Lower Yakima Valley Groundwater Management Program

Volume II

LOWER YAKIMA VALLEY
GROUNDWATER ADVISORY COMMITTEE

Volume II

Contents – Volume II

Appendices

Appendix A—Administrative Background

In May 1985, the Washington Legislature adopted a law authorizing the identification of ground water management areas and the identification of groundwater management procedures.1 Shortly thereafter, the Department of Ecology adopted "guidelines, criteria, and procedures for the designation of groundwater management areas, subareas or zones."2 They 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 regulations adopted an approach intended to "forge a partnership between a diversity of local, state, tribal and federal interests in cooperatively protecting the state's groundwater resources."

In February 2010, the Department of Agriculture, Department of Ecology, Department of Health, Yakima County Department of Public Works and U.S. Environmental Protection Agency published a report entitled *Lower Yakima Valley Groundwater Quality, Preliminary Assessment and Recommendations Document.*3 That Preliminary Assessment found that:

> "The existing studies and related water quality data indicate that nitrate and bacterial contamination of groundwater exist in the Lower Yakima Valley."4

and that:

> "Over 2,000 people in the area are exposed to nitrate over the maximum contaminant level (MCL) through their drinking water. While not all

1 Ch. 453, Laws of 1985 (RCW 90.44.400-.440.)

2 December 1985, pursuant to RCW 90.44.430.

3 *Lower Yakima Valley Groundwater Quality, Preliminary Assessment and Recommendations Document*, Washington State Department of Agriculture, Washington State Department of Ecology, Washington State Department of Health, Yakima County Department of Public Works, U.S. Environmental Protection Agency, Ecology Publication No. 10-10-009, February 2010. (Hereafter, "*Preliminary Assessment.*")

4 *Preliminary Assessment* p. ES 2.

groundwater supplies have been impacted, many residents rely on private wells that are in the most vulnerable portions of the aquifer. Approximately 12% of domestic well users are exposed to nitrate levels in their drinking water that exceed the health-based standard of 10 mg/L."5

The *Preliminary Assessment* made recommendations for subsequent action, including:

- Development of a conceptual site model for the Lower Valley
- Development of a nitrogen loading model for the Yakima basin
- Acknowledgement of the connection between groundwater and surface water
- Determination of the sources of contamination
- Identification of agricultural operations that use flood irrigation
- Assessment of agricultural applications of nitrogen fertilizers and Best Management Practices
- Education and outreach regarding nitrates and bacteria
- Assessment of cumulative risk factoring in synergistic health effects
- Exploration of shifting residents to public water systems where feasible
- Involvement of the Yakima Health District
- Exploration of the concept of developing a groundwater management area as one potential funding option
- Development of measures of success
- Identification and implementation of appropriate enforcement actions

The *Preliminary Assessment* also identified four "needs":

1. Better characterization of vulnerable groundwater supplies.
2. Improve water quality monitoring and coordination of data that can identify trends in water quality.
3. Funding options to support lower valley initiatives to better manage potential contaminant sources and improve groundwater quality.

5 *Preliminary Assessment*, p. ES 2.

4. A mechanism to coordinate future efforts and implement actions that result in improved water quality.

On April 17, 2012, the Department of Ecology and Yakima County executed an Interagency Agreement. The Agreement provided funds from Ecology to the County for the formation of a Groundwater Management Area for the lower Yakima Valley as set forth in WAC 173-100. The Agreement stated that "The purpose of the GWMA is to reduce nitrate contamination in groundwater to below state drinking water standards."

Yakima County was charged by the Agreement with performing the actions of Lead Agency6 for the development of a Groundwater Management Program, prepare a work plan, budget for development of a GWMA Program. The contents of a GWMA Program are identified in RCW 90.44.410. Yakima County has therefore conducted studies and collected data. It has not analyzed data or drawn conclusions therefrom. Information related to hydrogeology, water quality, water use, land use, and population are included in this Program

6 The role of lead agency is described in WAC 173-100-080.

> The lead agency shall be responsible for coordinating and undertaking the activities necessary for development of the groundwater management program. These activities shall include collecting data and conducting studies related to hydrogeology, water quality, water use, land use, and population projections; scheduling and coordinating advisory committee meetings; presenting draft materials to the committee for review; responding to comments from the committee; coordinating SEPA review; executing interlocal agreements or other contracts; and other duties as may be necessary. The lead agency shall also prepare a work plan, schedule, and budget for the development of the program that shows the responsibilities and roles of each of the advisory committee members as agreed upon by the committee. Data collection, data analysis and other elements of the program development may be delegated by the lead agency to other advisory committee members.

Appendix B—RCW 90.44.410

Requirements for groundwater management programs—Review of programs.

(1) The groundwater area or sub-area management programs shall include:

(a) A description of the specific groundwater area or sub-areas, or separate depth zones within any such area or sub-area, and the relationship of this zone or area to the land use management responsibilities of county government;

(b) A management program based on long-term monitoring and resource management objectives for the area or sub-area;

(c) Identification of water resources and the allocation of the resources to meet state and local needs;

(d) Projection of water supply needs for existing and future identified user groups and beneficial uses;

(e) Identification of water resource management policies and/or practices that may impact the recharge of the designated area or policies that may affect the safe yield and quantity of water available for future appropriation;

(f) Identification of land use and other activities that may impact the quality and efficient use of the groundwater, including domestic, industrial, solid, and other waste disposal, underground storage facilities, or storm water management practices;

(g) The design of the program necessary to manage the resource to assure long-term benefits to the citizens of the state;

(h) Identification of water quality objectives for the aquifer system which recognize existing and future uses of the aquifer and that are in accordance with department of ecology and department of social and health services drinking and surface water quality standards;

(i) Long-term policies and construction practices necessary to protect existing water rights and subsequent facilities installed in accordance with the groundwater area or sub-area management programs and/or other water right procedures;

(j) Annual withdrawal rates and safe yield guidelines which are directed by the long-term management programs that recognize annual variations in aquifer recharge;

(k) A description of conditions and potential conflicts and identification of a program to resolve conflicts with existing water rights;

(l) Alternative management programs to meet future needs and existing conditions, including water conservation plans; and

(m) A process for the periodic review of the groundwater management program and monitoring of the implementation of the program.

(2) The groundwater area or sub-area management programs shall be submitted for review in accordance with the state environmental policy act.

Appendix C—WAC 173-100-100

Groundwater management program content.

The program for each groundwater management area will be tailored to the specific conditions of the area. The following guidelines on program content are intended to serve as a general framework for the program, to be adapted to the particular needs of each area. Each program shall include, as appropriate, the following:

(1) An area characterization section comprised of:

(a) A delineation of the groundwater area, subarea or depth zone boundaries and the rationale for those boundaries;

(b) A map showing the jurisdictional boundaries of all state, local, tribal, and federal governments within the groundwater management area;

(c) Land and water use management authorities, policies, goals and responsibilities of state, local, tribal, and federal governments that may affect the area's groundwater quality and quantity;

(d) A general description of the locale, including a brief description of the topography, geology, climate, population, land use, water use and water resources;

(e) A description of the area's hydrogeology, including the delineation of aquifers, aquitards, hydrogeologic cross-sections, porosity and horizontal and vertical permeability estimates, direction and quantity of groundwater flow, water-table contour and potentiometric maps by aquifer, locations of wells, perennial streams and springs, the locations of aquifer recharge and discharge areas, and the distribution and quantity of natural and man-induced aquifer recharge and discharge;

(f) Characterization of the historical and existing groundwater quality;

(g) Estimates of the historical and current rates of groundwater use and purposes of such use within the area;

(h) Projections of groundwater supply needs and rates of withdrawal based upon alternative population and land use projections;

(i) References including sources of data, methods and accuracy of measurements, quality control used in data collection and measurement programs, and documentation for and construction details of any computer models used.

(2) A problem definition section that discusses land and water use activities potentially affecting the groundwater quality or quantity of the area. These activities may include but are not limited to:

- Commercial, municipal, and industrial discharges
- Underground or surface storage of harmful materials in containers susceptible to leakage
- Accidental spills
- Waste disposal, including liquid, solid, and hazardous waste
- Storm water disposal
- Mining activities
- Application and storage of roadway deicing chemicals
- Agricultural activities

- Artificial recharge of the aquifer by injection wells, seepage ponds, land spreading, or irrigation
- Aquifer over-utilization causing seawater intrusion, other contamination, water table declines or depletion of surface waters
- Improperly constructed or abandoned wells
- Confined animal feeding activities

The discussion should define the extent of the groundwater problems caused or potentially caused by each activity, including effects which may extend across groundwater management area boundaries, supported by as much documentation as possible. The section should analyze historical trends in water quality in terms of their likely causes, document declining water table levels and other water use conflicts, establish the relationship between water withdrawal distribution and rates and water level changes within each aquifer or zone, and predict the likelihood of future problems and conflicts if no action is taken. The discussion should also identify land and water use management policies that affect groundwater quality and quantity in the area. Areas where insufficient data exists to define the nature and extent of existing or potential groundwater problems shall be documented.

(3) A section identifying water quantity and quality goals and objectives for the area which (a) recognize existing and future uses of the aquifer, (b) are in accordance with water quality standards of the department, the department of social and health services, and the federal environmental protection agency, and (c) recognize annual variations in aquifer recharge and other significant hydrogeologic factors;

(4) 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.

(5) A recommendations section containing those management strategies chosen from the alternatives section that are recommended for implementation. The rationale for choosing these strategies as opposed to the other alternatives identified shall be given;

(6) An implementation section comprised of:

(a) A detailed work plan for implementing each aspect of the groundwater management strategies as presented in the recommendations section. For each recommended management action, the parties responsible for initiating the action and a schedule for implementation shall be identified. Where possible, the implementation plan should include specifically worded statements such as model ordinances, recommended governmental policy statements, interagency agreements, proposed legislative changes, and proposed amendments to local comprehensive plans, coordinated water system plans, basin management programs, and others as appropriate;

(b) A monitoring system for evaluating the effectiveness of the program;

(c) A process for the periodic review and revision of the groundwater management program.

Appendix D—BMPs Recommended by Irrigated Agriculture Work Group

Best Management Practices for Irrigated Cropland
OB = objective; MT = management target; BMP = best management practice
The IAWG has reviewed the list of BMPs compiled by HDR that could be implemented on irrigated cropland activities which may provide protections to nitrate (N) leaching to groundwater. These include irrigation practices, cropping practices, and N source management (type, quantity, and timing). The IAWG believes that the core BMPs to reduce negative impacts to ground water are 1) managing nutrient inputs to ensure that the 4R's are utilized (right amount, the right source, the right timing, and the right location) (accounting for all sources including soil amendments, compost, biosolids, manure and commercial fertilizer) and 2) irrigation water management. The IAWG felt that these two BMPs had the greatest potential to reduce the problem. They are also beneficial to all parties. The IAWG believes the BMPs included in the table below will not replace the core BMPs above but may provide additional proctections to ground water. The BMPs listed in the table below have a range of applicability in the Lower Yakima Valley GWMA. Some are potentially very effective, some moderately effective, and some that have no applicability in this GWMA. The comments in the right hand column are a compilation of input from the IAWG and are intended to provide the GWAC with some sense of the effectiveness of the BMPs as they would apply to this specific GWMA. The IAWG emphasized that the BMPs are voluntary, not always suited to a particular farm, and still require the judgment of the farm operator to achieve the desired results.

Management Target	Best Management Practices	References	Work Group Comments
MT 1.1.1 Perform irrigation system evaluation and monitoring	BMP 1.1.1.1 Conduct irrigation system performance evaluation	EM 4885 – IP 2.01.03; PNW 293; EM4828	More practical to preform routine maintenance and observe uniformity of coverage.
	BMP 1.1.1.2 Install and use flow meters or other measuring devices to track water volume applied to each field at each irrigation	EM 4885 – IP 2.01.01	Meters not practical; soil moisture sensing devices are used effecively - even required in some cases, to monitor and schedule irrigation.
	BMP 1.1.1.3 Conduct pump performance tests	EM 4885 – IP 2.01.02	Relatively simple and easy to do. Requires an ultrasonic flow meter and pressure gage.
MT 1.1.2 Improve irrigation scheduling	BMP 1.1.2.1 Use weather based irrigation scheduling	EM 4885 – IP 2.01.05, 2.01.06	This is one of the most practical way to help solve the issues. It is now free and easy to do. (http://weather.wsu.edu/is)
	BMP 1.1.2.2 Use plant-based irrigation scheduling	EM 4885 – IP 2.01.05, 2.01.06; EM4821; EB1513	Time consuming to do, unless there are automated sensors. Research is still being done in this area. It is not easy or very accurate.
	BMP 1.1.2.3 Measure soil moisture content to guide irrigation timing and amount	EM 4885 – IP 2.01.05, 2.01.06; PNW0475	Soil moistures sensors are expensive and data-interpretation requires assistance.
	BMP 1.1.2.4 Avoid heavy pre-plant or fallow irrigations		Depends on definition of "heavy"
MT 1.1.3 Improve surface gravity system design and operation	BMP 1.1.3.1 Convert to surge irrigation	EM 4885 – IP 2.02.03; EM4826	A good idea, but requires a certain field setup. Most people who have tried surge, migrate back to conventional rill irrigation. Better to encourage to conversion to sprinkler or drip.
	BMP 1.1.3.2 Use high flow rates initially, then cut back to finish off the irrigation	EM 4885 – IP 2.02.10; EM4828	Good idea, but difficult to implement unless irrigation delivery can be variable.
	BMP 1.1.3.3 Reduce irrigation run distances and decrease set times	EM 4885 – IP 2.02.04; EM4828	Good, but increases labor and equipment costs
	BMP 1.1.3.4 Increase flow uniformity among furrows (e.g., compaction furrows)	EM 4885 – IP 2.02.02	Encourange use of PAM
	BMP 1.1.3.5 Grade fields as uniformly as possible	EM 4885 – IP 2.02.05, 2.02.05	Good but within constraints of topography.
	BMP 1.1.3.6 Where high uniformity and efficiency are not possible, convert to drip, center pivot, or linear move systems	EM 4885 – IP 2.01.08	Good

MT 1.1.4 Improve sprinkler system design and operation	BMP 1.1.4.1 Monitor flow and pressure variations throughout system	EM 4885 – IP 2.03.02	Good idea on district scale (they already do much of this), but logging pressure and flow variation is not cost-effective for individual growers.
	BMP 1.1.4.2 Repair leaks and malfunctioning sprinklers, follow manufacturer recommended replacement intervals	EM 4885 – IP 1.00.05, 2.03.03	Power companies often have monitary energy savings incentives for repair of irrigation systems.
	BMP 1.1.4.3 Operate sprinklers during the least windy periods	EM 4885 – IP 2.03.05	For the most part not possible when water delivered by a major irrigation entitiy.
	BMP 1.1.4.4 Reduce distance between lateral lines or alternate lateral line location over successive irrigations	EM 4885 – IP 2.03.04, 2.03.06	Requires additional moves (labor $) and sometimes additional hardware (e.g. an additional wheel line). Get a good design!
	BMP 1.1.4.5 When pressure variation is excessive, use flow control or pressure regulating nozzles	EM 4885 – IP 2.03.02	Good.
MT 1.1.5 Improve micro-irrigation system design and operation	BMP 1.1.5.1 Use appropriate lateral hose length to improve uniformity	EM 4885 – IP 2.04.02	Good. i.e. get a good and appropriate irrigation system design.
	BMP 1.1.5.2 Check for clogging potential and prevent or correct clogging	EM 4885 – IP 2.04.03	Good and necessary for good crop yields and uniformity.
MT 1.1.6 Make other irrigation infrastructure improvements	BMP 1.1.6.1 Installation of subsurface drains	EM 4885 – IP 5.01.01	Good. When necessary.
	BMP 1.1.6.2 Backflow prevention	EM 4885 – IP 6.00.03, EB1722	Required by law if chemigating.

MT 1.2.1 Modify crop rotation	BMP 1.2.1.1 Grow cover crops	EM 4885 – IP 5.01.01	Good in areas where they are not water limited. Probably not cost effective.
	BMP 1.2.1.2 Include deep-rooted or "nitrogen scavenger" crop species in annual crop rotations	PNW513	Good.
	BMP 1.2.1.3 Grow more crops per year (double cropping)	Bul 869	Utilize extra cropping to utilize excess nutrients on soil
	BMP 1.2.1.4 Include perennial crop rotation	PNW513	Encourage crop rotation
MT 1.2.2 Monitor crops	BMP 1.2.2.1 Monitor crop performance for each field including yield, nitrogen content, estimate of nitrogen removed from field versus remaining in field	NRCS Part 651. Ch. 13, Appendix 13B	Great
MT 1.3.1. Improve rate, timing, and placement of N fertilizers	BMP 1.3.1.1 Adjust nitrogen fertilization rates based on soil nitrate testing	EM 4885 – IP 3.02.01	Great
	BMP 1.3.1.2 Adjust timing of nitrogen fertilization based on plant tissue analysis	EM 4885 – IP 3.02.03	Good.
	BMP 1.3.1.3 Apply nitrogen fertilizer in small multiple doses rather than single large dose	EM 4885 – IP 3.02.05	Great - use fertigation
	BMP 1.3.1.4 Measure nitrate content of irrigation water and adjust fertilizer accordingly	EM 4885 – IP 3.02.02	Very little N in irrigation water. More in rainfall, but that is negligible in the Yakima River Basin.
	BMP 1.3.1.5 Use low rates of foliar nitrogen instead of higher rates applied		This is an OK method for micro-nutrients, but not for macro-nutrients.

MT 1.3.1. Improve rate, timing, and placement of N fertilizers	BMP 1.3.1.6 Vary nitrogen application rates within large fields according to expected needs (precision agriculture)	Peters and Davenport	Good.
	BMP 1.3.1.7 When fertilizing in surface gravity systems, use delayed injection procedures		Chemigating with surface gravity systems is not recommended
	BMP 1.3.1.8 Develop a nitrogen budget that includes crop nitrogen harvest removal, supply of nitrogen from soil, and other inputs	CSU-XCM-173	Good.
	BMP 1.3.1.9 Use controlled release fertilizers, nitrification inhibitors, and urease inhibitors	EM 4885 – IP 3.02.06	Good.
	BMP 1.3.1.10 Assess the risk of contamination of ground and surface water due to fertilizer leaching or runoff	EM 4885 – IP 3.01.01	Good.
	BMP 1.3.1.11 Maintain records of all soil, tissue, and water tests, cropping rotations, yields, and applications (dates, material, method, results)	CSU-XCM-173	Good.
	BMP 1.3.1.12 Develop realistic yield goals	EM 4885 – IP 3.02.07	Good.

MT 1.3.2. Improve rate, timing, and placement of animal manure applications	BMP 1.3.2.1 Apply moderate rates of manure and compost, and use materials with high nitrogen content (inorganic fertilizer) to meet the peak nitrogen demand		Good.
	BMP 1.3.2.2 Incorporate solid manure immediately to decrease ammonia volatilization loss	EM 4885 – IP 3.03.05	Good.
	BMP 1.3.2.3 When applying liquid manure in surface gravity irrigation systems, use the delayed injection procedure to improve application uniformity		Not recommended
	BMP 1.3.2.4 Use quick test methods to monitor dairy lagoon water nitrogen content immediately before and during application, and adjust application rate accordingly		By law, dairies are required to test waste water once in the spring prior to the first application.
	BMP 1.3.2.5 Develop a nitrogen budget that includes crop nitrogen harvest removal, supply of nitrogen from manure, and other inputs	CSU-XCM-173; USU 2010	Good.
	BMP 1.3.2.6 Calibrate solid manure and compost spreaders	EM 4885 – IP 3.03.01; NRCS Part 651. Ch. 13, Appendix 13A	Good.
	BMP 1.3.2.7 Ensure uniformity of application with manure	EM 4885 – IP 3.03.07	Good.
	BMP 1.3.2.8 Do not apply manure to frozen ground, especially sloping fields	EM 4885 – IP 3.03.08	Good. Although this is a surface runoff issue, not a groundwater issue.
	BMP 1.3.2.9 Test manure or other waste materials for nutrient content	EM 4885 – IP 3.02.04; NRCS Part 651. Ch. 13, Appendix 13B	Great
	BMP 1.3.2.10 Use synchronized rate nutrient application of lagoon water to reduce or eliminate the need for fertilizer	NDESC 2005 (II)	

MT 1.3.3. Use fertilizer guides to determine and apply appropriate fertilizer amounted.	BMP 1.3.3.1 Follow recommendations of Fertilizer Guide: Home Vegetable Gardens, Irrigated Central Washington	FG0052	Good.
	BMP 1.3.3.2 Follow recommendations of Fertilizer Guide: Irrigated Alfalfa Central Washington	FG0003	All FG need to be looked at to make sure they are not outdated.
	BMP 1.3.3.3 Follow recommendations of Fertilizer Guide: Irrigated Asparagus	FG0012	Good.
	BMP 1.3.3.4 Follow recommendations of Fertilizer Guide: Irrigated Field Beans for Central Washington	FG0005	Good.
	BMP 1.3.3.5 Follow recommendations of Fertilizer Guide: Irrigated Field Corn for Grain or Silage	FG0006	Good.
	BMP 1.3.3.6 Follow recommendations of Fertilizer Guide: Irrigated Hops for Central Washington	FG0011	Good.
	BMP 1.3.3.7 Follow recommendations of Fertilizer Guide: Irrigated Mint Central Washington	FG0008	Good.
	BMP 1.3.3.8 Follow recommendations of Fertilizer Guide: Irrigated Peas for Central Washington	FG0033	Good.

MT 1.3.3. Use fertilizer guides to determine and apply appropriate fertilizer amounted.	BMP 1.3.3.9 Follow recommendations of Fertilizer Guide: Irrigated Small Grains, Central Washington	FG0009	Good.
	BMP 1.3.3.10 Follow recommendations of Fertilizer Guide: Irrigated Sudangrass Pasture or Silage	FG0036	Good.
	BMP 1.3.3.11 Follow recommendations of Fertilizer Guide: Irrigated Vineyards for Entire State	FG0013	Good.
	BMP 1.3.3.12 Follow recommendations of Fertilizer Guide: Ornamentals, Entire State Except Central Irrigated Washington	FG0049	Does not pertain to Irrigated AG
	BMP 1.3.3.13 Follow recommendations of Fertilizer Guide: Vegetable and Flower Gardens, Except Irrigated Central Washington	FG0050	Does not pertain to Irrigated AG
	BMP 1.3.3.14 Follow recommendations of Fertilizer Guide: Improved Pasture, Hay, Eastern Washington	FG0037	Good.
	BMP 1.3.3.15 Follow recommendations of Fertilizer Guide: Grass Seed for Eastern Washington	FG0038	Good.

MT 1.3.3. Use fertilizer guides to determine and apply appropriate fertilizer amounted.	BMP 1.3.3.16 Follow recommendations of Fertilizer Guide: Barley for Eastern Washington	FG0029	Good.
	BMP 1.3.3.17 Follow recommendations of Fertilizer Guide: Soil Samples/Orchards	FG0028C	Good.
	BMP 1.3.3.18 Follow recommendations of Fertilizer Guide: Instructions for Tree Fruit Leaf Nutrient Analysis	FG0028E	Good.
	BMP 1.3.3.19 Follow recommendations of Fertilizer Guide: Peas and Lentils for Eastern Washington	FG0025	Good.
	BMP 1.3.3.20 Follow recommendations of Fertilizer Guide: Lawns, Playfields and Other Turf, East and Central Washington	FG0024	Good.

