category 2.5 to 4 ft root depth, sprinkler irrigation and moderately high to high leaching potential.
C. 19% of the samples were in the category > 4 ft root depth, sprinkler irrigation and moderately high to high leaching potential.
D. 12% of the fields were in the category 2.5 to 4 ft root depth, rill irrigation and moderately high to high leaching potential.

Descriptive information was missing from 12 of the samples in the last round of testing. The South Yakima Conservation District did not provide nitrate leaching potentials for individual sites in spite of the fact that this was part of the plan.

There were enough samples for analysis of fields planted in triticale/corn silage, the largest cropping group in the study.

Initially, no data analysis was performed. There were delays in sharing the raw data. In August of 2017 the Friends of Toppenish Creek performed analysis of the entire data set and analysis of the fields planted in triticale/corn silage. (Attachment 23 & Attachment 24)

In the spring of 2018 Ecology performed a separate and different analysis of the DSS and the two studies were discussed within the Data Work Group.

Conclusions from the Data WG discussion have never been shared with the GWAC. The DSS work was not included in the Nitrogen Loading Assessment/Nitrogen Availability

Assessment performed by WSDA and Yakima County, in spite of the fact that this was part of their scope of work (SOW). (See 4th Quarter GWMA Report 2014)

3. High Risk Well Testing: On June 25, 2013, on behalf of the GWMA, Yakima County signed an agreement with the Yakima Health District (YHD) to conduct a minimum of 250 and up to 320 household surveys of private well owners. Services were to include:

a. Site visits to test tap water with test strips, and take samples using laboratory bottles
b. Deliver the sample bottles to the designated testing laboratory
c. Take pictures of the well head to document site visit and findings
d. Obtain location and depth of the wells for GIS database
e. Fill out a questionnaire and provide the information to Public Services.

On August 21, 2014 a report with lab results from 172 samples was shared with the GWAC. Results were:

A. 0 to 2.5 mg/L nitrate – 29.7%
B. 2.5 to 5 mg/L nitrate – 28.5%
C. 5 to 10 mg/L nitrate – 25.6%
D. 10 to 15 mg/L nitrate – 8.1%
E. 15 to 20 mg/L nitrate – 7%
F. 20 to 25 mg/L nitrate – 1.2%

Results from the questionnaires were not presented.

On September 8, 2015 on behalf of the GWMA, Yakima County signed an agreement with the Yakima Health District (YHD) to conduct a second round of High Risk Wells testing.

On February 16, 2016 there was a contract amendment to add 80 additional samples with a total cost of $70,000.

The February 16, 2016 report to the GWMA showed 288 sample results:

A. 0 to 5 mg/L nitrate – 60%
B. 5.01 to 9.99 mg/L nitrate – 26%
C. 10 to 35 mg/L nitrate – 14%

On April 12, 2016, after the fact, there was a contract amendment that increased the number of samples by 10.

Approximately 460 High Risk Well Assessments were performed – 172 during Phase I and 288 during Phase II.

A two page questionnaire accompanied the High Risk Well Assessments. Questionnaire results have never been shared with the GWAC in spite of numerous requests. Consequently, there is no analysis of the High Risk Well surveys. In June 2018 the Friends of Toppenish Creek reluctantly submitted a public records request for the data. There were no completed questionnaires.

4. USGS Domestic Well Testing: On February 15, 2017, on behalf of the GWMA, Yakima County signed a $491,320 contract with the U.S. Geological Survey to:

A. Take and test water samples every two months during 2017 from 140 to 160 domestic wells
B. Take and test water samples every two months during 2017 from 24 agricultural drains in the LYV
C. Take and test water samples from each of 20 to 30 purpose built monitoring wells every two months during 2017

The first two tasks were completed. The third was not completed because the purpose-built monitoring wells have not been drilled.

U.S.G.S offered to analyze the collected data for an additional reimbursement of $60,000 to $75,000. Yakima County declined and no data analysis was performed. The Friends of Toppenish Creek performed a rudimentary analysis of the raw data and offered it to the GWAC. (Attachment 28) Some important findings are:

A. Nitrate levels are higher in wells near the middle and southern portions of the GWMA.
B. There is no statistical correlation between well depth and nitrate levels or ground surface elevation and nitrate levels.
C. There were wells with low nitrate levels close to wells with high nitrate levels.
D. There were a few wells with wide fluctuations in nitrate levels.
E. Wells near the Yakima River had much lower nitrate levels than those farther from the river.
F. There is a farmed area east of the Toppenish Wildlife Refuge with surprisingly low nitrate levels.
G. Drains showed wide ranges in values from zero nitrates to > 20 mg/L nitrates.
H. Drains showed major seasonal fluctuations.

The GWAC has not commented or accepted these findings. At this point in time the GWMA possesses this new source of data that is un-analyzed and not utilized for problem solving.

5. Composting:

Testimony in the case of CARE and CFS versus Cow Palace (2015) supports the high probability that nitrates and other nitrogen compounds leach from manure compost yards to the underlying aquifers. (Attachment 49 & Attachment 50)

Members of the GWAC from the agricultural community were not convinced and they conducted their own deep soil sampling on pens, corrals and compost yards in 2015 with support from the WSDA. (Attachment 13, Attachment 14 & Attachment 15) This data also shows significant leaching from these production areas.

In 2016 and 2017 Friends of Toppenish Creek engaged in an unsuccessful campaign to convince the SYCD to endorse stronger protective practices on compost yards. (Attachment 51, Attachment 52 & Attachment 53)

The agricultural groups on the GWMA continue to question the validity of the environmentalists' position. Consequently nitrogen input from composting yards was omitted from the 2018 Nitrogen Availability Assessment. WSDA stated on page 13:

> *Manure composting areas were identified and the acreage was calculated as part of this analysis. Differences between composting areas and pens include surface construction, the lack of animal movement compacting surfaces, and the difference in moisture inputs between composting areas and pens. Due to these differences, as well as the diversity of potential compost management practices, NRAS did not feel use of the dairy/nondairy CAFO pen rate was appropriate for compost areas. The diversity of composting practices could include composting in windrows, composting in bags, spreading material out over a large surface to dry, turning frequency, moisture additions to maintain optimal composting conditions, or the use of a concrete pad for composting. With no information available in scientific literature about potential loading from compost areas, NRAS did not attempt a calculation for these areas. With the locations and dimensions of composting areas already identified, nitrogen loss from compost areas could easily be calculated in the future if new information becomes available.*

Reason v – Contract Mismanagement

In Brief: The *GWMA and GWMA contractors have not complied with the terms of their contracts. There have been no consequences. Most egregious - A Nitrogen Availability Assessment, the center piece of the GWMA analysis, ignored bio-solids and waste water spray-fields, ignored the GWMA Deep Soil Sampling, ignored inputs from beef feedlots and animals on pasture, ignored composting yards, failed to do a promised literature review and incorrectly stated that there is no leaching from alfalfa fields.*

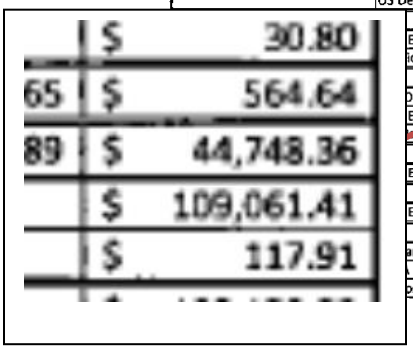
1. Work Plan: 2013 GWMA Work Plan spending projections:

Description	Low	Medium	High
Task 1. Plan Development and Administration	$300,000	$400,000	$500,000
Task 2. Monitoring and Characterization	$150,000	$575,000	$1,000,000
Task 3. Education and Public Outreach	$100,000	$250,000	$400,000
Task 4. BMP Redevelopment and Field Research	$200,000	$350,000	$500,000
TOTAL	$750,000	$1,575,000	$2,400,000

The projections were not taken seriously.

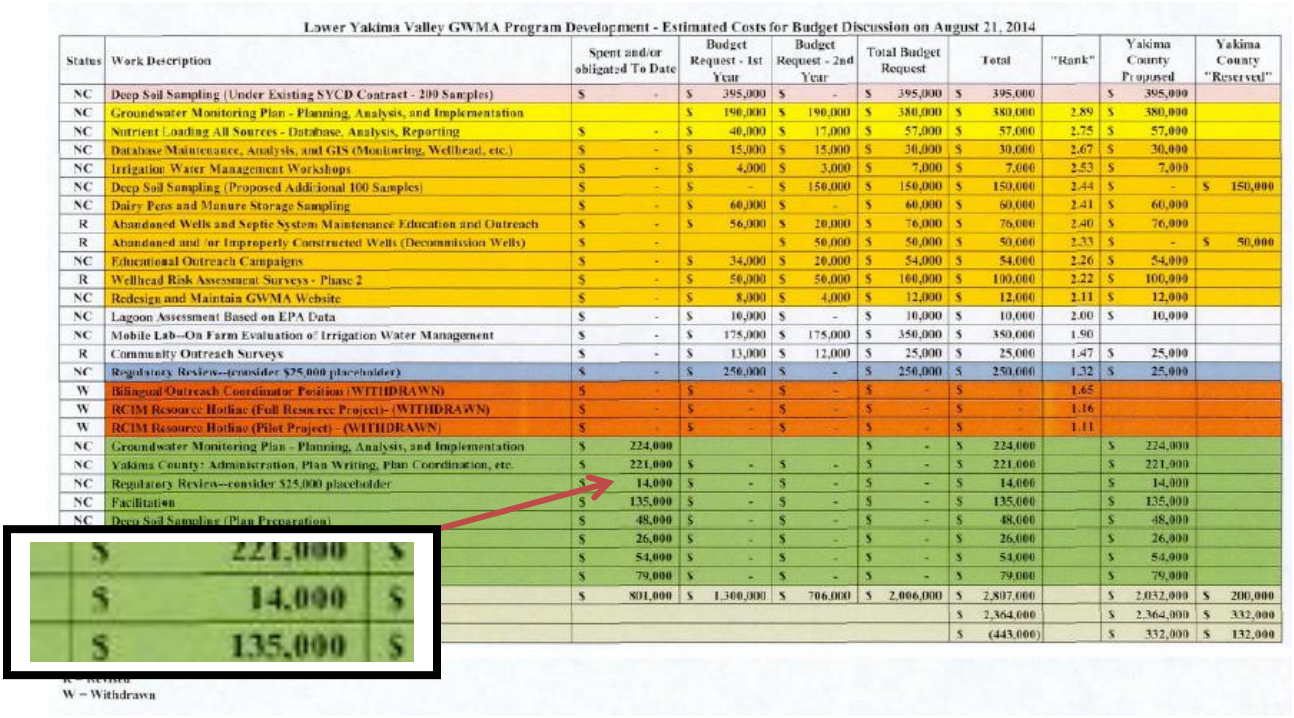
LYVGWMA Expenditures through December, 2017

Task Description	Subtask Description	VENDOR	2013	2014	2015	2016	2017	Grand Total
		Yakima Herald					$ 112.64	$ 112.64
	Program Support Total		$ 401.49	$ 1,666.43	$ 3,346.88	$ 3,696.27	$ 5,768.26	$ 14,879.33
	Public Survey	Brady, Roberta				$ 8.64		$ 8.64
		Ehlis, Carolyn	$ 855.01					$ 855.01
		Heritage University	$ 5,300.00					$ 5,300.00
		Nitrate Program - Postage		$ 139.38				$ 139.38
		Office Max				$ 23.78		$ 23.78
		POP UP BANNER				$ 325.34		$ 325.34
		SURVEYMONKEY				$ 288.13	$ 315.00	$ 603.13
	Public Survey Total		$ 6,155.01	$ 139.38		$ 645.89	$ 315.00	$ 7,255.28
	Travel	03 FORD F350					$ 56.98	$ 56.98
		Freund, Lisa	$ 25.99					$ 25.99
		Saunders, Christopher				$ 413.20	$ 37.67	$ 450.87
		Wurtz, Mary		$ 30.80				$ 30.80
	Travel Total		$ 25.99	$ 30.80		$ 413.20	$ 94.65	$ 564.64
Education and Outreach Total			$ 11,665.81	$ 13,259.24	$ 3,346.88	$ 6,194.54	$ 10,281.89	$ 44,748.36
Facilitation	GWAC Meetings	Enviroissues Inc.	$ 67,256.26	$ 41,805.15				$ 109,061.41
		U S Bank		$ 117.91				$ 117.91
	GWAC Meetings Total		$ 67,256.26	$ 41,923.06				$ 109,179.32
Facilitation Total			$ 67,256.26	$ 41,923.06				$ 109,179.32
Monitoring and Assessment	Data Analysis	Oliver-Murdock, Lee Ann			$ 3,123.46			$ 3,123.46
	Data Analysis Total				$ 3,123.46			$ 3,123.46
	Data Collection	Sedighi, Ali	$ 68,113.79					$ 68,113.79
		U S Bank			$ 43.26			$ 43.26
		US Dept of the Interior					$ 337,000.00	$ 337,000.00
			$ 68,113.79		$ 43.26		$ 337,000.00	$ 405,157.05
		Engineering Inc.	$ 43,080.07	$ 20,001.02				$ 63,081.09
		ic Groundwater Group Inc.				$ 37,485.00		$ 37,485.00
			$ 43,080.07	$ 20,001.02		$ 37,485.00		$ 100,566.09
		ORD ESCAPE 4x4	$ 44.08					$ 44.08
		Engineering Inc.	$ 33,626.01	$ 20,450.81				$ 54,076.82
			$ 1,406.60					$ 1,406.60
			$ 35,076.69	$ 20,450.81				$ 55,527.50
		Engineering Inc.	$ 10,422.87					$ 10,422.87
			$ 10,422.87					$ 10,422.87
		Engineering Inc.		$ 10,047.42				$ 10,047.42
				$ 10,047.42				$ 10,047.42
		ante Media Group		$ 900.00				$ 900.00
		Enterprises		$ 120.00	$ 280.00			$ 400.00
		os Media			$ 925.00			$ 925.00



At the end of 2017 the GWMA had spent $44,748.36 on Education and Public Outreach, about 11% of the projected expenditure. (1st Quarter Report 2018, Page 70/398) This estimate was part of the LYV GWMA Work Plan (page 20) that was submitted to Ecology for approval in February, 2013.

2. Regulatory Review: In August 2014 Yakima County reported paying $14,000 to HDR Engineering for a Regulatory Review. (See the 3rd Quarterly Report 2014, pages 77/169 and 78/169)



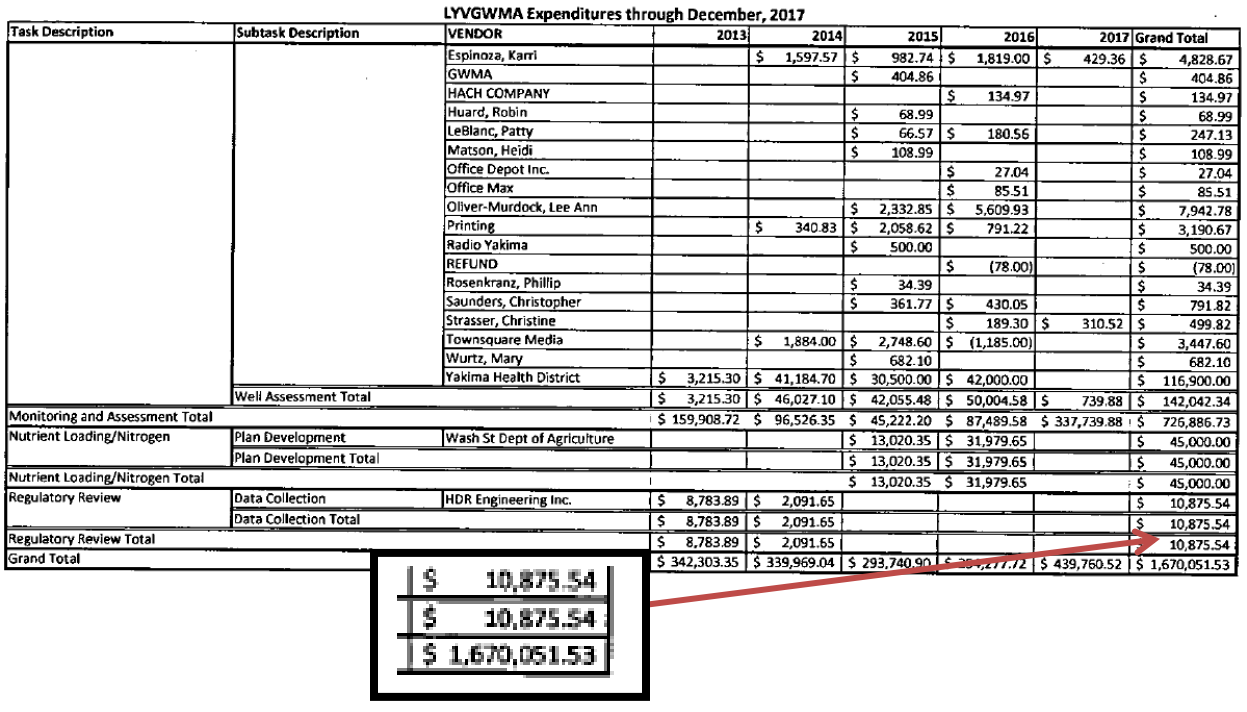
Lower Yakima Valley GWMA Program Development - Estimated Costs for Budget Discussion on August 21, 2014

Status	Work Description	Spent and/or obligated To Date	Budget Request - 1st Year	Budget Request - 2nd Year	Total Budget Request	Total	"Rank"	Yakima County Proposed	Yakima County "Reserved"
NC	Deep Soil Sampling (Under Existing SYCD Contract - 200 Samples)	$ -	$ 395,000	$ -	$ 395,000	$ 395,000		$ 395,000	
NC	Groundwater Monitoring Plan - Planning, Analysis, and Implementation		$ 190,000	$ 190,000	$ 380,000	$ 380,000	2.89	$ 380,000	
NC	Nutrient Loading All Sources - Database, Analysis, Reporting	$ -	$ 40,000	$ 17,000	$ 57,000	$ 57,000	2.75	$ 57,000	
NC	Database Maintenance, Analysis, and GIS (Monitoring, Wellhead, etc.)	$ -	$ 15,000	$ 15,000	$ 30,000	$ 30,000	2.67	$ 30,000	
NC	Irrigation Water Management Workshops	$ -	$ 4,000	$ 3,000	$ 7,000	$ 7,000	2.53	$ 7,000	
NC	Deep Soil Sampling (Proposed Additional 100 Samples)	$ -	$ -	$ 150,000	$ 150,000	$ 150,000	2.44	$ -	$ 150,000
NC	Dairy Pens and Manure Storage Sampling	$ -	$ 60,000	$ -	$ 60,000	$ 60,000	2.41	$ 60,000	
R	Abandoned Wells and Septic System Maintenance Education and Outreach	$ -	$ 56,000	$ 20,000	$ 76,000	$ 76,000	2.40	$ 76,000	
R	Abandoned and /or Improperly Constructed Wells (Decommission Wells)	$ -		$ 50,000	$ 50,000	$ 50,000	2.33	$ -	$ 50,000
NC	Educational Outreach Campaigns	$ -	$ 34,000	$ 20,000	$ 54,000	$ 54,000	2.26	$ 54,000	
R	Wellhead Risk Assessment Surveys - Phase 2	$ -	$ 50,000	$ 50,000	$ 100,000	$ 100,000	2.22	$ 100,000	
NC	Redesign and Maintain GWMA Website	$ -	$ 8,000	$ 4,000	$ 12,000	$ 12,000	2.11	$ 12,000	
NC	Lagoon Assessment Based on EPA Data	$ -	$ 10,000	$ -	$ 10,000	$ 10,000	2.00	$ 10,000	
NC	Mobile Lab--On Farm Evaluation of Irrigation Water Management	$ -	$ 175,000	$ 175,000	$ 350,000	$ 350,000	1.90		
R	Community Outreach Surveys	$ -	$ 13,000	$ 12,000	$ 25,000	$ 25,000	1.47	$ 25,000	
NC	Regulatory Review--(consider $75,000 placeholder)	$ -	$ 250,000	$ -	$ 250,000	$ 250,000	1.32	$ 25,000	
W	Bilingual Outreach Coordinator Position (WITHDRAWN)	$ -	$ -	$ -	$ -	$ -	1.65		
W	RCIM Resource Hotline (Full Resource Project)- (WITHDRAWN)	$ -	$ -	$ -	$ -	$ -	1.16		
W	RCIM Resource Hotline (Pilot Project) - (WITHDRAWN)	$ -	$ -	$ -	$ -	$ -	1.11		
NC	Groundwater Monitoring Plan - Planning, Analysis, and Implementation	$ 224,000			$ -	$ 224,000		$ 224,000	
NC	Yakima County: Administration, Plan Writing, Plan Coordination, etc.	$ 221,000	$ -	$ -	$ -	$ 221,000		$ 221,000	
NC	Regulatory Review--consider $25,000 placeholder	$ 14,000	$ -	$ -	$ -	$ 14,000		$ 14,000	
NC	Facilitation	$ 135,000	$ -	$ -	$ -	$ 135,000		$ 135,000	
NC	Deep Soil Sampling (Plan Preparation)	$ 48,000	$ -	$ -	$ -	$ 48,000		$ 48,000	
		$ 26,000	$ -	$ -	$ -	$ 26,000		$ 26,000	
		$ 54,000	$ -	$ -	$ -	$ 54,000		$ 54,000	
		$ 79,000	$ -	$ -	$ -	$ 79,000		$ 79,000	
		$ 801,000	$ 1,300,000	$ 706,000	$ 2,006,000	$ 2,807,000		$ 2,032,000	$ 200,000
						$ 2,364,000		$ 2,364,000	$ 332,000
						$ (443,000)		$ 332,000	$ 132,000

$ 221,000
$ 14,000
$ 135,000

W = Withdrawn

Later, in reported expenditures through December 2017 (1st Quarterly Report for 2018, page 74/398) Yakima County reported the costs at $10,875.54.



LYVGWMA Expenditures through December, 2017

Task Description	Subtask Description	VENDOR	2013	2014	2015	2016	2017	Grand Total
		Espinoza, Karri		$ 1,597.57	$ 982.74	$ 1,819.00	$ 429.36	$ 4,828.67
		GWMA			$ 404.86			$ 404.86
		HACH COMPANY				$ 134.97		$ 134.97
		Huard, Robin			$ 68.99			$ 68.99
		LeBlanc, Patty			$ 66.57	$ 180.56		$ 247.13
		Matson, Heidi			$ 108.99			$ 108.99
		Office Depot Inc.				$ 27.04		$ 27.04
		Office Max				$ 85.51		$ 85.51
		Oliver-Murdock, Lee Ann			$ 2,332.85	$ 5,609.93		$ 7,942.78
		Printing		$ 340.83	$ 2,058.62	$ 791.22		$ 3,190.67
		Radio Yakima			$ 500.00			$ 500.00
		REFUND				$ (78.00)		$ (78.00)
		Rosenkranz, Phillip			$ 34.39			$ 34.39
		Saunders, Christopher			$ 361.77	$ 430.05		$ 791.82
		Strasser, Christine				$ 189.30	$ 310.52	$ 499.82
		Townsquare Media		$ 1,884.00	$ 2,748.60	$ (1,185.00)		$ 3,447.60
		Wurtz, Mary			$ 682.10			$ 682.10
		Yakima Health District	$ 3,215.30	$ 41,184.70	$ 30,500.00	$ 42,000.00		$ 116,900.00
	Well Assessment Total		$ 3,215.30	$ 46,027.10	$ 42,055.48	$ 50,004.58	$ 739.88	$ 142,042.34
Monitoring and Assessment Total			$ 159,908.72	$ 96,526.35	$ 45,222.20	$ 87,489.58	$ 337,739.88	$ 726,886.73
Nutrient Loading/Nitrogen	Plan Development	Wash St Dept of Agriculture			$ 13,020.35	$ 31,979.65		$ 45,000.00
	Plan Development Total				$ 13,020.35	$ 31,979.65		$ 45,000.00
Nutrient Loading/Nitrogen Total					$ 13,020.35	$ 31,979.65		$ 45,000.00
Regulatory Review	Data Collection	HDR Engineering Inc.	$ 8,783.89	$ 2,091.65				$ 10,875.54
	Data Collection Total		$ 8,783.89	$ 2,091.65				$ 10,875.54
Regulatory Review Total			$ 8,783.89	$ 2,091.65				$ 10,875.54
Grand Total			$ 342,303.35	$ 339,969.04	$ 293,740.90	$ [illegible]	$ 439,760.52	$ 1,670,051.53

$ 10,875.54
$ 10,875.54
$ 1,670,051.53

The June 26, 2013 contract with HDR Engineering specifies payment for the Regulatory Review in the amount of $6,646.00. (2nd Quarter Report for 2013 page 100/142)

Compensation

The estimated total contract amount to complete the professional services identified in this Scope of Services is two-hundred fifteen thousand, one hundred and nine dollars ($215,109.00). If the optional tasks described in Attachment 1 are included, the estimated total contract amount to complete the professional services identified in this Scope of Services is two-hundred sixty-six thousand, four hundred and two dollars ($266,402.00). A summary of the costs by task is presented below.