MT 1.4.1 Avoid fertilizer material and manure spills during transport, storage, and application	BMP 1.3.4.1 Do not overfill trailers or tanks. Cap or cover loads.	EM 4885 – IP 4.01.06	Good
	BMP 1.3.4.2 When transferring fertilizer, take care not to allow materials to accumulate on the soil		Good.
	BMP 1.3.4.3 Maintain all fertilizer storage facilities and protect them from the weather		Good.

MT 1.4.1 Avoid fertilizer material and manure spills during transport, storage, and application	BMP 1.3.4.4 Clean up fertilizer spills promptly		Good.
	BMP 1.3.4.5 Shut off fertilizer applicators during turns and use check valves		Good.
	BMP 1.3.4.6 Maintain proper calibration of fertilizer application equipment	EM 4885 – IP 3.03.01	Good.
	BMP 1.3.4.7 Create a buffer around wellheads from fertilizer and manure storage, handling, and application	EM 4885 – IP 6.00.02	Good.
	BMP 1.3.4.8 Distribute rinse water from fertilizer application equipment throughout field		Good.
	BMP 1.3.4.9 Avoid manure spills/discharges during transport, storage, and application		Good.
	BMP 1.3.4.10 Prevent back siphonage/flow of chemicals or nutrients down a well after injection	EM 4885 – IP 6.00.03, EB1722	Required by law.
	BMP 1.3.4.11 Identify and properly seal all abandoned and improperly constructed wells	EM 4885 – IP 6.00.04	Good.

Appendix E—BMPs Recommended by Livestock/CAFO Work Group

NRCS Standards Recommended by Livestock/CAFO Work Group

Title	Revision Date
Amendments for Treatment of Agricultural Wastes (591) Standard	1/27/2014
Anaerobic Digester (366) Standard	1/11/2011
Animal Mortality Facility (316) Standard	1/11/2011
Composting Facility (317) Standard	1/11/2011
Dam (402) STANDARD	2/25/2013
Diversion (362) STANDARD	2/25/2013
Feed Management (592) Standard	1/15/2013
Filter Strip (393) Standard	2/11/2015
Heavy Use Area Protection (561) Standard	2/12/2015
Monitoring Well (353) Standard	2/11/2015
Nutrient Management (590) Standard	2/18/2014
Pond Sealing or Lining, Bentonite Sealant (521C) Standard	11/4/2015
Pond Sealing or Lining, Compacted Clay Treatment (521D) Standard	11/4/2015
Pond Sealing or Lining, Flexible Membrane (521A) STANDARD	2/25/2013
Pond Sealing or Lining, Soil Dispersant (521B) Standard	11/4/2015
Pumping Plant (533) Standard	2/12/2015
Roof Runoff Structure (558) STANDARD	2/12/2015
Short Term Storage of Animal Waste and By Products (318) – National NRCS Standard http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1263507.pdf	
Solid/Liquid Waste Separation Facility (632) Statement of Work	1/11/2008
Sprinkler System (442) Standard	11/4/2015
Stream Crossing (578) Standard	2/12/2015
VegetativeTreatment Area (635) Standard	1/29/2016
Waste Facility Closure (360) STANDARD	2/25/2013
Waste Recycling (633) STANDARD	2/25/2013
Waste Separation Facility (632) STANDARD	1/27/2014
Waste Storage Facility (313) Standard	2/11/2015
Waste Transfer (634) Standard	2/12/2015
Waste Treatment (629) Standard	2/12/2015
Waste Treatment Lagoon (359) STANDARD	2/25/2013
Water Well (642) Standard	2/12/2015
Well Decommissioning (351) Standard	2/11/2015
Groundwater Testing (355) Standard	2/11/2015

Appendix F—Program References

(Alt 2001) Alt, David, *Glacial Lake Missoula and Its Humongous Floods*, Mountain Press, Missoula, MT. (2001).

(Alt/Hyndman) Alt, David D., Hyndman, Donald W., *Roadside Geology of Washington*, Mountain Press Publishing Co., Missoula, MT, (1994, 2007).

(Anderson) Anderson, H.W., Jr., Effects of agriculture on quality of water in surficial sand-plain aquifers in Douglas, Kandiyohi, Pope, and Stearns Counties, Minnesota: U.S. Geological Survey Water-Resources Investigations Report 87-4040, p. 45.
https://pubs.usgs.gov/wri/1987/4040/report.pdf

(Armstrong et al 1995) Armstrong, S., Aulbach, C., Becenti, T.L., Campbell, N.P., Crane, S., Hendry, J. Jennings, J., Kandle, E., Ray, R., and Repasky, T.R., 1995, A Multi-Disciplinary Study of Groundwater in Toppenish Creek Basin, Yakama Indian Reservation: The 1st Symposium on the Hydrology of Washington State, Abstracts, August 28-30, 1995 Olympia, Washington, p. 136-137.

(Avery 1999) Avery AA., Infantile methemoglobinemia: reexamining the role of drinking water nitrates. *Environmental Health Perspectives*, 107:1–8, 1999.

(Beeson/Tolan 1990) Beeson, M.H. and Tolan, T.L., 1990, The Columbia River Basalt Group in the Cascade Range –A middle Miocene reference datum for structural analysis: *Journal of Geophysical Research*, v. 95, p. 19547-19559.

(Beck) Beck, Barry F., Loris Asmussen, Ralph Leonard, Relationship of Geology, Physiography, Agricultural Land Use, and Ground- Water Quality in Southwest Georgia, September 1985.
https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1745-6584.1985.tb01511.x

(Benton County 2013) Benton County, Board of County Commissioners. 2013. Letter of Request to Withdraw from the Lower Yakima Valley Groundwater Management Area.
http://www.yakimacounty.us/DocumentCenter/View/15961

(Bjornstad 2006) Bjornstad, Bruce, *On the Trail of the Ice Age Floods: A Geological Guide to the Mid-Columbia Basin.* Keokee Books; San Point, Idaho. (2006).

(Boening) Boening, Rose M, History of Irrigation in the State of Washington: The State Epoch of Canal Building, *The Washington Historical Quarterly*, Vol. 10, No. 1 (January, 1919), pp. 21-45, University of Washington. http://www.jstor.org/stable/23908750

(Carson/Pogue 1996) Carson, Robert J.; Pogue, Kevin R., *Flood Basalts and Glacier Floods: Roadside Geology of Parts of Walla Walla, Franklin, and Columbia Counties, Washington*. Washington State Department of Natural Resources (Washington Division of Geology and Earth Resources Information Circular 90), 1996.
http://www.dnr.wa.gov/publications/ger_ic90_roadside_floodbasalts_glacierfloods.pdf

(Clark et al 2000) Clark, Gregory M., D.K. Mueller, and M.A. Mast. Nutrient Concentrations and Yields in Undeveloped Stream Basins of the United States (appeared in August 2000 *JAWRA*, vol. 36, no 4 p 849-860), 2000.

(Coffin 2006) Coffin, Chris, R. Plotnikoff, and R. Anderson. *Lower Yakima River Suspended Sediment Total Maximum Daily Load Study: Water Quality Effectiveness Monitoring Report*, Publ. No. 06-03-014, 2006. https://fortress.wa.gov/ecy/publications/documents/0603014.pdf

(Crowe) Personal communication, Laurie Crowe, South Yakima Conservation District, February 2014.

(De Fraiter et al 2010) De Fraiture, et al, "Investing in Water for Food, Ecosystems, and Livelihoods: An Overview of the Comprehensive Assessment of Water Management in Agriculture," *Agricultural Water Management*, 97, pp. 495-501 (2010).

(Domagalski et al 2008) Domagalski, Joseph L., S. Ator, R. Coupe, K. McCarthy, D. Lampe, M. Sandstrom, and N. Baker. Comparative Study of Transport Processes of Nitrogen, Phosphorus, and Herbicides to Streams in Five Agricultural Basins, USA, *Journal of Environmental Quality*, vol. 37, p.1158-1169, 2008.

(Duff et al 2008) Duff, John H., A.J. Tesoriero, and W.B. Richardson. Whole-Stream Response to Nitrate Loading in Three Streams Draining Agricultural Landscapes, *Journal of Environmental Quality*, v. 37, p.1133:1144, 2008.

(Dyer 1965) Dyer, K.L., "Interpretation of Chloride and Nitrate Ion Distribution Patterns in Adjacent Irrigated and Nonirrigated Panoche Soils," *Soil Science Society of America Proceedings*, 29, 170-176, 1965.

(Ebbert et al 1998) Ebbert, James C. and Moon H. Kim. Relation between Irrigation Method, Sediment Yields, and Losses of Pesticides and Nitrogen, *Journal of Environmental Quality*, v. 27, p. 372-380, 1998.

(Ecology 1985) Molenaar, Dee. Water in the Lower Yakima River Basin, Washington, Washington State Department of Ecology, prepared in cooperation with the U.S. Geological Survey, *Water-Supply Bulletin* 53, 1985.

(Ecology 1996) Cook, K., Faulconer, L., and Jennings, D., A Report on Nitrate Contamination of Ground Water in the mid-Columbia Basin, Washington Department of Ecology Report 96-14, 1996.

(Ecology 1997) Joy, Joe and Barbara A. Patterson. Suspended Sediment and DDT Total Maximum Daily Load Evaluation Report for the Yakima River, Washington State Department of Ecology Report 97-321, 1997.
https://fortress.wa.gov/ecy/publications/documents/97321.pdf

(Ecology 2010) Washington State Department of Ecology, Washington State Department of Agriculture, Washington State Department of Health, the Yakima County Public Works Department, US Environmental Protection Agency. 2010. Lower Yakima Valley Groundwater Quality: Preliminary Assessment and Recommendations Document. Ecology Publication No. 10-10-009.
https://fortress.wa.gov/ecy/publications/documents/1010009.pdf

(Ecology 2011) Washington State Department of Ecology. 2011. Order Designating the Lower Yakima Valley Groundwater Management Area. Docket #8861.
http://www.yakimacounty.us/DocumentCenter/View/15881

(Ecology 2013) Washington State Department of Ecology. Letter Accepting Benton County's Request to Withdraw from the Lower Yakima Valley Groundwater Management Area., 2013. http://www.yakimacounty.us/DocumentCenter/View/15962

(Ecology 2017) Washington State Department of Ecology. National Pollutant Discharge Elimination System and State Waste Discharge General Permit for Concentrated Animal Feeding Operations. https://ecology.wa.gov/DOE/files/c8/c8a7577c-059a-4816-84ef-143e8faa5134.pdf

(EPA 1977) Environmental Protection Agency, Environmental Effects of Septic Tank Systems, EPA Document No. 600377096, https://nepis.epa.gov/Exe/ZyPDF.cgi/9100T3XP.PDF?Dockey=9100T3XP.PDF

(EPA 1999) Environmental Protection Agency Preliminary data summary, feedlots point source category study. January 1999. EPA821R99022.

(EPA 2001). Environmental assessment of proposed revisions to the national pollutant discharge elimination system regulation and the effluent guidelines for concentrated animal feeding operation, January 2001, EPA 821B01001, page 21.

(EPA 2002) US Environmental Protection Agency. 2002. Onsite Wastewater Treatment Systems Manual. EPA/625/R-00/008. https://cfpub.epa.gov/si/si_public_record_Report.cfm?dirEntryID=55133

(EPA 2004). Risk assessment evaluation for concentrated animal feeding operations. Office of Research and Development. May 2004. https://nepis.epa.gov/Exe/ZyPDF.cgi/901V0100.PDF?Dockey=901V0100.PDF

(EPA 2009). Livestock Manure Management, June 27, 2009, Page 52. http://www.epa.gov/outreach/reports/05manure.pdf

(EPA 2010) U.S. Environmental Protection Agency, Washington State Department of Agriculture, Washington State Department of Ecology, Washington State Department of Health, Yakima County Department of Public Works, "Lower Yakima Valley Groundwater Quality, Preliminary Assessment and Recommendations Document," Ecology Publication No. 10-10-009, February 2010.

(EPA 2011) U.S. EPA Region 9, Animal waste – What's the Problem? Page 1. http://www.epa.gov/region9/animalwaste/problem.html. Accessed January 2011.

(EPA 2012) US Environmental Protection Agency. Relation Between Nitrate in Water Wells and Potential Sources in the Lower Yakima Valley, Washington. EPA-910-R-12-003. https://www.epa.gov/sites/production/files/2017-12/documents/lower-yakima-valley-groundwater-report-2013.pdf

(Ex.Ord. 1994) Executive Order 12898. 1994. Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations. https://www.archives.gov/files/federal-register/executive-orders/pdf/12898.pdf

(Foster) Foster, D.R., 1992, Land-use history (1730-1990) and vegetation dynamics in central New England, U.S.A.: Journal of Ecology, v. 80, p. 753-772.

(GEFM) "Hyporheic Flow," Group of Environmental Fluid Mechanics. http://www.envirofluidgroup.it/it/ricerca/132-hyporeic-flow.html

(GSI 2009a), Geologic framework of selected sedimentary and Columbia River Basalt Group units in the Columbia Basin Ground Water Management Area of Adams, Franklin, Grant, and Lincoln Counties, Washington, Edition 3: Consultant report prepared for the Columbia Basin Ground Water Management Area of Adams, Franklin, Grant, and Lincoln Counties, Washington, prepared by GSI Water Solutions, Inc. and the Franklin County Conservation District, June 2009. https://fortress.wa.gov/ecy/publications/documents/1503201.pdf

(GSI 2009b), Groundwater level declines in the Columbia River Basalt Group and their relationship to mechanisms for groundwater recharge: A conceptual groundwater system model for the Columbia Basin Ground Water Management Area of Adams, Franklin, Grant, and Lincoln Counties, Washington: Consultant report prepared for the Columbia Basin Ground Water Management Area of Adams, Franklin, Grant, and Lincoln Counties, Washington, prepared by GSI Water Solutions, Inc., June 2009. http://www.cbgwma.org/pdf/GWMA_Groundwater%20Level%20Declines_%20TEXT_June%202009.pdf

(GSI 2011) Geologic framework of selected sedimentary and Columbia River Basalt Group units in the Columbia Basin Ground Water Management Area of Adams, Franklin, Grant, and Lincoln Counties, Washington, Edition 4: Consultant report prepared for the Columbia Basin Ground Water Management Area of Adams, Franklin, Grant, and Lincoln Counties, Washington, prepared by GSI Water Solutions, Inc. and the Franklin County Conservation District, June 2011.

(Glover/Zimmer 1980) Glover, J. Eric, and David W. Zimmer. Status of Water Quality in the Yakima Basin from 1976 to 1979, Water and Power Resources Service.

(Green et al 2008) Green, Christopher T., Fisher, and Lawrence H., Bekins, Barbara A., Nitrogen Fluxes through Unsaturated Zones in Five Agricultural Settings across the United States, *Journal of Environmental Quality*: Vol 37, pp. 1073-1085, 2008.

(Ham et al 1999) Ham, J.M., Reddi, L.N., Rice, C.W. Animal waste lagoon water quality study. A research report by Kansas State University.

(Ham 2002) Ham, J.M. Seepage Losses from Animal Waste Lagoons: A Summary of a four-year investigation in Kansas. Trans. ASAE 45:983992.

(Ham/DeSutter 1999) Ham, J.M., and DeSutter, T.M. Seepage losses and nitrogen export from swine-waste lagoons: A water balance study. *J. Environ. Qual.* 28:10901099.

(Ham/Desutter 2000) Ham, J.M., and DeSutter, T.M. "Toward site specific design standards for animal waste lagoons: protecting groundwater quality." *J. Environ. Qual.* 29:17211732.

(Harter 2009) Harter, Thomas, "Agricultural Impacts on Groundwater Nitrate." University of California, Davis. July/August 2009. http://www.swhydro.arizona.edu/archive/V8_N4/feature2.pdf

(Harter/Lund 2012a) Harter, Thomas, Lund Jay, Addressing Nitrate in California's Drinking Water, with a Focus on Tulare Lake Basin and Salinas Valley Groundwater. Technical

Report 1, Report for the State Water Resources Control Board Report to the Legislature. Davis, CA: Institute for Watershed Sciences, University of California, Davis. http://groundwaternitrate.ucdavis.edu/files/139111.pdf

(Harter/Lund 2012b) Harter, Thomas, Lund, Jay, "Project and Technical Report Outline, Technical Report 1, Addressing Nitrate in California's Drinking Water," July 2012.

(Harter et al 2002) Harter, T., Davis, H., Mathews, M.C., and Meyer, R.D. Shallow groundwater quality on dairy farms with irrigated forage crops. *Journal of Contaminant Hydrology*. 55(287315).

(HDR 2013a) HDR Engineering. Consolidated Comments to HDR's Draft Technical Memorandum No. 1 – Nitrate Regulatory Review. August 5, 2013. https://www.yakimacounty.us/DocumentCenter/View/17681/20130805-HDR-Comments-to-Reg-Review

(HDR 2013b) HDR Engineering. Technical Memorandum #1. Scope 1, Task 2 – Regulatory Review. August 27, 2013. https://www.yakimacounty.us/DocumentCenter/View/17683/20130827-HDR-Memo-Reg-Review

(HDR 2013c) HDR Engineering. Draft Initial Best Management Practices Database Summary. August 30, 2013. https://www.yakimacounty.us/DocumentCenter/View/17684/20130830-HDR-Draft-Initial-BMP-Database-Summary

(Hodne 2005) Hodne C., Concentrating on Clean Water: The Challenge of Concentrated Animal Feeding Operations. A Report for the Iowa Policy Project. http://www.iowapolicyproject.org/2005docs/050406-cafo-fullx.pdf

(Horizon 2040) Yakima County. 2017. Horizon 2040 Comprehensive Plan. http://www.yakimacounty.us/846/Horizon-2040-Comprehensive-Plan

(Jensen) Jensen, Charles A., Olshausen, B.A., Soil Survey of the Yakima Area, Washington (1901), NRCS, USDA, https://www.nrcs.usda.gov/Internet/FSE_MANUSCRIPTS/washington/yakimaWA1901/yakimaWA1901.pdf

(Koelliker et al) Koelliker, J.K., Steichen, J.M., Yearout, R.D., Heiman, A.T., Grosh, D.L., Identification of Factors Affecting Farmstead Well Water Quality in Kansas. Manhattan, Kan., Kansas Water Resources Research Institute, Kansas State University; 1987. Report G1226-02.

(Krider 1987) Krider James N., "Assessing Animal Waste Systems Impacts on Groundwater: Occurrences and Potential Problems," in Frank M. D'Itri, Lois G. Wolfson, *Rural Groundwater Contamination*, Lewis Publishers, 1987, p. 123 (citing National Academy of Sciences, Subcommittee on Nutrients and Toxic Elements in Water, "Nutrients and Toxic Substances in Water for Livestock and Poultry" (1974), and NAS Safe Drinking Water Committee, "Drinking Water and Health" (1977).

(Kross et al) Kross, Burton C., George R Hallberg; D. Roger Basner, Keith Cherryholmes, and J. Kent Johnson, The Nitrate Contamination of Private Well Water in Iowa, American Journal of Public Health, February 1993; 83(2): 270–272.
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1694569/pdf/amjph00526-0112.pdf

(Lilbra et al) Lilbra RD, Hallberg GR, Ressmeyer GR, Hoyer BE. Groundwater quality and hydrogeology of Devonian-Carbonate aquifers in Floyd and Mitchell counties, Iowa City, Iowa: Iowa Geological Survey; 1984.
https://s-iihr34.iihr.uiowa.edu/publications/uploads/OFR-1984-2.pdf

(Mackin 1961) Mackin, J.H., A Stratigraphic Section in the Yakima Basalt and Ellensburg Formation in south-central Washington: Washington Division of Mines and Geology Reports of Investigations, 1961.
http://www.dnr.wa.gov/Publications/ger_ri19_strat_yakima_basalt_ellensburg_form.pdf

(McCaffrey et al 2016) McCaffrey, Robert, King, Robert W.; Wells, Ray, Lancaster, Matthew, and Miller, M. Meghan: Contemporary deformation in the Yakima fold and thrust belt estimated with GPS, *Geophysical Journal International*, 2016.
https://doi.org/10.1093/gji/ggw252

(McCurdy/McSweeney 1993) McCurdy, M. and McSweeney, K. 1993. The origin and identification of macropores in an earthen-lined dairy manure storage basin. *J. Environ. Qual.* 22:148154.

(McDowel/Biggers 2017) McDowel, Sandy; Biggers, Alana M.D., What Is Methemoglobinemia? June 19, 2017.
https://www.healthline.com/health/methemoglobinemia

(NOAA) NOAA National Centers For Environmental Information
https://www.ncdc.noaa.gov/IPS/lcd/lcd.html?_page=0&state=WA&_target1=Next+%3E

(NcNab etal 2007) McNab, W.W., Singleton, M.J., Moran, J.E., and Esser, B.K. Assessing the impact of animal waste lagoon seepage on the geochemistry of an underlying shallow aquifer. *Environ. Sci. Technol.* Feb.1; 41(3) 753758, 2007.

(PGG 2011) Pacific Groundwater Group. Request for Identification: Lower Yakima Valley Groundwater Management Area, June 21, 2011.
http://www.yakimacounty.us/DocumentCenter/View/2359

(PGG 2013a) Pacific Groundwater Group. Consultant Agreement with HDR Engineering and Pacific Groundwater Group. June 25, 2013.
https://www.yakimacounty.us/DocumentCenter/View/17680/20130625-HDR-Consultant-Agreement

(PGG 2013b) Pacific Groundwater Group. 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

(PGG 2013c) Pacific Groundwater Group. 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

(PGG 2013d) Pacific Groundwater Group. 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

(PGG 2013e) Pacific Groundwater Group. 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

(PGG 2013f) Pacific Groundwater Group. 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

(PGG 2013g) Pacific Groundwater Group. Potential Groundwater Monitoring Stations, Yakima Groundwater Management Area. December 3, 2013.
https://www.yakimacounty.us/DocumentCenter/View/17689/20131203-PGG-Potential-Monitoring-Well-Locations

(PGG 2014a) Pacific Groundwater Group. Potential Groundwater Monitoring Stations, Response to Comments. March 2014.
https://www.yakimacounty.us/DocumentCenter/View/17690/201403-PGG-Response-To-Comments

(PGG 2014b) Pacific Groundwater Group. 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

(PGG 2014c) Pacific Groundwater Group. Deep Soil Sampling Plan, Lower Yakima Valley GWMA. March 28, 2014.
https://www.yakimacounty.us/DocumentCenter/View/17692/20140328-PGG-DSS-Plan-Version-6

(PGG 2014d) Pacific Groundwater Group. Draft Groundwater Monitoring Plan, Yakima Groundwater Management Area. June 2014.
https://www.yakimacounty.us/DocumentCenter/View/17693/201406-PGG-Response-To-Comments

(PGG 2014e) Pacific Groundwater Group. Interim Final Groundwater Monitoring Plan, Lower Yakima Valley GWMA, Initial Characterization. JE 1308, August 15, 2014.
http://www.yakimacounty.us/DocumentCenter/View/13277

(PGG 2015) Pacific Groundwater Group. Consultant Agreement for Professional Services with Pacific Groundwater Group. December 8, 2015.
https://www.yakimacounty.us/DocumentCenter/View/17696/20151123-PGG-Consultant-Agreement

(PGG 2016a) Pacific Groundwater Group. 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

(PGG 2016b) Pacific Groundwater Group. 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

(PGG 2016c) Pacific Groundwater Group. 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

(PGG 2016d) Pacific Groundwater Group. 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

(PGG 2018a) Pacific Groundwater Group. Consultant Agreement for Professional Services. January 9, 2018. https://www.yakimacounty.us/DocumentCenter/View/17702/20180109-PGG-Contract-for-Ambient-Monitoring-Wells

(PGG 2018b) Pacific Groundwater Group. Technical Specification Groundwater Monitoring Wells, Yakima County. February 13, 2018. https://www.yakimacounty.us/DocumentCenter/View/17726/20180216-PGG-Draft-Drill-SpecsYakima-V4

(PGG 2018c) Pacific Groundwater Group. Preliminary Drill Sites and Field Locations. February 13, 2018. https://www.yakimacounty.us/DocumentCenter/View/17703/20180213-PGG-YakimaGWMA_Field_Locations_v20180213

(PGG 2018d) Pacific Groundwater Group. Preliminary Drill Sites and Field Locations. February 15, 2018. https://www.yakimacounty.us/DocumentCenter/View/17705/20180215-PGG-YakimaGWMA_Field_Locations_v20180215

(PGG 2018e) Pacific Groundwater Group. 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

(PGG 2018f) Pacific Groundwater Group. Preliminary Drill Sites and Field Locations. April 5, 2018. https://www.yakimacounty.us/DocumentCenter/View/17709/20180405-PGG-YakimaGWMA_Field_Locations_v20180405

(PGG 2018g) Pacific Groundwater Group. Yakima County Monitoring Well Installation Coordinates. April 5, 2018. https://www.yakimacounty.us/DocumentCenter/View/17708/20180405-PGG-Drill-site-coordinates-v20180405

(Poe, 1961) Poe, Frederick W. *Irrigation Return Flows and Water Quality in the Yakima River Basin*, Master's Thesis, University of Washington, 1961.

(Prest) Statement in Regulatory Framework Work Group. Prest, Ginni, Washington State Department of Agriculture, 2016.

(NRCS Soil Survey) https://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx

(Redifer) Personal communication, Vern Redifer, Director, Yakima County Public Services, October 2014.

(Richardson) Richardson, Avery, Washington State Department of Ecology, Issue Paper presented December 5, 2016, LYVGWAC Abandoned Wells Joint Working Group. https://www.yakimacounty.us/DocumentCenter/View/17728/Abandoned-Wells-Per-Avery-Richardson

(RID 1998) Roza Irrigation District. Roza Irrigation District Comprehensive Water Conservation Plan Report, 1998.

(Ritter/Chirnside 1987) Ritter. W.F., and Chirnside, A.E.M. Influence of agricultural practices on nitrate in the water table aquifer. Biological Wastes. 19(3)165178.

(Roman et al.) Roman, C.T., Jaworski, Norbert, Short, F.T., Findlay, Stuart, and Warren, R.S., 2000, Estuaries of the northeastern United States: Habitat and land use signatures: Estuaries, v. 23, p. 743-764.

(Romey 2001) Romey, Bernard and Steven P. Cramer. Aquatic Habitat Survey of Irrigation Drainage Networks, Lower Yakima River Basin, S.P. Cramer & Associates, Inc., 2001.

(Royte) Royte, Elizabeth, The Simple River-Cleaning Tactics That Big Farms Ignore (Iowa), *National Geographic*, December 7, 2017. https://news.nationalgeographic.com/2017/12/iowa-agriculture-runoff-water-pollution-environment/

(RSJB 1999) Rice, William R. 1999. Roza-Sunnyside Board of Joint Control Water-Quality Laboratory Quality Assurance Manual, June 1999.

(RSJB 2001) Rice, Ann. Roza-Sunnyside Board of Joint Control, History of Drainage Issues in the Yakima Valley, 2001.

(RSJB 2009) Roza-Sunnyside Board of Joint Control; Zuroske, Marie; Water Quality Conditions in Irrigation Waterways Within the Roza and Sunnyside Valley Irrigation Districts, Lower Yakima Valley, Washington, 1997-2008. http://www.svid.org/images/WQ%20Conditions%20in%20Irrigation%20waterwaysReportFinal.pdf

(Scanlon 2008) Scanlon, B.R.; Reedy, R.C.; Bronson, K.F.; "Impacts of Land Use Change on Nitrogen Cycling Archived in Semiarid Unsaturated Zone Nitrate Profiles, Southern High Plains, Texas," *Environmental Science and Technology*, 42 (20) 7655-7572., October 15, 2008.

(Scott 2004) Scott, Michael J., L.W. Vail, C. Stöckle, and A. Kemanian. Climate Change and Adaptation in Irrigated Agriculture – A Case Study of the Yakima River, in 2004 Annual Proceedings of the Universities Council and Water Resources, 2004.

(Sell/Knutson 2002) Sell, R., Knutson, L., Quality of Ground Water in Private Wells in the Lower Yakima Valley, 2001-02, Valley Institute for Research and Education. Ecology Pub. 02-10-074. https://fortress.wa.gov/ecy/publications/documents/0210074.pdf

(Sheehan) Personal communication, Jason Sheehan, Dairy Farmer, August 2017.

(Severtson) Severtson, Peter, e-mail to Davies, Laurie; Rivard, James; Redding, Melanie; April 20, 2017, All Washington State Department of Ecology.

(Spalding et al 2001) Spalding, Roy F.; Watts, Darrell G.; Schepers, James S.; Burbach, Mark E.; Exner, Mary E.; Poreda, Robert J.; and Martin, Glen E.; Controlling Nitrate Leaching in Irrigated Agriculture, *Journal of Environmental Quality*, VOL. 30, July-Aug 2001.

(Stadler 2008) Stadler, S. et al, "Understanding the Origin and Fate of Nitrate in Groundwater of Semi-arid Environments," *Journal of Arid Environments*, 72, 1830-1842, 2008.

(Swann) Swann, Chris, The Influence of Septic Systems at the Watershed Level. http://www.sourcewaterpa.org/wp-content/uploads/2013/03/SwannC. Influence of Septic Systems at the Watershed Level-1.pdf

(SYCD 2004) Zuroske, Marie. Conservation Practices and Water Quality Trends in Sulphur Creek Wasteway and Granger Drain Watersheds, 1997 to 2002, South Yakima Conservation District.

(SYCD 2006) Zuroske, Marie. Water Quality in Small Irrigation Return Drains, Lower Yakima River, 2003 Irrigation Season, 2006.

(Tilman 2002) Tilman et al, "Agricultural Sustainability and Intensive Production Practices," *Nature*, 418, pp. 671-677, 2002.

(Toor et al 2011) Toor, G.S., Lusk, M., and Obreza, T. Onsite sewage treatment and disposal systems: Nitrogen. Florida Cooperative Extension Service, Institute of Food and Agricultural Science, University of Florida, June 2011. Publication Number SL348. https://edis.ifas.ufl.edu/pdffiles/SS/SS55000.pdf

(USBRa) U. S. Bureau of Reclamation https://www.usbr.gov/projects/index.php?id=400;

(USBRb) U.S. Bureau of Reclamation, "hydromet" https://www.usbr.gov/pn/hydromet/yakima/yakstats.txt

(UCD 2012) Center for Watershed Sciences, University of California, Davis. 2012. Addressing Nitrate in California's Drinking Water Technical Report 2: Nitrogen Sources and Loading to Groundwater, With a Focus on Tulare Lake Basin and Salinas Valley Groundwater, Report for the State Water Resources Control Board Report to the

Legislature. California Nitrate Project Implementation of Senate Bill X2 I. July. http://groundwaternitrate.ucdavis.edu/files/139110.pdf

(USDA 1997) U.S. Department of Agriculture, Natural Resources Conservation Service. Washington State Irrigation Guide. https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs144p2_033068.pdf

(USDA 2000) Kellog, Robert L.; Lander, Charles H.; Moffit, David C.; "Manure Nutrients Relative to the "Capacity of Cropland and Pastureland to Assimilate Nutrients: Spatial and Temporal," U.S. Department of Agriculture, Natural Resources Conservation Service, December 2000. https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs143_012133.pdf

(USDA 2008) U.S. Department of Agriculture, Natural Resources Conservation Service Agricultural Waste Management Field Handbook, Part 651, Appendix 10D Design and Construction Guidelines for Waste Impoundments Lined with Clay or Amendment Treated Soil, 2008. https://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=17767.wba

(USDA NASS 2014) National Agricultural Statistical Service. 2002. 2002 Census of Agriculture, County Profile, at http://www.nass.usda.gov

(USDOC Agriculture) *United States Department of Commerce, Bureau of the Census, United States Census of Agriculture,* https://www.agcensus.usda.gov/

(USDOC 2010) US Department of Commerce, Bureau of the Census. Decennial Census, 2010. https://www.census.gov/2010census/popmap/ipmtext.php?fl=53

(USDOC 2013) US Department of Commerce, Bureau of the Census. American Community Survey, 2009-2013.

(USGS 1962) Foxworthy, B.L., Geology and ground-water resources of the Ahtanum Valley, Yakima County, Washington: U.S. Geological Survey Water-Supply Paper 1598. http://pubs.er.usgs.gov/publication/wsp1598

(USGS 1963) Kinnison, H.B., and Sceva, J.E., Effects of hydraulic and geologic factors on streamflow of the Yakima River basin, Washington: U.S. Geological Survey Water-Supply Paper 1595. http://pubs.er.usgs.gov/usgspubs/wsp/wsp1595

(USGS 1982) Boucher, Phillip R., and M.O. Fretwell. Irrigation-Water Quality in the Sulphur Creek Basin, Yakima and Benton Counties, Washington, April 1976 through March 1977, U.S. Geological Survey in cooperation with the Department of Ecology, Open-File Report 81-1008, 1982. https://pubs.usgs.gov/of/1981/1008/report.pdf

(USGS 1983) Boucher, Phillip R., Sediment Transport by Irrigation Return Flows in Four Small Drains within the DID-18 Drainage of the Sulphur Creek Basin, Yakima County, Washington, April 1979 to October 1981, U.S. Geological Survey, Water-Resources Investigations Report 83-4167, 1983. https://pubs.usgs.gov/wri/1983/4167/report.pdf

(USGS 1984) Madison, R.J., and Brunett, J.O., Overview of the occurrence of nitrate in ground water of the United States, in U.S. Geological Survey, National Water Summary 1984: U.S. Geological Survey Water-Supply Paper 2275, p. 93-105, 1985.

(USGS 1985) Madison R.J., Brunett J.O., Overview of the occurrence of nitrate in ground water of the United States. In: National Water Summary 1984. Reston, Va: US Geological Survey; 1985:93-105. Water-Supply Paper 2275.

(USGS 1990a) Alexander, R.B., and Smith, R.A., County-level estimates of nitrogen and phosphorus fertilizer use in the United States, 1945 to 1985: U.S. Geological Survey Open-File Report 90-130, 1990. https://pubs.usgs.gov/of/1990/ofr90130/report.html

(USGS 1990b) Drost, B.W., Whiteman, K.J., and Gonthier, J.B., 1990, The geologic framework of the Columbia Plateau regional aquifer system, Washington, Oregon, and Idaho: U.S. Geological Survey Water-Resources Investigations Report 87-4238. http://pubs.er.usgs.gov/publication/wri874238.

(USGS 1992) Rinella, Joe F., S.W. McKenzie, and G.J. Fuhrer. Surface-Water-Quality Assessment of the Yakima River Basin, Washington: Analysis of Available Water-Quality Data through 1985 Water Year, U.S. Geological Survey, Open-File Report 91-453, 1992. https://pubs.usgs.gov/of/1991/0453/report.pdf

(USGS 1993a) Anderson, Henry W., Jr., Effects of Agricultural and Residential Land Use on Groundwater Quality, Anoka Sand Plain Aquifer, East-Central Minnesota, Water-Resources Investigations Report 93-4074. https://pubs.usgs.gov/wri/1993/4074/report.pdf

(USGS 1993b) Ebbert, J.C., Cox, S.E., Drost, B.W., Schurr, K.M., 1993, *Distribution and sources of nitrate, presence of fluoride and pesticides in parts of the Pasco Basin Washington,* 1986-88, U.S. Geological Survey, Water-Resources Investigations Report 93-4197. https://pubs.usgs.gov/wri/1993/4197/report.pdf

(USGS 1994) Fuhrer, Gregory J., McKenzie, S.W., Rinella, J. F., Sanzolone, R. F., and Skach, K.A., 1994, Surface-water-quality assessment of the Yakima River Basin in Washington--Analysis of major and minor elements in fine-grained streambed sediment, 1987, with a section on Geology, by Marshall W. Gannett.: U.S. Geological Survey Open-File Report 93-30. https://pubs.usgs.gov/of/1993/0030/report.pdf

(USGS 1998a) Sumioka, S.S., A Survey of Ground-Water Quality in the Toppenish Creek Basin, Yakama Indian Reservation, Washington 1989-91, USGS Water Resources Investigations Report 97-4194. https://pubs.usgs.gov/wri/1997/4194/report.pdf

(USGS 1998b) Jones, Joseph L, and L.M. Roberts. 1998. Shallow Ground-Water Quality Beneath Row Crops and Orchards in the Columbia Basin Irrigation Project Area, Washington, U.S. Geological Survey, Water-Resources Investigations Report, 97-4238. https://pubs.usgs.gov/wri/1997/4238/report.pdf

(USGS 1998c) Kim, Moon H., and James C. Ebbert. Irrigation and Surface-Water Quality in the Quincy and Pasco Basins, Washington, U.S. Geological Survey Fact Sheet FS-080-97, and Journal of Environmental Quality, v. 27, p. 372-380, 1998. https://pubs.usgs.gov/fs/1997/0080/report.pdf

(USGS 1999a) Fuhrer, Gregory J., Cain, Daniel J., McKenzie, Stuart W., Rinella, Joseph F., Crawford, J. Kent, Skach, Kenneth A., and Hornberger, Michelle I., Surface-Water-Quality Assessment of the Yakima River Basin in Washington: Spatial and Temporal Distribution of Trace Elements in Water, Sediment and Aquatic Biota, (Section on Geology by Marshall W. Gannett) U.S. Geological Survey Water-Supply Paper 2354-A, 1999.

https://pubs.usgs.gov/wsp/2354a/report.pdf

(USGS 1999b) Morace, Jennifer L., G.J. Fuhrer, J.F. Rinella, S.W. McKenzie, and others. 1999. Surface-Water-Quality Assessment of the Yakima River Basin, Washington: Overview of Major Findings, 1987-91, U.S. Geological Survey, WRIR 98-4113, 1999. https://pubs.usgs.gov/wri/1998/4113/report.pdf

(USGS 2000a) Fuhrer, Gregory J., J.L. Morace, H.M. Johnson, J.F. Rinella, J.C. Ebbert, S.S. Embrey, I.R. Waite, K.D. Carpenter, D.R. Wise, and C.A. Hughes. 2004. Water Quality in the Yakima River Basin, Washington, 1999-2000, U.S. Geological Survey, Circular 1237. https://pubs.usgs.gov/circ/2004/1237/pdf/circular1237.pdf

(USGS 2000b) Frans, L. M., Estimating the Probability of Elevate Nitrate Concentrations in Groundwater in the Columbia Basin Groundwater Management Area, Washington, Water Resources Investigations Report 00-4110. https://pubs.usgs.gov/wri/wri004110/pdf/wri004110.pdf

(USGS 2002) Mastin, M.C., and Vaccaro, J.J., Watershed models for decision support in the Yakima River basin, Washington: U.S. Geological Survey Open-File Report 02-404. http://pubs.usgs.gov/of/2002/ofr02404/

(USGS 2003a) Ebbert, James C., S.S. Embrey, and J.A. Kelley. 2003., Concentrations and Loads of Suspended Sediment and Nutrients in Surface Water of the Yakima River Basin, Washington, 1999-2000 – With an Analysis of Trends in Concentrations, USGS, 2003, WRIR 03-4026. https://pubs.usgs.gov/wri/wri034026/pdf/wri034026.pdf

(USGS 2003b) Kimbrough, R.A., Wiggins, W.D, Smith, R.R., Ruppert, G.P., Knowles, S.M., and Renslow, V.F., 2003, Water resources data, Washington, water year 2002: U.S. Geological Survey Water-Data Report WA-02-01. https://pubs.usgs.gov/wdr/WDR-WA-02-1/pdf/wdr-wa-02-1.pdf

(USGS 2003c) Keith W. Robinson, Jean P. Campbell, *and* Norbert A. Jaworski, Water-Quality Trends in New England Rivers During the 20th Century, USGS National Water Quality Assessment Program, Water-Resources Investigations Report 03-4012. https://pubs.usgs.gov/wri/wrir03-4012/wrir03-4012report.pdf

(USGS 2004), Fuhrer, Gregory J.; Morace, Jennifer L.; Johnson, Henry M.; Rinella, Joseph F.; Ebbert, James C.; Embrey, Sandra S.; Waite, Ian R.; Carpenter, Kurt D.; Wise, Daniel R.; Hughes, Curt A., Water Quality in the Yakima River Basin, Washington, 1999–2000, U.S. Geological Survey Circular 1237-2004. https://pubs.usgs.gov/circ/2004/1237/pdf/circular1237.pdf

(USGS 2006a) Jones, M.A., Vaccaro, J.J., and Watkins, A.M., Hydrogeologic framework of sedimentary deposits in six structural basins, Yakima River basin, Washington: U.S. Geological Survey Scientific Investigations Report 2006-5116. http://pubs.usgs.gov/sir/2006/5116/

(USGS 2006b) Vaccaro, J.J., and Sumioka, S.S., Estimates of ground-water pumpage from the Yakima River basin aquifer system, Washington, 1960–2000: U.S. Geological Survey Scientific Investigations Report 2006-5205. http://pubs.usgs.gov/sir/2006/5205/

(USGS 2006c) Vaccaro, J.J., 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. http://pubs.usgs.gov/sir/2006/5318/

(USGS 2007a) Vaccaro, J.J., and Olsen, T.D., 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. http://pubs.usgs.gov/sir/2007/5007/

(USGS 2007b) Vaccaro, J.J., and Olsen, T.D., 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. http://pubs.usgs.gov/of/2007/1238/

(USGS 2007c) 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. https://pubs.usgs.gov/sir/2007/5102/pdf/sir20075102.pdf

(USGS 2007d) Wise, Daniel R., F.A. Rinella III, J.F. Rinella, G.J. Fuhrer, S.S. Embrey, G.M. Clark, G.E. Schwarz, and S. Sobieszczyk. Nutrient and Suspended-Sediment Transport and Trends in the Columbia River and Puget Sound Basins, 1993-2003, U.S. Geological Survey Scientific Investigations Report 2007-5186, 2007. https://pubs.usgs.gov/sir/2007/5186/pdf/sir20075186.pdf

(USGS 2008a) Jones, M.A., and Vaccaro, J.J., 2008, Extent and depth to the top of basalt and interbed hydrogeologic units, Yakima River basin aquifer system, Washington: U.S. Geological Survey Scientific Investigations Report 2008-5045. http://pubs.usgs.gov/sir2008/5045/

(USGS 2008b) Keys, M.E., Vaccaro, J.J., Jones, M.A., and Julich, R.J., Hydrographs showing ground-water level trends for selected wells in the Yakima River basin aquifer system, Washington: U.S. Geological Survey Data Series 343. https://pubs.usgs.gov/ds/343/

(USGS 2008c) Frans, Lonna, Distribution of Elevated Nitrate Concentrations in Groundwater in Washington State, US Geological Survey Fact Sheet 2008-3063. https://pubs.usgs.gov/fs/2008/3063/pdf/fs20083063.pdf

(USGS 2009a) Vaccaro, J.J., Jones, M.A., Ely, M.D., Keys, M.E., Olsen, T.D., Welch, W.B., and Cox, S.E., 2009, Hydrogeologic framework the Yakima River basin aquifer system, Washington: U.S. Geological Survey Scientific Investigations Report 2009-5152. http://pubs.usgs.gov/sir/2009/5152/

(USGS 2009b) Effect of Agricultural Practices on Hydrology and Water Chemistry in a Small Irrigated Catchment, Yakima River Basin, Washington, U.S. Department of the Interior, U.S. Geological Survey Scientific Investigations Report 2009–5030. https://pubs.usgs.gov/sir/2009/5030/pdf/sir20095030.pdf

(USGS 2009c) Magirl, C.S., Julich, J., Welch, W.B., Curran, C.R., Mastin, M.C., and Vaccaro, JJ., Summary of Seepage Investigations in the Yakima River Basin, Washington, U.S. Geological Survey Data Series 473, 2009. https://pubs.usgs.gov/ds/473/

(USGS 2011a) United States Geological Survey. 2011. River-Aquifer Exchanges in the Yakima River Basin, Washington. Scientific Investigations Report 2011-5026. https://pubs.usgs.gov/sir/2011/5026/pdf/sir20115026.pdf

(USGS 2011b) Ely, D.M., Bachmann, M.P., and Vaccaro, J.J., Numerical simulation of groundwater flow for the Yakima River basin aquifer system, Washington; USGS Scientific Investigations Report 2011-5155, 2011. https://pubs.usgs.gov/sir/2011/5155/pdf/sir20115155.pdf

(USGS 2012) Burns, Erick R., Snyder, Daniel T., Haynes, Jonathan V., and Waibel, Michael S., Groundwater status and trends for the Columbia Plateau Regional Aquifer System, Washington, Oregon, and Idaho, U.S. Geological Survey Groundwater Resources Program in cooperation with the Oregon Water Resources Department, Scientific Investigations Report 2012-5261.https://pubs.usgs.gov/sir/2012/5261/pdf/sir2012-5261.pdf

(USGS 2013) Johnson, Henry M., Black, Robert W., and Wise, Daniel R., Estimation of Total Nitrogen and Total Phosphorus in Streams of the Middle Columbia River Basin (Oregon, Washington, and Idaho) Using SPARROW Models, with Emphasis on the Yakima River Basin, Washington Scientific Investigations Report 2013–5199. https://pubs.usgs.gov/sir/2013/5199/pdf/sir20135199.pdf

(USGS 2014) Ely, D.M., Burns, E.R., Morgan, D.S., and Vaccaro, J.J., 2014, Numerical Simulation of Groundwater Flow in the Columbia Plateau Regional Aquifer System, Idaho, Oregon, and Washington: U.S. Geological Survey, Scientific Investigations Report 2014-5127. https://pubs.usgs.gov/sir/2014/5127/pdf/sir2014-5127.pdf

(USGS 2018) Huffman, R.L., Concentrations of nitrate in drinking water in the lower Yakima River Basin, Groundwater Management Area, Yakima County, Washington, 2017: U.S. Geological Survey Data Series 1084, p. 18. https://pubs.usgs.gov/ds/1084/ds1084.pdf

(Vaccaro 2016) Vaccaro, J.J., Assessment of the Availability of Groundwater for Residential Development in the Rural Parts of Yakima County, Washington, Vaccaro G.W. Consulting, LLC, January 2016.

(Vermont) Vermont Nitrate Leaching Index, Vermont Open Geodata Portal. http://geodata.vermont.gov/datasets/vt-nitrate-leaching-index/data?geometry=-86.522%2C40.368%2C-58.397%2C45.971

(Viers et al 2012) Viers J, Liptzin D, Rosenstock T, Jensen V, Hollander A, McNally A, King A, Kourakos G, Lopez E, De La Mora N, et al. 2012. Addressing Nitrate in California's Drinking Water, with a Focus on Tulare Lake Basin and Salinas Valley Groundwater. Technical Report 2, Report for the State Water Resources Control Board Report to the Legislature. Davis, CA: Institute for Watershed Sciences, University of California, Davis. http://groundwaternitrate.ucdavis.edu/files/139110.pdf

(Walvoord et al 2003) Walvoord, Michelle A.; Phillips, Fred M.; Stonestrom, David A.; Evans, R. Dave; Harsough, Peter C.; Newman, Brend D.; et al, "A Reservoir of Nitrate Beneath Desert Soils," *Science*, 302, 1021-1024, 2003.