Scope Tasks	HDR Labor	Expenses	Subtotal
Base Scope Tasks:			
Task 1 - Project Management	$8,952	$796	$9,748
Task 2 - Regulatory Review	$6,081	$465	$6,546
Task 3 - Develop BMP Database	$11,374	$610	$11,984
Task 4 - BMP Effectiveness Evaluation	$20,305	$3,968	$24,273
Task 5 - Reports and Presentations	$25,333	$5,212	$30,545
Task 6 - GWMA Meetings and Workshops	$8,000	$2,000	$10,000
Task 7 - Initial Characterization Assessment (PGG)	$2,232	$119,781	$122,013
Task 8 - BMP Implementation Assistance and Monitoring (TBD)	$ -	$ -	$ -
Task 9 - Monitoring Plan Implementation (TBD)	$ -	$ -	$ -
Base Scope Total	$82,277	$132,832	$215,109

$6,546.00 for Regulatory Review

The Regulatory Review is an eight page document that a college freshman could have compiled in a few days using the Google search engine. (See Technical Memorandum #1 – Regulatory Review on page 79/161 of the 3rd Quarter Report for 2013). It has been essentially useless for the GWMA work. Very relevant rules and regulations, such as RCW 70.95 – Solid Waste Management, were omitted.

3. High Risk Wells. In 2013 the WA State Department of Health said they could perform high risk well testing for about $200 per well. The Yakima Health District (YHD) said they

could do the work for $80 per well and the GWAC selected YHD. A contract was signed for $100 per well plus $27.50 for lab testing.

Here is the history in detail of what happened next:

1. On June 25, 2013 Yakima County and YHD signed a $50,000 contract that required the health district to conduct a minimum of 250 and up to 320 high risk well assessments and surveys in the GWMA target area by October 31, 2013.
2. On November 25, 2013 the deadline was extended to March 31, 2014.
3. On March 25, 2014 the deadline was extended to May 31, 2014.
4. This Phase I of High Risk Well Testing resulted in surveys of 172 domestic wells, not 250 as required
5. YHD received $45, 400 for this work and the calculated cost was $264 per site visit
6. On September 8, 2015 Yakima County and YHD signed a contract that authorized the health district to conduct Phase II of High Risk Well Testing. The costs were not to exceed $50,000 and payments were $250 per site. The GWAC approved Phase II but was not informed about the doubling of costs.
7. By February 15, 2016 YHD had conducted 288 High Risk Well Assessments. Payment at $250 per site would exceed the $50,000 limit.
8. Yakima County and YHD signed a contract amendment on February 16, 2016 that increased the contract amount to $70,000.
9. The GWAC met on February 18, 2016 and received the test results.
10. On April 12, 2016 Yakima County and YHD signed a contract amendment that provided for up to 10 additional samples.
11. The GWAC has yet to see the results of survey questions.

4. Deep Soil Sampling: The LYV GWMA spent a great amount of time and effort designing a Deep Soil Sampling (DSS) project in order to access important information while providing anonymity for growers. At one time the GWAC approved costs for the DSS were over $400,000. Here is the history:

A. February 2013 - Stuart Turner and Kevin Lindsey estimate that deep soil testing can be done for $40,000 to $60,000. Kirk Cook from WSDA felt this was grossly underestimated. (From GWMA Summary Notes, February 3, 2013)
B. February 2013 - The Groundwater Area Committee agrees to dedicate $11,000 from the original $300,000 budget for deep soil testing.
C. June 2013 - Yakima County submits a budget to Ecology for the $750,000 allocated at that time. They ask for $117,000 for deep soil sampling.
D. June 2013 - "HDR Engineering was asked for a proposal to conduct Optional Task 10 which includes deep soil monitoring. Their cost estimate was $51,293. They would be doing 20 locations of analysis and digging 8 - 10 feet, sampling at one foot increments until the total depth is reached. We need to do 20 cropping systems with 6 - 10 samples per cropping system." (From Summary Notes, June 20, 2013)
E. June 19, 2013 - Contract signed between Yakima County and HDR for $266,402, includes $51,293 for Optional Task 10 - "Communication, Source Mapping, Deep Soil Sampling, and Data Publishing Assessment"
F. August 2013 - Technical Memorandum from Pony Ellingson to Don Gatchalian re *Considerations for Further Scoping of Deep Soil Sampling (DSS), Lower Yakima Valley GWMA* under Summary of Deep Soil Sampling (DSS) for the Columbia Basin GWMA says, "Educational sampling programs were conducted in 2000 and 2001. In 2000, 73 growers participated and 376 fields were sampled. The (Columbia) GWMA spent $43,640 for that task in 2000. In 2001 99 growers participated and 458 fields were sampled. . . . The plan was for five years of DSS, with funding in 2001 at $100,000 and additional money sought for subsequent 4 years."
G. August 2013 - Lower Yakima Valley Program Development - Estimated Costs - Submitted as 2013 Funding Request lists $175,500 for DSS with $30,173 spent and/or obligated.
H. September 2013 - Technical Memorandum from Pony Ellingson to Don Gatchalian and Jim Trull presents an approach for obtaining soil samples that reflect existing practices in the GWMA target area. Three parameters to be analyzed were N leaching type, crop type and irrigation type. Here are the five options:

CALCULATION OF NUMBERS OF FIELDS SAMPLED DEPENDING ON DESIGN OF ALLOCATION PROCESS

	hypothetical sample allocation				
	A	B	C	D	E
number of NRCS N Leach Potential values	4	4	3	3	3
number of crop types	6	6	5	4	4
number of irrigation types	4	4	3	3	3
number of categories:	96	96	45	36	36
number of fields sampled for first quintile	0	0	0	0	3
number of fields sampled for second quintile	0	0	0	0	3
number of fields sampled for third quintile	3	2	2	3	3
number of fields sampled for fourth quintile	5	4	4	4	3
number of fields sampled for fifth quintile	8	6	6	6	3
total number of fields sampled	307	230	108	94	100

I. September/October 2013 - The estimated budget for deep soil sampling is $216,925 to sample 150 sites at a cost of $422 per field. SYCD time is billed at $75 per hour. This estimate is soon increased to $239,680. SYCD time is now billed at $100 per hour.

J. Oct. 3, 2013 - Draft Deep Soil Sampling Plan: GWAC Review version 1 is presented. (See 4th Quarter Report 2013, Page 98/236)

K. February 29, 2014 - The GWAC approved the DSS plan by consensus.

L. March 2014 - *Deep Soil Sampling Plan for the Lower Yakima Valley Groundwater Management Area – Version 6, March 28, 2014* is unveiled. It differs significantly from the previous, approved versions. UIN numbers are now part of the project. SYCD is no longer required to utilize the NRCS N-leaching potential tool to evaluate fields prior to selection. SYCD is no longer required to select individual fields that will promote sampling across a broad spectrum of field cropping systems, irrigation systems and soil types. SYCD is no longer required to screen applicants against criteria. GIS mapping of sites has been eliminated. At some point crop type was changed to grouping by root depths.

M. April 2014 - According to the document *GWMA Expenditures Through April, 2014* the GWMA had spent $36,880 out of a contracted $47,965 with HDR for a Deep Soil Sampling Plan Development. According to that document the GWMA had already contracted with the South Yakima Conservation District to spend $245,025 for DSS data collection.

N. June 2014 - The Irrigated Ag Work Group (not the entire Groundwater Area Committee) receives a copy of an unsigned Interlocal agreement between the South Yakima Conservation District and Yakima County to collect and analyze 300 samples from 50 sites (6 samples per site) per season for four seasons. Cost not to exceed $245,025

O. August 2014 - The Irrigated Ag Work Group (not the entire Groundwater Area Committee) receives a copy of a signed contract between the South Yakima Conservation District and Yakima County to collect and analyze deep soil samples. The agreed payment is $394,563, an increase of almost $150,000.

P. August 2014 - A document entitled, "Lower Yakima Valley GWMA Program Development – Estimated Costs for Budget Discussion on August 21, 2014" says that the total cost for deep soil sampling is $443,000 and that 200 samples (sites?) will be collected. The spread sheet says this money has been spent or obligated. In addition Yakima County has "reserved" $150,000 for further deep soil sampling. (3rd Quarter Report 2014, page77).

Q. September, 2014 - A document entitled, "Lower Yakima Valley GWMA Program Development – Estimated Costs for Budget Discussions on August 21, 2014 – Revised Proposed List – Distributed to GWAC September 18, 2014" says that $48,000 has been spent or obligated for DSS plan development and requests $395,000 with $150,000 requested as a reserve for further testing.

R. Spring 2016 - At the completion of the GWMA DSS project 175 sites had been sampled. We do not know whether any were sampled twice. There was no description of NRCS leaching categories, a selling point in early presentations. Instead there was documentation of soil type. Twelve (12) of the samples in the spring 2016 phase lack survey data. The SYCD either lost the data or failed to gather the surveys.

The maximum amount approved for the DSS project was $245,025.00. When bids came in over budget Yakima County simply signed a new agreement for $394,563.40. The documents are available in the 3rd Quarterly GWMA Report for 2014. The GWAC was not

consulted regarding the increase in cost. The GWAC was simply informed of the decision. The GWAC was asked to approve contracts after they were already signed.

Conversion of crop type to root depth means that dissimilar crops are grouped together. For example, the 2.5 to 4 ft root depth includes both grapes and corn. The > 4 ft root depth includes tree fruit, hops and alfalfa. This change was not part of the approved plan but it was included in a South Yakima Conservation District/Sunnyside Irrigation District Power Point presentation to the GWAC. FOTC questions the wisdom of this decision.

The plan and contract with SYCD called for sampling of 50 sites in Fall 2014, Spring 2015, Fall 2015 and Spring 2016 for a total of 200 sites. The end result was a study with 175 sites. Survey data was missing for 13 of the sites in Spring 2016.

The GWMA spent $238,681 on DSS data collection or $1,364 per site. The DSS data was not compared to other survey data in the Nitrogen Availability Assessment as promised.

5. Health Care Providers Survey: On June 25, 2013 Yakima County signed a contract with YHD to conduct a two page survey of health providers that was designed by a physician and nurse from the GWMA Education and Public Outreach (EPO) Work Group. The purpose was two-fold: to assess the knowledge of providers in the area and to educate them about nitrate issues. The contract specified:

> *1. The HEALTH DISTRICT shall distribute Survey No. 3, with cover letter, methemoglobinemia fact sheet and GWMA program map to the health providers within the GWMA area.*
> *2. Estimated Cost – There are approximately 600 health providers in the GWMA area. It is estimated this effort will cost approximately $1,000 which includes labor, telephone, mailing and postage, etc.*
> *3. Deliverables:*
> *a. Completed survey forms*

Instead of mailing surveys to the 600 providers as required, the YHD simply faxed the surveys to 249 points of contact that included ambulance services, pharmacies, eye doctors, labs and nursing homes. Not surprisingly there were no responses.

In fact there are over 800 physicians, physician assistants and advanced practice nurses in the area. But YHD did not send the survey to individuals. Surveys were faxed to offices and received by secretaries. A single survey was sent to the YVMH ER where there are at least 22 doctors on staff. A single survey was sent to the Toppenish Farmworkers Clinic where there are four physicians who practice family medicine, four internists, four obstetricians, six pediatricians, and six primary care practitioners. (Attachment 48)

Non-providers received over 40% of the surveys. Here are the numbers:

Table 23. Health Care Survey Targets

Home Health Agencies	17
Eye Doctors	21
Ambulance Service	2
Podiatry	4
Pharmacies	7
Mental Health	12
Dialysis	3
Nursing Homes & Rehab	12
Laboratories & Radiology	16
Occupational & Worker Health	10
Dental Services	4
Hospital (Administration & General)	8
Hospital Infection Control	6
Hospital ER	4
Hospital Hospitalists & Physician Services	4
Residential & Correctional Facilities	4
School Nurses	1
Medical & Nursing Schools	2
Physicians' Offices & Clinics	112
Total	249

It is standard procedure when conducting surveys to send a numbered survey to each person in the sampling set along with a stamped return envelope. This is a very basic

component of Public Health theory and practice. The surveys, as distributed, could be filled out by any staff person with the most minimal qualifications.

6. Best Management Practices: On June 25, 2013, on behalf of the GWMA, Yakima County signed a contract with HDR Engineering that included $11,984 to develop a Best Management Practice database and $24,273 to evaluate Best Management Plan (BMP) effectiveness. (See 2nd Quarter Report 2013)

By the end of 2014 expenditures for a BMP Database QA/QC Plan and a BMP Effectiveness Evaluation totaled $76,500. (See LYVGWMA Expenditure through December 2017 in 1st Quarter Report 2018)

Most of the BMPs for irrigated agriculture were cut and pasted from *Technical Report 3: Nitrogen Source Reduction to Protect Groundwater Quality,* written by a team from the University of California, Davis. (Harter et al, 2012) 39 BMPs were taken verbatim from a paper by Canessa & Hermanson (1995) that was commissioned by the WA State Dept. of Ecology in 1994. The draft GWMA Plan, as of July, 2018 contains 80 BMPs for irrigated agriculture in tabular form with comments from the Irrigated AG Work Group for each listed BMP. There is no plan for distribution in a reader friendly format.

The GWMA CAFO/Livestock Work Group chose to reject the BMPs provided by HDR and substitute Guidelines from the Natural Resource Conservation Service for BMPs.

HDR also listed BMPs for Residential, Commercial, Industrial and Municipal (RCIM) sources, as well as BMP's for Turf grass & Landscaping, Sewer Leakage, and Septic Systems. (Fourth Quarterly GWMA Report for 2013) These were never reviewed, accepted or rejected. The BMPs for these minor sources were not incorporated into the GWAC analysis and selection of strategies.

7. EnviroIssues: In April, 2013, on behalf of the GWMA, Yakima County signed a contract with EnviroIssues of Seattle to facilitate and support GWMA meetings. The amount was not to exceed $80,980 and included 48 hours of travel time at $175 per hour. (Second Quarterly GWMA Report, 2013, page 140)

8. Nitrogen Loading Assessment: As early as January 2013 the GWAC acknowledged the need to develop a Nitrogen Loading Assessment in order to clearly understand the approximate contribution of nitrogen loading to groundwater from the major sources in the LYV. The EPA had performed a Nitrogen Budget Screening Analysis in 2012 (Attachment 35) and various members of the GWAC demanded a more in-depth, LYV specific study.

On October 17, 2013 WSDA made a power point presentation to the GWAC that described the methods and content of a proposed NLA. (Fourth Quarterly GWMA Report, 2013)

At the August 2014 GWMA meeting the GWAC considered a $57,000 bid from WSDA to develop an NLA. (Third Quarterly GMA Report, 2014) FOTC filed a minority report arguing that the funding was insufficient for the purpose of the project. (Attachment 39)

A modified Nitrogen Loading Assessment Scope of Work and Budget was approved by the GWAC in December 2014. (Fourth Quarterly GWMA Report, 2014) Yakima County signed an agreement with WSDA to do the work on March 31, 2015. The agreement assigned payment of $45,000 to WSDA and $12,000 to Yakima County. The agreement called for completion of the NLA by December 31, 2015 with a potential extension for up to 60 days.

December 31, 2015 came and went. February 28, 2016 came and went. December 31 2016 came and went. Finally, in April 2017 the report arrived. Members of the GWAC were shocked to find major deficiencies. WSDA and Yakima County had not followed the agreed upon scope of work. There was a process for sending comments and those comments are attached. (Attachment 27, Attachment 30, Attachment 40, Attachment 41, & Attachment 42) WSDA and Yakima County responded to comments in the fall of 2017 but made no modifications to the NLA/NAA at that time.

This document was supposed to provide a foundation for GWMA selection of the most helpful recommended solutions to the problem of nitrates in LYV groundwater. As of July, 2018 there was no approved document and the GWAC planned to evaluate a GWMA plan without this information. Since April 2017 Yakima County has posted inaccurate information on the GWMA GIS web page that is based upon the inaccurate information in this NAA.

Among other deficiencies:

A. There was no assessment of the contribution from bio-solids
B. There was no assessment of the contribution from spray fields used by waste water treatment plants
C. The authors promised to hold meetings with local farmers and conduct local surveys. Instead they conducted telephone interviews with a few managers, crop advisors and fertilizer salesmen
D. There was no comparison of the NAA results with the GWMA Deep Soil Sampling as promised
E. Nitrogen inputs from farm animals on pasture or beef feedlots were ignored
F. There was no literature review for leakage from manure lagoons as promised
G. Nitrogen leakage from composting areas was omitted
H. The study incorrectly stated that 77% of nitrogen availability from irrigated cropland comes from apple orchards
I. The study stated that the average apple orchardist applies 60 lb of nitrogen per acre at the beginning of the season and there are 90 lbs of nitrogen per acre on the land at the end of the season.
J. The study incorrectly stated that nitrogen from alfalfa fields does not leak below the root zone. The GWMA DSS clearly showed otherwise.
K. There was no mention of nitrogen runoff to surface waters

9. Purpose Built Monitoring Wells: Since the early stages the GWAC has agreed upon the need for a network of monitoring wells. Discussions have been ongoing. The GWAC has repeatedly supported the concept and approved successive plans by consensus.

According to the document *LYVGWMA Expenditures through December, 2017* (1st Quarter Report 2018, Page 73) the GWMA has spent $584,885 ($726,887 minus $142,042 for High Risk Well assessment) on Monitoring and Assessment. Since then the GWMA has contracted with the Pacific Groundwater Group (PgG) to facilitate monitoring well installation for an additional $147,706. PgG signed this agreement in January, 2017. Nothing happened for the rest of 2017. Yakima County signed the agreement in January, 2018.

As of October, 2018 there was no network of purpose built wells in the GWMA target area. There was no plan on paper for analysis of data from the purpose built monitoring wells.

Here is the history:

A. The third objective listed in the GWMA Work Plan is to "Establish and conduct (a) long-term groundwater quality monitoring program and evaluate progress."
B. On December 3, 2013 the Pacific Groundwater Group (PgG) delivered to the GWMA a document entitled *Potential Groundwater Monitoring Station Yakima Groundwater Management Area.*
C. During the 2nd quarter of 2014 the GWAC studied the document and submitted comments and PgG responded.
D. At the October 16, 2014 meeting the GWAC approved a budget with $380,000 for a groundwater monitoring plan with planning, analysis and implementation. At the same meeting the GWAC approved the *Interim Final Groundwater Monitoring Plan – version 7* prepared by PgG.
E. At the February 19, 2015 meeting the GWAC agreed to the design of an ambient groundwater monitoring system. A Timeline that was approved concurrently (item 177) called for the GWMA to "Establish (a) Monitoring System to measure the effectiveness of (the) Work plan" by 6/19/2015
F. On December 8, 2015 Yakima County signed a contract with PgG in the amount of $37,500 to design an ambient groundwater monitoring system for the LYV GWMA.

G. PgG delivered a Technical Memorandum entitled "Draft Ambient Groundwater Monitoring Network Location Selection Method" on March 18, 2016.
H. PgG delivered a "Draft Lower Yakima Valley GWMA Proposed Ambient Groundwater Monitoring Network" on June 8, 2016.
I. During the 4th quarter of 2016 the GWAC considered the proposed Ambient Groundwater Monitoring Plan. At the November 2016 meeting the GWAC approved the plan and authorized Yakima County to move forward with contracting.
J. In January, 2017 PgG signed a $147,000 contract to facilitate placement of monitoring wells. Yakima did not sign this contract until January, 2018.
K. Throughout 2017 the GWAC anticipated the drilling of purpose built monitoring wells needed to implement the Ambient Groundwater Monitoring Plan. As of August, 2018 those wells have not been drilled. In addition there is no real plan for analysis of the data from those wells. The contract with PgG says that organization will be paid $9,150 to support that work but PgG will not be the primary author. We do not know who will lead that effort.

There is currently no way to measure GWMA success by monitoring the LYV aquifers.

10. Project Advisor: In 2014 the Work Group Chairs agreed that the GWMA work required more than part time leadership. They recommended hiring a professional to do this work. Subsequently Yakima County contracted with retired attorney Jim Davenport to fill this role. (2nd Quarter Report 2014, Page 139/139) The GWAC was not asked to participate in this decision making.

A contract signed on June 12, 2014 specifies that Consultant (Mr. Davenport) "shall assist the Director of Public Services in the performance of the County's activities as Lead Agency in the Lower Yakima Valley Groundwater Management Area (LYV GWMA), management and coordination of the Lower Yakima Valley Groundwater Management Committee (LYV GWAC), and preparation of the Lower Yakima Valley Groundwater Management Program (LYV GWMP). Consultant "shall act as Yakima County's 'project director' of the LYV GWMA, GWMC and GWMP. Payment is $4,500 per month."

Yakima County has never shared a breakdown of tasks performed by this Consultant/Project Director. Members of the GWAC have asked. As of December 31, 2017 Mr. Davenport had received $173,099.59.

Under Mr. Davenport's leadership the GWAC has examined about 260 potential solutions to the nitrate problem that were developed by Mr. Davenport. There are significant problems with the process that are described elsewhere. (See Attachment 62, Attachment 63, Attachment 82)

The first four chapters of the Groundwater Management Plan (GWMP) were presented to the GWAC on December 7, 2017:

- Introduction (Draft VI)
- Characterization of the Area (Draft VI)
- Sources of Nitrate and the Regulatory Environment (Draft VI)
- Yakima County's Role in Groundwater Quality Protection (Draft VI)

The remaining chapters required by WAC 173-100-100 were:

- A Problem Definition Section
- A Section defining Water Quantity and Quality Goals & Objectives
- A Section outlining various land and water management strategies for addressing the problems identified in the Problem Definition Section
- A Section that recommends strategies chosen from the list of identified strategies
- An Implementation Section that includes a plan for periodic review of the program

These additional chapters were released on June 18, 2018 and are now available at https://wa-yakimacounty.civicplus.com/DocumentCenter/View/16501/LYVGWMA-Program-JHD-02-26-18

The draft GWMP was evaluated by the GWAC on June 21, 2018. The plan lacks substance. For example, here is the GWMA plan, in its entirety, for a required *Monitoring System for Evaluation of Effectiveness of Recommended Action*

The Ambient Water Quality Monitoring System is intended to be comprised of at least 30 randomly placed, water-table elevation groundwater quality monitoring wells. Data from these wells will be collected sufficiently often to track seasonal variation and general water quality over time.