(Ward 2005) Ward, Mary H.; deKok, Theo M.; Levallois, Patrick; Brender, Jean; Gulis, Gabriel; Nolan, Bernard T.; VanDerslice, James; Workgroup Report: Drinking-Water Nitrate

and Health—Recent Findings and Research Needs, *Environmental Health Perspectives*, Nov; 113(11): 1607–1614, 2005.

(WDOH 2005) Washington State Department of Health, Nitrogen Reducing Technologies for Onsite Wastewater Treatment Systems, June 2005. https://www.doh.wa.gov/Portals/1/Documents/Pubs/337-093.pdf

(WDOH 2007a) VanDerslice, Jim, *Dose-Response of Nitrates and other Methemoglobin Inducers on Methemoglobin Levels in Infants,* Washington Department of Health, Final Report, EPA Grant # R829781. https://cfpub.epa.gov/ncer_abstracts/index.cfm/fuseaction/display.highlight/abstract/5379/report/F

(WDOH 2007b) Washington Department of Health, *Coliform Bacteria and Drinking Water,* WDOH Publication # 331-181, 2007. http://www.yakimaco.us/GWMA/documents/library/Washington_Department_of_Health_2007_Coliform_Bacteria_and_Drinking_Water_WDOH_Publication_331-181.pdf

(WDOH 2007c) Washington Department of Health, *Nitrate in Drinking Water,* WDOH Publication # 331-214, 2007.

(WDOH 2016) Washington Department of Health, Questions and Answers, Nitrates in Drinking Water, DOH 331-214 updated July 2016. https://www.doh.wa.gov/Portals/1/Documents/Pubs/331-214.pdf

(WRCC) (Western Regional Climate Center) https://wrcc.dri.edu/

(WSDA 2013) Washington State Department of Agriculture. Agricultural History of Yakima County. http://www.yakimacounty.us/DocumentCenter/View/2375

(WSDA 2017a) Washington State Department of Agriculture. 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 2018) Bahr, Gary; Perry Beale, Perry; Drennan, Margaret; Hancock, Jaclyn; McLain, Kelly; Redifer, Vern; Martian, Michael, Kozma, Cynthia.; 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; April 2018. https://agr.wa.gov/FP/Pubs/docs/103-691YakimaGWMANitrogenTransportReport.pdf

(YCDAa) Yakima County Development Association/New Vision, http://www.yakimavalleytrends.ewu.edu/graph.cfm?cat_id=1&sub_cat_id=1&ind_id=1

(YCDAb)Yakima County Development Association/New Vision, http://www.yakimavalleytrends.ewu.edu/graph.cfm?cat_id=1&sub_cat_id=1&ind_id=6

(YCDAc) Yakima County Development Association/New Vision, http://www.yakimavalleytrends.ewu.edu/graph.cfm?cat_id=1&sub_cat_id=1&ind_id=5

(YCDAd) Yakima County Development Association/New Vision, http://www.yakimavalleytrends.ewu.edu/graph.cfm?cat_id=1&sub_cat_id=1&ind_id=3

(YCDAe) Yakima County Development Association/New Vision, http://www.yakimavalleytrends.ewu.edu/graph.cfm?cat_id=1&sub_cat_id=1&ind_id=7

(YBIWRP 2012) Yakima Basin Integrated Water Resource Plan Final Programmatic Environmental Impact Statement, Benton, Kittitas, Klickitat, Yakima County, Washington, dated March 2, 2012 (77 FR 12076 (2012). endorsed by the Washington State Legislature Laws of Washington State, 2013 2nd Sp.S. c.11, §§ 2, 3, 11 (RCW 90.38.010, .060, .120) https://fortress.wa.gov/ecy/publications/publications/1212002.pdf

Alternative land and water use management strategies for reaching program goals and objectives per WAC 172-100-100(4)		Evaluation Criteria per WAC 173-100-100 (4)						
Action	Proposed by	Feasibility	Effectiveness	Cost	Proposed funding	Time	Difficulty to implement	Degree of consistency with local comprehensive plans and water management programs
Remediation								
Pump, treat and reinject groundwater	WGD	not feasible, treatment area too large	not effective because of 3-dimensional size of treatment area	excessive				
Pump-and-fertilize. Use existing (or new) agricultural water wells to remove nitrate-contaminated groundwater and "treat" the water by using it to irrigate crops which will take up the nitrogen concentration in the irrigation water (presumes the existence of a proper nutrient management plan for the irrigated acreage).	JD							
Fill irrigation ditches with water and let it sit there to leak into groundwater. Use groundwater recharge as a means to dilute nitrate concentrations in the groundwater.	WGD						irrigation district canal maintenance in winter, increased personnel?, irrigation district compensation, relation to water rights? problem of freezing of flow meters in laterals, interaction with Bureau of Reclamation	
Drill new 1,500 foot wells to replace contaminated wells .	WGD			$12 million				
Regionalize and connect users to a larger system with reliable quality water.—pipe connection to an existing system	WGD							
Blend better quality water with contaminated water to reduce nitrate concentrations	JD	works for larger community systems with more than one water source.						
Construct a potable water line from nearby developed area into deadhead water stations at central rural location (permit potable water collection at deadhead water stations).	JD							
Discontinue use of shallow wells. Rebuild, repair or replace poorly constructed wells.	WGD							
Remediate local nitrate contamination hotspots only .	JD							

Alternative land and water use management strategies for reaching program goals and objectives per WAC 172-100-100(4)		Evaluation Criteria per WAC 173-100-100 (4)						
Action	Proposed by	Feasibility	Effectiveness	Cost	Proposed funding	Time	Difficulty to implement	Degree of consistency with local comprehensive plans and water management programs
Administration/Lead Agency--Yakima County?								
Identify or create of an organization (Lead Entity) responsible for implementation and oversight of the LYV GWMA Groundwater Management Plan and acquisition of stable funding to support their activities. Potential entities include, Yakima County, South Yakima Conservation District (SYCD), Yakima County Health District, Washington State Department of Agriculture (WSDA), Ecology, and/or a yet to be formed entity.	L/C WG							
Implement an Adaptive Management Plan utilizing data collected, progress made, or lack of progress to inform the community on adjustments that need to be implemented. Plan could incorporate availability of technology, education and outreach, tracking exports, land use regulations, treatment systems, and other changes to inform decision makers regarding management changes necessary for a successful program.	L/C WG							
Let the lead agency determine who will do monitoring. Possible assignment of long-term monitoring after 2017 to Yakima Health District.	WGD							
Inform livestock operators and facilitate a dialogue with representatives of the regulatory agencies, other agricultural producers, and the general public through a public information/education program to protect the quality of the area groundwater resource. Information and incentives provided to Lower Yakima Valley agricultural operators will expedite implementation of BMPs.	L/C WG							
Collect, analyze, and interpret data to track water quality improvement progress, nutrients generated, applied, or exported, which will inform the implementation of an Adaptive Management Plan within the LYV GWMA.	L/C WG							
Focus implementation of analyzed data based on information and data included in the Nitrogen Loading Assessment, Soil Sampling Program, Ambient Groundwater Monitoring Plan, USGS Reports, and other similar scientifically based publications.	L/C WG							
Increase education and outreach efforts by improving the availability of technical assistance to develop nutrient management plans for all livestock industries. Assist industry trade organizations to enhance their local efforts to bring information to their members. Help increase livestock operator awareness of the need for procedures for proper management of animal wastes and wastewater. Potential funding sources include industry, government, educational institutions, grants, industry associations, etc...	L/C WG							
Cooperate with the WCC and WSDA in their efforts to document regulatory compliance for dairies within the GWMA that are completing and implementing Dairy Nutrient Management Plans (DNMP). Explore the possibility of disclosing non-proprietary data produced through the DNMP process.	L/C WG							
Further develop a local forum for disseminating information and facilitating technical exchange regarding BMPs for livestock management and groundwater protection. Endorse and distribute materials by all effective means that will educate the public about the facts of livestock waste management and the science of groundwater protection.	L/C WG							

Alternative land and water use management strategies for reaching program goals and objectives per WAC 172-100-100(4)		Evaluation Criteria per WAC 173-100-100 (4)						
Action	Proposed by	Feasibility	Effectiveness	Cost	Proposed funding	Time	Difficulty to implement	Degree of consistency with local comprehensive plans and water management programs
Quantify the nutrient value and rate of release of nitrate from livestock waste under various Lower Yakima Valley conditions to become part of the nutrient management guidelines.	L/C WG							
Voluntary development and implementation of NMPs by operations not already required to hold permits or a DNMP as an effective means of environmental protection.	L/C WG							
Allocate cost share funding or other funding assistance to operators implementing environmental protection measures.	L/C WG							
Develop strategies for marketing the economic, fertilizer value, and soil enhancing properties of appropriate application of manure and other livestock wastes.	L/C WG							
Provide Yakima County fiscal support to maintain its GIS data base on the GWMA over time.	JD							
Overlay GIS density maps reflecting different sources of nitrogen in order to geographically indicate the total density from all sources.	JD							
Map those areas that can tolerate more nitrogen application and areas that are more vulnerable to its application.	JD							
Use USGS particle tracking model to indicate where groundwater moves faster (permeability).	WGD							
Assess groundwater contamination potential, making use of the available information on soils, geology, and groundwater in order to identify those areas that are the most vulnerable to contamination. These areas may be closer to surface water, areas where recharge is faster or more frequent, or areas where shallow soils overlie soluble bedrock. Identify strategies "upstream" of sensitive areas to reduce contributions of nitrate sources.	WGD							
Enact County ordinances that would affect the problem grower.	WGD						Difficult to enforce.	
Maintain the County's GWMA website.	WGD							
Create an aquifer protection area.	WGD	Requires vote of people within protection area		Generates tax revenue				
Consider the enactment of a county ordinance addressing the density of segments of nitrate producing agricultural activity within the areas currently zoned as agricultural within the GWMA.	WGD		Prospective application					
Consider creation of subcategories of agricultural zoning, limiting density in those areas where soils are more permeable or groundwater moves faster.	WGD		Prospective application					
Consider "overlay" zoning ordinance adding special groundwater conservancy restrictions to otherwise conventionally zoned properties. Uses consumptive of groundwater quality resources are precluded or more generally regulated. Uses that are not consumptive of groundwater quality resource are permitted. Specific limitations might include limitations of water use, drainage, development density, septic use.	JD		Prospective application					

Alternative land and water use management strategies for reaching program goals and objectives per WAC 172-100-100(4)		Evaluation Criteria per WAC 173-100-100 (4)						
Action	**Proposed by**	**Feasibility**	**Effectiveness**	**Cost**	**Proposed funding**	**Time**	**Difficulty to implement**	**Degree of consistency with local comprehensive plans and water management programs**
Define "conditional uses" that can be allowed after assurance that groundwater resources would not be damaged.	JD		Prospective application					
Consider a county ordinance concerning overapplication of manure.	WGD		Prospective application				Difficult to enforce	
Create county ordinance limiting total number or density of cows or dairies (lid).	WGD		Prospective application				Difficult to enforce	
Adopt a LYC GWMA or county-wide CAFO ordinance	L/C WG (no consensus in WG)	Lengthy public process to create a CAFO Ordinance. Uncertain outcomes and timing. Too much uncertainty to rely on this option for the plan at this time. The county might consider legislative action as an alternative if public outreach, voluntary compliance, implementation of identified BMP's, and other efforts are not						
Establish a quota system through zoning regulations establishing how much nitrogen could be applied (based on agronomic rates for individual crop types) within fixed zones.	WGD		Prospective application				Difficult to enforce	
Consider density limitations, building codes for farm structures, development standards for farm activities.	WGD		Prospective application					
Regulate crop mix to weight more toward nitrogen-light crops--	JD						Difficult to enforce	

Alternative land and water use management strategies for reaching program goals and objectives per WAC 172-100-100(4)		Evaluation Criteria per WAC 173-100-100 (4)						
Action	**Proposed by**	**Feasibility**	**Effectiveness**	**Cost**	**Proposed funding**	**Time**	**Difficulty to implement**	**Degree of consistency with local comprehensive plans and water management programs**
Consider limitation of septic systems (therefore building permit) where soil filtration rate is high, where housing density is already big, where nitrate concentration is already great downstream of the septic plume	JD	Applied admnistratively, requires GIS mapping of soil zones					Growers view as governmental interference with economic choice if nitrogen-heavy crops generate better returns	
Property tax for properties with onsite septic systems, waived in the case of proper inspection and pumping	JD							
Protect Critical Aquifer Recharge Areas	WGD							
Require bonding as prerequisite to permitting of livestock operations so as to assure financial capability for clean up in the instance of bankruptcy or other economic failure.	GWACD							
Measure the effects of GWAC program on Yakima County economics.	WGD							
Establish a more interactive and frequent relationship between Yakima County and NRCS.	WGD							
Education								
Develop post GWAC education and outreach campaign	EPO							
Broaden the pool of people GWMA is educating or communicating with.	EPO							
Maintain a public education program regarding nitrate pollution and health risk over a 5-10 year period. Provide all materials distributed to the public in English and Spanish.	EPO							
Billboard campaign – urging well testing	EPO							
Create 1 FTE Bilingual Outreach Coordinator Position to implement a post-adoption outreach campaign (EPO meeting summary 8/1/2014 & proposed to GWAC 8/21/14 - voted low priority)	EPO	Low	Unknown	$83,000 annually		1 FTE	Requires clear, measurable outcomes[1], a "home" agency to house, provide oversight, and to measure effectiveness; and ongoing funding.	
Develop a K-12 education program about groundwater and best management practices--mobile program visiting schools.	EPO							
Employ/enlist college students to conduct surveys, consider outreach methodologies as part of classwork to assist with GWMA education	EPO							
Educate the public, particularly in towns, about lawn and garden nitrogen applications' contribution to nitrate concentrations	EPO							
Educate private well owners: Re: protect your family; know who's at risk; test your well regularly.	EPO							
Private well owners' responsibility to protect WQ	EPO							

Alternative land and water use management strategies for reaching program goals and objectives per WAC 172-100-100(4)		Evaluation Criteria per WAC 173-100-100 (4)						
Action	Proposed by	Feasibility	Effectiveness	Cost	Proposed funding	Time	Difficulty to implement	Degree of consistency with local comprehensive plans and water management programs
Publish public information about proper septic system construction and operation	EPO							
Advise the public that GWMA is looking for abandoned wells. Wellhead protection education	EPO							
Offer incentives for property owners to identify and properly abandon wells.	EPO							
Offer incentives to drill deeper wells for homeowners served by shallow, poorly constructed, poorly located wells.	EPO							
Offer incentives to connect households on private wells near community water systems to connect to a community water system. (Nitrate Treatment Pilot Program-June 2011)	EPO							
Provide a resource hotline (as proposed by RCIM on 8/2014)	EPO							
Prepare a fact sheet/develop outreach campaign to growers that explains agronomic rates – applying nutrients at the right time/right place/right amount	EPO							
Study report outreach: Show/Identify how much nitrogen is left after nutrient uptake in crops.	EPO							
Encourage commodity groups to provide education on water management and fertilizer use through regular meetings.	EPO							
Outreach targeted to small farm/hobby farm/rachettes manure management	EPO							
Educate irrigation users on the consequences of too much irrigation.	EPO							
Inform farmers about technological improvements in irrigation that permit easier management of water, descriptions of specific improved technology, and economic viability of technological advancements .	EPO							
Enlist advocacy groups/Farm Bureau/federations/associations to host workshops/informational meetings regarding GWMA education goals and partnerships in success	EPO							
Make presentations at trade shows, communicate with agricultural consultants who have positive relationships with farmers suggesting that they change practices	EPO							
Partner with UW Pediatric Environmental Health Specialty Unit (PEHSU) to continue training local healthcare providers to recognize and address Nitrate risk in their patients (pregnant women and infants up to six months)	EPO	Feasible	Effective	Up to $30,000 annually (.25 FTE; + translation, printing, coordination)	Unknown	.25 FTE	Coordinate partnership through either DOH or YHD	
Advise the public that GWMA is looking for abandoned wells	WGD							
Encourage commodity groups to provide education on water management and fertilizer use through regular meetings	WGD							

Alternative land and water use management strategies for reaching program goals and objectives per WAC 172-100-100(4)		Evaluation Criteria per WAC 173-100-100 (4)						
Action	Proposed by	Feasibility	Effectiveness	Cost	Proposed funding	Time	Difficulty to implement	Degree of consistency with local comprehensive plans and water management programs
Research and Data Collection								
Use both method-based measurement and performance-based measurement.	WGD							
Establish performance objectives against which monitoring data can be compared--number of at risk wells, BMP implementation, funding success, reduction in number of underperforming farming practices	JD							
Implement Ambient Groundwater Monitoring Plan	GWAC	Feasable						
Implement Drinking Water Quality Monitoring Plan	GWAC	Feasable						
Establish a fund and plan to analyze data collected in ambient water quality monitoring and drinking water well monitoring programs. Study short-term seasonal variations in nitrate concentrations over next year or two--addresses how changes in nutrient application over the agricultural cycle affects things. Study long-term trends that develop over several years--to track whether the overall picture is getting better, whether changes recommended by GWMA are having impact.	WGD							
Use hydro-geologically directed monitoring well placement to detect cause/effect remediation opportunities.	JD							

Alternative land and water use management strategies for reaching program goals and objectives per WAC 172-100-100(4)		Evaluation Criteria per WAC 173-100-100 (4)						
Action	Proposed by	Feasibility	Effectiveness	Cost	Proposed funding	Time	Difficulty to implement	Degree of consistency with local comprehensive plans and water management programs
Building from the WSDA's Nitrogen Availability Assessment, develop a Nitrogen Loading Assessment for all agricultural, residential and commercial properties, using newly collected data. Hire a technical consultant to conduct a literature review to determine the most relevant information and accurate factors for use in the Nitrogen Loading Assessment. Periodically repeat the grower survey used in the Nitrogen Availability Assessment to compare against the currently established data. Collect data on how many acres in the GWMA are fertilized in various crops with manure and how many with commercial fertilizer. Update and monitor the percentage of acreage in various crops, particularly silage corn and field corn. Study effect of contribution of nitrogen from cover crops used to form mulch. Determine acreage for triticale. Discover commercial fertilizer tonnage for Yakima County and/or for GWMA. Explore how much nitrogen leaches into groundwater from drains and wasteways. Study atmospheric deposition more comprehensively. Understand the difference between plant uptake and plant removal of nitrogen.	WGD, JD							
Get fertilizer loading numbers per crop type. Get economic engine factors per crop type. Determine crop/fertilizer utility ratios. Consider economic benefit of various crop type categories. Consider agricultural usage categories (e.g., field crop, row crop, vineyard, orchard, dairy. Determine amount of land appropriate for each, and location best for each given soil, climate, effect upon groundwater, etc. Ensure adequate supply of each in order to permit opportunity of market choice.	JD							
Recommend that the Yakima Health District or Yakima County continue the High Risk Well Assessment (survey to identify outreach messaging related to health risks and well sampling) periodically over a 5-10 year period. Collect more information on wells known to have high nitrate concentrations, perhaps identifying whether the concentration is self-caused	WGD							
Conduct recurrent drinking water testing where drinking water standards have previously been exceeded.	JD							
Design and implement pilot studies focusing on innovative farm techniques which reduce nitrogen loading to crops and monitor results for future expansion of findings.	JD							
Explore whether nitrate leaching is greater with vetch amended soil or commercial fertilizer amended soil. The results of one study indicate that vetch nitrogen, in comparison to fertilizer nitrogen, leads to lower concentrations of soil inorganic nitrogen and greater immobilization of added nitrogen in soil organic matter. This would reduce the potential for nitrate leaching.	JD							
Recommend that WSU Extension Service update Appendices A and B of the Washington Irrigation Guide.	WGD							
Recommend that Western Fertilizer Handbook, Western Plant Health Association, Ninth Edition (2002) be updated.	WGD							
Fund professional adaptation of Utah Fertilizer Guide for Washington State http://extension.usu.edu/files/publications/publication/AG_431.pdf	JD							

Alternative land and water use management strategies for reaching program goals and objectives per WAC 172-100-100(4)		Evaluation Criteria per WAC 173-100-100 (4)						
Action	Proposed by	Feasibility	Effectiveness	Cost	Proposed funding	Time	Difficulty to implement	Degree of consistency with local comprehensive plans and water management programs
Washington State Department of Agriculture								
Develop Nitrogen Loading Assessment as provided in Research and Data Collection above.	WGD							
Summarize the DNMP reporting and provide information that would disclose the amount of manure the CAFO's in the GWMA created and where it was distributed.	WGD							
Review and evaluate the WSDA Dairy Nutrient Management Program inspection protocols to assist in determining if additional resources should be allocated and identify any areas for improvement of the inspections themselves.	L/C WG							
Add staff to WSDA to oversee Dairy Nutrient Management Plans and complaints regarding manure spills.	WGD							
Promote on-going research for managing animal nutrients.	WGD							
Southern Yakima Conservation District								
Ask SYCD for projected plan to expand fiscal and administrative capacity	JD							
Fund post GWMA education and outreach through Conservation District	WGD							
Put request for $$$ for SYCD in State Conservation Commission budget	WGD							
Enhance engineering expertise (personnel) within Conservation District--none there or at NRCS	WGD							
Charge dairies for Conservation District preparation of Dairy Nutrient Management Plans	WGD							
Recommend funding for Southern Yakima Conservation District review of Dairy Nutrient Management Plans	WGD							
Provide better funding and more staffing for Conservation District: hard money funding, increase property tax assessment, create exceptions to taxation for demonstrated testing and monitoring.	WGD							
Develop water sorption graph or chart. List volumes of water applied, soil types, absorption/compaction rates, depths to water, pre-season and post-season appropriate moisture levels.	JD							
US Geological Survey								
Use USGS Particle Tracking Model	WGD							
Use USGS particulate tracking model to identify targets of education	WGD							
USGS Particle Tracking Model Overview--potentially combined with MT3D MODFLOW application to the vadose Zone	WGD							
Yakima Health District								
Study potential nitrate contamination attributable to improperly operated septic systems. Consider restoration/retrofit of older septic systems through incentives or county property tax breaks.	WGD							
Drill deeper water wells further from septic drain systems	WGD							
Require builders to demonstrate that septic system design will not add to nitrogen loading problem as condition of construction	WGD							
Publish and distribute homeowner guide on how to use septic systems	WGD							
Department of Ecology								

Alternative land and water use management strategies for reaching program goals and objectives per WAC 172-100-100(4)		Evaluation Criteria per WAC 173-100-100 (4)						
Action	Proposed by	Feasibility	Effectiveness	Cost	Proposed funding	Time	Difficulty to implement	Degree of consistency with local comprehensive plans and water management programs
Publish the Department of Ecology's lists of certified laboratories that can test private wells for nitrates and pathogens and Ecology's providing funding to low income, private well users, in order to conduct this testing.	WGD							
Encourage an increase in the number and availability of soil testing laboratories.	JD							
Make grants that complement projects related to non-point source pollution.	WGD							
Provide grant funding for well decommissioning.	WGD							
Search for abandoned wells.	WGD							
Send a postcard to 10 % of known property owners on record having a well asking about knowledge of older wells.	WGD							
Compare Google Earth to Yakima County GIS images to determine building changes and thus possible well usage changes. Focus first on hotspot high density areas in GWMA. Ground truth suspected problem wells.	WGD							
Educate realtors and banking industry about disclosure of abandoned wells in property transfers.	WGD							
Educate public regarding liability of an ill-secured well.	WGD							
Provide some form of protection for self-reporting of abandoned or improperly decommissioned wells.	WGD							
Seek legislative change on requirements for well decommissioning, making them cheaper.	WGD							
Amend RCW 18.104.055 to dedicate a portion of "notice of intent" fees to a fund to be used by Ecology (or Health) for the proper decommissioning of wells in those cases where DOE (or Health) determines that such publicly-funded action is necessary in the public interest to protect or enhance the quality of public health ("infirmity" of the public health).	JD							
Amend authority of Department of Ecology to gain access to properties where manure is spread outside land subject to nutrient management plans	WGD							
Residential, Commercial, Industrial, Municipal								
Encourage municipalities within the GWMA to extend municipal sewer systems within urban growth areas and retire ROSS and LOSS.	RCIM WG							
Encourage connection of residences within urban growth zones to sewer systems extended by municipalities.	RCIM WG							
Encourage the development of group septage-management or treatment systems in areas outside urban growth zones where the density of residential development could exacerbate the effect of multiple OSS on groundwater quality.	RCIM WG							
Establish or maintain ongoing, extended funding necessary for the Yakima County Department of Public Services and Yakima Health District to actively participate in water quality improvement, testing, monitoring, scientific data analysis, and infrastructure development.	RCIM WG							

Alternative land and water use management strategies for reaching program goals and objectives per WAC 172-100-100(4)		Evaluation Criteria per WAC 173-100-100 (4)						
Action	Proposed by	Feasibility	Effectiveness	Cost	Proposed funding	Time	Difficulty to implement	Degree of consistency with local comprehensive plans and water management programs
Request Yakima County Public Services to perform an engineering study of locations outside urban growth areas where there is rural residential medium to high density OSS and the nitrate concentration is greater than the state water quality standard where community water systems could feasibly be constructed in lieu of individual water wells.	RCIM WG							
Request Yakima County Public Services to perform an engineering study of locations outside urban growth areas where there is rural residential medium to high density OSS and the nitrate concentration is greater than the state water quality standard where community waste water systems could feasibly be constructed in lieu of individual on-site septic systems.	RCIM WG							
Request that the Yakima Health District prepare a plan, as required and described by WAC 246-272A-0015, giving primary emphasis on educational programs for operation and maintenance of existing on-site septic systems (OSS), reserving a determination regarding the advisability of the establishment of regulatory or enforcement programs until data is available from the GWMA's monitoring well system.	RCIM WG							
Request the Yakima Health District to consider the nitrate density element when approving proposed septic systems, including those technologies verified by the U.S. EPA's Environmental Technology Verification Program, for reducing the nutrient nitrogen in domestic wastewater discharged from OSS, including fixed film trickling filter biological treatment, media filter biological treatment, and submerged attached-growth biological treatment.	RCIM WG							
Recommend that soil testing be performed below at least two ROSS drain fields (one with a shallow water table, one with a deeper water table) in high density areas to analyze nitrogen loads as the septage approaches the water table.	RCIM WG							
Request that the State Department of Health determine, prior to issuing or reissuing LOSS permits, that all employee counts are regularly reported, so that the LOSS will continue to operate as designed.	RCIM WG							
Recommend that the State Department of Health consider not approving additional LOSS or otherwise require an effective nitrate removal system.	RCIM WG							
Request that the Department of Ecology analyze the trends of nitrate data contained within reports required by NPDES and SDWA permits.	RCIM WG							
Educate the public regarding the importance of the integrity of wells, particularly those without a well log, and fund and encourage periodic well inspection by the Yakima Health District or professional well engineers.	RCIM WG							
Require that site inspections for possible abandoned wells be performed before building permits are issued for properties that are proposed to be redeveloped after prior development of domestic, agricultural or industrial uses.	RCIM WG							

Alternative land and water use management strategies for reaching program goals and objectives per WAC 172-100-100(4)		Evaluation Criteria per WAC 173-100-100 (4)						
Action	Proposed by	Feasibility	Effectiveness	Cost	Proposed funding	Time	Difficulty to implement	Degree of consistency with local comprehensive plans and water management programs
Request that the Department of Ecology develop a plan for finding and decommissioning abandoned wells in the next 12 months, using the LYVGWMA as a pilot project.	RCIM WG							
Permit the repair or decommissioning of wells by general contractors, rather than exclusively by well-drillers, so as to diminish costs of decommissioning.	RCIM WG							
Assist hobby farmers to locate ROSS drain fields on their property so as to avoid animal farming over the drain field.	RCIM WG							
Request the county include the EPO flyer on OSS maintenance in correspondence with GWMA home owners for 5 years. i.e. tax bills, property transfers.	RCIM WG							
Make facility process improvements in waste treatment and food processing plants to reduce nitrogen and total discharge volume.	JD							
Replace aging sewer system infrastructure and ensure proper system maintenance to reduce nitrate leaching.	JD							
Require new developments to address impacts on groundwater quality through permitting review of "site plan review criteria."	JD							
Technology								
Identify and support opportunities, including educational research institutions, for private, public, and industry investment in technology specific to addressing nitrate contamination in groundwater.	L/C WG							
AKART--industry can't keep up with technology, required if performance already meets performance standards?	WGD							
AKART problems--does standard mandate installation of new technologies even when existing ones accomplish the measured objective	WGD							

Alternative land and water use management strategies for reaching program goals and objectives per WAC 172-100-100(4)		Evaluation Criteria per WAC 173-100-100 (4)						
Action	Proposed by	Feasibility	Effectiveness	Cost	Proposed funding	Time	Difficulty to implement	Degree of consistency with local comprehensive plans and water management programs
Require nitrogen reducing technologies for onsite septic systems:	WGD			estimated installation costs $20,000, yearly operational costs about $1,500, recirculating sand filters, carbon systems, old system retrofits cost $5,000-7,000 per system				
Explore public investment in waste to energy technology	WGD							
Promote new products that are found through research	WGD							
Promote markets for those products	WGD							
Use commodity group "check off" money for research and development	WGD							
BMPs								
Inform farmers of those BMPs prioritized by Livestock/CAFO and Irrigated Agriculture Work Groups from HDR list to reflect greatest effectiveness in nitrate reduction	WGD							
Determine who implements the BMP and who monitors it and the time frame in which to measure/monitor it--problem with available expertise, timing, installation cost	WGD							
Identify and publish a list of poor management practices. Recommend that they be terminated or avoided.	JD							
Establish a BMP monitoring well network. Monitor BMP performance and effectiveness with the monitoring well network first, then monitor water quality.	Bowen: Having a monitoring plan for the BMP's in place is part of the work the GWAC is required to do.							

Alternative land and water use management strategies for reaching program goals and objectives per WAC 172-100-100(4)		Evaluation Criteria per WAC 173-100-100 (4)						
Action	Proposed by	Feasibility	Effectiveness	Cost	Proposed funding	Time	Difficulty to implement	Degree of consistency with local comprehensive plans and water management programs
Livestock								
Recommend that dairies and CAFOs use those Best Management Practices contained within Attachment B to the Livestock/CAFO Work Group's Report to GWAC	L/C WG	Feasable	GWAC has not reached consensus that pursuing this recommendation alone would accomplish Goals # 1, 2.					
Encourage the WSDA and Conservation Districts to continue education and outreach to livestock operators about impacts and practices related to compliance with relevant State and federal requirements for groundwater protection, particularly addressing those not currently acting in good faith toward that objective.	L/C WG	Feasability depends upon available resources		2 additional FTE's cost ?	Industry, government, private or public research and development, foundations, and industry associations.			
Implement an Education and Outreach Program (EOP) informing producers of Best Management Practices (BMP's) including increased funding for the DNMP assistance program.	L/C WG							
Create and maintain a central depository of public information online, as part of an Education and Outreach Program (EOP) informing producers of the nitrate issue, community impacts, and Best Management Practices (BMP's).	L/C WG				Industry, government, private or public research and development, foundations, and industry associations.			
Increase funding for the local Conservation District and Natural Resources Conservation Service (NRCS) so that assistance programs for nutrient management planning, engineering, cost share, and loan funds are more available.	L/C WG				Industry, government, private or public research and development, foundations, and industry associations.			
Streamline current enforcement activities so as to improve customer service and protocols, increase clarity of process, escalate enforcement for facilities not following management practices, identify methods to discourage repeatedly unfounded complaints, and improve overall transparency.	L/C WG							

Alternative land and water use management strategies for reaching program goals and objectives per WAC 172-100-100(4)		Evaluation Criteria per WAC 173-100-100 (4)						
Action	Proposed by	Feasibility	Effectiveness	Cost	Proposed funding	Time	Difficulty to implement	Degree of consistency with local comprehensive plans and water management programs
Collect data to track water quality improvement progress and nutrients generated, applied, or exported within the LYV GWMA. Generate data through soil testing, Ambient Groundwater Monitoring Plan implementation - including purpose built and existing wells, sampling of liquid and solid waste to be field applied, composted, or exported, the CAFO General Permit, and tracking nutrients applied by non-dairy operations.	L/C WG							
Support and advocate private, public, and industry investment in technology, including at research institutions, specific to addressing nitrate contamination in groundwater, especially where it creates improvements for the public good.	L/C WG							
Require more complete disclosure of Dairy Nutrient Management Plans.	WGD							
Incentivize technology and management of fertilizers and manures.	WGD							
Install separation systems--separate liquids from solids.	WGD							
Use anaerobic digestion in waste storage lagoons	WGD			Very expensive				
Install liners in liquid waste storage lagoons.	WGD							
Install impervious surfaces beneath silage/feed storage.	WGD							
Revise WAC 246-203-130 so that it defines "health hazard" and "nuisance" and includes specific and enforceable requirements designed to protect human health.	WGD, JD							
Compost more manure	WGD							
Improve composting regulations	WGD							
Provide underlying soils information to each livestock opeeration so that individual evaluations can be made.	JD							
Remove wastes from barnyards and other areas of animal concentrations and frequently convey them to waste storage or treatment facilities.	JD							
Prevent contaminants from flowing into wells by ensuring that the external areas around well casings are properly sealed and that wastes are kept the recommended distance from wells.	JD							
Entrain water (as rain or snow-melt) collected from roofs away from animal pen or manure collection facilities.	JD							
Drain low areas where ponds accumulate to collect and manage waste waters.	JD							
Treat manure supply in excess of that which can reasonably be applied as nutrient to agricultural lands as a “waste” product. Apply waste management strategies including land disposal at designated site, incineration, centralized waste-to-energy facility.	JD							
Create a state CAFO Siting Team, composed of representatives of relevant state agencies with support from USGS, to which the county commission could refer proposed CAFO sitings or expansions. The CAFO Siting Team would provide a recommended site suitability determination, based upon a predetermined scoring system, including description of environmental risk factors and mitigation strategies.	WSDA, Gary Bahr							
Amend Dairy Nutrient Management Act to extend WSDA’s authority t land application acreage with which dairy facilities contract pursuant to nutrient management plans.	JD							

Alternative land and water use management strategies for reaching program goals and objectives per WAC 172-100-100(4)		Evaluation Criteria per WAC 173-100-100 (4)						
Action	Proposed by	Feasibility	Effectiveness	Cost	Proposed funding	Time	Difficulty to implement	Degree of consistency with local comprehensive plans and water management programs
Collect data to track water quality improvement progress and nutrients generated, applied, or exported within the LYV GWMA. Generate data through soil testing, Ambient Groundwater Monitoring Plan implementation - including purpose built and existing wells, sampling of liquid and solid waste to be field applied, composted, or exported, the CAFO General Permit, and tracking nutrients applied by non-dairy operations.	L/C WG							
Support and advocate private, public, and industry investment in technology, including at research institutions, specific to addressing nitrate contamination in groundwater, especially where it creates improvements for the public good.	L/C WG							
Require more complete disclosure of Dairy Nutrient Management Plans.	WGD							
Incentivize technology and management of fertilizers and manures.	WGD							
Install separation systems--separate liquids from solids.	WGD							
Use anaerobic digestion in waste storage lagoons	WGD			Very expensive				
Install liners in liquid waste storage lagoons.	WGD							
Install impervious surfaces beneath silage/feed storage.	WGD							
Revise WAC 246-203-130 so that it defines "health hazard" and "nuisance" and includes specific and enforceable requirements designed to protect human health.	WGD, JD							
Compost more manure	WGD							
Improve composting regulations	WGD							
Provide underlying soils information to each livestock opeeration so that individual evaluations can be made.	JD							
Remove wastes from barnyards and other areas of animal concentrations and frequently convey them to waste storage or treatment facilities.	JD							
Prevent contaminants from flowing into wells by ensuring that the external areas around well casings are properly sealed and that wastes are kept the recommended distance from wells.	JD							
Entrain water (as rain or snow-melt) collected from roofs away from animal pen or manure collection facilities.	JD							
Drain low areas where ponds accumulate to collect and manage waste waters.	JD							
Treat manure supply in excess of that which can reasonably be applied as nutrient to agricultural lands as a "waste" product. Apply waste management strategies including land disposal at designated site, incineration, centralized waste-to-energy facility.	JD							
Create a state CAFO Siting Team, composed of representatives of relevant state agencies with support from USGS, to which the county commission could refer proposed CAFO sitings or expansions. The CAFO Siting Team would provide a recommended site suitability determination, based upon a predetermined scoring system, including description of environmental risk factors and mitigation strategies.	WSDA, Gary Bahr							
Amend Dairy Nutrient Management Act to extend WSDA's authority t land application acreage with which dairy facilities contract pursuant to nutrient management plans.	JD							

Alternative land and water use management strategies for reaching program goals and objectives per WAC 172-100-100(4)		Evaluation Criteria per WAC 173-100-100 (4)						
Action	Proposed by	Feasibility	Effectiveness	Cost	Proposed funding	Time	Difficulty to implement	Degree of consistency with local comprehensive plans and water management programs
Irrigated Agriculture								
Anecdotal results of deep soil sampling carried out by SYCD with farmers with pre-existing relationship with SYCD were informative. Word-of-mouth reporting within farmer community greatly increased acres sampled. Establish a multi-year deep soil sampling program where farmers subscribe for a duration with pre-determined fiscal remuneration for completed sampling. Cost share with farmer. Farmer to provide checklist indicating performance with BMPs. Test throughout growing year, in order to observe effects of fertilization throughout year. Share data with public.	WGD			Expensive	Federal or State			
Do deep soil sampling on fields within GWMA that apply biosolids.	WGD							
Make shallow (1, 2, 3 foot) soil testing reports prerequisites for funding, lending or building permits.	WGD							
Hire soil scientists to do publicly funded "spot auditing" soil checks for feedback to farmers and fertilizer sellers.	JD							
Incentivize development and provide information about improvements made in nutrient management and agronomic rate application of fertilizer by specific developing technologies	JD							
Commission the creation of a data assembly software that could receive, translate, assemble and analyze the data produced by agricultural equipment technology manufactured by different agricultural equipment manufacturers, so as to permit integration of data per field, crop or enterprise.	WGD, Doug Simpson							
Monitor nitrate concentrations of irrigation water at headgates.	JD							
Stimulate news coverage of progress in irrigation technology.	WGD							
Land acquisition—purchase properties with greatest nitrate contribution and retire uses that generate nitrate.	JD							
Incentives—provide credit against county real property tax for investment in source abatement.	WGD							
Develop farmer-specific irrigation water use programs including collection of data, records of irrigation management, education of farmer regarding new processes and technology.	WGD							
Create irrigation management plans (similar to nutrient management plans) for farms over a minum size and provide financial assistance for implemented plans.	WGD							
Encourage advanced irrigation management. Recognizing that there is significant cost involved in changing an irrigation system, look for strategic opportunities in the area where the use of more advanced irrigation management systems could have the greatest benefit for reducing nitrogen impacts to groundwater. One example of advanced irrigation management is electronic sensor irrigation water management (IWM). Identify federal, state and local incentive programs, such as grants, and low interest loans, to facilitate a transition to more advanced irrigation management in those areas	EPA Region 10							
Provide funding for a mobile irrigation lab to assess the efficiency of current or advised irrigation practices, either through a singular lab or component parts.	WGD							

Alternative land and water use management strategies for reaching program goals and objectives per WAC 172-100-100(4)		Evaluation Criteria per WAC 173-100-100 (4)						
Action	Proposed by	Feasibility	Effectiveness	Cost	Proposed funding	Time	Difficulty to implement	Degree of consistency with local comprehensive plans and water management programs
Provide financial assistance for 1) conversions from rill irrigation to sprinkler or drip irrigation, 2) installation of flow meters and moisture meters to reflect over-irrigation, high water table, drought conditions, 3) the cost of hiring third party sampling , measuring equipment, personnel or self-test kits, 4) management of sprinkler systems so they do not drive nutrients past the root system.	WGD							
Establish a voluntary irrigation management cost-share program with SYCD. Data shared with public.	WGD							
Manage sprinkler systems so they do not drive nutrients past the root system.	WGD							
Advise farmers of the relative propensity of wheel lines, center pivots, and drip lines to cause leaching.	JD							
Use available techniques to determine how much and when irrigation is needed instead of irrigating according to a prearranged schedule.	JD							
Schedule water and nitrogen application according to the need for optimal crop yields.	JD							
Analyze irrigation practices to discover whether frequency or volume creates greater propensity for leaching.	JD							
Identify and decommission abandoned agricultural irrigation wells.	JD							
Upgrade irrigation districts' open, earthen or concrete delivery laterals and head ditches to PVC pipe.	JD							
Route irrigation-return flow through a constructed managed wetland to reduce concentrations of nutrients and suspended sediment.	JD							
Add polyacrylamide (PAM) to irrigation water.	JD							
Install effective backflow prevention devices on supply lines of water supplied from groundwater wells to avoid backflow from chemigation.	JD							
Structure irrigation water pricing by volume per acre used with preference for lower volume use.	JD							
Improve micro-irrigation system design and operation.	JD							
Recommend that irrigation districts be authorized to condition delivery of irrigation water on irrigation practices consistent with agronomic rate of application of water.	WGD							
Require irrigated agriculture nutrient management plans. Record the source and type of fertilizer and number of acres fertilized with each.	WGD							
Establish water use "domains" (zones) to apply water use constraints, or well construction design constraints, for agricultural uses.	JD							
Develop and implement Nutrient Management Plans (NMPs) for all producers (those that apply manure and those that apply synthetic fertilizer that include annual soil testing for phosphorus and nitrogen and which follow available guidance (i.e. Land Grant University) for developing appropriate land application rates for phosphorus and nitrogen. These NMPs can identify site specific conservation practices that are, or will be, implemented to minimize the transport of phosphorus or nitrogen to surface and ground waters. NMPs that are "adaptive" -- adjusted based on annual soil tests, the types of crops grown, and other site or field specific factors – allow producers to adjust their plans and practices as new information becomes available.	EPA Region 10							

Alternative land and water use management strategies for reaching program goals and objectives per WAC 172-100-100(4)		Evaluation Criteria per WAC 173-100-100 (4)						
Action	Proposed by	Feasibility	Effectiveness	Cost	Proposed funding	Time	Difficulty to implement	Degree of consistency with local comprehensive plans and water management programs
Provide funding for nutrient management education or information distribution.	WGD							
Make Nutrient Management Plan records available upon Department of Agriculture determination of potential excessive application of nutrients.	JD							
Incentivize investment in crops that require less fertilization, or which take up greater amounts of nitrogen.	JD							
Distribute information to farmers on what can happen with applied manure, what should be applied and reasonable, agronomic rates of application.	WGD							
Integrate use of animal waste and synthetic fertilizer, balancing nutrient application amounts so as to maximize crop production and full nitrogen uptake.	JD							
Track nutrients and their application regardless of the end user, including commercial fertilizer.	L/C WG		Nutrients from animal waste are tracked now while in the control of dairy operations. Once those nutrients are transferred to a third party no further regulation exists.					
Keep track of synthetic fertilizer sales.	WGD							
Avoid fertilizer material and manure spills during transport, storage, and application.	WGD							
Use effective application schedules, placement, rate and time of application and speed of release for specific crop requirements.	JD							
Where possible, apply nitrogen through to plant-specific root zone means, rather than broadcast application.	JD							
Identify areas with highly permeable and susceptible soils where fertilization and pesticide application should be most carefully managed.	JD							
Amend Yakima County Code 16C.09.070 to include excess fertilizer application to list of prohibited uses within critical aquifer recharge areas.	WGD							
Amend the list of prohibited uses under the Critical Aquifer Recharge Area ordinance 16C.09.070 (6) to include "activities that would add nutrients to the soil column beyond those amounts that can be taken up within a reasonable time by plant materials." Or perhaps, activities inconsistent with NCRS Code 590	JD							
Inform farmers that fertilization and supplemental irrigation beyond the optimum rate will not necessarily produce better yields or higher profits without serious side effects.	WGD							
Develop an approach for data collection of volume and location of manure application off dairy sites.	WGD							
Place areawide limitation on number of acres where manure can be spread as fertilizer. Require permit to spread manure as fertilizer. Allow market in permits. Allow dairies to own permits which could be leased to other agricultural properties.	JD							

Alternative land and water use management strategies for reaching program goals and objectives per WAC 172-100-100(4)		Evaluation Criteria per WAC 173-100-100 (4)						
Action	Proposed by	Feasibility	Effectiveness	Cost	Proposed funding	Time	Difficulty to implement	Degree of consistency with local comprehensive plans and water management programs
Intermittent fallowing (leaving lands dormant) to reduce both natural plant nitrogen and fertilizer nitrogen additions to the soil.	JD							
Refrain from tilling under herbaceous remnants of prior crops, reducing plant nitrogen contributions to soil column.	JD							
No Action								
Consider costs of health risks to families from nitrate exposures, costs incurred by growers and producers of various recommendations, costs of bottled water, costs to connect to public sewage systems, cost for WSDA to monitor DNMP, costs of soil sampling	WGD							

Appendix H: Consensus list of potential recommendations with which no one would disagree and could be evaluated pursuant to WAC 173-100-100 (4).