However . . . .
The wells have not been drilled. There is no plan for analysis of the data gathered from these wells. And a contract with the Pacific Groundwater Group to oversee the well installation states:

PGG has budgeted for installation of 20 wells, which is expected to exceed the number to be drilled.

(See 1st Quarterly GWMA Report, page 394/398)

In summary the Friends of Toppenish Creek believe that the GWMA leadership has performed inadequate oversight of contractors. This leaves the GWMA with a superficial and inadequate plan for addressing groundwater problems in the LYV.

Reason VI - Ignored Impact on the People

In Brief: The GWMA has not addressed the impact of groundwater pollution on the health and well-being of the people who live in the Lower Yakima Valley. The GWAC has ignored Environmental Justice.

Safe Drinking Water: The *Request for Identification* that Yakima County submitted in order to establish the Lower Yakima Valley Groundwater Management Area states (Attachment 2, page 6):

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. Progress towards identifying

and reducing the sources of groundwater contamination will be evaluated by 2013 and shared with the public. Specific objectives are listed below.

This was the promise that brought members of the GWAC to the table, the promise that we would clean up the aquifer and provide safe drinking water to the people who live in the lower valley – and we would see results in five years.

The GWMA Work Plan states:

The primary long-term goal of the GWMA is to reduce concentrations of nitrate in groundwater to below Washington State drinking water standards.

Drinking Water System Objectives from the Work Plan are:

- *Provide water quality and hydrogeologic data to assess needs and methods of expanding public water supplies, and provide a forum for initiation of these plans.*
- *Consider options to encourage appropriate expansion of public water supplies to areas that are currently dealing with contaminated private supplies.*
- *Assist residents whose supplies have been contaminated to access safe and reliable water supplies, using culturally-appropriate communications.*

Section IV of the Work Plan, Immediate Public Health Needs, states:

Approximately 75,000 persons reside within the Lower Yakima Basin area. Of that amount, it is estimated that about 25,000 residents (34% of the population) obtain their drinking water from private wells. Water quality testing conducted by various entities during the last twenty years shows that up to twenty percent of the private drinking water wells may exceed drinking water standards for nitrate. Accordingly, a conservative calculation indicates that upwards of 1,800 private wells within the area may exceed nitrate drinking water standards.

The GWAC recognizes and supports the primary long-term goal of the GWMA to reduce concentrations of nitrate in groundwater to below Washington State drinking water standards in order to protect the health and safety of the residents of the Lower Yakima Basin, The GWAC believes, based on similar efforts within the State of Washington and the Nation, that fulfillment of this goal will undoubtedly take many years to achieve. The GWAC is very concerned about the public health effects nitrates may have on the existing residents during this period of time.

Accordingly, the GWAC will work with Federal, State, and Local governments to immediately seek funding and implement programs to provide clean drinking water to the residents of the Lower Yakima Basin.

The last paragraphs above were added in February, 2013 at the request of community and environmental representatives. The GWAC was struggling to compile the Work Plan and members complained that public health was missing. We asked for measures to address public health. The GWMA leadership obligingly wrote some nice words . . . and proceeded to ignore the commitment.

To be clear:

1. The GWAC has not sought funding to provide clean drinking water to the residents of the Lower Yakima Basin
2. Yakima County returned $150,000 that was appropriated to help residents of the LYV access clean drinking water
3. People who live in the LYV probably spend $1 million ever year on bottled water
4. The adverse impact of elevated nitrates in LYV drinking water is unknown

Failure to Inform: To educate children about a dangerous situation it is sufficient to give explicit instructions:

- Wash your hands after you go to the bathroom

- Put on a coat, it is cold outside
- Eat your vegetables

To educate adults it is important to explain why certain actions are important.

- It is important to send your children to school every day so they won't miss important lessons and fall behind
- Vote for this bond so the public works department can fix the roads

The GWMA Education and Public Outreach worked hard to convince people to maintain their septic systems and protect their wells – to prevent nitrate contamination of drinking water. But the EPO failed to tell people about the elephant in the room.

The GWMA has failed to inform the public about the real reason for the groundwater contamination in the valley:

A. 35% of all the milk cows in Washington State are confined in the 273 square area that comprises the LYV GWMA. This is like having a city of 2.5 million people with no sanitation.
B. Dairies in the GWMA target area do not follow their nutrient management plans and this means that nitrate from the dairies leaches to the groundwater
C. 61% of domestic wells one mile downgradient from the "dairy cluster" have water that is unsafe for drinking. Septic system maintenance and water testing will not change this. The only way to change that fact is for dairies to properly manage their manure.
D. Pollution of the groundwater is illegal, but no one is charged with a crime

The GWMA has failed to inform the public about studies that connect high nitrate levels in drinking water to a number of adverse health issues.

A. We know with certainty that high nitrate levels cause reproductive problems in cattle (Ozmen et al, 2005)
B. There are case histories of spontaneous abortions among women whose well water has high nitrates (Ward et al, 2005)

C. There are case histories of blue baby syndrome in children who drank formula made with well water that had nitrates around 20 mg/L (Knobeloch et al, 2000)
D. Epidemiological studies show a correlation between elevated nitrates and birth defects, heart disease and some cancers (Ward et al, 2005; Brender et al, 2004)
E. A 2009 study in south central Washington found higher levels of methemoglobin in infants from homes with nitrate contaminated well water (VanderSlice, 2009)
F. FOTC submitted a list of credible research that describes the health impacts from elevated nitrate levels in water. The GWMA ignored that list and has not posted it on the GWMA website. (Attachment 29)

Environmental Justice:

> *Environmental justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies.*
>
> (EPA, 2018f)

This means that in a community such as the LYV where most residents are people of color, where many live in poverty, there should not be a heavier burden such as polluted water. And . . . when problems are identified the people who are impacted must be involved in seeking solutions.

In 2010 when the EPA came to the Yakima Valley to study our issues they designated us an Environmental Justice Showcase Community. This meant that we would be a shining example of Environmental Justice at work. Sadly, the word Environmental Justice is absent from all the GWMA proceedings. Some members of the GWAC have openly rejected the concept. (Attachment 43)

In early 2012, as the GWMA began to take shape, this writer arranged for a meeting between Commissioner Rand Elliott and three women of color who then worked for Radio KDNA, the only public radio station for farmworkers in the United States. The hope was

that he would get to know them and consider them for membership on the GWAC. On the scheduled day we waited for an hour and the commissioner never arrived. We called the courthouse and he responded that he had failed to put the meeting on his official calendar. End of story. The commissioner did not re-schedule and the meeting never took place.

FOTC asked to have meeting summaries translated into Spanish for the large LYV population that speaks English less than well. The EPO Work Group rejected the idea as not cost effective. FOTC asked to have GWMA meetings recorded for accuracy. The request was denied.

Meeting announcements are published in the county's largest English language newspaper. They are not published in any of the Spanish language newspapers and are not announced on either English or Spanish radio.

In 2013 the GWAC went to great lengths to develop and approve a Power Point for community presentations. The purpose was to agree on language that presented the situation without bias. The Power Point was never translated into Spanish.

Two women of color from Radio KDNA volunteered to serve on the EPO work group. They spent a great deal of time working with a professor from the University Of Washington School Of Public Health on a project that would bring ten graduate students to the valley to assist the GWMA with public outreach. A dairywoman on the committee organized resistance to the plan and defeated the project. Why? She did not like the text book for the class, *Fresh Fruit, Broken Bodies,* which chronicled the experience of a physician and anthropologist who traveled with a group of Oaxacan farmworkers on their journeys from California to Washington.

In early 2017 FOTC asked the EPO to develop educational information in Spanish that explained concepts that are central to understanding the GWMA work. We composed several one page pieces that talk about the roles of EPA and Ecology, movement of groundwater through the soils, and a description of agronomic rates. The EPO never even discussed the proposal.

The only Hispanic representative on the GWAC missed all GWMA meetings for 2017. Late that year FOTC brought this to the attention of the GWMA leadership and introduced two people who are well connected in the Latino community and were willing to take his place. There were meetings and conversations. David Bowen, Ecology's GMWA oversight manager, elected to contact the absent representative and bring him back to the group.

As of July, 2018 there are no plans to educate the public in English or in Spanish about the GWMA activities in preparation for public meetings on the final GWMA plan. People will be invited, with translators present, and they will be quickly overwhelmed with technical jargon.

Reason VII – Funding Failure

In Brief: The GWMA has used up $2.3 million and left a program with no funds for implementation and no road map for how to obtain funds.

Early in the GWMA project several members of the GWAC signed up for the Funding Work Group but the GWMA leadership did not schedule meetings. The Funding Work Group did not meet until the summer of 2017 and then for only three meetings. None of the identified tasks were completed.

Now the GWMA Plan is awaiting approval and 43 out of 54 the proposed alternative solutions will require the implementing agencies to find their own source of funding. This is hard work that the GWMA was supposed to facilitate by laying the groundwork, writing model ordinances, policy statements, interagency agreements, and proposed legislative changes.
It is easy to say, for example, in Recommended Solution RCIM 2:

> *Yakima County should "Perform an engineering study of water supply alternatives."*

It is something else to provide the implementing agencies with the tools to follow through. There is no road map for how to acquire funding; no description of what a study would

look like, not even supporting statements to justify the need. If we wanted a study of water supply alternatives we were supposed to perform one.

Beginning on page 18, the GWMA Work Plan describes the role of the Funding Work Group.

5.0 Funding

5.1 Problem Definition — Determine funding short-term and long-term needs

a. Data Collection, Characterization, Monitoring (DCCM)

b. Livestock & CAFO - Yards, corrals, lagoons, manure field application

c. Irrigated Agriculture

d. Pollutants from Residential, Commercial, Industrial, Municipal and Domestic

e. Regulatory Framework

f. Education and Outreach

g. Prepare and submit funding needs to GWAC

h. Incorporate GWAC comments and prepare final report

5.2 Funding Strategy - Determine and develop short-term and long-term funding Strategy

a. Data Collection, Characterization, Monitoring (DCCM)

b. Livestock & CAFO - Yards, corrals, lagoons, manure field application

c. Irrigated Agriculture

d. Pollutants from Residential, Commercial, Industrial, Municipal and Domestic

e. Regulatory Framework

f. Education and Outreach

g. Prepare and submit funding needs to GWAC

h. Incorporate GWAC comments and prepare final report

5.3 Implementation - Seek and apply for all funding opportunities local, state, federal including private-public venture

a. Seek aid obtain private, local, state, federal and tribal financial assistance

b. Prepare and submit preliminary funding strategy status report to GWAC

c. Incorporate GWAC comments, finalize final grant report and submit to Ecology

5.4 Monitoring - Develop a long-term monitoring system for evaluating the effectiveness of each strategy and where to spend effort, time and funding

5.5 Review - Develop a plan and process for the periodic review of funding needs and where to obtain funding

5.6 Develop GWMA Program Report (combine with other workgroups)

5.7 Submit Final GWMA Program Report (combine with other workgroups)

The Funding Work Group has failed to do this.

WAC 173-100-100 (4) requires a GWMA plan to include:

An alternatives section outlining various land and water use management strategies for reaching the program's goals and objectives that address each of the groundwater problems discussed in the problem definition section. If necessary, alternative data collection and analysis programs shall be defined to enable better characterization of the groundwater and potential quality and quantity problems. Each of the alternative strategies shall be evaluated in terms of feasibility, effectiveness, cost, time and difficulty to implement, and degree of consistency with local comprehensive plans and water management programs such as the coordinated water system plan, the water supply reservation program, and others. The alternative management strategies shall address water conservation, conflicts with existing water rights and minimum instream flow requirements, programs to resolve such conflicts, and long-term policies and construction practices necessary to protect existing water rights and subsequent facilities installed in accordance with the groundwater management area program and/or other water right procedures.

Summary

Nitrate contamination of groundwater in the Lower Yakima Valley is a worsening problem that threatens the well-being of people who live in the area on many levels. Nitrates in groundwater endanger the health of humans and animals, are linked to other pollutants, and contribute to pollution of surface waters. Efforts to address the problem often lead to worsening air quality.

Since 2012 the LYV Groundwater Management Area has studied the problem through research that includes a public survey of rural LYV residents, deep soil sampling, domestic well testing and a nitrogen availability assessment. The data has not been well analyzed.

There are several potential nitrate sources but one stands out from all the others – Concentrated Animal Feeding Operations. Dairy CAFOs at one LYV hot spot have caused 61% of domestic wells one mile down gradient to be unsafe for human consumption. Nitrate levels in CAFO monitoring wells have been measured as high as 234 mg/L. The likely routes for nitrate movement to groundwater are leaching from manure lagoons, pens and compost areas, along with over-application of manures to cropland.

Efforts to address nitrate pollution of groundwater began in the 1990's with the development of best management practices for agriculture and the institution of a regulatory approach under the WA State Dairy Nutrient Management Act, RCW 90.64. These efforts span at least 25 years. In spite of the allocation of public and private resources and much hard work the trend of increasing nitrate levels continues.

Dairies are financially unable to take all the measures necessary for groundwater protection under this intensive form of agriculture. Indeed, some dairies are going bankrupt and medium sized dairies in Yakima County are being absorbed by mega-dairies. It is difficult to ask the many low income people who live in the GWMA target area to support allocation of public monies for continued support of this struggling industry when there are so many other pressing needs; when other forms of agriculture cause fewer side effects.

A cost effective solution is to control the number of animals per acre in the LYV. The soils, water and air can absorb a certain level of nitrate contamination. There is a tipping point after which the costs to address associated problems exceed any benefits from sale of milk products. We have passed that tipping point.

References

Agency for Toxic Substances and Disease Registry. (2001). Case Studies in Environmental Medicine Nitrate/Nitrite Toxicity. *Department of Health & Human Services*. Atlanta, GA. Retrieved from http://www.atsdr.cdc.gov/csem/nitrate/docs/nitrate_nitrite.pdf

Agency for Toxic Substances and Disease Registry (2017). Toxicological profile for nitrate and nitrite [ATSDR Tox Profile]. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. Available at https://www.atsdr.cdc.gov/toxprofiles/tp204.pdf

Alexander, D. and Palmer, R.N. (2007) Technical Memorandum #8: Impacts of Climate Change on Groundwater Resources: A Literature Review. Technical Memorandum #8: Impacts of Climate Change on Groundwater Resources: A Literature Review. WA State Dept. of Ecology Publication No. 14-13-031. Available at https://fortress.wa.gov/ecy/publications/documents/1403031.pdf

Almasri, M. N., & Kaluarachchi, J. J. (2003). Regional variability of on ground nitrogen loading due to multiple land uses in agriculture dominated watersheds. In *Proceedings of the Seventh International Conference on Diffuse Pollution and Basin Management, Dublin, Ireland*. Available at https://www.researchgate.net/profile/Jagath_Kaluarachchi/publication/242351619_REGIONAL_VARIABILITY_OF_ON-GROUND_NITROGEN_LOADING_DUE_TO_MULTIPLE_LAND_USES_IN_AGRICULTURE-DOMINATED_WATERSHEDS/links/02e7e536a6b7eaf07d000000.pdf

Almasri, M.N., Kaluarachchi, J.J., 2004a. Implications of on-ground nitrogen loading and soil transformations on groundwater quality management. Journal of the American Water Resources Association (JAWRA) 40 (1), 165–186. Available at https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1752-1688.2004.tb01017.x

Almasri, M.N., Kaluarachchi, J.J., 2004b. Assessment and management of long-term nitrate pollution of ground water in agriculture-dominated watersheds. Journal of Hydrology 295, 225–245. Available at https://www.sciencedirect.com/science/article/pii/S0022169404001775

Almasri, M. N. (2007). Nitrate contamination of groundwater: a conceptual management framework. *Environmental Impact Assessment Review*, *27*(3), 220-242. Available at https://staff-old.najah.edu/sites/default/files/Nitrate_Contamination_Of_Groundwater_A_Conceptual_Management_Framework.pdf

Anderson, B, Anderson, C., Christensen, D, Inman, R. and Marti, J. (2016) 2015 Drought Response Summary Report . *WA State Dept of Ecology – Water Resources Program Publication no.16-11-0 01.* Available at https://fortress.wa.gov/ecy/publications/documents/1611001.pdf

American Public Health Association (2003) Precautionary Moratorium on New Concentrated Animal Feed Operations. Retrieved from http://www.apha.org/advocacy/policy/policysearch/default.htm?id=1243

Anderson, B, Anderson, C., Christensen, D, Inman, R. and Marti, J. (2016) 2015 Drought Response Summary Report . *WA State Dept of Ecology – Water Resources Program Publication no.16-11-0 01.* Available at https://fortress.wa.gov/ecy/publications/documents/1611001.pdf

Arbuckle TE, Sherman GJ, Corey PN, Walters D, Lo B. (1988) Water nitrates and CNS birth defects: a population-based case-control study. Arch Environ Health 43:162–167. Available at https://www.tandfonline.com/doi/abs/10.1080/00039896.1988.9935846

Ascott, M. J., Gooddy, D. C., Wang, L., Stuart, M. E., Lewis, M. A., Ward, R. S., & Binley, A. M. (2017). Global patterns of nitrate storage in the vadose zone. *Nature Communications*, *8*(1), 1416. Available at https://www.nature.com/articles/s41467-017-01321-w

Bachmann, Matt (2008) Approaches for assessing ground water availability under competing demands and climate change [poster]: American Geophysical Union Fall Meeting, San Francisco, California, December 15-19, 2008, PDF, 6.7 MB. Available at https://wa.water.usgs.gov/projects/yakimagw/data/Bachmann_YakimaPoster.pdf

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. Available at https://pubs.er.usgs.gov/publication/sir20155149

Bahr, G., Beale, P., Drennan, M., Hancock, J., McLain, K., Redifer, V., Martian, M., Kozma, C. *Estimated Nitrogen Available for Transport in the Lower Yakima Valley Groundwater Management Area: A Study by the Washington State Department of Agriculture and Yakima County*. Available at https://agr.wa.gov/FP/Pubs/docs/103-691YakimaGWMANitrogenTransportReport.pdf

Barry, D.A.J., Goorahoo, D., and Goss, M.J., 1993, Estimation of nitrate concentrations in ground water using whole farm nitrogen budgets: Journal of Environmental Quality, v. 22, no. 4, p. 767-775

Barton, A. (2017) in WA State Office of the Attorney General Sunshine Meetings (2017) *Public Records Exemptions Accountability Committee – Meeting Minutes, October 24, 2017.* Available at https://agportal-s3bucket.s3.amazonaws.com/uploadedfiles/Home/About_the_Office/Open_Government/Sunshine_Committee/Materials/2017/Minutes%20October%2024%20Meeting.pdf

Bary, A. I., Sullivan, D. M., & Cogger, C. G. (2000). Fertilizing with manure. WA State University Extension PNW 0533.

https://my.extension.illinois.edu/documents/1722091307090709/Fertilizing%20with%20Manure1.pdf

Bary, A. I., Sullivan, D. M., & Cogger, C. G. (2016). Fertilizing with manure and other organic amendments. Available at http://cru.cahe.wsu.edu/CEPublications/PNW533/PNW533.pdf

Beutel, M. W., Newton, C. D., Brouillard, E. S., & Watts, R. J. (2009). Nitrate removal in surface-flow constructed wetlands treating dilute agricultural runoff in the lower Yakima Basin, Washington. *Ecological Engineering*, *35*(10), 1538-1546. Available at http://www.svid.org/images/Beutel%20et%20al.%202009%20Yakima%20Wetlands.pdf

Bosch, H. M., Rosenfield, A. B., Huston, R., Shipman, H. R., & Woodward, F. L. (1950). Methemoglobinemia and Minnesota well supplies. *Journal (American Water Works Association)*, *42*(2), 161-170. Available at https://www.jstor.org/stable/41236191?seq=1#page_scan_tab_contents

Brender, J., Olive, J., Felkner, M., Suarez, L., Hendricks, K., & Marckwardt, W. (2004). Intake of nitrates and nitrites and birth defects in offspring. *Epidemiology*, *15*(4), S184. Retrieved from http://journals.lww.com/epidem/Citation/2004/07000/Intake_of_Nitrates_and_Nitrites_and_Birth_Defects.487.aspx

Brender, J. D., Weyer, P. J., Romitti, P. A., Mohanty, B. P., Shinde, M. U., Vuong, A. M., ... & Huber Jr, J. C. (2013). Prenatal nitrate intake from drinking water and selected birth defects in offspring of participants in the National Birth Defects Prevention Study. *Environmental health perspectives*, *121*(9), 1083-1089. Available at https://ehp.niehs.nih.gov/doi/pdf/10.1289/ehp.1206249

Bunting, D., D/P. Jones, and M. Wagner (2011) *The Economic Impact of Washington Tree Fruit Industry.* Eastern Washington University, Institute for Public Policy & Economic Analysis.

Bukowski, J., Somers, G., & Bryanton, J. (2001). Agricultural contamination of groundwater as a possible risk factor for growth restriction or prematurity. *Journal of occupational and environmental medicine*, *43*(4), 377-383. Available at https://journals.lww.com/joem/Abstract/2001/04000/Agricultural_Contamination_of_Groundwater_as_a.16.aspx

Canessa, P., & Hermanson, R. E. (1995). Irrigation management practices to protect ground water and surface water quality State of Washington. Available at http://kaga.wsulibs.wsu.edu/cdm4/item_viewer.php?CISOROOT=/cahnrs-arch&CISOPTR=321&CISOBOX=1&REC=8

Carey, B. (1986) Quality Assurance Interim Guidelines for Water Quality Sampling and Analysis: Ground Water Management Areas Program. WA State Dept. of Ecology Publication No. 90-19. Available at https://fortress.wa.gov/ecy/publications/documents/9019.pdf

Carey, B. (1987 a) Ground Water Monitoring Strategy for Washington, I. Objectives for Ground Water Monitoring Activities. WA State Dept. of Ecology Publication No. 85-8a. Available at https://fortress.wa.gov/ecy/publications/documents/858a.pdf

Carey, B. (1987 b) Ground Water Monitoring Strategy for Washington, II. Summary of Ground Water Monitoring Activities. WA State Dept. of Ecology Publication No. 85-88. Available at https://fortress.wa.gov/ecy/publications/documents/858b.pdf

Carey, B. (1988) Ground Water Monitoring Strategy for Washington: III. Ground Water Monitoring Needs Evaluation. IV. Recommended Strategy for Addressing Monitoring Needs. WA State Dept. of Ecology Publication No. 85-8c. Available at https://fortress.wa.gov/ecy/publications/documents/858c.pdf

Carey, B. and Jacobson, J. (1994) Vadose Zone Monitoring at Tree Top Land Application Site in Selah, WA, June-Dec. 1992. WA State Dept. of Ecology Publication No. 94-148. Available at https://fortress.wa.gov/ecy/publications/documents/94148.pdf

Carey, B. (2002) Effects of Land Application of Manure on Groundwater at Two Dairies over the Sumas-Blaine Surficial Aquifer Implications for Agronomic Rate Estimates. WA State Dept. of Ecology Publication No. 02-03-084. Available at https://fortress.wa.gov/ecy/publications/documents/0203007.pdf

Carey, B. (2009) Quality Assurance Project Plan Effects of Conventional versus Minimum Tillage on Groundwater Nitrate at a Manured Grass Field WA State Dept. of Ecology Publication No. 09-23-126. Available at https://fortress.wa.gov/ecy/publications/documents/0903126.pdf

Carey, B., Skipper, K., & Weisman, K. (2011) Focus on Groundwater Quality in Whatcom County. Available at https://fortress.wa.gov/ecy/publications/documents/1103027.pdf

Carey, B. & Harrison, J. (2014 a) Study evaluates nitrogen at a manured grass field. WA State Dept. of Ecology . Available at https://fortress.wa.gov/ecy/publications/documents/1403011.pdf

Carey, B. & Harrison, J. (2014 b) Nitrogen Dynamics at a Manured Grass Field Overlying the Sumas-Blaine Aquifer in Whatcom County. WA State Dept. of Ecology Publication No. 14-03-001. Available at https://fortress.wa.gov/ecy/publications/documents/1403001.pdf

Carey, B., C. Pitz, and J. Harrison (2016) POSTER: Evaluation of field N budgets and soil nitrate as indicators of N leaching to groundwater in a Pacific Northwest U.S. dairy grass field. WA State Dept. of Ecology Publication No. 16-03-030. Available at https://fortress.wa.gov/ecy/publications/documents/1603030.pdf

Carey, B. (2017) Sumas -Blaine Aquifer Long-Term Groundwater Quality Monitoring, 2009-2016. WA State Dept. of Ecology Publication No. 17-03-013. Available at https://fortress.wa.gov/ecy/publications/documents/1703013.pdf

Carey, B. (2018) Quality Assurance Project Plan Sumas-Blaine Aquifer Nitrate Characterization, 2018. WA State Dept. of Ecology Publication No. 18-03-1 0Available at https://fortress.wa.gov/ecy/publications/documents/1803103.pdf

Cedergren, M. I., Selbing, A. J., Löfman, O., & Källen, B. A. (2002). Chlorination byproducts and nitrate in drinking water and risk for congenital cardiac defects. *Environmental research*, *89*(2), 124-130. Available at https://www.sciencedirect.com/science/article/pii/S0013935101943622

Centers for Disease Control and Prevention. (1995) A survey of the quality of water drawn from domestic wells in nine Midwest states. *US Department of Health and Human Services*. Retrieved from http://www.cdc.gov/nceh/hsb/disaster/pdfs/A%20Survey%20of%20the%20Quality%20ofWater%20Drawn%20from%20Domestic%20Wells%20in%20Nine%20Midwest%20States.pdf

Centers for Disease Control and Prevention (1996) Spontaneous abortions possibly related to ingestion of nitrate-contaminated well water—LaGrange County, Indiana, 1991–1994. MMWR Morbidity and Mortality Weekly Rep 45:569–572. Available at https://www.ncbi.nlm.nih.gov/pubmed/9132576

Chastain, J. P., & Camberato, J. J. (2004). Dairy manure production and nutrient content. *Chapter 3a in Confined Animal Manure Managers Certification Program Manual B Dairy Version*, *1*. Available at https://www.clemson.edu/extension/camm/manuals/dairy/dch3a_04.pdf

Columbia Basin Groundwater Management Area (2009) Subsurface Mapping and Aquifer Assessment Project Final Project Performance Report. Available at https://fortress.wa.gov/ecy/publications/publications/1203262.pdf

Columbia Basin Groundwater Management Area (2012) Columbia Basin Ground Water Management Area Municipal Groundwater Supply Review: Current Conditions and Predicted Future Conditions. Available at http://www.cbgwma.org/pdf/munireports/Summary.pdf

Comly, H. H. (1945). Cyanosis in infants caused by nitrates in well water. *Jama*, *129*(2), 112-116. Available at https://jamanetwork.com/journals/jama/article-abstract/366259

Comly, H. H. (1987). Cyanosis in infants caused by nitrates in well water. *Jama*, *257*(20), 2788-2792. Available at https://jamanetwork.com/journals/jama/article-abstract/366259

Community Association for Restoration of the Environment (CARE) and Center for Food Safety (CFS) Versus Cow Palace (2015a) Bosma Consent Decree with Exhibits at http://charlietebbutt.com/files/Cluster%20CD/246%20-%20Bosma%20Consent%20Decree%20with%20exhibits.pdf

Community Association for Restoration of the Environment (CARE) and Center for Food Safety (CFS) Versus Cow Palace (2015b) Cow Palace Consent Decree with Exhibits at http://charlietebbutt.com/files/Cluster%20CD/396%20-%20Cow%20Palace%20Consent%20Decree%20with%20exhibits.pdf

Community Association for Restoration of the Environment (CARE) and Center for Food Safety (CFS) Versus Cow Palace (2015c) DeRuyter Consent Decree with Exhibits at http://charlietebbutt.com/files/Cluster%20CD/169%20-%20DeRuyter%20Consent%20Decree%20with%20exhibits.pdf

Community Association for Restoration of the Environment (CARE) and Center for Food Safety (CFS) Versus Cow Palace (2015d) Expert Report of Byron Shaw, PhD. at http://charlietebbutt.com/files/CP/237-2%20-%20Expert%20Report%20of%20Byron%20Shaw.pdf

Community Association for Restoration of the Environment (CARE) and Center for Food Safety (CFS) Versus Cow Palace (2015e) Expert Report of David Erickson at http://charlietebbutt.com/files/CP/237-3%20-%20Expert%20Report%20of%20%20David%20Erickson.pdf

Community Association for Restoration of the Environment (CARE) and Center for Food Safety (CFS) Versus Cow Palace (2015f) Expert Report of Dr. Robert Lawrence, MD at http://charlietebbutt.com/files/CP/238%20-%20Expert%20Report%20of%20%20Robert%20Lawrence.pdf

Community Association for Restoration of the Environment (CARE) and Center for Food Safety (CFS) Versus Cow Palace (2015g) Order Granting in Part Motion for Summary Judgement at http://charlietebbutt.com/files/CP/320%20-%20Order%20Granting%20in%20Part%20Mtn%20for%20Summary%20Judgment.pdf

Community Association for Restoration of the Environment (CARE) and Center for Food Safety (CFS) Versus Cow Palace (2015h) Reply in Support of Motion for Summary Judgement at http://charlietebbutt.com/files/CP/304%20-%20Reply%20in%20Support%20of%20Mtn%20for%20Summary%20Judgment.pdf

Community Association for Restoration of the Environment (CARE) and Center for Food Safety (CFS) Versus Cow Palace (2015i) Statement of Material Facts at http://charlietebbutt.com/files/CP/211-1%20%20Stmnt%20of%20Material%20Facts.pdf

Community Attributes Inc. (2015) *Washington State Agriculture & Food Processing Economic/Fiscal Impact Study* http://www.pnwer.org/uploads/2/3/2/9/23295822/cai.wa_farm_bureau_agriculture_&_food_processing_economic_and_fiscal_impact_study_2015_0121_(1).pdf

Cornell University Cooperative Extension. (2005) Nitrogen Basics – The Nitrogen Cycle. Available at http://cceonondaga.org/resources/nitrogen-basics-the-nitrogen-cycle

County Health Rankings (2012) County Health Ranking and Roadmap for Washington State. Retrieved from http://www.countyhealthrankings.org/app/washington/2012/rankings/outcomes/overall

Cox, S. E., & Kahle, S. C. (1999). *Hydrogeology, ground-water quality, and sources of nitrate in lowland glacial aquifers of Whatcom County, Washington, and British Columbia, Canada* (No. 98-4195). US Geological Survey. Available at https://pubs.usgs.gov/wri/1998/4195/report.pdf

Croen, L. A., Todoroff, K., & Shaw, G. M. (2001). Maternal exposure to nitrate from drinking water and diet and risk for neural tube defects. *American Journal of Epidemiology*, *153*(4), 325-331.Available at https://academic.oup.com/aje/article/153/4/325/129007

Dairy Herd Management (2011) *Drinking water for dairy cattle: Part 1.* Available at https://www.dairyherd.com/article/drinking-water-dairy-cattle-part-1

Davidson, E. A., David, M. B., Galloway, J. N., Goodale, C. L., Haeuber, R., Harrison, J. A., ... & Peel, J. L. (2011). Excess nitrogen in the US environment: trends, risks, and solutions. *Issues in Ecology*, (15). Available at http://www.esa.org/esa/wp-content/uploads/2013/03/issuesinecology15.pdf

Dept. of Justice (2004) United States of America versus Yakima County CV-04-3072-LRS Consent Decree. Available at https://www.justice.gov/crt/voting-rights-act-section-203-cases-13

Devaney, J. (2018) Presentation at WA State Employment Security (2018) *2018 Yakima and Central Washington Economic Symposium*

Croen, L. A., Todoroff, K., & Shaw, G. M. (2001). Maternal exposure to nitrate from drinking water and diet and risk for neural tube defects. *American Journal of Epidemiology*, *153*(4), 325-331.Available at https://academic.oup.com/aje/article/153/4/325/129007

Ecology Water Resources Program (1965) Ground water in Washington -- its chemical and physical quality. WA State Dept. of Ecology Publication No. WSB-24. Available at https://fortress.wa.gov/ecy/publications/documents/wsb24.pdf

Ecology Water Resources Program (1971) Geology and Ground Water Availability, Selah Area, Washington. WA State Dept. of Ecology Publication No. 71-11-007. Available at https://fortress.wa.gov/ecy/publications/documents/7111007.pdf

Ecology Water Resources Program (1985) Water in the Lower Yakima River Basin, Washington WA State Dept. of Ecology Publication No. WSB-53. Available at https://fortress.wa.gov/ecy/publications/documents/wsb53.pdf

Ecology Water Resources Program (1987) Date Reporting Manual for the Ground Water Management Program. WA State Dept. of Ecology Publication No. 88-900. Available at https://fortress.wa.gov/ecy/publications/documents/88900.pdf

ECONorthwest (2017) Water Security for the Yakima River Basin's Economy, Communities, and Watersheds. *Yakima River Basin Water Enhancement Project Workgroup Economic Subcommittee.* Available at https://fortress.wa.gov/ecy/publications/documents/1712009.pdf

Ely, D.M., Bachmann, M.P., and Vaccaro, J.J. (2011) Numerical simulation of groundwater flow for the Yakima River basin aquifer system, Washington: U.S. Geological Survey Scientific Investigations Report 2011-5155, 90 p. Available at https://pubs.usgs.gov/sir/2011/5155/

Environmental Protection Agency. Integrated Risk Information System (IRIS) database. (nd) Nitrate (CASRN 14797-55-8). Washington, DC: US Environmental Protection Agency. 2002. Available at URL: http://www.epa.gov/iris

Environmental Protection Agency (2004) Consumer factsheet on: nitrates/nitrites. Washington, DC: US Environmental Protection Agency; 2004. Available from URL: http://www.epa.gov/safewater/dwh/c-ioc/nitr

Environmental Protection Agency (2007) *Nitrates and Nitrites TEACH Chemical Summary.* Retrieved from http://www.epa.gov/teach/chem_summ/Nitrates_summary.pdf

Environmental Protection Agency Region X (2010). Situation Assessment Report On Yakima Valley Groundwater Assessment. Available at https://www.epa.gov/sites/production/files/2017-12/documents/lower-yakima-valley-groundwater-situation-assessment-report-2010.pdf

Environmental Protection Agency (2011) Reactive Nitrogen in the United States: An Analysis of Inputs, Flows, Consequences, and Management Options A Report to the EPA Science Advisory Board. EPA-SAB-11-013. Available at https://yosemite.epa.gov/sab/sabproduct.nsf/WebBOARD/INCFullReport/$File/Final%20INC%20Report_8_19_11(without%20signatures).pdf

Environmental Protection Agency Region X (2013 a) Administrative Order on Consent, Yakima Valley Dairies, Docket No. SDWA-10-2013-0080_ Available at https://www.epa.gov/sites/production/files/2017-12/documents/lower-yakima-valley-groundwater-consent-order-2013.pdf

Environmental Protection Agency Region X (2013 b). Relation Between Nitrate in Water Wells and Potential Sources in the Lower Yakima Valley, Washington Available at https://www.epa.gov/sites/production/files/2017-12/documents/lower-yakima-valley-groundwater-report-2013.pdf

Environmental Protection Agency Region X (2013 c). Monitoring Well Installation and Data Summary Report, Lower Yakima Valley, Washington. Available at

https://www.epa.gov/sites/production/files/2017-12/documents/lower-yakima-valley-groundwater-monitoring-well-installation-data-summary-report-2013.pdf

Environmental Protection Agency Region X (2013 d). Particle Tracks for Residential Drinking Water Wells Near Several Dairies in the Lower Yakima Valley. Available at https://www.epa.gov/sites/production/files/2017-12/documents/lower-yakima-valley-groundwater-particle-tracking-for-selected-wells-2015.pdf

Environmental Protection Agency Region X (2014). Fact Sheet: Yakima Dairies Consent Order Update - December 2014 . Available at https://www.epa.gov/sites/production/files/2017-12/documents/lower-yakima-valley-groundwater-fact-sheet-december-2014.pdf

Environmental Protection Agency Region X (2016). Fact Sheet: Yakima Valley Dairies Consent Order Update - June 2016. Available at https://www.epa.gov/sites/production/files/2017-12/documents/lower-yakima-valley-groundwater-fact-sheet-june-2016.pdf

Environmental Protection Agency (2018a) Reporting Requirements for Air Releases of Hazardous Substances from Animal Waste at Farms https://www.epa.gov/epcra/cercla-and-epcra-reporting-requirements-air-releases-hazardous-substances-animal-waste-farms

Environmental Protection Agency (2018b) *Healthy Watersheds Protection.* Available at https://www.epa.gov/hwp

Environmental Protection Agency (2018c) *National Primary Drinking Water Regulations.* Available at https://www.epa.gov/ground-water-and-drinking-water/national-primary-drinking-water-regulations

Environmental Protection Agency (2018d) *Climate Change Indicators in the United States 2016.* Available at https://www.epa.gov/sites/production/files/2016-08/documents/climate_indicators_2016.pdf

Environmental Protection Agency (2018e) *Estimated Nitrate Concentrations in Groundwater Used for Drinking.* Available at https://www.epa.gov/nutrient-policy-data/estimated-nitrate-concentrations-groundwater-used-drinking

Environmental Protection Agency (2018f) *Environmental Justice.* Available at https://www.epa.gov/environmentaljustice

Environmental Working Group (2018) EWG's Tap Water Data Base – City of Grandview. Available at https://www.ewg.org/tapwater/system-contaminant.php?pws=WA5328970&contamcode=1040#.W2W4msIh2M8

Erickson, D. (1988) Agricultural Chemicals Pilot Study Yakima County Study Area--Sampling and Analysis Plan. WA State Dept. of Ecology Publication No. 88-e-03. Available at https://fortress.wa.gov/ecy/publications/documents/88e03.pdf

Erickson, D., & Norton, D. (1990). Washington State agricultural chemicals pilot study, final report. *Washington State Department of Ecology, Olympia*. Available at https://fortress.wa.gov/ecy/publications/documents/9046.pdf

Erickson, D. (1991) Edaleen Dairy Lagoon Ground Water Quality Assessment February 1990 to February 1991. WA State Dept. of Ecology Publication No. 92-e25. Available at https://fortress.wa.gov/ecy/publications/documents/91e11.pdf

Erickson, D. (1992 a) Gleed Agricultural Chemicals Ground Water Quality Assessment. WA State Dept. of Ecology Publication No. 92-e22. Available at https://fortress.wa.gov/ecy/publications/documents/92e22.pdf

Erickson, D. (1992 b) Summary of Ecology Lagoon Ground Water Assessments. Memorandum to Phil KauzLoric. WA State Dept. of Ecology Publication No. 92-e26. Available at https://fortress.wa.gov/ecy/publications/documents/92e26.pdf

Erickson, D. (1992 c) Ground Water Quality Assessment: Sheridan Dairy Lagoon - Adna, Washington. WA State Dept. of Ecology Publication No. 92-e24. Available at https://fortress.wa.gov/ecy/publications/documents/92e24.pdf

Erickson, D. (1992 d) Ground Water Quality Assessment: Whatcom County Dairy Lagoon #2 - Lynden, Washington. WA State Dept. of Ecology Publication No. 92-e25. Available at https://fortress.wa.gov/ecy/publications/documents/92e25.pdf

Erickson, D. (1993) Ground Water Quality Assessment: Hornby Dairy Lagoon, Sunnyside, Washington. WA State Dept. of Ecology Publication No. 92-e23. Available at https://fortress.wa.gov/ecy/publications/documents/92e23.pdf

Erickson, D. (1994) Effects of Leakage from Four Dairy Waste Storage Ponds on Ground Water Quality, Final Report. WA State Dept. of Ecology Publication No. 94-109. Available at https://fortress.wa.gov/ecy/publications/documents/94109.pdf

Erickson, D. (1998) Sumas-Blaine Surficial Aquifer Nitrate Characterization. WA State Dept. of Ecology Publication No. 98-310. Available at https://fortress.wa.gov/ecy/publications/documents/98310.pdf

Erickson, D. (2000) Northcentral Sumas - Blaine Surficial Aquifer Nitrate Characterization Project - June 1999. WA State Dept. of Ecology Publication No. 00-03-010. Available at https://fortress.wa.gov/ecy/publications/documents/0003010.pdf

Erickson, D. and Matthews, W. (2002) Effects of Land Application of Dairy Manure and Wastewater on Groundwater Quality Pre- and Post-Animal Waste Holding Pond Monitoring. WA State Dept. of Ecology Publication No. 02-03-002. Available at https://fortress.wa.gov/ecy/publications/documents/0203002.pdf

Erickson, D. (2003) Quality Assurance Project Plan Monitoring for Nitrate Trends in the Central Sumas-Blaine Surficial Aquifer. WA State Dept. of Ecology Publication No. 02-03-084. Available at https://fortress.wa.gov/ecy/publications/documents/0203084.pdf

Extension. Farm Business Management Report. Available at http://ses.wsu.edu/wp-content/uploads/2014/12/2011-Economic-Contribution-Analysis-of-Washington-Dairy-Farms-and-Dairy-Processing.pdf

Fenn, M. E., Haeuber, R., Tonnesen, G. S., Baron, J. S., Grossman-Clarke, S., Hope, D., ... & Sickman, J. O. (2003). Nitrogen emissions, deposition, and monitoring in the western United States. *AIBS Bulletin*, *53*(4), 391-403. Available at https://academic.oup.com/bioscience/article/53/4/391/250293

Find Law (2011) Five Corners Family Farms versus Washington Cattlemen et al. Available at https://caselaw.findlaw.com/wa-supreme-court/1589776.html

Fletcher, K. (2014) *Dairy farm to produce pipeline-quality biogas*. Bio-Mass Magazine. Available at http://biomassmagazine.com/articles/10612/dairy-farm-to-produce-pipeline-quality-biogas

Frans, L.M. (2000) Estimating the probability of elevated nitrate (NO2 + NO3 - N) concentrations in ground water in the Columbia Basin Ground Water Management Area, Washington: U.S. Geological Survey Water-Resources Investigations Report 00-4110, 24 p. Available at https://pubs.usgs.gov/wri/wri004110/pdf/wri004110.pdf

Frans, L.M. (2005) Evaluating regional trends in ground-water nitrate concentrations of the Columbia Basin Groundwater Management Area, Washington [poster]: 5th Washington Hydrogeology Symposium, Tacoma, Washington, April 12-14, 2005. (PDF, 1.06 MB). Available at https://wa.water.usgs.gov/projects/cbgwma/data/waBAK00-01_poster.pdf

Institute of Agriculture and Natural Resources (2016) *How much water do cows drink per day?* Available at https://beef.unl.edu/amountwatercowsdrink

Frans, L.M., and Helsel, D.R. (2005) Evaluating regional trends in ground-water nitrate concentrations of the Columbia Basin Ground Water Management Area, Washington: U.S. Geological Survey Scientific Investigations Report 2005-5078, 7 p. Available at https://pubs.usgs.gov/sir/2005/5078/pdf/sir20055078.pdf

Frans, Lonna, (2008) Distribution of Elevated Nitrate Concentrations in Groundwater in Washington State, US Geological Survey Fact Sheet 2008-3063, p. 2. Available at https://pubs.usgs.gov/fs/2008/3063/

Fuchs, M.S. (1990) Ground Water Monitoring Guidance for Solid Waste Facilities. WA State Dept. of Ecology Publication No. 90-004. Available at https://fortress.wa.gov/ecy/publications/documents/90004.pdf

Fuhrer, G. J., McKenzie, S. W., Rinella, J. F., Sanzolone, R. F., & Skach, K. A. (1993). *Surface-water-quality assessment of the Yakima River basin in Washington; analysis of major and minor elements in fine-grained streambed sediment, 1987* (No. 93-30). US Geological Survey;

Books and Open-File Reports Section [distributor], Available at https://pubs.usgs.gov/of/1993/0030/report.pdf

Garland, D. and Erickson, D. (1994) Ground Water Quality Survey near Edaleen Dairy, Whatcom County, Washington, January 1990 to April 1993. WA State Dept. of Ecology Publication No. 94-037. Available at https://fortress.wa.gov/ecy/publications/documents/9437.pdf

Goulding, K.W.T. (1990) Nitrogen deposition to land from the atmosphere: Soil Use Management, v. 6, no. 2, p. 61-63. Goulding, K.W.T., 1990, Nitrogen deposition to land from the atmosphere: Soil Use Management, v. 6, no. 2, p. 61-63.