	Recommend To:	Recommendation	Details	Feasible?	Effective?	Cost?	Proposed funding?	Time?	Difficult to implement?	Consistent with local comprehensive plans and water management programs?
	Education									
1	DOH, Yakima Health District, Lead Agency	Develop a health-risk education and outreach campaign	Establish a public education program regarding nitrate pollution and health risk over a 5-10 year period. Broaden the pool of people GWMA is educating or communicating with. Provide all materials distributed to the public in English and Spanish. Provide education about concepts that people can understand.Billboard campaign – urging well testing. Partner with UW Pediatric Environmental Health Specialty Unit (PEHSU) to continue training local healthcare providers to recognize and address Nitrate risk in their patients (pregnant women and infants up to six months)	Feasible	Effective	$50K; $100K (5 Year plan)	Ecology, Legislature	2019 Session	Not difficult	Consistent with NS-9.10
2	Yakima Health District	Publish and distribute homeowner guide on how to maintain septic systems		Feasible	Effective	Part of previous item cost.	Ecology, Legislature	2019 Session	Easy	Consistent with NS-9.6
3	OSPI, ESD 105	Develop educational materials that could be elected by instructors at 8-12 levels about aquifer protection, groundwater and best management practices.		Feasible	Effective depending on use	$10K. Contract with educational consultant; see what materials/models out there already	County General Fund	One year	Difficult to fit into curriculum	Consistent with NS-9.6, 9.10
4	Lead Agency	Develop an urban and hobby agriculturalist education and outreach campaign.	Provide information targeted to small farm/hobby farm/ranchettes about manure management. Publish public information about proper septic system construction and operation. Educate the public, particularly in towns, about lawn and garden nitrogen applications' contribution to nitrate concentrations. Recommend against farming around a water well	Feasible	Not Effective, based on prior efforts	$30 K	Legislature	2019 Session	Easy	Consistent with NS-8.2
5	WCC, WSU Extention, DOE, SYCD, WSDA, Lead Entity, Ag Industry Associations	Develop a post-GWAC agricultural producer education and outreach campaign. Create a broad-based advocacy group (e.g., regulatory agencies, AG industry associations such as the Farm Bureau, Dairy Federation, hop growers, wine grape growers and producers) to carry out the educational components. . Create a central repository (e.g., website) of agricultural information that provides technical assistance to growers and producers, provides education on nitrate, and identifies BMPs specific to each local agricultural industry. Address consequences of too much irrigation. Technological improvements in irrigation that permit easier management of water. Descriptions of specific improved technology. Economic viability of technological advancements BMP implementation, irrigation water management, soil nutrient management and manure management and application.	Elements could include: encourage commodity groups to provide education on water management and fertilizer use through regular meetings; distribute information to producers on what can happen with applied nitrogen, what should be applied and reasonable, agronomic rates of application; encourage agencies and subject matter experts to make presentations at trade shows; ask agricultural consultants to share the latest BMP developments with their clients; increase livestock operators' awareness of the need for procedures for proper management of animal wastes and wastewater; provide producers with information on funding sources (e.g., industry, government, educational institutions, industry associations etc.) that will improve their ability to apply BMPs; enlist partners (Farm Bureau/federations/associations) to host workshops/informational meetings regarding GWMA goals and recommendations.	Feasible	Effective	DOE: $100 K /yr; SYCD; $100 K / yr, WSDA $50-100 K / yr	Operating budgets	2019 Session	Ask WCC, WSU	Consistent with NS-9.10
6	SYCD, WCC	Establish a local forum for disseminating information and facilitating technical exchange regarding BMPs for irrigated agriculture and livestock management and groundwater protection.	Prepare a fact sheet/develop outreach campaign to growers that explains agronomic rates, applying nutrients at the right time/right place/right amount. Endorse and distribute materials that will educate producers about the facts related to all fertilizer types, including livestock waste and the science of groundwater protection.	Feasible	Effective depending on attendance	Included in above item	Operating budgets	2019 Session	Easy	Consistent with NS-9.10
7	WSDA, SYCD	Inform farmers of those BMPs prioritized by Livestock/CAFO and Irrigated Agriculture Work Groups to reflect greatest effectiveness in nitrate reduction.	Focus implementation of BMPS based on information and data included in the Nitrogen Availability Assessment, Soil Sampling Program, Ambient Groundwater Monitoring Plan, USGS Reports, and other similar scientifically based publications. GWMA: Publish lists as appendices to GWMA Program. WSDA: Adopt a llist Lower Yakima Valley GWMA-specific BMPs; Determine who implements each BMP and who monitors it. Determine the time frame in which to measure/monitor each BMP. SYCD: provide farmer-specific consultation.	Feasible	Effective	Included in above item	Operating budgets	2019 Session	Easy	Consistent with NS-9.6
8	WSDA, SYCD	Encourage appropriate use of surface banding ("dribblling," "stripping" of liquid fertilizer, "broadcasting" or prompt incorporation of manures and fertilizers after application to cropland..	broadcast is effective for corn, alfalfa, triticale. Incorporation should occur within 24 hours.	Ask WSDA	Effective	Included in above item	Operating budgets	2019 Session	Ask WSDA	Ask WSDA
9	WSDA, SYCD	Continue to provide underlying soils information to individual livestock operations, provide same for all irrigated agriculture	So that individual property owners can evaluate contamination potential., already in DNMP process	Feasible, info available from NRCS	Effective	Current service of NRCS, SYCD	None	N/A	Easy	Consistent with NS-9.10

	Recommend To:	Recommendation	Details	Feasible?	Effective?	Cost?	Proposed funding?	Time?	Difficult to implement?	Consistent with local comprehensive plans and water management programs?
		Administrative								
1	DOE, Lead Agency, Yakima Health District	Establish or maintain ongoing, extended funding necessary for the Yakima County Department of Public Services and Yakima Health District to actively participate in water quality improvement, testing, monitoring, scientific data analysis, and infrastructure development.	Collect data to track water quality improvement progress and nutrients generated, applied, or exported within the LYV GWMA. Generate data through soil testing, Ambient Groundwater Monitoring Plan implementation - including purpose built and existing wells, sampling of liquid and solid waste to be field applied, composted, or exported, the CAFO General Permit, and tracking nutrients applied by non-dairy operations. Collect, analyze, and interpret data to track water quality improvement progress, nutrients imported, generated, applied, or exported, which will inform the implementation of an Adaptive Management Plan within the LYV GWMA.	Feasible	Effective	DOE $250 K yr. Other cost included in other itemized recommendations	DOE: State operating budget; YHD paid by applicant	2019 Session	Easy	
2	Washington Conservation Commission	Fund SYCD, through State Conservation Commission budget, for projected educational, administrative, nutrient management planning, engineering, cost share, and lending activities.		Feasible,	Effective	Cost included in other itemized recommendations	State operating budget	2019 Session	Easy	
3	SYCD, WSDA	Monitor changes occurring in agricultural operations. Evaluate whether those changes positively affect improvement in groundwater quality.	Requires cooperation of producers & landowners, multi-year effort to account for crop rotation, dry vs. wet years, changing technology, decades to monitor groundwater quality change. WSDA: prepare report to Legislature and Department of Ecology.	Feasible	Effective	$100 K at SYCD; $50 K at WSDA	WCC Operating Budget; WSDA Operating Budget	2019 Session	Requires cooperation of producers	Consistent with NS-9.10
4	Lead Agency	Establish a Lead Agency reponsible for implementation and oversight of the LYV GWMA Groundwater Management Plan and acquisition of stable funding to support their activities.	Administration of Groundwater Quality Program. Administer funds and distribute to other entities by subcontract. Maintain Yakima County's GWMA website. Maintain a GIS data base on the GWMA.	Feasible	Effective	$100 K / yr	Legislature	2019 Session	Not difficult	Consistent with NS-9.10
5	Lead Agency	Perform an engineering study of water supply alternatives.	Possible alternatives: 1) Discontinue use of contaminated shallow wells. Build new 1,500 foot community wells. 2) Rebuild, repair or replace poorly constructed wells. 3) Construct a potable water line from nearby developed area into deadhead water stations at central rural location (permit potable water collection at deadhead water stations). 4) Offer incentives to drill deeper wells or connect households on private wells near community water systems to connect to a community water system. (Nitrate Treatment Pilot Program-June 2011).	Feasible	Effective	$100 K	Legislature	2019 Session	Not difficult	Consistent with NS-9.10, UT-1.1-1.7, 3.1, 3.5, 6.5
6	Lead Agency	Adopt and Implement an Adaptive Management Plan	Utilizing data collected, progress made, or lack of progress, to inform the community on adjustments that need to be implemented. Plan would incorporate necessary adjustments to availabley of technology, education and outreach, tracking exports, land use regulations, treatment systems, and other changes to inform decision makers regarding management changes necessary for a successful program.	Feasible	Effective	$100 K / yr	Legislature	Continuous, 2018-2030	Not difficult, depends on funding	Consistent with NS-9.10
7	EPA, DOE, WSDA	Streamline current regulatory enforcement activities	Improve customer service and protocols, increase clarity of process, escalate enforcement for facilities not following management practices, identify methods to discourage repeatedly unfounded complaints, and improve overall transparency.	Feasible	Effective	$ 0 - $ 300 K / yr, WSDA $100 K	Legislature	2019 Session	Not difficult	Consistent with NS-9.10
8	DOE, WSDA	Improve composting regulations (statutory)	Unclear as to particular reguations proposed	Yes	Potentially effective. .	$50 K	Legislature	2019	Unceertain	Consistent with NS-9.2 , 9.6, 9.10
9	DOE	Inspect, monitor and regulate stockpiled manures.	Coordinate with WSDA. Currently being done; currently required as part of dairy nutrient management plans	Feasible	DOE:	$0 (part of current work)	NA	2018	Not difficult	Consistent with NS-9.2 & 9.4 & 9.10
10	DOE	Review applications for and issue exemptions for agricultural composting operations in a manner that protects public health and the environment, as required by state rules and regs		Feasible	Currently being done	$0 (part of current work)	NA	2018	Not difficult	Consistent with NS-9.2 & 9.6 & 9.10
11	DOE	Provide assistance to local departments of health regarding the regulation of agricultural composting operations		Feasible	Currently being done	$0 (part of current work), 1/4 FTE/yr	NA	2018	Not difficult	Consistent with NS-9.2 & 9.6 & 9.10
12	DOE	Analyze the trends of nitrate data contained within reports required by NPDES and SWD permits.		Feasible	Currently being done	$0 (part of current work), 1/4 FTE/yr	NA	2018	Not difficult	

	Recommend To:	Recommendation	Details	Feasible?	Effective?	Cost?	Proposed funding?	Time?	Difficult to implement?	Consistent with local comprehensive plans and water management programs?
13	DOE,	Develop a plan for finding and decommissioning abandoned wells in the next 12 months, using the LYVGWMA as a pilot project.	Educate the public regarding liability of an ill-secured well, and the importance of the integrity of wells, particularly those without a well log. Educate realtors and banking industry officials about disclosure of abandoned wells in property transfers. Compare Google Earth to GIS images to determine where building or usage changes indicate possible well usage changes. Focus first on hotspot high density areas in GWMA. Ground truth suspected problem wells. Offer incentives, for property owners to identify and properly abandon wells. Offer grant funding to Yakima Health District or professional engineers for well inspections and to assist in abandoned well decomissioning. Provide some form of protection for self-reporting of abandoned or improperly decommissioned wells.	Feasible	Unknown	$30-50 K / yr	Legislature	Two years	Difficult	Consistent with NS-8.2, 9.2, 9.8, 9.10, UT-4, 6.1, 6.5, 7.2, 8, 12.5, 13.1
14	DOE	Require facility process improvements in waste treatment and food processing plants to reduce nitrogen and total discharge volume.	Addressed by Department of Ecology General Permit for Food Processing, specific problems can be addressed through "special protection areas, " WAC 173-200-090.	Difficult, in general, feasible in specific	Uncertain	$20 K administrative cost. Costly to fruit processing facilities	DOEOperating Budget, Private	2019	Requires amendment to state Water Pollution Control Act (RCW 90.48)?	
15	DOE, EPA	Study the relationship between nitrogen emissions and atmospheric deposition of reactive nitrogen. Develop a model that predicts what percentage of emissions return to the GWMA area as atmospheric deposition.		Feasible, but inconsequential	Not effective, has deminimus impact on problem	Cost disproprotionate to benefit		2019-2122	Possible	Consistent with NS-3.1, 3.2, 3.3, 8.1
16	WDOH	Determine, prior to issuing or reissuing LOSS permits, that all employee counts are regularly reported.	So that the LOSS will continue to operate as designed.	Feasible, already being done	Effective	$0 part of current work	DOH operating budget	2018	Easy	Consistent with NS-9.3 & 9.4
17	WDOH	Revise WAC 246-203-130 (keeping of animals)	So that it includes specific and enforceable requirements designed to protect human health.	Feasible	Effective	$200K	Legislature	2019 Session	Not difficult	Consistent with NS-9.10
18	WSDA	Design and implement pilot studies focusing on innovative farm techniques which reduce nitrogen loading to crops and monitor results..		Feasible	Effective	$ 25 K	WSDA operating budget			
19	WSDA	Document and publish regulatory compliance for dairies within the GWMA that are completing and implementing Dairy Nutrient Management Plans (DNMP).	Explore the possibility of disclosing non-proprietary data produced through the DNMP process. Summarize the DNMP reporting and provide information that would disclose the amount of manure the CAFO's in the GWMA create and where it is distributed.	Feasible	Effective	$ 50 K	WSDA / DNMP operating budget	2018	Easy	Consistent with NS-9.10
20	DOE, Yakima Regional Clean Air Agency, WSDA	Estimate emissions of reactive nitrogen - gaseous nitrogen oxides (NO_x), ammonia (NH_3), nitrous oxide (N_2O), the anion nitrate, NO_3^- -from animal agriculture, manure and fertilizer applications in the Lower Yakima Valley. Use this to inform the nitrogen balance data base for the GWMA area and refine estimates of atmospheric deposition.	Use this to inform the nitrogen balance data base for the GWMA area and refine estimates of atmospheric deposition.	Not Feasible CAA Not Willing		"big and expensive"				Consistent with NS-3.1, 3.2, 3.3, 8.1
21	WSDA	Establish a monitoring system for compliance with NRCS Standard 317 on new composting facilities at Washington dairies (phased in for existing facilities).		Feasible but inconsequential	Ask WSDA	Ask WSDA	Ask WSDA	Ask WSDA	Ask WSDA	Ask WSDA
22	Yakima Health District	Issue permits for agricultural composting operations, to appropriately inspect composting operations and to enforce regulations that protect public health and the environment, as required by state rules and regs.		Feasible, requires authorization from County Board of Health	Effective	$10K, depends upon number of composting facilities	Legislature, balance funded by permit applicant.	2019	Not difficult	Consistent with NS-9.2 & 9.6 & 9.10
23	Yakima Health District	Require new developments outside towns to address potential impacts on groundwater quality	Through permitting review of site plan criteria.	Feasible	Effective	Approx. $25-50 K Costly for developer & purchaser	Developer/ purchaser	Decades	Requires BOCC approval	Consistent with NS-8.2
24	Yakima Health District	Study potential nitrate contamination attributable to improperly operated septic systems.	Consider restoration/retrofit of older septic systems through incentives or county property tax breaks. Require nitrogen reducing technologies for onsite septic systems where appropriate. Assist hobby farmers to locate ROSS drain fields on their property so as to avoid animal farming over the drain field.	Feasible	Effective	$700 per applicant for system repair permit application fee. 100 applicants subsidezed = $70K; subsidize cost of reconstruction = $500K	permit applicant	2020	Not difficult	Consistent with NS-9.2 & 9.3 & 9.10
25	Yakima Health District	Issue permits for agricultural composting operations, to appropriately inspect composting operations and to enforce regulations that protect public health and the environment, as required by state rules and regulations.		Uncertain	Uncertain	Cost would be charged to permittee	Perrmit applicant	?	?	Consistent with NS-9.2 & 9.6 & 9.10
26	Yakima County Building Department	Require new developments to address potential impacts on groundwater quality. Limit new development utilizing septic system where soil filtration rate is high, where housing density is already big, where nitrate concentration is already great downstream of the septic plume. Consider the nitrate density element (# of systems per-area) when approving proposed septic systems in order to reduce the nutrient nitrogen in domestic wastewater discharged from OSS.	Recommendations for conditions on issuance of building permits. Determine "density" evaluation criteria. Including those technologies verified by the U.S. EPA's Environmental Technology Verification Program: fixed film trickling filter biological treatment, media filter biological treatment, and submerged attached-growth biological treatment. Recommend use of anaerobic digestion in waste storage lagoons as a best management practice.	Feasible; Not Feasible for YHD, Would need authorization from County Board of Health. Feasible for YC Planning	Effective	Approx. $10-50 K; Costly for developer & purchaser. $410 per applicant for septic permit from YHD; Building permit application fee	Developer / purchaser / permit applicant	Decades	Requires BOCC approval. Requires knowledge of specific area soils and current septic densities.	Consistent with NS 8.2; NS-9.2 & 9.3 & 9.10; Inconsistent with NS-9.7

	Recommend To:	Recommendation	Details	Feasible?	Effective?	Cost?	Proposed funding?	Time?	Difficult to implement?	Consistent with local comprehensive plans and water management programs?
		Data Collection and Monitoring								
1	DOE, DOH	Establish time-based performance objectives against which well-monitoring data can be compared. Establish criteria by which to measure whether performance of nitrate reduction strategies is successful.	E.g., number of at risk wells, BMP implementation, funding success, reduction in number of underperforming farming practices. Use both method-based measurement and performance-based measurement.	Feasible, depends upon immediacy of expectations	Effective in measuring attainment of objectives	DB: $200-250K / Yr; GS 25 K, 1/4 FTE	DOE, DOH Operating Budget	2019 Session	Difficult; need to define timeframe for water quality improvement	Consistent with NS-9.10
2	Yakima County Public Works	Install Ambient Groundwater Monitoring Wells	Monitoring well construction: Monitoring well data collection:	Feasible	Effective	$700,000 in hand, balance uncertain;	Balance from DOE Capital Budget	2019 Session	Already designed, to be installed before 12/31/18	
3	YHD	Collect data from Ambient Groundwater Monitoring Wells	Study short-term seasonal variations in nitrate concentrations over next year or two.--addresses 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.	Feasible	Effective	$20K / year	DOE Operating Budget			
4	Irrigation Districts	Monitor nitrate concentrations of irrigation water at headgates.	Report nitrate concentrations annually to Department of Ecology	Feasible	Effective	$30 K	Ratepayers or DOE grant	2019	Ditch-rider expense	
5	USGS	Contract with USGS to collect data from water well system per 2017		Feasible	Effective	$300K				
6	USGS	Contract with USGS to do particle tracking model study to indicate where groundwater moves faster (permeability).	USGS Particle Tracking Model Overview--potentially combined with MT3D MODFLOW application to the vadose Zone	Feasible, already exists	Unknown	$50K Agency Memo only, $500 + K for 5-year study	Legislature	2019 Session	Easy	
7	WSDA, DOE, Lead Agency	Assess Nitogen Loading. Building from the WSDA's Nitrogen Availability Assessment, develop a Nitrogen Loading Assessment for all agricultural, residential and commercial properties, using newly collected data.	Hire a technical consultant to conduct a literature review to determine the most relevant information and accurate factors for use in the Nitrogen Loading Assessment. Periodically repeat the grower survey used in the NAA to compare against currently established data. Collect data on how many acres in the GWMA are fertilized in various crops with manure and/or commercial fertilizer. Update and monitor the percentage of acreage in various crops, particularly silage corn and field corn. Study effect nitrogen contribution from cover crops. Determine acreage for triticale. Discover commercial fertilizer tonnage for Yakima County and/or for GWMA. Explore how much nitrogen leaches into groundwater from drains and wasteways. Study atmospheric deposition more comprehensively. Understand the difference between plant uptake and plant removal of nitrogen. Ask EPA to use its CMAQ model, or other tools, to estimate emissions of reactive nitrogen - gaseous nitrogen oxides (NOx), ammonia (NH_3), nitrous oxide (N_2O), the anion nitrate, NO_3,- from animal agriculture, manure and fertilizer applications.. Use this to inform the nitrogen balance data base and refine estimates of atmospheric deposition.	Feasible	Dependent upon completion of NAA & GWAC resolution of course of action	WSDA $1 million. DOE $250 K	WSDA, DOE Operating Budget	Dependent upon completion of NAA & GWAC resolution of course of action	Dependent upon completion of NAA & GWAC resolution of course of action	Consistent with NS-9.10
			Water							
1	WSU	Provide funding to WSU for a mobile irrigation lab to assess the efficiency of current or advised irrigation practices, either through a singular lab or component parts.	Inform farmers of the relative propensity of wheel lines, center pivots, and drip lines to cause leaching and that fertilization and supplemental irrigation beyond the optimum rate will not necessarily produce better yields or higher profits without serious side effects.. Advise re corn and triticale water practices.	Feasible	Effective	Approx. $100 K / yr (IAWG)	WSU Operating Budget	2019 Session	Not difficult	Consistent with NS-9.10, 12.1, 12.2, 12.4
2	SYCD, WSDA, WSU	Create Irrigation Management Plans (similar to Nutrient Management Plans) for farms over a minimum size and provide financial assistance for implemented plans.	Use available techniques to determine how much and when irrigation is needed instead of irrigating according to a prearranged schedule. Analyze irrigation practices to discover whether frequency or volume creates greater propensity for leaching. Manage sprinkler systems so they do not drive nutrients past the root system. Improve micro-irrigation system design and operation. Schedule water and nitrogen application according to the need for optimal crop yields. Monitor the timing of application of fertilizers to fields and how much water was then applied.	Difficult	Effective	WCC $200 K / yr; SYCD $200 K / yr	WCC , WSU Operating Budgets	2019 Session	Difficult, plans are property-specific,	Consistent with NS-9.10, 12.1, 12.2, 12.3
3	WSU, SYCD, WSDA, WCC	Encourage advanced irrigation management. Integrate management of synthetic/organic fertilizers and application of water	Recognizing that there is significant cost involved in changing an irrigation system, look for strategic opportunities where the use of more advanced irrigation management systems could have the greatest benefit for reducing nitrogen impacts to groundwater. One example of advanced irrigation management is electronic sensor irrigation water management (IWM). Identify federal, state and local incentive programs (like EQIP), such as grants, and low interest loans, to facilitate a transition to more advanced irrigation management in those areas. Provide financial assistance for 1) conversions from rill irrigation to sprinkler or drip irrigation, 2) installation of flow meters and moisture meters to reflect over-irrigation, high water table, drought conditions, 3) the cost of hiring third party sampling , measuring equipment, personnel or self-test kits, 4) management of sprinkler systems so they do not drive nutrients past the root system. Establish a voluntary irrigation management cost-share program from which data may be shared with the public.	Feasible	Effective	$25 million (18 K acres of rill irrigation in GWMA @ $3 K / acre, split 50/50 with landowner) $36 million @ $4 K / acre.	Identify federal, state and local incentive programs (like EQIP), such as grants, and low interest loans, financial assistance	Short & Long-Term		Consistent with NS-9.10

	Recommend To:	Recommendation	Details	Feasible?	Effective?	Cost?	Proposed funding?	Time?	Difficult to implement?	Consistent with local comprehensive plans and water management programs?
		Public Works								
1	Municipalities	Provide funding for municipalities to replace aging sewer system infrastructure and ensure proper system maintenance to reduce nitrate leaching.	Municipalities need to estimate costs and system integration.	Feasible	Effective	$10 million	Congress, Infrastructure Bill	Decades	Requires upgrades to meet all current standards	Consistent with UT-1.3, 1.6, 11.5, 11.6, 11.7
2	Lead Agency	Encourage municipalities within the GWMA to extend municipal sewer systems within urban growth areas and retire ROSS and LOSS., alternatively extend public water systems. Encourage connection of residences within urban growth zones to sewer systems extended by municipalities		Feasible	Effective	$5 million	Congress, Infrastructure Bill	Decades	Hasn't been accomplished to date	Consistent with UT-1.3, 1.6, 11.5, 11.6, 11.7
		Research and Development								
1	EPA, DOE	Identify and support opportunities, including educational research institutions, for private, public, and industry investment in technology specific to addressing nitrate contamination in groundwater.	EPA & DOE construct a LYVGWMA Program for coordinated implementation.	Feasible	Effective	$100-250 K / yr	Agency budgets	2018	Easy	
2	WSDA	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.	WSDA construct LYVGWMA administrative program.	Feasible	Effective	$1.75-$4 million, WSDA $10 million	WSDA Capital Budget	2018	Easy	
3	USDOE, USDOA	Explore investment in animal and agricultural waste to energy technology	Explore state of technology, economic viability, return on investment (national corporate research & development/ governmental incentives)	Feasible	Effective	Included in item above	Congress, Energy Bill	2020	Easy	Consistent with NS-9.10
4	WSU Extension Service	Continue research of water management with application of agricultural nutrients.	Develop water sorption graph or chart. List volumes of water applied, soil types, infiltration rates, water holding capacity, absorption/compaction rates, depths to water, pre-season and post-season appropriate moisture levels, evapotranspiration rates.	Feasible	Effective	$250 K	WSU Operating Budget	Five years	Continuous effort	
5	WSU, Producers	Integrate use of animal waste and synthetic fertilizer.	Research chemical integration of animal waste and synthetic ferlizers with objective of balancing nutrient application amounts in order to maximize crop production and full nitrogen uptake.	Feasible	Effective	$250 K	Private, WSU Operating Budget	Ongoing, 2019 Session	Not difficult, but requires knowledge of soil chemistry	Consistent with NS-9.10
6	WSDA, WSU	Quantify the nutrient value and rate of release of nitrate from livestock waste under various Lower Yakima Valley conditions to become part of nutrient management guidelines.		Feasible	Effective	$500 K. $100 K	WSDA, WSU Operating Budgets	2019 Session	Difficult without knowledge of sub-area soil chemistry and moisture information	Consistent with NS-9.10
7	WSDA	Develop strategies for marketing the economic, fertilizer value, and soil enhancing properties of appropriate application of manure and other livestock wastes.		Feasible	Effective	$25 K	WSDA Operating Budghet	2019 Session	Ask WSDA	Consistent with NS-9.10
8	WCC	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.		Feasible	Effective	$1 million	WCC Capital Budget	2019 Session	Not difficult	
9	Legislature	Require Commodity Commissions to dedicate "check off" money for research and development in water quality technology and practices.	include in funding alternatives for technology R & D	Feasible	Effective	Portion of other estimates above.	CC Members	2019	Research CC statutes	
10	USDOE, USDOA	Explore investment in animal and agricultural waste to energy technology	Explore state of technology, economic viability, return on investment (national corporate research & development/ governmental incentives)	Feasible	Effective	$1 million	Congress	2020	Easy	Consistent with NS-9.10
11	SYCD, WSDA, WSU, Private Industry, Producers	Educate producers regarding aplication of nutrients at Agronomic Rate	Develop technologies and provide information about improvements made in nutrient management and agronomic rate application of fertilizer by specific developing technologies.	Feasible	Effective	Dependent on technologies included in combined education recommendation GB $500,000	Private, Legislature	Ongoing, 2019 Session	Dependent on technologies	Consistent with NS-9.10