Grandview, City of (2016) 2016 Water Quality Report. Available at https://grandview.wa.us/wp-content/uploads/2013/06/2016-Water-Quality-Report.pdf

Gruber, N., & Galloway, J. N. (2008). An Earth-system perspective of the global nitrogen cycle. *Nature*, *451*(7176), 293. Available at https://www.nature.com/articles/nature06592.pdf

Habets, N. (2015) Presentation to the GWMA Regulatory Work Group. Available at http://www.yakimacounty.us/DocumentCenter/View/10514/2015_04_23-Regulatory-Framework-Working-Group-Study-Session-II-Final-Summary

Harter, T., K. Dzurella, G. Kourakos, A. Hollander, A. Bell, N. Santos, Q. Hart, A. King, J. Quinn, G. Lampinen, D. Liptzin, T. Rosenstock, M. Zhang, G.S. Pettygrove, and T. Tomich, (2017). Nitrogen Fertilizer Loading to Groundwater in the Central Valley. Final Report to the Fertilizer Research Education Program, Projects 11-0301 and 15-0454, California Department of Food and Agriculture and University of California Davis, 333p., http://groundwaternitrate.ucdavis.edu. Available at http://groundwaternitrate.ucdavis.edu/files/268749.pdf

Report to Legislature: 2012

Harter, T., J. R. Lund, J. Darby, G. E. Fogg, R. Howitt, K. K. Jessoe, G. S. Pettygrove, J. F. Quinn, J. H. Viers, D. B. Boyle, H. E. Canada, N. DeLaMora, K. N. Dzurella, A. Fryjoff-Hung, A. D. Hollander, K. L. Honeycutt, M. W. Jenkins, V. B. Jensen, A. M. King, G. Kourakos, D. Liptzin, E. M. Lopez, M. M. Mayzelle, A. McNally, J. Medellin-Azuara, and T. S. Rosenstock. 2012. Addressing Nitrate in California's Drinking Water with a Focus on Tulare Lake Basin and Salinas Valley Groundwater. Report for the State Water Resources Control Board Report to the Legislature. Center for Watershed Sciences, University of California, Davis. 78 p. http://groundwaternitrate.ucdavis.edu. Available at http://groundwaternitrate.ucdavis.edu/files/138956.pdf

Technical Report 1 – Project and Technical Report Outline
Harter, T. and J. R. Lund. 2012. Project and Technical Report Outline. Technical Report 1 in:

Addressing Nitrate in California's Drinking Water with A Focus on Tulare Lake Basin and Salinas Valley Groundwater. Report for the State
Water Resources Control Board Report to the Legislature. Center for Watershed Sciences, University of California, Davis. Available at
http://groundwaternitrate.ucdavis.edu/files/139111.pdf

Technical Report 2 – Nitrogen Sources and Loading to Groundwater
Viers, J.H., Liptzin, D., Rosenstock, T.S., Jensen, V.B., Hollander, A.D., McNally, A., King, A.M., Kourakos, G., Lopez, E.M., De La
Mora, N., Fryjoff-Hung, A., Dzurella, K.N., Canada, H.E., Laybourne, S., McKenney, C., Darby, J., Quinn, J.F. & Harter, T. (2012) Nitrogen Sources and Loading to Groundwater. Technical Report 2 in: Addressing Nitrate in California's Drinking Water with a Focus on Tulare Lake Basin and Salinas Valley Groundwater. Report for the State Water Resources Control Board Report to the Legislature. Center for Watershed Sciences, University of California, Davis. Available at
http://groundwaternitrate.ucdavis.edu/files/139110.pdf

Appendix to Technical Report 2 at
http://groundwaternitrate.ucdavis.edu/files/149916.pdf

Technical Report 3 – Nitrogen Source Reduction to Protect Groundwater Quality
Dzurella, K.N., Medellin-Azuara, J., Jensen, V.B., King, A.M., De La Mora, N., Fryjoff-Hung, A., Rosenstock, T.S., Harter, T., Howitt, R., Hollander, A.D., Darby, J., Jessoe, K., Lund, J.R.,& Pettygrove, G.S. (2012) Nitrogen Source Reduction to Protect Groundwater Quality. Technical Report 3 in: Addressing Nitrate in California's Drinking Water with a Focus on Tulare Lake Basin and Salinas Valley Groundwater. Report for the State Water Resources Control Board Report to the Legislature. Center for Watershed Sciences, University of California, Davis. Available at
http://groundwaternitrate.ucdavis.edu/files/139103.pdf

Technical Report 4 – Groundwater Nitrate Occurrence
Boyle, D., King, A., Kourakos, G., Lockhart, K., Mayzelle, M., Fogg, G.E. & Harter, T. (2012) Groundwater Nitrate Occurrence. Technical Report 4 in: Addressing Nitrate in California's Drinking Water with a Focus on Tulare Lake Basin and Salinas Valley Groundwater. Report for the State Water Resources Control Board Report to the Legislature. Center for Watershed Sciences, University of California, Davis. Available at http://groundwaternitrate.ucdavis.edu/files/139106.pdf

Technical Report 5 – Groundwater Mediation and Management for Nitrate
King, A., Jensen, V., Fogg, G.E. & Harter, T. (2012) Groundwater Remediation and Management for Nitrate. Technical Report 5 in: Addressing Nitrate in California's Drinking Water with a Focus on Tulare Lake Basin and Salinas Valley Groundwater. Report for the State Water Resources Control Board Report to the Legislature. Center for Watershed Sciences, University of California, Davis. Available at
http://groundwaternitrate.ucdavis.edu/files/139112.pdf

Technical Report 6 – Drinking Water Treatment for Nitrate
Jensen, V.B., Darby, J.L., Seidel, C. & Gorman, C. (2012) Drinking Water Treatment for Nitrate. Technical Report 6 in: Addressing Nitrate in California's Drinking Water with a Focus on Tulare Lake Basin and Salinas Valley Groundwater. Report for the State Water Resources Control Board Report to the Legislature. Center for Watershed Sciences, University of California, Davis. Available at http://groundwaternitrate.ucdavis.edu/files/139107.pdf

Technical Report 7 – Alternative Water Supply Options for Nitrate Contamination
Honeycutt, K., Canada, H.E., Jenkins, M.W. & Lund, J.R. (2012) Alternative Water Supply Options for Nitrate Contamination. Technical Report 7 in: Addressing Nitrate in California's Drinking Water with A Focus on Tulare Lake Basin and Salinas Valley Groundwater. Report for the State Water Resources Control Board Report to the Legislature. Center for Watershed Sciences, University of California, Davis. Available at http://groundwaternitrate.ucdavis.edu/files/139108.pdf

Technical Report 8 – Regulatory and Funding Options for Groundwater Nitrate Contamination
Canada, H.E., Harter T., Honeycutt, K., Jessoe, K., Jenkins, M.W. & Lund, J.R. (2012) Regulatory and Funding Options for Nitrate Groundwater Contamination. Technical Report 8 in Addressing Nitrate in California's Drinking Water with a Focus on Tulare Lake Basin and Salinas Valley Groundwater. Report for the State Water Resources Control Board Report to the Legislature. Center for Watershed Sciences, University of California, Davis. Available at http://groundwaternitrate.ucdavis.edu/files/139105.pdf

Helmers, M. J., Isenhart, T. M., Dosskey, M. G., Dabney, S. M., & Strock, J. S. (2008). Buffers and vegetative filter strips. Available at https://lib.dr.iastate.edu/cgi/viewcontent.cgi?article=1580&context=abe_eng_pubs

Hristov, A. N. (2011). Contribution of ammonia emitted from livestock to atmospheric fine particulate matter (PM2. 5) in the United States. *Journal of dairy science*, *94*(6), 3130-3136. Available at https://kundoc.com/pdf-technical-note-contribution-of-ammonia-emitted-from-livestock-to-atmospheric-fin.html

Hubble, J. D. (2012). Yakima River Basin Integrated Water Resource Management Plan: Final Programmatic Environmental Impact Statement. *Fish Benefits Analysis Technical Memorandum, US Bureau of Reclamation*. Available at https://fortress.wa.gov/ecy/publications/documents/1212002.pdf

Huffman, R. L. (2018). *Concentrations of Nitrate in Drinking Water in the Lower Yakima River Basin, Groundwater Management Area, Yakima County, Washington, 2017* (No. 1084). US Geological Survey. Available at https://pubs.usgs.gov/ds/1084/ds1084.pdf
Institute of Agriculture and Natural Resources (2016) *How much water do cows drink per day?* Available at https://beef.unl.edu/amountwatercowsdrink

International Agency for Research on Cancer (2010) Ingested nitrate and nitrite and cyanobacterial peptide toxins. Lyon, France. Available at http://monographs.iarc.fr/ENG/Monographs/vol94/mono94.pdf

lvens, W.P.M.F. , Draaijcr , G.P.J. , and Bleuten, W. , (1988) Atmospheric nitrogen deposition in a forest next to an intensively used agricultural area, *in* Mathy, P. , cd., Air Pollution and Ecosystem : Dordrecht, Reidel Publishing Co., p. 536-541 .

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. Available at https://pubs.usgs.gov/sir/2008/5045/

Jones, M.A., and Vaccaro, J.J. (2008) Extent and Depth to Top of Basalt and Interbed Hydrogeologic Units, Yakima River Basin Aquifer System, Washington: U.S. Geological Survey Scientific Investigations Report 2008-5045, 22 p., 5 pls. Available at https://pubs.usgs.gov/sir/2008/5045/

Jones, M.A., and Julich, R.J. (2008) 3D hydrogeologic framework of basalt and interbed units, Yakima, Washington. Available at https://wa.water.usgs.gov/projects/yakimagw/video.html

Keeney, D. R., & Hatfield, J. L. (2008). The nitrogen cycle, historical perspective, and current and potential future concerns. In *Nitrogen in the Environment (Second Edition)* (pp. 1-18). Available at https://digitalcommons.unl.edu/cgi/viewcontent.cgi?referer=https://scholar.google.com/&httpsredir=1&article=1258&context=usdaarsfacpub

Kellogg, R. L., Lander, C. H., Moffitt, D. C., & Gollehon, N. (2000). Manure nutrients relative to the capacity of cropland and pastureland to assimilate nutrients: Spatial and temporal trends for the United States. *Proceedings of the Water Environment Federation*, *2000*(16), 18-157. Available at http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.387.9742&rep=rep1&type=pdf

Keys, M.E., Vaccaro, J.J., Jones, M.A., and Julich, R.J. (2008) Hydrographs showing ground-water level trends for selected wells in the Yakima River basin aquifer system, Washington: U.S. Geological Survey Data Series 343 Available at https://pubs.usgs.gov/ds/343/

Kimsey, M. (2005) Implementation Guidance for the Ground Water Quality Standards. WA State Dept. of Ecology Publication No. 96-02. Available at https://fortress.wa.gov/ecy/publications/documents/9602.pdf

Kinnison, H. B., & Sceva, J. E. (1963). *Effects of hydraulic and geologic factors on streamflow of the Yakima River Basin, Washington* (No. 1595). US Government Printing Office. Available at https://pubs.usgs.gov/wsp/1595/report.pdf

Knobeloch L., Salna B., Hogan A., Postle J., Anderson H. (2000) Blue babies and nitrate-contaminated well water. *Environ Health Perspect 108*(7) Retrieved from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1638204/pdf/envhper00308-0137.pdf

Knobeloch, L., and M. Proctor (2001) Eight blue babies. *WMJ. 100*(8) pp. 43-47. http://www.wisconsinmedicalsociety.org/_WMS/publications/wmj/issues/wmj_v100n8/100-8-SA-Knobeloch.pdf

Koenig, R. T., Horneck, D., Platt, T., Petersen, P., Stevens, R., Fransen, S., & Brown, B. (2009). Nutrient management guide for dryland and irrigated alfalfa in the Inland Northwest. *Pacific Northwest Ext. Pub. PNW0611*. Available at http://agresearch.montana.edu/wtarc/producerinfo/agronomy-nutrient-management/Alfalfa/NutrientManagementGuide.pdf

Kross, B. C., Hallberg, G. R., Bruner, D. R., Cherryholmes, K., & Johnson, J. K. (1993). The nitrate contamination of private well water in Iowa. *American Journal of Public Health*, *83*(2), 270-272. Available at https://ajph.aphapublications.org/doi/pdf/10.2105/AJPH.83.2.270

Leip, A., Billen, G., Garnier, J., Grizzetti, B., Lassaletta, L., Reis, S., ... & Westhoek, H. (2015). Impacts of European livestock production: nitrogen, sulphur, phosphorus and greenhouse gas emissions, land-use, water eutrophication and biodiversity. *Environmental Research Letters*, *10*(11), 115004. Available at http://iopscience.iop.org/article/10.1088/1748-9326/10/11/115004/pdf

Liu, J., You, L., Amini, M., Obersteiner, M., Herrero, M., Zehnder, A. J., & Yang, H. (2010). A high-resolution assessment on global nitrogen flows in cropland. *Proceedings of the National Academy of Sciences*, *107*(17), 8035-8040.Available at http://www.pnas.org/content/pnas/107/17/8035.full.pdf

LYV GWMA (2012a) Committee Operating Guidelines. Third Quarterly Report 2012 (page 47/75) available at http://www.yakimacounty.us/DocumentCenter/Home/View/8449

LYV GWMA (2012b) Education and Public Outreach Plan. Third Quarterly Report 2012 (page 54/75) available at http://www.yakimacounty.us/DocumentCenter/Home/View/8449

LYV GWMA (2012c) Professional Services Agreement with EnviroIssues. Third Quarterly Report 2012 (page 61/75) available at http://www.yakimacounty.us/DocumentCenter/Home/View/8449

LYV GWMA (2012d) Amendment No.1 to Ecology Agreement No. C 1200235. Third Quarterly Report 2012 (page 73/75) available at http://www.yakimacounty.us/DocumentCenter/Home/View/8449

LYV GWMA (2012e) GWAC Work Plan. Fourth Quarterly Report 2012 (page 76/128) available at http://www.yakimacounty.us/DocumentCenter/Home/View/8450

LYV GWMA (2012e) Education and Public Outreach Plan. Fourth Quarterly Report 2012 (page 113/128) available at http://www.yakimacounty.us/DocumentCenter/Home/View/8450

LYV GWMA (2013a) Contract with HDR Engineering, Second Quarterly Report 2013 (page 88/142) available at http://www.yakimacounty.us/DocumentCenter/Home/View/8452

LYV GWMA (2013b) Agreement with Yakima County Health District, Second Quarterly Report 2013 (page 118/142) available at http://www.yakimacounty.us/DocumentCenter/Home/View/8452

LYV GWMA (2013c) Agreement with Heritage University, Second Quarterly Report 2013 (page 129/142) available at http://www.yakimacounty.us/DocumentCenter/Home/View/8452

LYV GWMA (2013d) Contract revision with EnviroIssues, Second Quarterly Report 2013 (page 140/142) available at http://www.yakimacounty.us/DocumentCenter/Home/View/8452

LYV GWMA (2013e) Technical Memorandum #1 – Regulatory Review. Third Quarterly Report 2013 (page 79/161) available at http://www.yakimacounty.us/DocumentCenter/Home/View/8453

LYV GWMA (2013f) Heritage University Community Survey – Questions and Results. Third Quarterly Report 2013 (page 132/161) available at http://www.yakimacounty.us/DocumentCenter/Home/View/8453

LYV GWMA (2013g) Connect with your government – English/Spanish script. Third Quarterly Report 2013 (page 157/161) available at http://www.yakimacounty.us/DocumentCenter/Home/View/8453

LYV GWMA (2013h) Nutrient Loading Assessment for the Lower Yakima Valley PP Fourth Quarterly Report 2013 (page 82/236)0 Available at http://www.yakimacounty.us/DocumentCenter/Home/View/8454

LYV GWMA (2013i) Draft Deep Soil Sampling Plan Oct. 3, 2013 – GWAC Review version 1. Fourth Quarterly Report 2013 (Page 98/236) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/8454

LYV GWMA (2013j) Draft Initial Best Management Practices Data Base Summary. Fourth Quarterly Report (Page 133/236). Available at http://www.yakimacounty.us/DocumentCenter/Home/View/8454

LYV GWMA (2013k) GWAC Self-Assessment Survey. Fourth Quarterly Report 2013 (Page 162/236) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/8454

LYV GWMA (2013l) Standardized GWAC Talking Points PP. Fourth Quarterly Report (Page 172/236). Available at http://www.yakimacounty.us/DocumentCenter/Home/View/8454

LYV GWMA (2013m) High Risk Bi-lingual Outreach Materials. Fourth Quarterly Report 2013 (Page 181/236). Available at http://www.yakimacounty.us/DocumentCenter/Home/View/8454

LYV GWMA (2013n) Amendment to Agreement with the Yakima Health District, Fourth Quarterly Report 2013 (Page 190/236). Available at http://www.yakimacounty.us/DocumentCenter/Home/View/8454

LYV GWMA (2013o) Technical Memorandum Calculations to Allocate Soil Samples in 2014. Fourth Quarterly Report 2013 (Page 192/236). Available at http://www.yakimacounty.us/DocumentCenter/Home/View/8454

LYV GWMA (2013p) Draft Potential Groundwater Monitoring Stations December 3, 2013. Fourth Quarterly Report 2013 (Page 200/236) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/8454

LYV GWMA (2014a) 2014 Work Group Task List. First Quarterly Report 2014 (Page 86/162) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/8455

LYV GWMA (2014b) Draft Best Management Practices (BMP) Effectiveness Evaluation Summary (Technical Memorandum #2) February 27, 2014. First Quarterly Report 2014 (Page 87/162) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/8455

LYV GWMA (2014c) Potential Groundwater Monitoring Stations document December 3, 2013. First Quarterly Report 2014 (Page 90/162) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/8455

LYV GWMA (2014d) GWAC Accomplishments News Release January 16, 2014. First Quarterly Report 2014 (Page 136/162) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/8455

LYV GWMA (2014e) Radio Spots. First Quarterly Report 2014. (Page 138/162) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/8455

LYV GWMA (2014f) Free Well Testing Flyer English/Spanish. First Quarterly Report 2014. (Page 142/162) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/8455

LYV GWMA (2014g) Department of Ecology Contract Amendment 2 – March 4, 2014. First Quarterly Report 2014 (Page 145/162) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/8455

LYV GWMA (2014h) EnviroIssues Professional Services Amendment 2 – January 21, 2014. First Quarterly Report 2014 (Page 149/162) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/8455

LYV GWMA (2014i) HDR Amendment 1 – February 5, 2014. First Quarterly Report 2014 (Page 151/162) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/8455

LYV GWMA (2014j) Radio KDNA Conference Room Contract – February 5, 2014. First Quarterly Report 2014 (Page 153/162) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/8455

LYV GWMA (2014k) Radio KDNA Draft Public Affairs Underwriting Agreement – Jan. 23, 2014. First Quarterly Report 2014 (Page 161/162) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/8455

LYV GWMA (2014l) Yakima Health District Contract Amendment 2 – March 25, 2014. First Quarterly Report 2014 (Page 162/162) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/8455

LYV GWMA (2014 m) GWAC Comments and PgG Responses - Draft Groundwater Monitoring Plan (Page 72/139) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/8514

LYV GWMA (2014 n) Deep Soil Sampling Plan (Page 70/139) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/8514

LYV GWMA (2014 o) Deep Soil Sampling Questionnaire (Page 113/139) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/8514

LYV GWMA (2014 p) Invitation to Growers (Page 118/139) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/8514

LYV GWMA (2014 q) Yakima Herald Republic June 29, 2014 Legal Notice Bids for Deep Soil Sampling (Page 120/139) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/8514

LYV GWMA (2014 r) New Mom Flyer (Page 122/139) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/8514

LYV GWMA (2014 s) Nitrate Education Slides (Page 123/139) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/8514

LYV GWMA (2014 t) High Risk Well Assessment (English/Spanish) News Release (Page 136/139) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/8514

LYV GWMA (2014 u) Signed Agreement with JH Davenport LLC of June 17, 2014 (Page 139/139) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/8514

LYV GWMA (2014 v) Listing of Work Group Budget Proposals (Page 77/169) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/8456

LYV GWMA (2014 w) GWAC Budget Discussion Framework (Page 79/169) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/8456

LYV GWMA (2014 x) Legal Notice – Bid Proposals for Deep Soil Sampling (Page 119/169) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/8456

LYV GWMA (2014 y) Newspaper Ads and Articles re Deep Soil Sampling (Page 120/169) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/8456

LYV GWMA (2014 z) High Risk Well Assessment Report – August 21, 2014 (Page 128/169) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/8456

LYV GWMA (2014 aa) Draft WSDA Comprehensive Nitrogen Loading Assessment for the Lower Yakima Valley Groundwater Management Area – Scope of Work & Budget August 2014 (Page 130/169) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/8456

LYV GWMA (2014 bb) EPA's Summary Yakima Administrative Order of Consent Dairies Draft Data PP – Sept. 2014 (Page 143/169) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/8456

LYV GWMA (2014 cc) BOCC307-2014 Interlocal Agreement with South Yakima Conservation District for Deep Soil Sampling dated July 15, 2014 (Page 161/169) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/8456

LYV GWMA (2014 dd) BOCC Amendment No. 1 to Interlocal Agreement with South Yakima Conservation District for Deep Soil Sampling dated August 5, 2014 (Page 168/169) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/8456

LYV GWMA (2014 ee) Lower Yakima Valley GWMA Program Development _ Estimated Costs for Budget Discussions (Page 80/157) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/8457

LYV GWMA (2014 ff) Interim Final Groundwater Monitoring Plan Version 7 (Page 82/157) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/8457 Available at http://www.yakimacounty.us/DocumentCenter/Home/View/8457

LYV GWMA (2014 gg) Deep Soil Sampling Combined Report (Page 129/157) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/8457

LYV GWMA (2014 hh) Deep Soil Sampling Soil Report (Page 137/157) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/8457

LYV GWMA (2014 ii) Comprehensive Nitrogen Loading Assessment for the Lower Yakima Valley Groundwater Management Area – Scope of Work and Budget – Version 1.2a dated December 3, 2014 (Page 139/157) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/8457

LYV GWMA (2015 a) Ground Water Management Plan Timeline (Page 62/99) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/8458

LYV GWMA (2015b) Round One Deep Soil Sampling Data Report (Page 70/99) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/8458

LYV GWMA (2015 c) Deep Soil Sampling Plan Questionnaire Revised (Page 71/99) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/8458

LYV GWMA (2015d) Amendment to Agreement between Yakima County and Radio KDNA for Conference Room Rentals (Page 74/99) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/8458

LYV GWMA (2015e) Interlocal Agreement between Washington State Department of Agriculture and Yakima County to Develop a Comprehensive Nitrogen Loading Assessment for the Lower Valley Groundwater Management Area (Page 76/99) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/8458

LYV GWMA (2015f) Deep Soil Sampling Report – Spring 2015 (Page 83/124) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/8459

LYV GWMA (2015 g) Lower Yakima Valley Groundwater Management Area Plan – Table of Contents (Page 96/124) Sample Letter (English/Spanish) to High Risk Well Assessment Survey Participants with N results ≥ 10 mg/L (Page 100/124) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/8459

LYV GWMA (2015 h) Letter Enclosures (page 104/124) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/8459

LYV GWMA (2015 i) Amendment No.3 to Agreement between Ecology and Yakima County (Page 123/124) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/8459

LYV GWMA (2015 j) High Risk Well Assessment Phase II Outreach Schedule and Materials (Page 62/80) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/8448

LYV GWMA (2015 k) Interlocal Agreement between Yakima Health District and Yakima County (Page 74/80) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/8448

LYV GWMA (2015 l) Amended Interagency Agreement between the Department of Ecology and Yakima County (IAA No. C1600074) dated November 17, 2015 (Page 56/76) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/9078

LYV GWMA (2015 m) Pacific Groundwater Group (PgG) Agreement with Yakima County dated December 8, 2015 (Page 68/76) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/9078

LYV GWMA (2015 n) Agreements for Radio Advertising with Bustos Media, Radio Yakima, Radio KDNA and Townsquare Media October 2015 (Page 71/76) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/9078

LYV GWMA (2016 a) Deep Soil Sampling Fall Report 2015 (Page 84/143) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/10061

LYV GWMA (2016 b) PgG Technical Memorandum "Draft Ambient Groundwater Monitoring Network Location Selection Method" dated March 18, 2016 (Page 104/143) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/10061

LYV GWMA (2016 c) High Risk Well Assessment Phase II 2016 Outreach Materials (Page 108/143) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/10061

LYV GWMA (2016 d) Well Assessment Survey Test Results (Page 139/143) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/10061

LYV GWMA (2016 e) Amendment No. 1 to the Yakima Health District Agreement dated February 16, 2016 (Page 142/143) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/10061

LYV GWMA (2016 f) Landau Associates "Deep Soil Sampling Program Fall 2014; Spring 2015; Fall 2015; Spring 2016 Preliminary Data Analysis PP (page 123/211) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/1131

LYV GWMA (2016g) PgG's report "Draft Lower Yakima Valley GWMA Proposed Ambient Groundwater Monitoring Network June 8, 2016 (Page 152/211) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/1131

LYV GWMA (2016 h) Amendment No. 2 to the Yakima Health District Agreement dated April 12, 2016 (Page 209/211) Available at
http://www.yakimacounty.us/DocumentCenter/Home/View/1131

LYV GWMA (2016 i) GWMA Expenditures through July 31, 2016 (Page 89/97) Available at
http://www.yakimacounty.us/DocumentCenter/Home/View/11922

LYV GWMA (2016 j) EPO's Test Your Well Billboard Campaign proposed to GWAC August 18, 2016 (Page 92/97) Available at
http://www.yakimacounty.us/DocumentCenter/Home/View/11922

LYV GWMA (2016 k) Ambient Monitoring Network PowerPoint Presentation: "GWMA AMN and Other Monitoring" (Page 91/170) Available at
http://www.yakimacounty.us/DocumentCenter/Home/View/13094

LYV GWMA (2016 l) GWMA Ambient Monitoring Network Report for Final Approval (Page 98/170)) Available at
http://www.yakimacounty.us/DocumentCenter/Home/View/13094

LYV GWMA (2016 m) GWMA Ambient Monitoring Network Report Attachments (Page 116/170)) Available at
http://www.yakimacounty.us/DocumentCenter/Home/View/13094

LYV GWMA (2016 n) Recommendation Groundwater Monitoring from Data Work Group (Page 160/170)) Available at
http://www.yakimacounty.us/DocumentCenter/Home/View/13094

LYV GWMA (2016 o) 2016_1030 GWAC Budget Discussion (Page 162/170)) Available at
http://www.yakimacounty.us/DocumentCenter/Home/View/13094

LYV GWMA (2016 p) GWMA LTD-2016 12-15-16 Group Decisions Exhibit A (Page 162/170)) Available at
http://www.yakimacounty.us/DocumentCenter/Home/View/13094

LYV GWMA (2016 q) AMN Final Draft Comments from Data Working Group 2016_0706 (Page 165/170)) Available at
http://www.yakimacounty.us/DocumentCenter/Home/View/13094

LYV GWMA (2016 r) Contract with Lamar Advertising in the amount of $4,000 executed on October 4, 2016 (Page 168/170)) Available at
http://www.yakimacounty.us/DocumentCenter/Home/View/13094

LYV GWMA (2016 s) Contract with Paul's Properties LLC in the amount of $1,800 executed on October 4, 2016 (Page 170/170)) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/13094

LYV GWMA (2016 t) November Meeting Summary for the Regulatory Work Group. Available at http://www.yakimacounty.us/DocumentCenter/View/12515/2016_11_09-Regulatory-Framework-Working-Group-Meeting-Final-Summary

LYV GWMA (2017a) EPO Questionnaire Summary (Page 76/99) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/14003

LYV GWMA (2017 b) "What You Can Do" English/Spanish Outreach Flyers (Page 79/99) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/14003

LYV GWMA (2017 c) Contract with US Geological Survey, United States Department of the Interior, in the amount of $491,320 executed on March 7, 2017 (Page 89/99) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/14003

LYV GWMA (2017 d) Amendment #1 between Paul's Properties LLC and Yakima County in the amount of $550 on February 21, 2017 (Page 98/99) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/14003

LYV GWMA (2017 e) GWAC's April 20, Tentative Schedule for Completion (Page 99/302) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/15866

LYV GWMA (2017 f) June 29, Compiled List of Alternative Strategies (Page 102/302) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/15866

LYV GWMA (2017 g) Draft Nitrogen Availability Assessment and Attachments (Page 116/302) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/15866

LYV GWMA (2017 h) Jean Mendoza's May 18 Alternatives Presentation (Page 218/302) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/15866

LYV GWMA (2017 i) "What You Can Do to Protect Well Water" English/Spanish Flyer (Page 241/302) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/15866

LYV GWMA (2017 j) RCIM Final Report to the GWAC (Page 244/302) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/15866

LYV GWMA (2017 k) Groundwater Quality Regulation in Washington (Page 252/302) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/15866

LYV GWMA (2017 l) Draft Livestock/CAFO Working Group Report to the GWAC (Page 283/302) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/15866

LYV GWMA (2017 m) LYV GWMA Groundwater Management Plan – Livestock/CAFO (Page 290/302) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/15866

LYV GWMA (2017 n) GWAC Work Plan Excerpt – Funding Working Group (Page 302/302) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/15866

LYV GWMA (2017 o) Work Group alternatives with WG recommendations 6-22-17 (The original alternatives list presented to the GWAC) (Page 113/140) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/15497

LYV GWMA (2017 p) Copy of the GWMA Survey Report after GWAC 9.21.17(GWAC's September 21 version) (Page 127/140) Available at http://www.yakimacounty.us/DocumentCenter/Home/View/15497

LYV GWMA (2017) GWMA Strategies Spreadsheet – Comprehensive List of Blue Alternatives before 10-5-17 meeting. Available at https://www.yakimacounty.us/DocumentCenter/View/16458/2017-4th-Quarter-Report

LYV GWMA (2017) GWMA Strategies 12-1-17 JHD Available at https://www.yakimacounty.us/DocumentCenter/View/16458/2017-4th-Quarter-Report

LYV GWMA (2017) First four GWMA program chapters presented to the GWAC on December 7, 2017:

- Introduction (Draft VI)
- Characterization of the Area (DRAFT VI)
- Sources of Nitrate and the Regulatory Environment (Draft VI)
- Yakima County's Role in Groundwater Quality Protection (Draft VI)
  Available at https://www.yakimacounty.us/DocumentCenter/View/16458/2017-4th-Quarter-Report

LYV GWMA (2017) GWAC member comment form Available at https://www.yakimacounty.us/DocumentCenter/View/16458/2017-4th-Quarter-Report

LYV GWMA (2017) 2017_1102 Summary of NAA Comments Available at https://www.yakimacounty.us/DocumentCenter/View/16458/2017-4th-Quarter-Report

LYV GWMA (2017) October 19 presentation Map, Identifying the GIS layers in the GWMA Available at https://www.yakimacounty.us/DocumentCenter/View/16458/2017-4th-Quarter-Report

LYV GWMA (2018 a) Master GWMA Strategies, 1-29-18 Available at https://www.yakimacounty.us/DocumentCenter/View/17248/2018-1st-Quarter-Report

LYV GWMA (2018 b) Horizon 2040_YC Comprehensive Plan – Water Quality Goals and Objectives Available at https://www.yakimacounty.us/DocumentCenter/View/17248/2018-1st-Quarter-Report

LYV GWMA (2018 c) GWMA LTD-2017, 12-13-17 Prelim Available at https://www.yakimacounty.us/DocumentCenter/View/17248/2018-1st-Quarter-Report

LYV GWMA (2018 d) PGG Preliminary Drill Sites 1-30-18 Available at https://www.yakimacounty.us/DocumentCenter/View/17248/2018-1st-Quarter-Report

LYV GWMA (2018e) Index for 3.1.2018 Program Release to GWAC Available at https://www.yakimacounty.us/DocumentCenter/View/17248/2018-1st-Quarter-Report

LYV GWMA (2018 f) LYVGWMA Program JHD, 02-26-18 Available at https://www.yakimacounty.us/DocumentCenter/View/17248/2018-1st-Quarter-Report

LYV GWMA (2018 g) MR_Deep Soil Sampling (DSS) in the Lower Yakima Valley GWMA Available at https://www.yakimacounty.us/DocumentCenter/View/17248/2018-1st-Quarter-Report

LYV GWMA (2018 h) MR_Draft Deep Soil Sampling Analytical Analysis Available at https://www.yakimacounty.us/DocumentCenter/View/17248/2018-1st-Quarter-Report

LYV GWMA (2018 i) Analysis of DSS Attachment 1 – 204 03 28 Deep Soil Sampling Plan Available at https://www.yakimacounty.us/DocumentCenter/View/17248/2018-1st-Quarter-Report

LYV GWMA (2018 j) Analysis of DSS Attachment 2 – DSS PowerPoint Available at https://www.yakimacounty.us/DocumentCenter/View/17248/2018-1st-Quarter-Report

LYV GWMA (2018 k) DSS Presentation to LYV GWMA Data WG Available at https://www.yakimacounty.us/DocumentCenter/View/17248/2018-1st-Quarter-Report

LYV GWMA (2018 l) Soil Types and GWMA DSS Available at https://www.yakimacounty.us/DocumentCenter/View/17248/2018-1st-Quarter-Report

LYV GWMA (2018 m Amendment Number 1 to Agreement C1600074 Available at https://www.yakimacounty.us/DocumentCenter/View/17248/2018-1st-Quarter-Report

LYV GWMA (2018 n) Contract between Yakima County and PGG for the Monitoring Well Installation Available at https://www.yakimacounty.us/DocumentCenter/View/17248/2018-1st-Quarter-Report

Magirl, C.S., Julich, R.J., Welch, W.B., Curran, C.R., Mastin, M.C., and Vaccaro, J.J. (2009) Summary of Seepage Investigations in the Yakima River Basin, Washington: U.S. Geological Survey Data Series 473 Available at https://pubs.usgs.gov/ds/473/

Manassaram, D. M., Backer, L. C., & Moll, D. M. (2005). A review of nitrates in drinking water: maternal exposure and adverse reproductive and developmental outcomes. *Environmental Health Perspectives*, *114*(3), 320-327. Available at https://ehp.niehs.nih.gov/doi/full/10.1289/ehp.8407

Marshall W. Gannett.: U.S. Geological Survey Open-File Report 93-30, 226 p.
Green, Christopher T., Fisher, and Lawrence H., Bekins, Barbara A., (2008) *Nitrogen Fluxes through Unsaturated Zones in Five Agricultural Settings across the United States,* Journal of Environmental Quality: Vol 37, pp. 1073-1085. Available at http://199.68.131.20/GWMA/documents/library/Nitrogen%20Fluxes%20through%20Unsaturated%20Zones%20in%20Five%20Agricultural%20Settings%20across%20the%20United%20States.pdf

McCarthy, K. A., & Johnson, H. M. (2009). *Effect of agricultural practices on hydrology and water chemistry in a small irrigated catchment, Yakima River basin, Washington* (No. 2009-5030). US Geological Survey. Available at https://pubs.usgs.gov/sir/2009/5030/pdf/sir20095030.pdf

McClain, K. (2015) Agricultural History of Yakima County. Available at http://www.yakimaco.us/GWMA/documents/History%20of%20Yakima.pdf

Monk, P. (2001). Fish surveys in the Roza-Sunnyside Board of Joint Control irrigation drain network: Summary of Major Findings for 2001. *Roza-Sunnyside Board of Joint Control, Sunnyside, WA*. Available at http://www.svid.org/images/final%20RSBOJC%20fish%20survey%20report.pdf

Moore, A. D., Martí, M. E. D. H., & Chen, L. (2015). *Sampling Dairy Manure and Compost for Nutrient Analysis*. University of Idaho. Available at http://www.cals.uidaho.edu/edcomm/pdf/PNW/PNW673.pdf

Morace, J. L., Fuhrer, G. J., Rinella, J. F., McKenzie, S. W., Gannett, M. W., Bramblett, K. L., ... & Meador, M. R. (1999). *Surface-water-quality assessment of the Yakima River Basin in Washington: Overview of major findings, 1987-91* (No. 98-4113). US Geological Survey. Available at https://pubs.usgs.gov/wri/1998/4113/report.pdf

Morgan, L. (2002) Aquifer Vulnerability Analysis Using the Pesticide Root-Zone Model (PRZM2) Columbia Basin Irrigation Project Area. WA State Dept. of Ecology Publication No. 01-10-027. Available at https://fortress.wa.gov/ecy/publications/documents/0110027.pdf

Morgan, L. (2005) Critical Aquifer Recharge Areas Guidance Document. WA State Dept. of Ecology Publication No. 96-02. Available at https://fortress.wa.gov/ecy/publications/documents/0510028.pdf

Morgan, L. (2014) Quality Assurance Project Plan Washington Nitrate Prioritization Project. WA State Dept. of Ecology Publication No. 14-10-005. Available at https://fortress.wa.gov/ecy/publications/documents/1410005.pdf

Morgan, L. (2016) WA Nitrate Prioritization Project. Available at https://fortress.wa.gov/ecy/publications/documents/1610011.pdf

National Association of Local Boards of Health (2010) Understanding Concentrated Animal Feeding Operations and Their Impact on Communities. Retrieved from http://www.cdc.gov/nceh/ehs/Docs/Understanding_CAFOs_NALBOH.pdf

National Atmospheric Deposition Program (2018) AMoN Data Access. Available at http://nadp.slh.wisc.edu/data/sites/list/?net=AMoN

National Oceanic and Space Administration (2017) *Gulf of Mexico 'dead zone' is the largest ever measured.* Available at http://www.noaa.gov/media-release/gulf-of-mexico-dead-zone-is-largest-ever-measured

Natural Resources Conservation Services Agricultural Waste Management Field Handbook (nd) Available at https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/technical/ecoscience/mnm/?cid=stelprdb1045935

Chapter 1 – Laws, Regulations, Policy, and Water Quality Criteria at https://www.wcc.nrcs.usda.gov/ftpref/wntsc/AWM/handbook/ch1.pdf

Chapter 2 – Planning Considerations at https://www.wcc.nrcs.usda.gov/ftpref/wntsc/AWM/handbook/ch2.pdf

Chapter 3 – Agricultural Wastes and Water, Air, and Animal Resources at https://www.wcc.nrcs.usda.gov/ftpref/wntsc/AWM/handbook/ch3.pdf

Chapter 4 – Agricultural Waste Characteristics at https://www.wcc.nrcs.usda.gov/ftpref/wntsc/AWM/handbook/ch4.pdf

Chapter 5 – Role of Soils in Waste Management at https://www.wcc.nrcs.usda.gov/ftpref/wntsc/AWM/handbook/ch5.pdf

Chapter 6 – Role of Plants in Waste Management at https://www.wcc.nrcs.usda.gov/ftpref/wntsc/AWM/handbook/ch6.pdf

Chapter 7 – Geological and Groundwater Considerations at https://www.wcc.nrcs.usda.gov/ftpref/wntsc/AWM/handbook/ch7.pdf

Chapter 8 – Siting Agricultural Waste Management Systems at
https://www.wcc.nrcs.usda.gov/ftpref/wntsc/AWM/handbook/ch8.pdf

Chapter 9 – Agricultural waste Management Systems at
https://www.wcc.nrcs.usda.gov/ftpref/wntsc/AWM/handbook/ch9.pdf

Chapter 10 – Agricultural Waste Management System Component Design at
https://www.wcc.nrcs.usda.gov/ftpref/wntsc/AWM/handbook/ch10.pdf

Chapter 11 – Waste Utilization at
https://www.wcc.nrcs.usda.gov/ftpref/wntsc/AWM/handbook/ch11.pdf

Chapter 12 – Waste Management Equipment at
https://www.wcc.nrcs.usda.gov/ftpref/wntsc/AWM/handbook/ch12.pdf

Chapter 13 – Operation, Maintenance and Safety at
https://www.wcc.nrcs.usda.gov/ftpref/wntsc/AWM/handbook/ch13.pdf

Chapter 15 – Computer Software and Models at
https://www.wcc.nrcs.usda.gov/ftpref/wntsc/AWM/handbook/ch15.pdf

Natural Resources Conservation Service Field Office Technical Guide for Washington State (nd) Available at https://efotg.sc.egov.usda.gov/treemenuFS.aspx

Amendments for Treating Agricultural Wastes No. 591 at
https://efotg.sc.egov.usda.gov/references/public/WA/591_stnd_012214.pdf

Anaerobic Digester No. 366 at
https://efotg.sc.egov.usda.gov/references/public/WA/366_stnd_100915.pdf

Animal Mortality Facility No. 316 at
https://efotg.sc.egov.usda.gov/references/public/WA/316_stnd_100915.pdf

Bedding No. 310 at
https://efotg.sc.egov.usda.gov/references/public/WA/310_stnd_012214.pdf

Channel Bed Stabilization No. 584 at
https://efotg.sc.egov.usda.gov/references/public/WA/584_stnd_071917.pdf

Composting Facility No. 317 at
https://efotg.sc.egov.usda.gov/references/public/WA/317_stnd_071717.pdf

Conservation Cover No. 327 at
https://efotg.sc.egov.usda.gov/references/public/WA/327_stnd_032316.pdf

Conservation Crop Rotation No. 328 at
https://efotg.sc.egov.usda.gov/references/public/WA/328_stnd_032316.pdf

Constructed Wetland No. 356 at
https://efotg.sc.egov.usda.gov/references/public/WA/656_stnd_012213.pdf

Contour Buffer Strips No. 332 at
https://efotg.sc.egov.usda.gov/references/public/WA/332_std_012716.pdf

Cover Crop No. 340 at
https://efotg.sc.egov.usda.gov/references/public/WA/340_stnd_032316.pdf

Critical Area Planting No. 342 at
https://efotg.sc.egov.usda.gov/references/public/WA/342_std_020217.pdf

Drainage Water Management No. 554 at
https://efotg.sc.egov.usda.gov/references/public/WA/554_stnd_071917.pdf

Feed Management No. 592 at
https://efotg.sc.egov.usda.gov/references/public/WA/592_stnd_011717.pdf

Irrigation Ditch Lining No. 428 at
https://efotg.sc.egov.usda.gov/references/public/WA/428_stnd_012213.pdf

Irrigation Reservoir No. 426 at
https://efotg.sc.egov.usda.gov/references/public/WA/436_stnd_012213.pdf

Irrigation System, Micro irrigation No. 441 at
https://efotg.sc.egov.usda.gov/references/public/WA/441_stnd_071917.pdf

Irrigation System, Surface and Subsurface No. 443 at
https://efotg.sc.egov.usda.gov/references/public/WA/443_stnd_012213.pdf

Irrigation System, Tailwater Recovery No. 447 at
https://efotg.sc.egov.usda.gov/references/public/WA/447_stnd_020515.pdf

Irrigation Water Management No. 449 at
https://efotg.sc.egov.usda.gov/references/public/WA/449_stnd_020515.pdf

Monitoring Well No. 553 at
https://efotg.sc.egov.usda.gov/references/public/WA/353_stnd_020515.pdf

Mulching No. 484 at
https://efotg.sc.egov.usda.gov/references/public/WA/484_stnd_1217.pdf

Nutrient Management No 590 at
https://efotg.sc.egov.usda.gov/references/public/WA/590_stnd_021814.pdf

Pond No. 378 at
https://efotg.sc.egov.usda.gov/references/public/WA/378_stnd_071917.pdf

Pond Sealing or Lining No. 520 at
https://efotg.sc.egov.usda.gov/references/public/WA/520_stnd_051916.pdf

Pond Sealing or Liner Geosynthetic No. 521 at
https://efotg.sc.egov.usda.gov/references/public/WA/521A_stnd_071917.pdf

Residue and Tillage Management, No Till No. 329 at
https://efotg.sc.egov.usda.gov/references/public/WA/329_stnd_1017.pdf

Residue and Tillage Management, Reduced Till No. 345 at
https://efotg.sc.egov.usda.gov/references/public/WA/345_stnd_1017.pdf

Riparian Herbaceous Cover No. 390 at
https://efotg.sc.egov.usda.gov/references/public/WA/390_stnd_020515.pdf

Sprinkler System No. 442 at
https://efotg.sc.egov.usda.gov/references/public/WA/442_stnd_071917.pdf

Streambank and Shoreline Protection No. 580 at
https://efotg.sc.egov.usda.gov/references/public/WA/580_stnd_012214.pdf

Subsurface Drain No. 606 at
https://efotg.sc.egov.usda.gov/references/public/WA/606_stnd_012213.pdf

Surface Drain No. 607 at
https://efotg.sc.egov.usda.gov/references/public/WA/607_stnd_071917.pdf

Vegetative Buffer No. 601 at
https://efotg.sc.egov.usda.gov/references/public/WA/601_std_012716.pdf

Waste Facility Closure No. 360 at
https://efotg.sc.egov.usda.gov/references/public/WA/360_stnd_012213.pdf

Waste Separation Facility No. 632 at
https://efotg.sc.egov.usda.gov/references/public/WA/632_stnd_012214.pdf

Waste Storage Facility No. 313 at
https://efotg.sc.egov.usda.gov/references/public/WA/313_stnd_071917.pdf

Waste Treatment No. 629 at
https://efotg.sc.egov.usda.gov/references/public/WA/629_stnd_020515.pdf

Waste Treatment Lagoon No. 359 at
https://efotg.sc.egov.usda.gov/references/public/WA/359_stnd_012213.pdf

Well Decommissioning No. 351 at
https://efotg.sc.egov.usda.gov/references/public/WA/351_stnd_020515_NC.pdf

Wetland Creation No. 658 at
https://efotg.sc.egov.usda.gov/references/public/WA/658_stnd_020515.pdf

Wetland Restoration No. 657 at
https://efotg.sc.egov.usda.gov/references/public/WA/657_stnd_020515.pdf

Natural Resources Conservation Service (2011) The Nitrogen Cycle: Its transformation effects on water, soil and air quality resource concerns in Idaho. WSDA Natural Resources Conservation Service Technical Note Available at https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs144p2_046108.pdf

Natural Resources Conservation Service (2013) NRCS Assessment Procedures for Existing Waste Storage Ponds: Technical Note 23. Available at https://ecology.wa.gov/DOE/files/a0/a0a6c01a-af2c-428b-83ba-a30f10d8e643.pdf

Natural Resources Conservation Service (2014) Guides for Equators: Soil Nitrogen. Available at https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_051575.pdf

Natural Resources Conservation Service (2018) NRCS Soil Survey. Available at https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx

Neibergs, J.S. & Brady, M. (2013) 2011 *Economic Contribution Analysis of Washington Dairy Farms and Dairy Processing: An Input-Output Analysis.* Washington State University Extension. Available at http://ses.wsu.edu/wp-content/uploads/2014/12/2011-Economic-Contribution-Analysis-of-Washington-Dairy-Farms-and-Dairy-Processing.pdf

Neibergs, J. S. (2014). *2014 Economic Contribution Analysis of the Washington Beef Industry* (Doctoral dissertation, Washington State University Pullman). Available at http://ses.wsu.edu/wp-content/uploads/2014/12/2014-Economic-Contribution-of-Washington-Beef-Industry1.pdf

Nemecek, E.A. (1978 a) Aquifer Test, Sandlin Well – 11N/21E-22G, Lower Yakima Valley, Results and Projections. WA State Dept. of Ecology Publication No. OFTR 78-03. Available at https://fortress.wa.gov/ecy/publications/documents/oftr7803.pdf

Nemecek, E.A. (1978 b) Aquifer Test, Prentice Well – 11N, 21E, 17N, Results and Projections, Lower Yakima Valley. WA State Dept. of Ecology Publication No. OFTR 78-02. Available at https://fortress.wa.gov/ecy/publications/documents/oftr7802.pdf

Nemecek, E.A. (1978 c) Aquifer Test – Carpenter Well – 11N, 21E, 35F, Lower Yakima Valley. WA State Dept. of Ecology Publication No. OFTR 78-01. Available at https://fortress.wa.gov/ecy/publications/documents/oftr7801.pdf

Nolan, B. T., Ruddy, B. C., Hitt, K. J., & Helsel, D. R. (1998). A national look at nitrate contamination of ground water. *Water Conditioning and Purification*, *39*(12), 76-79. Available at https://pubs.er.usgs.gov/publication/70046294

Nolan, B. T., Hitt, K. J., & Ruddy, B. C. (2002). Probability of nitrate contamination of recently recharged groundwaters in the conterminous United States. *Environmental science & technology*, *36*(10), 2138-2145. Available at https://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1074&context=usgsstaffpub

Nolan, B. T., Puckett, L. J., Ma, L., Green, C. T., Bayless, E. R., & Malone, R. W. (2010). Predicting unsaturated zone nitrogen mass balances in agricultural settings of the United States. *Journal of Environmental Quality*, *39*(3), 1051-1065. Available at https://www.researchgate.net/profile/Christopher_Green2/publication/43183168_Predicting_Unsaturated_Zone_Nitrogen_Mass_Balances_in_Agricultural_Settings_of_the_United_States/links/0fcfd51016d4c01e7b000000.pdf

Northwest Indian Fisheries Commission (2009) *Tulalip Tribes' biomethane plant to benefit salmon restoration.* Available at https://nwifc.org/tulalip-tribes-biomethane-plant-to-benefit-salmon-restoration/

Opportunities Industrialization Center (2015) *Community Needs Assessment.* Available at https://www.yvoic.org/img/pdf/4.pdf

Ozmen, O., Mor, F., Sahinduran, S., & Unsal, A. (2005). Pathological and toxicological investigations of chronic nitrate poisoning in cattle. *Toxicological & Environmental Chemistry*, *87*(1), 99-106. Available at https://www.tandfonline.com/doi/abs/10.1080/02772240400007104

Pacific Groundwater Group. (2011) Request for Identification: Lower Yakima Valley Groundwater Management Area, June 21, 2011. Available at http://www.yakimacounty.us/DocumentCenter/View/2359

Pacific Groundwater Group. (2013a) Consultant Agreement with HDR Engineering and Pacific Groundwater Group. June 25, 2013. https://www.yakimacounty.us/DocumentCenter/View/17680/20130625-HDR-Consultant-Agreement

Pacific Groundwater Group. (2013b) Technical Memorandum – Considerations for Further Scoping of Deep Soil Sampling (DSS), Lower Yakima Valley GWMA. August 6, 2013. https://www.yakimacounty.us/DocumentCenter/View/17682/20130806-PGG-Memo-DSS-Scoping