	Recommend To:	Recommendation	Details	Feasible?	Effective?	Cost?	Proposed funding?	Time?	Difficult to implement?	Consistent with local comprehensive plans and water management programs?
		Agriculture								
1	NRCS, DOE	Provide financial assistance for implementation of Irrigation Management Plans.	1) conversions from rill irrigation to sprinkler or drip irrigation, 2) installation of flow meters and moisture meters to reflect over-irrigation, high water table, drought conditions, 3) the cost of hiring third party sampling , measuring equipment, personnel or self-test kits, 4) management of sprinkler systems so they do not drive nutrients past the root system.	Feasible	Effective	$ 1 million one time ($250 K x 4; NRCS EQIP program limited to $450 K per farmer unless new Farm Bill authorization)	Congress (Farm Bill), DOE Capital Budget	2019 Session	Doable	Consistent with NS-9.10, 12.1, 12.2, 12.4
2	DOE, WSDA	Make grants and allocate cost share funding or other funding assistance to people implementing environmental protection measures affecting groundwater quality.	Assign personnel to investigate which environmental protection measures utilized by irrigated agriculturalists and livestock/dairy producers have positive influence on groundwater quality and explore means to share costs of implementing such measures. (Coordinated DOE, WSDA, Conservation District program). See NRCS Environmental Stewardship Program (2012).Also WCC, Voluntary Stewardship Program (Bill Isler), USDA Rural Community Assistance Group environmental program	Feasible	Effective, depending upon definition of "environmental measures"	DOE: $1 million, WSDA: $500 K	DOE, WSDA Capital Budget	2019 Session	Difficult, dependent on interagency communication & relationships with producers	Consistent with NS-9.6, 9.10
3	SYCD, Producers	Develop and implement Nutrient Management Plans for all farmers.	Mandatory or Voluntary. Farming operations currently are not required to hold permits or a prepare a Nutrient Management Plan.	Feasible	Effective	SYCD $200 K, on farm costs born by producer	WCC Operating Budget	Recurrent/ Annual	Not difficult	Consistent with NS-9.10
4	WSDA	Amend the Dairy Nutrient Management Act to extend WSDA's authority to manure application on properties other than those owned by dairies, provide more complete disclosure of Nutrient Management Plans.		Feasible	Effective	$200 K / yr	WSDA Operating Budget	2019 Session	Requires legislative approval	Consistent with NS-9.10. Inconsistent with NS-7.64. (Mutually inconsistent provisions.)
5	SYCD	Establish a multi-year deep soil sampling program where farmers subscribe for a duration with pre-determined fiscal remuneration for completed sampling. Cost share with farmer. Farmer to provide checklist indicating performance with BMPs. Test throughout growing year, in order to observe effects of fertilization throughout year. Share data with public.	Farmers would subscribe for a duration with pre-determined fiscal remuneration for completed sampling. Cost share with farmer. Farmer would provide checklist indicating performance with BMPs. Testing would occur throughout growing year, in order to observe effects of fertilization throughout year. Data grossly accumulated would be shared with public without attribution to individual farmers. Anecdotal results of deep soil sampling carried out by SYCD with farmers with pre-existing relationship with SYCD were informative. Word-of-mouth reporting within farmer community greatly increased acres sampled.	Feasible	Effective	$250 K / year for 5 years to finance extensive deep soil sampling program;	WCC Operating Budget	2019 Session	How to share data is unresolved, public distribution may limit participation by producers & landowners	Consistent with NS-9.10
6	WSDA	Complete NRCS Technical Note 23 inspections on all waste storage ponds (lagoons) within the GWMA boundaries.		Feasible	Ask WSDA	WSDA $20 K	WSDA Operating Budget	2019 Session	Ask WSDA	Unknown
7	Producers	Make capital improvements	Install liners in liquid waste storage lagoons. Install impervious surfaces beneath silage storage.	Feasible	Effective	$10 million	Cost-share/ producers & WSDA (Legislature)	2019	Feasible	Consistent with NS-9.10
8	Legislature	Make shallow (1, 2, 3 foot) soil testing reports prerequisites for funding, lending or building permits.	In the nature of Phase I Environmental Audits. Makes nitrate-related information/data available for water quality management.	Feasible	Effective	$2 k / per mit application	Private	2019	Amend GMA (RCW 36.70A)	

What You Can Do_7 things Well Water Health Finalpng_Page1.docx

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE

What you can do to protect well water

Groundwater Management Area (GWMA):
The purpose of the GWMA is to reduce nitrate contamination concentrations in groundwater below state drinking water standards

Steps to assure you have safe drinking water

Things to consider if you are a private household well owner:

Have your water tested – at least once a year for nitrates and coliform bacteria. High nitrates can harm pregnant women, new-born babies and the elderly, and high bacteria counts can cause illnesses. More information on Lower Yakima Valley Groundwater Management Area at http://www.yakimacounty.us/1617/Ground-Water-Management-Area. A list of certified labs and information on water testing are available online at http://www.yakimacounty.us/344/Drinking-Water-Testing.

Locate all wells on your property, both active and inactive. Make sure to cap your wells securely with manufactured or welded caps to prevent pollution and objects from entering your well.

Have your septic pumped - Neglecting septic system maintenance can result in backed-up sewage, expensive repairs and surface seepage that can pollute your well. A system for a four-person household should be pumped every three years.

Use less water – Not only does your septic system function better with less water, pumping more water from your well can pull nearby pollution toward your home.

Manage fertilizers and chemicals – Excess fertilizer moves easily through the soil and contributes to high nitrate levels. Spilled chemicals can reach your well water. Recycle household and hazardous wastes at the County collection facility. Never dump these items on your property or pour them down the drain.

Shield animal waste – Animal yards and piles of composting manure are sources for nitrates and bacteria. Take steps to prevent runoff and soil seepage.

Install backflow preventers – on all your outdoor faucets. Sometimes water can siphon backwards through a hose and down your well. Be very careful when you attach a chemical sprayer to your hose.

Do your part to keep groundwater safe and clean.

GROUNDWATER MANAGEMENT AREA

The purpose of the Lower Yakima Valley Groundwater Management Area is to reduce nitrate contamination where concentrations do not meet drinking water standards.

GWAC Working Groups

- Data Collection, Characterization, Monitoring
- Education and Public Outreach
- Funding
- Irrigated Agriculture
- Livestock/CAFO
- Regulatory Framework
- Residential, Commercial, Industrial and Municipal

To get involved, call (509) 574-2300

More information at: www.yakimacounty.us

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE

Septic Safety: What you can do

Groundwater Management Area (GWMA):
The purpose of the GWMA is to reduce nitrate contamination concentrations in groundwater below state drinking water standards

Failing septic systems can pollute drinking water wells

Check it, fix it, maintain it:

Bacteria, viruses and other pollutants from the sewage of a failing septic system, may contaminate drinking water wells, groundwater aquifers, lakes, rivers and streams.

A septic system doesn't have to be a problem.

- Get regular inspections and maintenance. Choose a date or time of the year that's easy to remember for the inspection. Mark it on the calendar.
- Regularly pump your system. Typically, once every three years for a four-person household.
- Learn how to keep your system working properly. Be careful what you flush or pour down the drain. No pet waste, medications, grease, or toxic chemicals.
- Watch for clues that your tank is nearing capacity or your system is failing. Got odors? Get someone to check it out right away. Then fix it, if needed.
- Keep trees at least 30 feet from edge of drain field to keep their roots from invading. Never drive over the system.
- Conserve water. Too much can cause solids to escape your tank and plug your drain field.
- Repair or replace your system when it fails or is otherwise inadequate.

Locate your septic tank and drain field:

- Use your property map or follow discharge pipe from your house. Probe the ground with a rod to determine the location of your septic tank.
- Underground pipes distribute wastewater in a drain field. Wet spots can indicate a failing drain field that needs professional attention.

Do your part to keep groundwater safe and clean.

For more information:
http://www.ecy.wa.gov/programs/wq/wqguide/septic.html
http://www.yakimacounty.us/335/Septic-Systems

GROUNDWATER MANAGEMENT AREA

The purpose of the Lower Yakima Valley Groundwater Management Area is to reduce nitrate contamination where concentrations do not meet drinking water standards.

GWAC Working Groups
- Data Collection, Characterization, Monitoring
- Education and Public Outreach
- Funding
- Irrigated Agriculture
- Livestock/CAFO
- Regulatory Framework
- Residential, Commercial, Industrial and Municipal

To get involved, call (509) 574-2300

More information at: www.yakimacounty.us

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE

Small Farms: What you can do

Groundwater Management Area (GWMA):
The purpose of the GWMA is to reduce nitrate contamination concentrations in groundwater below state drinking water standards

Poor manure management can threaten drinking water wells

Collect, cover and compost:

Livestock manure can be great fertilizer. It may also be a source of water pollution when exposed to the weather. If you keep livestock, even just one or two, you have a special role to play in protecting drinking water, groundwater aquifers, rivers and streams.

What can you do to help?

- Use downspouts to direct runoff away from manure.
- Pick up manure from farm yards and paddocks at least every three days.
- Store manure under cover in a convenient site that's sheltered from heavy winds.
- When you use a tarp for a cover, secure it well. The tarp should be durable, heavy-weight and large enough to fully cover the pile.
- Work with the local conservation district office to make a plan and learn how to best handle your manure.
- Build a compost system or have an off-site compost facility collect the manure.

Washington's Dairy Nutrient Management Act requires all licensed dairies to develop and implement nutrient management plans. Large livestock operations must follow confined animal feeding operation (CAFO) regulations to protect water quality.

Good manure management also helps you:

- Prevent parasite re-infestation.
- Keep groundwater clean.
- Build goodwill with your neighbors.
- Support a healthy watershed.

Do your part to keep groundwater safe and clean.

For more information:
http://www.ecy.wa.gov/washington_waters/farms.html

GROUNDWATER MANAGEMENT AREA

The purpose of the Lower Yakima Valley Groundwater Management Area is to reduce nitrate contamination where concentrations do not meet drinking water standards.

GWAC Working Groups
- Data Collection, Characterization, Monitoring
- Education and Public Outreach
- Funding
- Irrigated Agriculture
- Livestock/CAFO
- Regulatory Framework
- Residential, Commercial, Industrial and Municipal

To get involved, call (509) 574-2300

More information at: www.yakimacounty.us

What You Can Do_Well Safety (Abandoned Wells) Finalpng_Page1.docx

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE

Well Safety: What you can do

Groundwater Management Area (GWMA):
The purpose of the GWMA is to reduce nitrate contamination concentrations in groundwater below state drinking water standards

The dangers of uncapped, abandoned or hand dug wells

Capping prevents pollution, serious injuries:

All wells must be securely capped, including those that are not in use, temporarily out of service, or not yet decommissioned, to protect the drinking water and the aquifer from contamination. Proper capping also prevents objects, animals and people from falling into the well.

Common methods of capping wells, include using:

- Manufactured well caps.
- Metal plates welded to the top of the well casing.
- A well-seal/artesian style cap for wells in vaults or located in areas where surface water ponds.

These can be found at pump and water supply stores. Securely attach the cap so that it prevents contamination and unpermitted access to the wells. *Don't use an overturned bucket or loose plate to cover the well casing.*

What to look for when searching for an abandoned well:

Landowners who don't know the history of wells on their property should look for the following when searching for abandoned wells:

- Pipes sticking out of the ground.
- Old well houses.
- Depressions.
- Concrete vaults, pits or tile.
- Metal plates, or old plywood lying on the ground or over concrete tile or vaults.

Do your part to keep groundwater safe and clean.

For more information:
http://www.ecy.wa.gov/programs/wr/wells/abandon-wells.html
https://fortress.wa.gov/ecy/publications/publications/96br097.pdf

GROUNDWATER MANAGEMENT AREA

The purpose of the Lower Yakima Valley Groundwater Management Area is to reduce nitrate contamination where concentrations do not meet drinking water standards.

GWAC Working Groups
- Data Collection, Characterization, Monitoring
- Education and Public Outreach
- Funding
- Irrigated Agriculture
- Livestock/CAFO
- Regulatory Framework
- Residential, Commercial, Industrial, and Municipal

To get involved, call (509) 574-2300

More information at: www.yakimacounty.us

Granjas pequenas_Lo que usted puede hacer_Sp2.docx

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE

Granjas pequeñas: Lo que usted puede hacer

Área de Manejo de Aguas Subterráneas (GWMA):
El propósito de GWMA es reducir concentraciones de contaminación de nitratos en aguas subterráneas por debajo de los estándares de agua potable del estado.

Un mal manejo del estiércol puede amenazar los pozos de agua potable

Recoja, cubra y haga composta:

El estiércol de ganado puede ser un gran fertilizante. También puede ser una fuente de contaminación del agua cuando se expone al clima. Si tiene ganado, incluso solo uno o dos, usted tiene un papel especial que desempeñar en la protección del agua potable, los acuíferos subterráneos, los ríos y arroyos.

Qué puede hacer para ayudar?

- Use canalones para dirigir el escurrimiento de agua lejos del estiércol.
- Recoja el estiércol de los corrales y potreros por lo menos cada tres días.
- Almacene el estiércol bajo cubierta en un sitio conveniente que esté al abrigo de vientos fuertes.
- Cuando utilice una lona como cubierta, asegúrela bien. La lona debe ser durable, pesada y lo suficientemente grande para cubrir totalmente el montón.
- Trabaje con la oficina local de conservación del distrito para hacer un plan y aprender a manejar mejor su estiércol.
- Construya un sistema de composta o busque una planta de compostaje para que recoja su estiércol.

La Ley de Manejo de Nutrientes de Leche de Washington Dairy Nutrient Management Act requiere que todas las lecherías con licencia desarrollen e implementen planes de manejo de nutrientes nutrient management plans. Las operaciones mayores de ganado deben seguir las regulaciones de operación de animales confinados (CAFO) para proteger la calidad del agua.

El buen manejo del estiércol también lo ayuda a:

- La prevención de reinfestación de parásitos.
- Mantener el agua subterránea limpia.
- Desarrollar buena voluntad con sus vecinos.
- Apoyar una cuenca acuífera saludable.

Haga su parte para mantener las aguas subterráneas limpias y seguras.

Para más información viste:
http://www.ecy.wa.gov/washington_waters/farms.html

ÁREA DE MANEJO DE AGUAS SUBTERRÁNEAS

El propósito del Área de Manejo de Aguas Subterráneas del Valle Bajo de Yakima es reducir la contaminación de nitratos donde la concentración no cumplen con standares de Agua potable.

Grupos de trabajo GWAC

- Recolección de datos, caracterización, monitoreo
- Educación y divulgacion al publico
- Financiacion
- Agricultura de riego
- Ganado/CAFO
- Marco Regulatorio
- Residencial, comercial, industrial y municipal

Para participar, llame al:
(509) 574-2300

Para más información visite:
www.yakimacounty.us

Que puede hacer para proteger el agua de pozo.docx

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE

Qué puede hacer para proteger el agua de pozo

Área de Manejo de Aguas Subterráneas (GWMA):
El propósito de GWMA es reducir concentraciones de contaminación de nitratos en aguas subterráneas por debajo de los estándares de agua potable del estado.

Pasos para asegurar que tenga agua potable

Cosas a considerar si tiene una vivienda con pozo privado:

Haga pruebas a su agua – Al menos una vez al año para nitratos y bacterias coliformes. Los altos niveles de nitratos pueden afectar a mujeres embarazadas, a los recién nacidos y a los ancianos, y las altas concentraciones de bacterias pueden causar enfermedades. Más información sobre el Área de Manejo de Aguas Subterráneas del Valle Bajo de Yakima en: http://www.yakimacounty.us/1617/Ground-Water-Management-Area. Una lista de laboratorios certificados e información sobre pruebas de agua está disponible en línea en: http://www.yakimacounty.us/344/Drinking-Water-Testing.

Localice todos los pozos en su propiedad, activos e inactivos. Asegúrese de tapar sus pozos de forma segura con tapas prefabricadas o soldadas para evitar que contaminación y objetos caigan a su pozo.

Haga un bombeo a su fosa séptica – Descuidar el mantenimiento de su sistema séptico puede resultar en que se regresen las aguas residuales, reparaciones costosas y filtración superficial que puede contaminar su pozo. Un sistema para un hogar de cuatro personas debe bombearse cada tres años.

Utilice menos agua – No solo su sistema séptico funciona mejor con menos agua, sino también el bombear más agua de su pozo puede atraer contaminación cercana hacia su hogar.

Maneje los fertilizantes y productos químicos – El exceso de fertilizante se mueve fácilmente a través del suelo y contribuye a altos niveles de nitrato. Productos químicos derramados pueden alcanzar el agua de su pozo. Recicle los residuos domésticos y peligrosos en los centros de recolección del Condado. Nunca tire estos productos en su propiedad ni los vierta en el drenaje.

Aísle los residuos animales– Los corrales de animales y los montones de estiércol son fuentes de nitratos y bacterias. Tome medidas para evitar el escurrimiento y la filtración del suelo.

Instale válvulas preventivas de reflujo – en todas sus llaves de agua fuera de la casa. A veces, el agua puede sifonar de regreso a través de una manguera y hacia su pozo. Tenga cuidado cuando conecte rociadores de químicos a su manguera.

Haga su parte para mantener las aguas subterráneas limpias y seguras.

ÁREA DE MANEJO DE AGUAS SUBTERRÁNEAS

El propósito del Área de Manejo de Aguas Subterráneas del Valle Bajo de Yakima es reducir la contaminación de nitratos donde la concentración no cumplen con standares de Agua potable.

Grupos de trabajo GWAC

- Recolección de datos, caracterización, monitoreo
- Educación y divulgacion al publico
- Financiacion
- Agricultura de riego
- Ganado/CAFO
- Marco Regulatorio
- Residencial, comercial, industrial y municipal

Para participar, llame al: (509) 574-2300

Para más información visite: www.yakimacounty.us

Seguridad de sistemas septicos.docx

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE

Seguridad de sistemas sépticos: Lo que usted puede hacer

Área de Manejo de Aguas Subterráneas (GWMA):
es reducir concentraciones de contaminación de nitratos en aguas subterráneas por debajo de los estándares de agua potable del estado

Los sistemas sépticos que fallan pueden contaminar los pozos de agua potable

Revíselo, arréglelo y dele mantenimiento:

La bacteria, los virus y otros contaminantes de las aguas residuales de un sistema séptico que falla pueden contaminar pozos de agua potable, acuíferos subterráneos, lagos, ríos y arroyos.

Un sistema séptico no tiene que ser un problema.

- Obtenga inspección y mantenimiento regular. Elija una fecha o una época del año que sea fácil de recordar para tener la inspección. Anótelo en su calendario.
- Bombee regularmente su sistema. Normalmente, una vez cada tres años para un hogar de cuatro personas.
- Aprenda a mantener su sistema funcionando correctamente. Tenga cuidado con lo que vierte por el desagüe. No desechos de mascotas, medicamentos, grasas ni químicos tóxicos.
- Esté atento a las señales de que su tanque está cerca de la capacidad o de que su sistema está fallando. ¿Tiene olores? Pídale a alguien que lo revise inmediatamente. Luego, arréglelo si es necesario.
- Mantenga los árboles por lo menos a 30 pies del borde del campo de drenaje para evitar que las raíces lo invadan. Nunca conduzca sobre el sistema.
- Conserve agua. Demasiada agua puede causar que los sólidos escapen del tanque y que tapen las líneas del campo de drenaje.
- Repare o reemplace el sistema cuando falle o cuando sea inadecuado.

Localice el tanque séptico y el campo de drenaje:

- Utilice el plano de su propiedad o siga la línea de descarga de su casa. Pruebe el suelo con una barra para determinar la ubicación del su tanque séptico.
- Las tuberías subterráneas distribuyen las aguas residuales en el campo de drenaje. Las áreas húmedas pueden indicar un campo de drenaje defectuoso que necesita atención profesional.

Haga su parte para mantener las aguas subterráneas limpias y seguras.
Para más información visite:
http://www.ecy.wa.gov/programs/wq/wqguide/septic.html
http://www.yakimacounty.us/335/Septic-Systems

ÁREA DE MANEJO DE AGUAS SUBTERRÁNEAS

El propósito del Área de Manejo de Aguas Subterráneas del Valle Bajo de Yakima es reducir la contaminación de nitratos donde la concentración no cumplen con standares de Agua potable.

Grupos de trabajo GWAC

- Recolección de datos, caracterización, monitoreo
- Educación y divulgacion al publico
- Financiacion
- Agricultura de riego
- Ganado/CAFO
- Marco Regulatorio
- Residencial, comercial, industrial y municipal

Para participar, llame al:
(509) 574-2300

Para más información visite:
www.yakimacounty.us

Seguridad en pozos.docx

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE

Seguridad en pozos: Lo que usted puede hacer

Área de Manejo de Aguas Subterráneas (GWMA):
El propósito de GWMA es reducir concentraciones de contaminación de nitratos en aguas subterráneas por debajo de los estándares de agua potable del estado.

Los peligros de pozos destapados, abandonados o excavados a mano.

Las tapas evitan la contaminación y lesiones graves:

Todos los pozos deben estar tapados, incluyendo los que no están en uso, temporalmente fuera de servicio o que todavía no están retirados de servicio para proteger el agua potable y el acuífero de la contaminación. Una cubierta adecuada también impide que objetos, animales y personas caigan en el pozo.

Los métodos comunes de tapado de pozos, incluyen el uso de:

- Tapas para pozo prefabricadas.
- Placa de metal soldada a la parte superior del revestimiento del pozo.
- Una tapa de sello para pozo estilo artesiano en bóvedas o localizados en áreas donde el agua superficial se acumula.