Pacific Groundwater Group. (2013c) Draft Deep Soil Sampling Plan with comments, Lower Yakima Valley GWMA. September 2, 2013. https://www.yakimacounty.us/DocumentCenter/View/17685/20130902-PGG-DSS-Plan-Version-0

Pacific Groundwater Group. (2013d) Groundwater Monitoring, Quality Assurance/Quality Control Plan: Lower Yakima Valley GWMA, Initial Characterization. JE 1308, September 16, 2013. http://www.yakimacounty.us/DocumentCenter/View/15880

Pacific Groundwater Group. (2013e) Draft Deep Soil Sampling Plan, Lower Yakima Valley GWMA. October 3, 2013. https://www.yakimacounty.us/DocumentCenter/View/17687/20131003-PGG-DSS-Plan-Version-1

Pacific Groundwater Group. (2013f) Technical Memorandum: Calculations to Allocate Soil Samples in 2014 – Revision 1. November 25, 2013. https://www.yakimacounty.us/DocumentCenter/View/17688/20131125-PGG-Memo-Soil-Sample-Allocations

Pacific Groundwater Group. (2013g) Potential Groundwater Monitoring Stations, Yakima Groundwater Management Area. December 3, 2013. https://www.yakimacounty.us/DocumentCenter/View/17689/20131203-PGG-Potential-Monitoring-Well-Locations

Pacific Groundwater Group. (2014a) Potential Groundwater Monitoring Stations, Response to Comments. March 2014. https://www.yakimacounty.us/DocumentCenter/View/17690/201403-PGG-Response-To-Comments

Pacific Groundwater Group. (2014b) Potential Groundwater Monitoring Stations, Response to Comments PowerPoint Presentation. March 20, 2014. https://www.yakimacounty.us/DocumentCenter/View/17691/20140320-PGG-Response-To-Comments-on-March-6-Presentation

Pacific Groundwater Group. (2014c) Deep Soil Sampling Plan, Lower Yakima Valley GWMA. March 28, 2014. https://www.yakimacounty.us/DocumentCenter/View/17692/20140328-PGG-DSS-Plan-Version-6

Pacific Groundwater Group. (2014d) Draft Groundwater Monitoring Plan, Yakima Groundwater Management Area. June 2014. https://www.yakimacounty.us/DocumentCenter/View/17693/201406-PGG-Response-To-Comments

Pacific Groundwater Group. (2014e) Interim Final Groundwater Monitoring Plan, Lower Yakima Valley GWMA, Initial Characterization. JE 1308, August 15, 2014. http://www.yakimacounty.us/DocumentCenter/View/13277

Pacific Groundwater Group. (2015) Consultant Agreement for Professional Services with Pacific Groundwater Group. December 8, 2015. https://www.yakimacounty.us/DocumentCenter/View/17696/20151123-PGG-Consultant-Agreement

Pacific Groundwater Group. (2016a) Technical Memorandum. Draft Ambient Groundwater Monitoring Network Location Selection Method. March 18, 2016. https://www.yakimacounty.us/DocumentCenter/View/17697/20160318-PGG-Memo-Network-Location-Selection

Pacific Groundwater Group. (2016b) Draft Technical Memorandum: Proposed Groundwater Monitoring Locations from Irrigation Drains, Lower Yakima Valley GWMA. April 12, 2016. https://www.yakimacounty.us/DocumentCenter/View/17698/20160412-PGG-Memo-Proposed-Drain-Monitoring-Locations

Pacific Groundwater Group. (2016c) Lower Yakima Valley GWMA Proposed Ambient Groundwater Monitoring Network. June 8, 2016. https://www.yakimacounty.us/DocumentCenter/View/17700/20160608-PGG-Ambient-Monitoring-Network-Report-Final-for-Approval-approved-11-2016

Pacific Groundwater Group. (2016d) Lower Yakima Valley GWMA Proposed Ambient Groundwater Monitoring Network Attachments. June 8, 2016. https://www.yakimacounty.us/DocumentCenter/View/17699/20160608-PGG-Ambient-Monitoring-Network-Report-Attachments

Pacific Groundwater Group. (2018a) Consultant Agreement for Professional Services. January 9, 2018. https://www.yakimacounty.us/DocumentCenter/View/17702/20180109-PGG-Contract-for-Ambient-Monitoring-Wells

Pacific Groundwater Group. (2018b) Technical Specification Groundwater Monitoring Wells, Yakima County. February 13, 2018. https://www.yakimacounty.us/DocumentCenter/View/17726/20180216-PGG-Draft-Drill-SpecsYakima-V4

Pacific Groundwater Group. (2018c) Preliminary Drill Sites and Field Locations. February 13, 2018. https://www.yakimacounty.us/DocumentCenter/View/17703/20180213-PGG-YakimaGWMA_Field_Locations_v20180213

Pacific Groundwater Group. (2018d) Preliminary Drill Sites and Field Locations. February 15, 2018. https://www.yakimacounty.us/DocumentCenter/View/17705/20180215-PGG-YakimaGWMA_Field_Locations_v20180215

Pacific Groundwater Group. (2018e) Contract Specifications for the Construction of Lower Yakima Valley GWMA Monitoring Wells. Yakima County Public Services Project FC 3463. March 15, 2018. https://www.yakimacounty.us/DocumentCenter/View/17707/20180315-PGG-Contract-Documents

Pacific Groundwater Group. (2018f) Preliminary Drill Sites and Field Locations. April 5, 2018. https://www.yakimacounty.us/DocumentCenter/View/17709/20180405-PGG-YakimaGWMA_Field_Locations_v20180405

Pacific Groundwater Group. (2018g) Yakima County Monitoring Well Installation Coordinates. April 5, 2018. https://www.yakimacounty.us/DocumentCenter/View/17708/20180405-PGG-Drill-site-coordinates-v20180405

Paulot, F., & Jacob, D. J. (2014). Hidden cost of US agricultural exports: particulate matter from ammonia emissions. *Environmental science & technology*, *48*(2), 903-908. Available at http://acmg.seas.harvard.edu/publications/2014/paulot_export_2014.pdf

Payne, K. L., & Sumioka, S. S. (1994). *Selected water-quality data for the Toppenish Creek Basin, Yakima Indian Reservation, Washington, 1989* (No. 93-486). US Geological Survey; USGS Earth Science Information Center, Open-File Reports Section [distributor], Available at https://pubs.usgs.gov/of/1993/0486/report.pdf

Payne, Karen l., Johnson, Henry M., Black, Robert W. (2007) *Environmental Setting of the Granger Drain and DR2 Basins, Washington, 2003-04,* US Geological Survey Scientific Investigations Report 2007-5102, pp. 22-25. Available at https://pubs.usgs.gov/sir/2007/5102/pdf/sir20075102.pdf

Pediatric Environmental Health Specialty Unit (2014 a) Nitrates, Blue Baby Syndrome and Drinking Water: A fact Sheet for Families. Available at http://deohs.washington.edu/sites/default/files/documents/Nitrates_Blue_Baby_Syndrome_and_Drinking_Water_Community_Factsheet_Mar_2016.pdf

Pediatric Environmental Health Specialty Unit (2014 b) Nitrates, Methemoglobinemia and Drinking Water: A Factsheet for Clinicians. Available at http://deohs.washington.edu/sites/default/files/documents/Nitrates_Methemoblobinemia_and_Drinking_Water_Health_Professionals_Factsheet_July_2014.pdf

PEW Commission (2008) Putting Meat on the Table: Industrial Farm Animal Production in America. Retrieved from http://www.pewtrusts.org/uploadedFiles/wwwpewtrustsorg/Reports/Industrial_Agriculture/PCIFAP_FINAL.pdf

Pitz, C. (2007) Report to Management: Groundwater Assessment Program Pilot Study. WA State Dept. of Ecology Publication No. 07-03-008. Available at https://fortress.wa.gov/ecy/publications/documents/0703008.pdf

Pitz, C. (2014) Spreadsheet Models for Determining the Influence of Land Applications of Fertilizer on Underlying Groundwater Nitrate Concentrations. Available at https://fortress.wa.gov/ecy/publications/documents/1403018.pdf

Pitz, C. (2016) Predicted Impacts of Climate Change on Groundwater Resources of Washington State. WA State Dept. of Ecology Publication No. 16-03-006. Available at https://fortress.wa.gov/ecy/publications/documents/1603006.pdf

Potter, S.R., Andrews, S., Atwood, J.D., Kellogg, R.L., Lemunyon, J., Norfleet, L., Oman, D. (2006) *Model Simulation of Soil Loss, Nutrient Loss, and Change I Soil Organic Carbon Associated with Crop Production*. United States Department of Agriculture, Natural Resources Conservation Service. Conservation Assessment Effects Project. Available at https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs143_013138.pdf

Powell, H. and Myers, W. (1979) Preliminary Groundwater Assessment of the Horse Heaven Hills. WA State Dept. of Ecology Publication No. OFTR 79-04. Available at https://fortress.wa.gov/ecy/publications/documents/oftr7904.pdf

Prest, V. (2014) Dairy Nutrient Management Program PP. Available at http://www.yakimacounty.us/Archive/ViewFile/Item/528

Ramirez-Dorronsoro, J.C., H.S. Joo, P. Ndegwa, and A.J. Heber. 2010. National Air Emissions Monitoring Study: Data from Two Dairy Freestall Barns in Washington WA5B, Final Report. Purdue University, West Lafayette, IN, July 30.

Rau, B. (2015) Washington's Water Quality Management Plan to Control Nonpoint Sources of Pollution. WA State Dept. of Ecology Publication No. 15-10-015. Available at https://fortress.wa.gov/ecy/publications/documents/1510015.pdf

Redding, M. (2008) Nitrate Trends in the Central Sumas-Blaine Surficial Aquifer. WA State Dept. of Ecology Publication No. 08-03-018. Available at https://fortress.wa.gov/ecy/publications/documents/0803018.pdf

Redding, M. (2011) Sumas-Blaine Aquifer Long-Term Groundwater Quality Monitoring Network. WA State Dept. of Ecology Publication No. 11-03-015. Available at https://fortress.wa.gov/ecy/publications/documents/1103015.pdf

Redding, M. (2016) Manure and Groundwater Quality Literature Review. WA State Dept. of Ecology Publication No. 16-03-026. Available at https://fortress.wa.gov/ecy/publications/documents/1603026.pdf

Reis, S., Bekunda, M., Howard, C. M., Karanja, N., Winiwarter, W., Yan, X., ... & Sutton, M. A. (2016). Synthesis and review: tackling the nitrogen management challenge: from global to local scales. *Environmental Research Letters*, *11*(12), 120205. Available at http://iopscience.iop.org/article/10.1088/1748-9326/11/12/120205/pdf

Rodgers, A.K. (2016) *Agricultural Pollution in Puget Sound: Inspiration to Change Washington's Reliance on Voluntary Incentive Programs to Save Salmon*. Western Environmental Law Center. Available at https://westernlaw.org/sites/default/files/Agricultural%20Pollution%20in%20Puget%20Sound%20-%20April%202016%20-%20Web.pdf

Romey, B., & Cramer, S. P. (2001). Aquatic habitat survey of irrigation drainage networks, lower Yakima River Basin. *Prepared for RSBOJC and USBR, prepared by SP Cramer and Assoc., Sandy, Or*, *97055*, 76. Available at

http://www.svid.org/images/yakima%20drain%20habitat%20report%20final%201-48.pdf

Rotz, C. A. (2004). Management to reduce nitrogen losses in animal production 1. *Journal of animal science*, *82*(13_suppl), E119-E137. Available at https://www.researchgate.net/profile/Ca_Rotz/publication/8243583_Management_to_Reduce_Nitrogen_Losses_in_Animal_Production/links/549af0830cf2b803713716b2.pdf

Roy F. Spalding, Darrell G. Watts, James S. Schepers, Mark E. Burbach, Mary E. Exner, Robert J. Poreda, and Glen E. Martin (2001) *Controlling Nitrate Leaching in Irrigated Agriculture,* Journal of Environmental Quality, VOL. 30, July-Aug 2001. Available at https://digitalcommons.unl.edu/cgi/viewcontent.cgi?referer=http://scholar.google.com/&httpsredir=1&article=1368&context=agronomyfacpub

Roza-Sunnyside Irrigation Districts (2009) Water Quality Improvements in RSBOJC Irrigation Return Waterways, 1997-2008. *Roza-Sunnyside Board of Joint Control, Sunnyside, WA.* Available at http://www.svid.org/images/WQ%20Conditions%20in%20Irrigation%20waterwaysPublicSummary.pdf

Roza –Sunnyside Joint Board of Control (2010) Policies and programs to improve water quality and the use of water. Available at http://www.roza.org/wp-content/uploads/2018/06/BOJC-Policies-Programs-for-Water-quality-updated-March-16-2010.pdf

Ryan Dumas, C. (2018a) April dairy exports break record. Capital Press, Sept. 24, 2018. Available at http://www.capitalpress.com/Dairy/20180611/april-dairy-exports-break-record

Ryan Dumas, C. (2018b) Meat exports post strong gains in April. Capital Press, June 14, 2018. Available at http://www.capitalpress.com/Livestock/20180614/meat-exports-post-strong-gains-in-april

Sanchez-Echaniz, J., Benito-Fernández, J., & Mintegui-Raso, S. (2001). Methemoglobinemia and consumption of vegetables in infants. *Pediatrics*, *107*(5), 1024-1028. Available at http://extranet.hospitalcruces.com/doc/adjuntos/art_8.pdf

Sanderson, M., and LaValle, P.O., 1979, Surface loading from pollutant in precipitation in southern Ontario-some climatic and statistical aspects: Journal of Great Lake Research, v. 5, no. I, p. 52-60.

Savino, F., Maccario, S., Guidi, C., Castagno, E., Farinasso, D., Cresi, F., ... & Mussa, G. C. (2006). Methemoglobinemia caused by the ingestion of courgette soup given in order to resolve constipation in two formula-fed infants. *Annals of nutrition and metabolism*, *50*(4), 368-371. Available at https://www.karger.com/Article/PDF/94301

Scott, T., J. Kohr, R. Granger, A. Marshall, D. Gombert, M. Winkowski,E. Bosman Clark and S. Vigg (2016) Columbia River Instream Atlas (CRIA), FY2016. A component of the Columbia River Basin 2016 Water Supply & Demand Forecast. November 9, 2016. Funded by Washington Office of the Columbia River, Department of Ecology. Available at https://fortress.wa.gov/ecy/publications/documents/1612006.pdf

Sell, R., & Knutson, L. (2002). *Quality of ground water in private wells in the Lower Yakima Valley, 2001-02*. Valley Institute for Research and Education. Available at http://www.sec.nv.gov/cafo/tab_t_pt1.pdf

Sernia, O., Rivetti, S., Rossano, C., & Orecchia, L. (1984). Carrot soup as the cause of methemoglobinemia in an infant. Case report. *Annali dell'Ospedale Maria Vittoria di Torino*, *27*(1-6), 85-92. Available at https://europepmc.org/abstract/med/6545121

Shaw, B. (2015) Expert Testimony in CARE versus Cow Palace. Available at http://charlietebbutt.com/files/CP/237-2%20-%20Expert%20Report%20of%20Byron%20Shaw.pdf

Shields, J.W. (1996) *An Examination of Methemoglobinemia in Washington State.* WA State Dept. of Health Office of Toxic Substances.

Sinclair, K. and Roberts, T. (2007) Ambient Groundwater Quality in the Moxee Valley Surficial Aquifer, Yakima County, January-June 2006. WA State Dept. of Ecology Publication No. 07-03-023. Available at https://fortress.wa.gov/ecy/publications/documents/0703023.pdf

Sinclair, K. (2003) Groundwater Quality in the Central Ahtanum Valley, Yakima County. WA State Dept. of Ecology, publication no. 03-03-040. Available at https://fortress.wa.gov/ecy/publications/documents/0303040.pdf

Sinclair, K. (2005) Quality Assurance Project Plan Assessment of Ambient Groundwater Quality Conditions in the Surficial Unconsolidated Sedimentary Aquifer of the Moxee Valley, Yakima County, Washington. WA State Dept. of Ecology Publication No. 05-03-119. Available at https://fortress.wa.gov/ecy/publications/documents/0503119.pdf

Smith, D. L., Johnson, G., & Williams, T. (2006). Natural streamflow estimates for watersheds in the lower Yakima River. *SP Cramer & Associates, Sandy, OR*. Available at http://www.svid.org/images/Natural%20Streamflow%20Report%20Revised%20for%20website.pdf

South Yakima Conservation District (2018) Annual Work Plan. Available at http://scc.wa.gov/wp-content/uploads/2018/05/FY-2019-SYCD-Annual-Work.pdf

Staben, M. L., Ellsworth, J. W., Sullivan, D. M., Horneck, D. A., Brown, B. D., & Stevens, R. G. (2003). *Monitoring soil nutrients using a management unit approach*. [Corvallis, Or.]: Oregon State University Extension Service. Available at https://catalog.extension.oregonstate.edu/sites/catalog/files/project/pdf/pnw570.pdf

Steffen, W., Richardson, K., Rockström, J., Cornell, S. E., Fetzer, I., Bennett, E. M., ... & Folke, C. (2015). Planetary boundaries: Guiding human development on a changing planet. *Science*, *347*(6223), 1259855. Available at https://openresearch-repository.anu.edu.au/bitstream/1885/13126/3/1259855.full.pdf

Sullivan, D. M., & Cogger, C. G. (2003). *Post-harvest soil nitrate testing for manured cropping systems west of the Cascades*. Corvallis, Or.: Extension Service, Oregon State University.
Sullivan, D. M., & Cogger, C. G. (2003). *Post-harvest soil nitrate testing for manured cropping systems west of the Cascades*. Corvallis, Or.: Extension Service, Oregon State University. Available at https://efotg.sc.egov.usda.gov/references/public/WA/A.7_Post_Harvest_Soil_Nitrate_Test.pdf

Sullivan, D. M. (2008). Estimating plant-available nitrogen from manure. Available at https://catalog.extension.oregonstate.edu/sites/catalog/files/project/pdf/em8954.pdf

Sumioka, S.S. (1998) A Survey of Ground-Water Quality in the Toppenish Creek Basin, Yakama Indian Reservation, Washington 1989-91, USGS Water Resources Investigations Report 97-4194, pp. 10-14 Tri-County Water Resource Agency, 2003, Watershed Plan-Chapter 6, Management of Groundwater Quality, pp. 6-1 thru 6-21. Available at https://pubs.usgs.gov/wri/1997/4194/report.pdf

Sunnyside Community Hospital (2013) *Community Needs Assessment.* Available at https://www.sunnysidehospital.org/media/1032/sunnyside-community-hospital-and-clinics-chna-report.pdf

Sunnyside Community Hospital (2016) *Community Health Needs Assessment.* Available at https://www.sunnysidehospital.org/media/1136/chna-2016-_-final.pdf

Sunnyside Irrigation District Water Quality Links and Data Reports at http://www.svid.org/wcwq.htm

Granger Drain Turbidity Graph at http://www.svid.org/images/2006%20granger%20turbibity%20graph%20.pdf

Sulphur Creek Wasteway Turbidity Graph at http://www.svid.org/images/2006%20sulphur%20ck%20ww%20turbidity.pdf

Spring Creek Wasteway Turbidity Graph at http://www.svid.org/images/2006%20spring%20ck%20ww%20turbidity%20.pdf

Snipes Creek Wasteway Turbidity Graph at http://www.svid.org/images/2006%20snipes%20ck%20ww%20turbidity.pdf

Sutton, M. A., Howard, C. M., Erisman, J. W., Billen, G., Bleeker, A., Grennfelt, P., ... & Grizzetti, B. (Eds.). (2011). *The European nitrogen assessment: sources, effects and policy perspectives*. Cambridge University Press. Available at http://www.nine-esf.org/node/360/ENA-Book.html

General (Cover, Contributors, etc.) at http://www.nine-esf.org/files/ena_doc/ENA_pdfs/ENA_pre.pdf

Summary for Policy Makers at http://www.nine-esf.org/files/ena_doc/ENA_pdfs/ENA_policy%20summary.pdf

Technical Summary at http://www.nine-esf.org/files/ena_doc/ENA_pdfs/ENA_policy%20summary.pdf

Chapter 1 – Introduction at http://www.nine-esf.org/files/ena_doc/ENA_pdfs/ENA_c1.pdf

Chapter 2 – The European Nitrogen Problem in a Global Perspective at http://www.nine-esf.org/files/ena_doc/ENA_pdfs/ENA_c1.pdf

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Chapter7– Nitrogen Processes in Aquatic Systems at http://www.nine-esf.org/files/ena_doc/ENA_pdfs/ENA_c7.pdf

Chapter 8 – Nitrogen Processes in Coastal and Marine Ecosystems at http://www.nine-esf.org/files/ena_doc/ENA_pdfs/ENA_c8.pdf

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Chapter 26 – Societal Choice and Communicating the European Nitrogen Challenge at http://www.nine-esf.org/files/ena_doc/ENA_pdfs/ENA_c26.pdf

Glossary – http://www.nine-esf.org/files/ena_doc/ENA_pdfs/ENA_Glossary.pdf

Index – http://www.nine-esf.org/files/ena_doc/ENA_pdfs/ENA_Index.pdf

Tabacova, S., Baird, D. D., & Balabaeva, L. (1998). Exposure to oxidized nitrogen: lipid peroxidation and neonatal health risk. *Archives of Environmental Health: An International Journal*, *53*(3), 214-221. Available at https://www.tandfonline.com/doi/abs/10.1080/00039899809605698

Tabacova, S., & Balabaeva, L. (1993). Environmental pollutants in relation to complications of pregnancy. *Environmental health perspectives*, *101*(Suppl 2), 27. Available at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1519942/pdf/envhper00379-0034.pdf

Tanaka, H.H. (1976) Estimated Drawdown of Water Levels and Degree of Hydraulic Interference between an Existing and a Proposed Well, Moxee Valley, Yakima County, Washington. WA State Dept. of Ecology Publication No. OFTR 76-01. Available at https://fortress.wa.gov/ecy/publications/documents/oftr7601.pdf

Tomlinson, S. A. (1997 a). *Evapotranspiration for Three Sparse-canopy Sites in the Black Rock Valley, Yakima County, Washington, March 1992 to October 1995* (Vol. 96, No. 4207). US Department of the Interior, US Geological Survey. Available at https://pubs.usgs.gov/wri/1996/4207/report.pdf

Tomlinson, S. A. (1997 b). *Evaluating evapotranspiration for six sites in Benton, Spokane, and Yakima counties, Washington, May 1990 to September 1992*. US Department of the Interior, US Geological Survey. Available at https://pubs.usgs.gov/wri/1996/4002/report.pdf

United Nations (1999) The World at Six Billion. Available at http://www.un.org/esa/population/publications/sixbillion/sixbillion.htm

U.S. Bureau of Reclamation (2017) *Yakima River Basin Integrated Water Resource Management Plan Technical Memorandum Hydrologic Modeling of System Improvements Phase 3 Report.* Available at https://www.usbr.gov/pn/programs/yrbwep/2011integratedplan/YRBhydrologic2017.pdf

United States Census 2000: http://www.census.gov/census2000/states/us.html

United States Census 2010: http://2010.census.gov/2010census/data/

U.S. Census Bureau (2018a) *American Fact Finder.* Available at https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml

U.S. Climate Data (2018b) *Climate Yakima Washington.* Available at https://www.usclimatedata.com/climate/yakima/washington/united-states/uswa0502

U.S. Environmental Protection Agency. (2005) Priority List of Hazardous Substances for the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 104(i). Retrieved form http://www.atsdr.cdc.gov/cercla/

U.S. Environmental Protection Agency. (2006 a) 2006 Edition of the Drinking Water Standards and Health Advisories. Retrieved from http://www.epa.gov/waterscience/criteria/drinking/dwstandards.pdf

U.S. Environmental Protection Agency (2006 b) Drinking Water Contaminants. Retrieved from http://www.epa.gov/safewater/contaminants/index.html

U.S. Environmental Protection Agency (2009) Contaminant occurrence support document for category 2 contaminants for the second six-year review of national primary drinking

water regulations [EPA Report]. (EPA-815-B-09-011). Washington, D.C.: U.S. Environmental Protection Agency, Office of Water. Available at https://www.epa.gov/sites/production/files/2014-12/documents/815b09011.pdf

U.S. Environmental Protection Agency (2010 a) Report on Groundwater Contamination in the Lower Yakima Valley: ftp://ftp.epa.gov/reg10ftp/sites/yakima/groundwater_data/

U.S. Environmental Protection Agency (2010 b) Yakima Valley Groundwater Contamination: Summary of EPA Sampling Activities. Available at http://www.yakimaco.us/GWMA/documents/library/Yakima%20Valley%20EPA%20Sampling%20Summary%20June%2022%202010.pdf

U.S. Environmental Protection Agency (2012 a) Preliminary data Lower Yakima Valley well testing. Retrieved from ftp://ftp.epa.gov/reg10ftp/sites/yakima/groundwater_data/

U.S. Environmental Protection Agency (2012 b) *Relation between nitrate in water wells and potential sources in the lower Yakima Valley, Washington.* U.S. EPA Region X. Retrieved from http://www.epa.gov/region10/pdf/sites/yakimagw/nitrate_in_water_wells_study_9-27-2012.pdf

U.S. EPA. (2017a) IRIS Assessment Plan for Nitrate and Nitrite (Scoping and Problem Formulation Materials). U.S. Environmental Protection Agency, Washington, DC, EPA/635/R-17/331, 2017. Available at https://cfpub.epa.gov/ncea/iris_drafts/recordisplay.cfm?deid=337470

U.S. EPA IRIS Assessment Plan for Nitrate and Nitrite. (2017b) U.S. Environmental Protection Agency, Washington, DC EPA/635/R-17/331 Available at https://yosemite.epa.gov/sab/sabproduct.nsf/8AF41B299F1C342C852581980075D17D/$File/Nitrate-Nitrite_IAP_draft_plan+9.8.17.pdf

U.S. Environmental Protection Agency (2018) CERCLA and EPCRA Reporting Requirements for Air Releases of Hazardous Substances from Animal Waste at Farms. Available at https://www.epa.gov/epcra/cercla-and-epcra-reporting-requirements-air-releases-hazardous-substances-animal-waste-farms

US Geological Survey. (2008) Distribution of Elevated Nitrate concentrations in Ground Water in Washington State, Fact Sheet 2008-3063. Available at https://pubs.usgs.gov/fs/2008/3063/

US Geological Survey (2018) Water Science School. Available at https://water.usgs.gov/edu/qa-home-percapita.html

US Geological Survey (2018) Exploring Groundwater Surface Water Interactions. Available at https://www.usgs.gov/science-explorer-results?es=Groundwater-+surface+water+interactions+

US Natural Resources Conservation Service. (2006). *Model simulation of soil loss, nutrient loss, and change in soil organic carbon associated with crop production*. US Department of Agriculture, Natural Resources Conservation Service. Available at https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs143_013138.pdf

University of California at Davis (2018) Vadose Zone Modeling: Web-Links. Available at http://groundwater.ucdavis.edu/Materials/Vadose_Zone_Modeling__Web-Links/

Vaccaro, J.J., and Maloy, K.J. (2006) A method to thermally profile long river reaches to identify potential areas of ground-water discharge and preferred salmonid habitat: U.S. Geological Survey Scientific Investigations Report 2006-5136, 16 p Available at https://pubs.usgs.gov/sir/2006/5136/

Vaccaro, J.J., and Olsen, T.D. (2007) Estimates of monthly ground-water recharge to the Yakima River Basin aquifer system, Washington, 1960-2001, for current land-use and land-cover conditions: U.S. Geological Survey Open-File Report 2007-1238, 2 p. Available at https://pubs.usgs.gov/of/2007/1238/

Vaccaro, J.J., and Olsen, T.D. (2007) Estimates of ground-water recharge to the Yakima River Basin aquifer system, Washington, for predevelopment and current land-use and land-cover conditions: U.S. Geological Survey Scientific Investigations Report 2007-5007, 30 p. Available at https://pubs.usgs.gov/sir/2007/5007/pdf/sir20075007.pdf

Vaccaro, J.J. (2007) A deep percolation model for estimating ground-water recharge: Documentation of modules for the modular modeling system of the U.S. Geological Survey: U.S. Geological Survey Scientific Investigations Report 2006-5318, 30 p Available at https://pubs.usgs.gov/sir/2006/5318/

Vaccaro, J.J. (2008) A thermal profile method for long river reaches to identify potential areas of ground-water discharge and preferred salmonid habitat and to document the longitudinal temperature regime, Symposium on Identifying, Protecting, and Restoring Thermal Refuges for Coldwater Fishes, A.F.S., May 4-8, 2008, Portland, Oregon. Available at https://wa.water.usgs.gov/projects/yakimagw/video.html

Vaccaro, J.J., Keys, M.E., Julich, R.J., and Welch, W.B. (2008) Thermal profiles for selected river reaches in the Yakima River basin, Washington: U.S. Geological Survey Data Series 342 Available at https://pubs.usgs.gov/ds/342/

Vaccaro, J.J., Jones, M.A., Ely, D.M., Keys, M.E., Olsen, T.D., Welch, W.B., and Cox, S.E. (2009) Hydrogeologic framework of the Yakima River basin aquifer system, Washington: U.S. Geological Survey Scientific Investigations Report 2009-5152, 106 p. Available at https://pubs.usgs.gov/sir/2009/5152/

Vaccaro, J.J. (2011) River-aquifer exchanges in the Yakima River basin, Washington: U.S. Geological Survey Scientific Investigations Report 2011-5026, 98 p. Available at https://pubs.usgs.gov/sir/2011/5026/

Vaccaro, J.J., and Sumioka, S.S., 2006, Estimates of ground-water pumpage from the Yakima River Basin Aquifer System, Washington, 1960-2000: U.S. Geological Survey Scientific Investigations Report 2006-5205, 56 p Available at https://pubs.usgs.gov/sir/2006/5205/

VanDerslice, J. (2007) *Dose-Response of Nitrates and other Methemoglobin Inducers on Methemoglobin Levels in Infants* Washington Department of Health, Final Report, EPA Grant # R829781 Washington Department of Health, 2007, *Coliform Bacteria and Drinking Water,* WDOH Publication # 331-181 Available at https://cfpub.epa.gov/ncer_abstracts/index.cfm/fuseaction/display.highlight/abstract/5379/report/F

VanDerslice, J. (2009). Final Report: Dose-Response of Nitrate and Other Methemoglobin Inducers on Methemoglobin Levels of Infants. National Center for Environmental Research WA State Department of Health. Olympia, WA. Retrieved from http://cfpub.epa.gov/ncer_abstracts/index.cfm/fuseaction/display.abstractDetail/abstract/5379/report/F

Vedachalam, S., Mandelia, A.J., and Heath, E.A. (2018) Source Water Quality and the Cost of Nitrate Treatment in the Mississippi River Basin, *Northeast-Midwest Institute Report, 44 pp.,* Available at http://www.nemw.org/
Virginia Mason Memorial (2016) *Community Needs Assessment.* Available at https://www.yakimamemorial.org/pdf/about/community-hna-2016.pdf

Vitousek, P. M., Aber, J., Howarth, R. W., Likens, G. E., Matson, P. A., Schindler, D. W., ... & Tilman, G. D. (1997). Human alteration of the global nitrogen cycle: Causes and consequences, Ecological Society of America, Issues in Ecology, Issue 1. Available at https://cfpub.epa.gov/watertrain/pdf/issue1.pdf

Wald, A.R. (1982) Water Development Policies Regarding Ground Water Mining and Protection of Works in the Nineteen Western States. WA State Dept. of Ecology Publication No. OFTR 82-01. Available at https://fortress.wa.gov/ecy/publications/documents/oftr8201.pdf

Waller, S. A., Paul, K., Peterson, S. E., & Hitti, J. E. (2010). Agricultural-related chemical exposures, season of conception, and risk of gastroschisis in Washington State. *American journal of obstetrics and gynecology*, *202*(3), 241-e1. Available at https://www.ajog.org/article/S0002-9378(10)00034-7/fulltext

Walton, G. (1951). Survey of literature relating to infant methemoglobinemia due to nitrate-contaminated water. Am J Public Health 41: 986-996. Available at http://dx.doi.org/doi:10.2105/AJPH.41.8_Pt_1.986

Walton, B. (2017) Kansas town faces big bill to clean drinking water. *Circle of Blue.* Available at https://www.circleofblue.org/2017/water-quality/kansas-town-faces-big-bill-clean-drinking-water/

Walton, B. (2018) More Evidence of Nitrate Cancer Risk in Drinking Water. *Circle of Blue.* Available at https://www.circleofblue.org/2018/world/more-evidence-of-nitrate-cancer-risk-in-drinking-water/

Ward, L.B. (2009) in Yakima Herald Republic. "Hidden Wells, Dirty Water" available at http://www.yakima-herald.com/stories/2008/10/11/hidden-wells-dirty-water

Ward M.H., deKok T.M., Levallois P., Brender J., Gulis G., Nolan B.T., VanDerslice J. (2005) Workgroup report: Drinking-water nitrate and health - - recent findings and research needs. *Environ Health Perspect 113*(11) pp. 1607-1614. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/16263519 http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1310926/pdf/ehp0113-001607.pdf

Washington State Department of Agriculture. (2015) 2015 Drought and Agriculture: A Study by the Washington State Department of Agriculture. AGR PUB 104-495 (N/2/17). https://agr.wa.gov/FP/Pubs/docs/495-2015DroughtReport.pdf

WSDA Dairy Nutrient Management Program (2016) Implementation of Nutrient Management Training Program for Farmers WSDA Publication No. 713-533(N/6/16) Available at https://app.leg.wa.gov/ReportsToTheLegislature/Home/GetPDF?fileName=533-DNMPReportToLegJune2016_e9a85fda-7303-4899-a2fb-c30aea1728df.pdf

WSDA Dairy Nutrient Management Program (2017) Implementation of Nutrient Management Training Program for Farmers and Manure Management Program Review. WSDA Publication No. 713-634(N/6/17) Available at https://app.leg.wa.gov/ReportsToTheLegislature/Home/GetPDF?fileName=634-DNMP2017LegReport_b2479af1-2fc9-4218-8200-1a0118e3063b.pdf

WSDA & Yakima County (2017) *Estimated Nitrogen Available for Transport in the Lower Yakima Valley Groundwater Management Area.* Available at https://agr.wa.gov/FP/Pubs/docs/103-691YakimaGWMANitrogenTransportReport.pdf

WA State Dept of Agriculture (2018) Annual Budget. Available at https://agr.wa.gov/AboutWSDA/Docs/492-BienniumQuickReference-2017.pdf

Washington State Conservation Commission (2018) Conservation Districts: Annual Reports and Work Plans. Available at http://scc.wa.gov/plans-reports/

WA State Dept of Ecology (1998, revised 2006) Washington Water Law A Primer. Available at https://fortress.wa.gov/ecy/publications/documents/98152.pdf

WA State Dept. of Ecology (2009a) Water Treatment Plant General Permit – A National Pollutant Discharge Elimination System and State Waste Discharge General Permit. Available at https://ecology.wa.gov/DOE/files/44/448796a9-6762-4fd0-82c6-9c6fd536e30d.pdf

WA State Dept. of Ecology (2009b) Water Treatment Plant General Permit Fact Sheet. Available at https://ecology.wa.gov/DOE/files/14/14993d7f-baa4-4b17-9db8-45f639ad84b1.pdf

WA State Dept. of Ecology (2010a) Groundwater and Surface Water A Single Resource in Washington. Available at https://fortress.wa.gov/ecy/wrdocs/WaterRights/wrwebpdf/09012010_gw_sw_singleresource.pdf

WA State Dept. of Ecology, (2010b) Lower Yakima Groundwater Quality – Preliminary Assessment and Recommendations Document, Ecology Publication No. 10-10-00 Available at https://fortress.wa.gov/ecy/publications/documents/1010009.pdf

WA State Dept. of Ecology (2011a) Eastern Washington Phase II Municipal Stormwater Permit Fact Sheet. https://ecology.wa.gov/DOE/files/fc/fc28b906-d36e-46c4-a8e0-ff88864fc3e1.pdf

WA State Dept. of Ecology (2011b) Eastern Washington Phase II Municipal Stormwater Permit. Available at https://ecology.wa.gov/Regulations-Permits/Permits-certifications/Stormwater-general-permits/Municipal-stormwater-general-permits/Eastern-Washington-Phase-II-Municipal-Stormwat-(1)

WA State Dept. of Ecology (2011c) Memorandum of Understanding between Washington State Department of Agriculture and Washington State Department of Ecology. Available at https://ecology.wa.gov/DOE/files/6f/6f30de07-feb0-463a-958e-cf48df3a43bf.pdf

WA State Dept. of Ecology (2016) Fact sheet for the concentrated animal feeding operation pollutant discharge elimination system and concentrated animal feeding operation state waste discharge general permit and state waste discharge general permit. Available at https://ecology.wa.gov/DOE/files/a3/a36ceb3d-7767-4a21-a354-d4b7c1965c95.pdf

WA State Dept. of Ecology (2017) Response to Comments for the concentrated animal feeding operation pollutant discharge elimination system and concentrated animal feeding operation state waste discharge general permit and state waste discharge general permit. Available at https://ecology.wa.gov/DOE/files/5f/5f39ec9a-7687-442e-b8f1-1376ba2a4687.pdf

WA State Dept. of Ecology (2016a) Fresh Fruit Packing General Permit. A National Pollutant Discharge Elimination System and State Waste Discharge General Permit. Available at https://ecology.wa.gov/DOE/files/c8/c8cbd444-b2b0-4c42-b3f4-d56fb26a5357.pdf

WA State Dept. of Ecology (2016b) Fact Sheet for the Fruit Packing General Permit. Available at https://ecology.wa.gov/DOE/files/18/180a4dfe-46a6-401a-b718-ba0cf485ce97.pdf

WA State Dept. of Ecology (2016c) Sand and Gravel General Permit. A National Pollutant Discharge Elimination System and State Waste Discharge General Permit. Available at https://ecology.wa.gov/DOE/files/d2/d276657e-8179-48bb-bbc0-bebb05ea993b.pdf

WA State Dept. of Ecology Office of the Columbia River (2016d) *Integrating Groundwater Declines in Eastern Washington into Supply and Demand Forecasting.* Available at https://fortress.wa.gov/ecy/publications/documents/1612001.pdf

WA State Dept. of Ecology (2017 a) Concentrated Animal Feeding Operation Fact Sheet – English and Spanish. Available at https://fortress.wa.gov/ecy/publications/documents/1710002.pdf

WA State Dept of Ecology (2017 b) Concentrated Animal Feeding Operation – Economic Impact Analysis. Available at https://fortress.wa.gov/ecy/publications/documents/1710001.pdf

WA State Dept. of Ecology (2017c) Concentrated Animal Feeding Operation National Pollutant Discharge Elimination System and State Waste Discharge General Permit. Available at https://ecology.wa.gov/DOE/files/c8/c8a7577c-059a-4816-84ef-143e8faa5134.pdf

WA State Dept. of Ecology (2017d) Concentrated Animal Feeding Operation State Only General Permit. Available at https://ecology.wa.gov/DOE/files/45/453aff0c-051e-4129-982e-ea59660c2db3.pdf

WA State Dept. of Ecology (2018a) Sand and Gravel General Permit. A National Pollutant Discharge Elimination System and State Waste Discharge General Permit. Available athttps://ecology.wa.gov/DOE/files/42/42f629f5-c24f-4dfc-86c9-5a11d70a06d9.pdf

WA State Dept. of Ecology (2018b) Winery General Permit Final Draft. Available at https://ecology.wa.gov/Regulations-Permits/Permits-certifications/Winery-permit

WA State Dept. of Ecology (2018c) Water Quality Permitting and Reporting Information System (PARIS) Available at https://fortress.wa.gov/ecy/paris/PermitSearch.aspx

WA State Dept. of Ecology (2018d) *State Groundwater Assessment: 2017.* Available at https://fortress.wa.gov/ecy/publications/documents/1811011.pdf

WA State Dept of Employment Security (2018) *Yakima County Profile.* Available at https://esd.wa.gov/labormarketinfo/county-profiles/yakima

WA State Dept. of Revenue (2017) 2017 Tax Legislation. Available at https://dor.wa.gov/get-form-or-publication/publications-subject/tax-topics/2017-tax-legislation#water

WA State Dept. of Health (2010 a) Nitrate in Drinking Water – Questions and Answers (English) Retrieved from http://www.doh.wa.gov/ehp/dw/Publications/331-214.pdf

WA State Dept. of Health (2010 b) Nitrate in Drinking Water – Questions and Answers (Spanish) Retrieved from http://www.doh.wa.gov/ehp/dw/Publications/331-214s.pdf

WA State Dept. of Health (2012 a) Communicable Disease Surveillance Data: http://www.doh.wa.gov/DataandStatisticalReports/DiseasesandChronicConditions/CommunicableDiseaseSurveillanceData.aspx

WA State Department of Health (2012 b) Drinking Water System Data: http://www.doh.wa.gov/DataandStatisticalReports/EnvironmentalHealth/DrinkingWaterSystemData/DataDownload.aspx

WA State Dept. of Health (2012 c) Vital Statistics Data: http://www.doh.wa.gov/DataandStatisticalReports/VitalStatisticsData.aspx

WA State Dept. of Health (2017) Anencephaly Investigation. Available at https://www.doh.wa.gov/YouandYourFamily/IllnessandDisease/BirthDefects/AnencephalyInvestigation

WA State Dept. of Health (2018a) Washington Tracking Network. Available at https://fortress.wa.gov/doh/wtn/WTNPortal/

WA State Dept. of Health (2018b) Water Quality Exceedances. *Division of Environmental Health, Office of Drinking Water*. Available at https://fortress.wa.gov/doh/eh/portal/odw/si/FindWaterQuality.aspx

WA State Dept of Employment Security (2018) *Yakima County Profile.* Available at https://esd.wa.gov/labormarketinfo/county-profiles/yakima

Washington State Interagency Groundwater Committee (1997) Groundwater in Washington State. Available at https://fortress.wa.gov/ecy/publications/documents/96007.pdf

Washington State Office of Finance & Management (2018) Growth Management Act population projections for counties: 2010 to 2040. Available at https://ofm.wa.gov/washington-data-research/population-demographics/population-forecasts-and-projections/growth-management-act-county-projections/growth-management-act-population-projections-counties-2010-2040-0

Washington State Pollution Control Hearing Board (2018a) Puget Soundkeepers et al versus Ecology. Available at http://www.eluho.wa.gov/Decision/Search_Cases

WA State Pollution Control Hearing Board (2018b) Appeal of the Concentrated Animal Feeding Operation General Permit (NPDES and State Waste Discharge General Permit). P 17-016 and P 017 17-017. Available at http://www.eluho.wa.gov/Decision/Search_Cases

Wasserman, L. (2016) *The push for "big dumb" buffers to save salmon* in Western Environmental Law Center (2016) Agricultural Pollution of Puget Sound. Available at

https://westernlaw.org/sites/default/files/Agricultural%20Pollution%20in%20Puget%20Sound%20-%20April%202016%20-%20Web.pdf

Whiley, A. (2015) Relationship between Land Use and Nitrate Concentrations in Washington State Department of Ecology Monitored Watersheds: Technical Memorandum. WA State Dept. of Ecology Publication No. 15-10-037. Available at https://fortress.wa.gov/ecy/publications/documents/1510037.pdf

Wildrick, L. and Blair, M. (1985) Roza Irrigation District Ground Water Supply Study: Report for Yakima River Basin Water Enhancement Project. WA State Dept. of Ecology Publication No. OFTR 85-01. Available at https://fortress.wa.gov/ecy/publications/documents/oftr8501.pdf

Wishart, B. (2017) in WA State Office of the Attorney General Sunshine Meetings (2017) *Public Records Exemptions Accountability Committee – Meeting Minutes, October 24, 2017.* Available at https://agportal-s3bucket.s3.amazonaws.com/uploadedfiles/Home/About_the_Office/Open_Government/Sunshine_Committee/Materials/2017/Minutes%20October%2024%20Meeting.pdf

World Health Organization (2016) Nitrate and nitrite in drinking-water: Background document for development of WHO guidelines for drinking-water quality. (WHO/FWC/WSH/16.52). Geneva, Switzerland. Available at http://www.who.int/water_sanitation_health/dwq/chemicals/nitrate-nitrite-background-jan17.pdf

Yakama Nation (2016) Climate Adaptation Plan for the Territories of the Yakama Nation. Available at http://www.critfc.org/wp-content/uploads/2016/05/Yakama-Nation-Climate-Adaptation-Plan-.pdf

Yakima County (n.d.) Yakima County Code. *Code Publishing.* Available at http://www.codepublishing.com/WA/YakimaCounty/

Yakima County (2011a) Nitrate Treatment Pilot Program – Final Report. Retrieved from http://www.yakimacounty.us/nitrateprogram/english/Docs/Nitrate%20Treatment%20Pilot%20Program.pdf

Yakima County (2011b) Request for identification Lower Yakima Valley Groundwater Management Area. Available at https://www.yakimacounty.us/DocumentCenter/View/2359/2011-Request-for-Identification-Lower-Yakima-Valley-Groundwater-Management-Area-PDF

Yakima County (2011c) Lower Yakima Basin Nitrate Treatment Pilot Program. Available at http://www.yakimaco.us/GWMA/documents/library/Yakima%20County%20Nitrate%20Treatment%20Pilot%20Program%20Final%20Report%202011.pdf

Yakima County (2018a) Voluntary Stewardship Program. Available at https://www.yakimacounty.us/1657/Voluntary-Stewardship-Program-VSP

Yakima County (2018b) VSP Approved Work Plan. Available at https://www.yakimacounty.us/DocumentCenter/View/15671/1_Yakima_Compiled_Work_Plan_2017_1030

Yakima County (2018c) VSP Maps. Available at https://www.yakimacounty.us/DocumentCenter/View/15672/2_Appendix_A_Maps_2017_1030

Yakima County (2018d) VSP Appendices. Available at https://www.yakimacounty.us/DocumentCenter/View/15673/3_Appendices_B_to_M_2017_1030

Yakima County (2018e) LYV GWMA Monitoring Wells Bid Openings. Available at http://www.yakimacounty.us/bids.aspx?bidID=67

Yakima Valley Memorial Hospital (2013) *Community Needs Assessment.* Available at https://www.yakimamemorial.org/pdf/about/community-hna.pdf

ZipCodes.com (2012) 2000/2010 Census Comparisons. Retrieved from http://www.zip-codes.com/zip-code-database.asp

Zuroske, M. (2009) Water Quality Conditions in Irrigation Waterways within the Roza and Sunnyside Valley Irrigation Districts, Lower Yakima Valley, Washington, 1997-2008. *Roza-Sunnyside Board of Joint Control, Sunnyside, WA.* Available at http://www.svid.org/images/WQ%20Conditions%20in%20Irrigation%20waterwaysReportFinal.pdf

Attachments

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Attachment 6: Interim Final GW Monitoring Plan

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Attachment 32: WSDA_Yakima County_ Estimated Nitrogen Available for Transport in the Lower Yakima Valley Groundwater Management Area June 2018

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Last Updated December 11, 2018 JRM