Estos pueden encontrarse en tiendas de materiales para irrigación y bombas de agua. Fije la tapa para evitar la contaminación y el acceso no permitido al pozo. *No utilice solo un balde volteado o una placa suelta para cubrir el pozo.*

En qué debe fijarse durante la búsqueda de un pozo abandonado:

Los propietarios que no saben la historia de los pozos en su propiedad deben fijarse en lo siguiente durante la búsqueda de pozos abandonados:

- Tuberías que salen de la tierra.
- Estructuras y cobertizos para pozos.
- Depresiones en el suelo.
- Bóvedas de hormigor, hoyos, o Azulejo.
- Placas de metal o madera en el suelo o sobre revestimientos o bóvedas de concreto.

Haga su parte para mantener las aguas subterráneas limpias y seguras.

Para más información viste:
http://www.ecy.wa.gov/programs/wr/wells/abandon-wells.html
https://fortress.wa.gov/ecy/publications/publications/96br097.pdf

ÁREA DE MANEJO DE AGUAS SUBTERRÁNEAS

El propósito del Área de Manejo de Aguas Subterráneas del Valle Bajo de Yakima es reducir la contaminación de nitratos donde la concentración no cumplen con standares de Agua potable.

Grupos de trabajo GWAC

- Recolección de datos, caracterización, monitoreo
- Educación y divulgacion al publico
- Financiacion
- Agricultura de riego
- Ganado/CAFO
- Marco Regulatorio
- Residencial, comercial, industrial y municipal

Para participar, llame al: (509) 574-2300

Para más información visite: www.yakimacounty.us

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE

Qué puede hacer para proteger el agua de pozo

Área de Manejo de Aguas Subterráneas (GWMA):

El propósito de GWMA es reducir concentraciones de contaminación de nitratos en aguas subterráneas por debajo de los estándares de agua potable del estado.

Pasos para asegurar que tenga agua potable

Cosas a considerar si tiene una vivienda con pozo privado:

Haga pruebas a su agua – Al menos una vez al año para nitratos y bacterias coliformes. Los altos niveles de nitratos pueden afectar a mujeres embarazadas, a los recién nacidos y a los ancianos, y las altas concentraciones de bacterias pueden causar enfermedades. Más información sobre el Área de Manejo de Aguas Subterráneas del Valle Bajo de Yakima en: http://www.yakimacounty.us/1617/Ground-Water-Management-Area. Una lista de laboratorios certificados e información sobre pruebas de agua está disponible en línea en: http://www.yakimacounty.us/344/Drinking-Water-Testing.

Localice todos los pozos en su propiedad, activos e inactivos. Asegúrese de tapar sus pozos de forma segura con tapas prefabricadas o soldadas para evitar que contaminación y objetos caigan a su pozo.

Haga un bombeo a su fosa séptica – Descuidar el mantenimiento de su sistema séptico puede resultar en que se regresen las aguas residuales, reparaciones costosas y filtración superficial que puede contaminar su pozo. Un sistema para un hogar de cuatro personas debe bombearse cada tres años.

Utilice menos agua – No solo su sistema séptico funciona mejor con menos agua, sino también el bombear más agua de su pozo puede atraer contaminación cercana hacia su hogar.

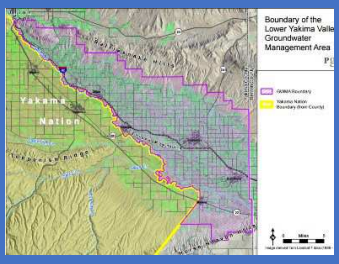
Maneje los fertilizantes y productos químicos – El exceso de fertilizante se mueve fácilmente a través del suelo y contribuye a altos niveles de nitrato. Productos químicos derramados pueden alcanzar el agua de su pozo. Recicle los residuos domésticos y peligrosos en los centros de recolección del Condado. Nunca tire estos productos en su propiedad ni los vierta en el drenaje.

Aísle los residuos animales– Los corrales de animales y los montones de estiércol son fuentes de nitratos y bacterias. Tome medidas para evitar el escurrimiento y la filtración del suelo.

Instale válvulas preventivas de reflujo – en todas sus llaves de agua fuera de la casa. A veces, el agua puede sifonar de regreso a través de una manguera y hacia su pozo. Tenga cuidado cuando conecte rociadores de químicos a su manguera.

Haga su parte para mantener las aguas subterráneas limpias y seguras.

ÁREA DE MANEJO DE AGUAS SUBTERRÁNEAS



El propósito del Área de Manejo de Aguas Subterráneas del Valle Bajo de Yakima es reducir la contaminación de nitratos donde la concentración no cumplen con standares de Agua potable.

Grupos de trabajo GWAC

- Recolección de datos, caracterización, monitoreo
- Educación y divulgacion al publico
- Financiacion
- Agricultura de riego
- Ganado/CAFO
- Marco Regulatorio
- Residencial, comercial, industrial y municipal

Para participar, llame al: (509) 574-2300

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE

lad de sistemas sépticos: Lo que usted puede hacer

Área de Manejo de Aguas Subterráneas (GWMA):

reducir concentraciones de contaminación de nitratos en aguas subterráneas por debajo de los estándares de agua potable del estado

Los sistemas sépticos que fallan pueden contaminar los pozos de agua potable

Revíselo, arréglelo y dele mantenimiento:

La bacteria, los virus y otros contaminantes de las aguas residuales de un sistema séptico que falla pueden contaminar pozos de agua potable, acuíferos subterráneos, lagos, ríos y arroyos.

Un sistema séptico no tiene que ser un problema.

- Obtenga inspección y mantenimiento regular. Elija una fecha o una época del año que sea fácil de recordar para tener la inspección. Anótelo en su calendario.
- Bombee regularmente su sistema. Normalmente, una vez cada tres años para un hogar de cuatro personas.
- Aprenda a mantener su sistema funcionando correctamente. Tenga cuidado con lo que vierte por el desagüe. No desechos de mascotas, medicamentos, grasas ni químicos tóxicos.
- Esté atento a las señales de que su tanque está cerca de la capacidad o de que su sistema está fallando. ¿Tiene olores? Pídale a alguien que lo revise inmediatamente. Luego, arréglelo si es necesario.
- Mantenga los árboles por lo menos a 30 pies del borde del campo de drenaje para evitar que las raíces lo invadan. Nunca conduzca sobre el sistema.
- Conserve agua. Demasiada agua puede causar que los sólidos escapen del tanque y que tapen las líneas del campo de drenaje.
- Repare o reemplace el sistema cuando falle o cuando sea inadecuado.

Localice el tanque séptico y el campo de drenaje:

- Utilice el plano de su propiedad o siga la línea de descarga de su casa. Pruebe el suelo con una barra para determinar la ubicación del su tanque séptico.
- Las tuberías subterráneas distribuyen las aguas residuales en el campo de drenaje. Las áreas húmedas pueden indicar un campo de drenaje defectuoso que necesita atención profesional.

Haga su parte para mantener las aguas subterráneas limpias y seguras.
Para más información visite:
http://www.ecy.wa.gov/programs/wq/wqguide/septic.html
http://www.yakimacounty.us/335/Septic-Systems

ÁREA DE MANEJO DE AGUAS SUBTERRÁNEAS

El propósito del Área de Manejo de Aguas Subterráneas del Valle Bajo de Yakima es reducir la contaminación de nitratos donde la concentración no cumplen con standares de Agua potable.

Grupos de trabajo GWAC

- Recolección de datos, caracterización, monitoreo
- Educación y divulgacion al publico
- Financiacion
- Agricultura de riego
- Ganado/CAFO
- Marco Regulatorio
- Residencial, comercial, industrial y municipal

Para participar, llame al: (509) 574-2300

Para más información visite: www.yakimacounty.us

Granjas pequeñas: Lo que usted puede hacer

Área de Manejo de Aguas Subterráneas (GWMA):

El propósito de GWMA es reducir concentraciones de contaminación de nitratos en aguas subterráneas por debajo de los estándares de agua potable del estado.

Un mal manejo del estiércol puede amenazar los pozos de agua potable

Recoja, cubra y haga composta:

El estiércol de ganado puede ser un gran fertilizante. También puede ser una fuente de contaminación del agua cuando se expone al clima. Si tiene ganado, incluso solo uno o dos, usted tiene un papel especial que desempeñar en la protección del agua potable, los acuíferos subterráneos, los ríos y arroyos.

Qué puede hacer para ayudar?

- Use canalones para dirigir el escurrimiento de agua lejos del estiércol.
- Recoja el estiércol de los corrales y potreros por lo menos cada tres días.
- Almacene el estiércol bajo cubierta en un sitio conveniente que esté al abrigo de vientos fuertes.
- Cuando utilice una lona como cubierta, asegúrela bien. La lona debe ser durable, pesada y lo suficientemente grande para cubrir totalmente el montón.
- Trabaje con la oficina local de conservación del distrito para hacer un plan y aprender a manejar mejor su estiércol.
- Construya un sistema de composta o busque una planta de compostaje para que recoja su estiércol.

La Ley de Manejo de Nutrientes de Leche de Washington Dairy Nutrient Management Act requiere que todas las lecherías con licencia desarrollen e implementen planes de manejo de nutrientes nutrient management plans. Las operaciones mayores de ganado deben seguir las regulaciones de operación de animales confinados (CAFO) para proteger la calidad del agua.

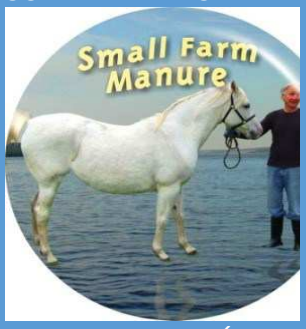
El buen manejo del estiércol también lo ayuda a:

- La prevención de reinfestación de parásitos.
- Mantener el agua subterránea limpia.
- Desarrollar buena voluntad con sus vecinos.
- Apoyar una cuenca acuífera saludable.

Haga su parte para mantener las aguas subterráneas limpias y seguras.

Para más información viste:
http://www.ecy.wa.gov/washington_waters/farms.html

ÁREA DE MANEJO DE AGUAS SUBTERRÁNEAS



El propósito del Área de Manejo de Aguas Subterráneas del Valle Bajo de Yakima es reducir la contaminación de nitratos donde la concentración no cumplen con standares de Agua potable.

Grupos de trabajo GWAC

- Recolección de datos, caracterización, monitoreo
- Educación y divulgacion al publico
- Financiacion
- Agricultura de riego
- Ganado/CAFO
- Marco Regulatorio
- Residencial, comercial, industrial y municipal

Para participar, llame al:
(509) 574-2300

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE

lad en pozos: Lo que usted puede hacer

Área de Manejo de Aguas Subterráneas (GWMA):

:l propósito de GWMA es reducir concentraciones de contaminación de nitratos en aguas subterráneas por debajo de los estándares de agua potable del estado.

Los peligros de pozos destapados, abandonados o excavados a mano.

Las tapas evitan la contaminación y lesiones graves:

Todos los pozos deben estar tapados, incluyendo los que no están en uso, temporalmente fuera de servicio o que todavía no están retirados de servicio para proteger el agua potable y el acuífero de la contaminación. Una cubierta adecuada también impide que objetos, animales y personas caigan en el pozo.
Los métodos comunes de tapado de pozos, incluyen el uso de:

- Tapas para pozo prefabricadas.
- Placa de metal soldada a la parte superior del revestimiento del pozo.
- Una tapa de sello para pozo estilo artesiano en bóvedas o localizados en áreas donde el agua superficial se acumula.

Estos pueden encontrarse en tiendas de materiales para irrigación y bombas de agua. Fije la tapa para evitar la contaminación y el acceso no permitido al pozo. *No utilice solo un balde volteado o una placa suelta para cubrir el pozo.*

En qué debe fijarse durante la búsqueda de un pozo abandonado:

Los propietarios que no saben la historia de los pozos en su propiedad deben fijarse en lo siguiente durante la búsqueda de pozos abandonados:

- Tuberías que salen de la tierra.
- Estructuras y cobertizos para pozos.
- Depresiones en el suelo.
- Bóvedas de hormigor, hoyos, o Azulejo.
- Placas de metal o madera en el suelo o sobre revestimientos o bóvedas de concreto.

Haga su parte para mantener las aguas subterráneas limpias y seguras.

Para más información viste:
http://www.ecy.wa.gov/programs/wr/wells/abandon-wells.html
https://fortress.wa.gov/ecy/publications/publications/96br097.pdf

ÁREA DE MANEJO DE AGUAS SUBTERRÁNEAS

El propósito del Área de Manejo de Aguas Subterráneas del Valle Bajo de Yakima es reducir la contaminación de nitratos donde la concentración no cumplen con standares de Agua potable.

Grupos de trabajo GWAC

- Recolección de datos, caracterización, monitoreo
- Educación y divulgacion al publico
- Financiacion
- Agricultura de riego
- Ganado/CAFO
- Marco Regulatorio
- Residencial, comercial, industrial y municipal

Para participar, llame al: (509) 574-2300

Para más información visite: www.yakimacounty.us

Lower Yakima Valley Groundwater Management Area

Education & Public Outreach (EPO's) Accomplishments Timeline

2012-2017

2012

1. EPO develops the Education and Public Outreach (EPO) Plan as required under WAC 173-100-090 (1) Groundwater advisory committee.
2. December 12, 2012 - GWAC approves the outreach plan; Yakima County submits it to the Department of Ecology.

***2013 - EPO Implements Education and Outreach Plan**

3. EPO creates GWAC logo options for GWAC consideration.
4. March 13, 2013 - GWAC approves a GWMA logo, which is used for all subsequent outreach materials, including but not limited to the website, letterhead, news releases, outreach flyers, program banner, and billboards.
5. **Public Awareness Survey (English & Spanish).** GWAC contracts with Heritage University to conduct **bilingual** door-to-door surveys in the GWMA. EPO designs survey to gauge the public's awareness of the nitrate issue and its potential health impacts. (Work included but was not limited to creating the survey content (**English & Spanish)** and packets, mapping the areas to be surveyed, training 16 Heritage University **bilingual** students to conduct the survey, troubleshooting issues, conducting quality control of the survey methods, and entering data into a spreadsheet.)

a. **Outreach results:** 300 Direct **Bilingual** Contacts (direct mail, in person, flyers) to households in the GWMA.
b. 136 surveys completed
c. **Spanish/English** news releases issued to media (pre-and post-survey).
d. EPO issues survey results in English/**Spanish** and posts to the website.

6. **Health provider outreach.** Over 200 healthcare providers receive nitrate-related health information and a survey asking them if they have observed symptoms of methemoglobinemia in their maternal or infant patients (English).
7. July 18- Commissioner Rand Elliott and Andy Cervantes make a presentation to the Central Family Medicine Residency Program on the GWMA and nitrates.
8. September - EPO creates script for—and GWAC/EPO member Andy Cervantes participates in—an **Hispanic Affairs Commission "Connect with Your Government" Spanish-language** statewide radio talk show to increase awareness about the GWMA
9. **December -** Commissioner Elliott gives a presentation on the GWMA, and seeks support of the upcoming well assessment survey, to the Community Advisory Board for **El Proyeto Bienestar**
10. **December-High Risk Well Assessment Survey Phase I (English/Spanish)** EPO Creates a survey instrument and develops an outreach campaign for a well assessment survey in the target area. (Wrote and released **bilingual** materials including PSA's, a direct mail piece,

GWAC Chair letter to area newspapers; explored ministerial outreach to churches)

11. **GWMA website.** EPO develops and launches a community website that offers information about the committee, its meetings and information on nitrate-related topics.

***2014-**

12. January-EPO issues a news release announcing the GWAC's accomplishments

13. EPO updates the website and maintains it in "real time" from its inception to the present (English)

14. EPO continues **(English/Spanish)** outreach for High Risk Well Assessment Survey Phase I

    April 7 - issues an **(English/Spanish)** news release announcing that the survey deadline has been extended

15. **New Mom Campaign (English/Spanish)**

    a. EPO develops and obtains GWAC approval for new mom messages to be distributed in hospitals and clinics.

    b. EPO prints and distributes over 2000 English/**Spanish** new mom flyers to hospitals, clinicians and at health fairs and community events (including but not limited to Zillah Days and Granger Agricultural bilingual event)

    c. **EPO seeks and obtains partnership with the University of Washington's** Pediatric Environmental Health Specialty Unit (PEHSU) to collaborate on the New Mom campaign

i. PEHSU conducts clinician trainings in Yakima and Lower Valley to raise clinician awareness of nitrate issue, resources and treatment

ii. PEHSU obtains authorization to offer Continuing Education Units (CEU) to participating healthcare providers.

iii. PEHSU creates and distributes Clinician Training video

iv. Nitrate/new mom materials posted to PEHSU's national website

16. **GWAC educational materials**: EPO creates and obtains GWAC approval of GWAC slide deck (GWAC background information and nitrate education series); posted to website
17. **May - Deep Soil Sampling Launched.** EPO partners with Irrigated Ag working group to promote program.
18. May 2 - EPO issues a **bilingual** news release reminding households of the May 31 deadline to participate in Phase I Free Well Testing.

19. **Phase I of the (English/Spanish) High Risk Well Assessment Sampling Surveys is completed** (172 Total)

    a. **Outreach: Bilingual** outreach included multiple presentations to Sunnyside Workforce clients, talk show **participation** on **Spanish** (KDNA) and English radio stations, paid advertisement on **Spanish** and English-language radio, 600 **Spanish**-English direct mail pieces, and GWAC Chair editorial outreach published in area English and **Spanish** papers.

20. GWAC approves a two-year outreach budget developed by the EPO

TOTAL $267,000:

- Abandoned Wells and Septic System Maintenance $76,000
- Educational Outreach Campaigns $54,000
- Wellhead Risk Assessment Surveys-Phase 2 $100,000
- Redesign and Maintain GWMA Website $12,000
- Community Outreach Surveys $25,000

21. EPO releases the High Risk Well Assessment results.

22. EPO prints and distributes 2000 double-sided English/**Spanish** New Mom Flyers at health fairs in Prosser, Yakima and other outlets.

***2015 –**

23. EPO rebuilds and launches the new GWMA website

24. High Risk Well Assessment Follow-up (English/Spanish)

EPO communicates test results, prevention messages and GWAC information to high risk well assessment participants (171 unique mail pieces in English and **Spanish**)

25. EPO evaluates and reports back to the GWAC regarding the Phase I High Risk Well Assessment results. They agree that the data show a great need for well owners to be familiar with their wells, and to test their wells more frequently.

26. EPO announces Phase II Well Assessment survey. EPO's goal is to complete 200 sampling surveys.

EPO agrees to use Phase I methodology for messaging in Phase II. Targets: areas of known high nitrate, areas where little nitrate data exists. Direct mail list is increased from 600 (Phase I) to 1000 in Phase II.

27. Phase II **(English/Spanish)** outreach continues. December-EPO evaluates its outreach methods (direct mail, radio advertising, flyers and newspaper coverage.) Response from survey participants indicates that direct mail is the most cost-effective method of eliciting participation. Accordingly, EPO plans a second direct-mail release in January 2016.

***2016**

28. County sends 115 **(English/Spanish)** results letters to recent well assessment participants with their certified lab results and educational materials. January-350 additional household invitation letters are sent.

29. January and March-**(English/Spanish)** news releases inviting well assessment participation are released.

30. March 31-Phase II high risk well assessment survey closes.

31. April-the County mails the last round of **(English/Spanish)** results letters to the Phase II well assessment participants with their certified lab results and educational materials. The letters included **(English/Spanish)** handouts on nitrate, coliform, and private well and septic system maintenance.

32. EPO Completes Phase II of the High Risk Well Assessment Sampling Surveys (289) for a total of 466 completed surveys (Phase I-177 + Phase II- 289).

a. **Outreach: Bilingual** outreach included multiple presentations to Sunnyside Workforce clients, talk show participation on **Spanish** and English radio stations, paid advertisement on **Spanish** and English-language radio, 600 Spanish-English direct mail pieces, and GWAC Chair editorial outreach published in area English and **Spanish** papers.

b. **Follow-up (English/Spanish)** County communicates test results, prevention messages, septic system maintenance and GWAC information to high risk well assessment participants (289 unique mail pieces in English and **Spanish**)

33. ***GWAC/EPO participate in five Spanish-language Fred Hutch-sponsored health fairs (Sunnyside, Mabton, Zillah, Granger and Toppenish) between May and August 2016.**

    Volunteers make **bilingual**, one-on-one contact with approximately 250 lower Valley residents.

    (English/Spanish) Information on private wells, nitrate in groundwater, new mom flyers is distributed to visitors.

    Visitors are also asked to complete the GWAC's **(English/Spanish)** public survey.

Residents on private wells are offered **(English/Spanish)** nitrate test step strips for a "do-it-yourself" drinking water test. Self-addressed stamped envelopes are included with the test strips so people can return their test results directly to Yakima County.

34. EPO develops, presents and receives GWAC approval to launch a "Test Your Well" English/**Spanish billboard** campaign in the Lower Yakima Valley.
35. **December - first (English/Spanish) billboard goes live in the LYV GWMA.**

***2017**

36. **January - Second of two (English/Spanish) "Test Your Well" Billboards Goes Live**

37. EPO creates, translates and posts five **(English/Spanish)** "**What You Can Do**" flyers to the GWMA website.

38. EPO Launches a (English/Spanish) "What You Can Do to Protect Well Water Campaign

(in response to wide-spread local flooding, especially in the unincorporated community of Outlook) March & April 2017

- **(English/Spanish)** "What You Can Do to Protect Well Water" flyers "(English/Spanish) and test trips distributed door-To-door in Outlook (Yakima Health District).
- **(English/Spanish)** 12,000 What You Can Do to Protect Well Water flyers inserted in the Sunnyside Daily Sun News on March 29, 2017
- **(English/Spanish)** 10,700 flyers inserted in the Spanish-language *El Sol* weekly publication on March 30, 2017
- **Spanish-language** KDNA news show participation – April 4, 2017 (Andy Cervantes and Ignacio Marquez)
- KIT interview-March 30, 2017 (Commissioner Rand Elliott)
- April 29- **(English/Spanish)** flyers (using a **Spanish-speaking EPO member)** distributed at the Sunnyside Walmart store

39. PEHSU (English/Spanish) New Mom Flyers

200 **(English/Spanish)** flyers are distributed to the Toppenish Community Hospital (restock order)

40. EPO Requests Working Groups to Complete an EPO Questionnaire

EPO asks all working groups to answer EPO's questions related to their mission, accomplishments, discoveries, target audiences and messages.

The purpose of this exercise is to help the EPO develop a short-and long-term (post adoption) Communications and Outreach Plan for the GWAC's consideration.

This information is compiled in a summary distributed to the GWAC.

41. **June - EPO begins to develop its alternatives recommendations for the GWMA program.**

- EPO requests GWAC assistance to identify specific messages and outreach

3 - SURVEY letter to physicians_GWAC APPROVED_ATTACHMENT

Dear Medical Provider:

The Lower Yakima Valley Ground Water Management Area Advisory Committee (GWAC) is working to address nitrate contamination and its sources in a wide area where elevated levels of nitrate have been identified in private drinking water wells (see attached map).

This letter is being written in cooperation with the Benton-Franklin and Yakima County Health Districts, which are active members of the advisory committee, and is designed to alert you to the health risks associated with nitrate contamination.

Attached is a handout to provide you with a brief refresher about methemoglobinemia in infants. Symptoms are common and have the potential of being under diagnosed.

At greatest risk are infants younger than six months of age because of the immaturity of their enzyme systems which convert methemoglobin back to hemoglobin.

Maternal exposure to environmental nitrates and nitrites may increase the risk of pregnancy complications such as anemia, abortion, premature labor, or preeclampsia. Study of other potential reproductive, developmental, or carcinogenic effects has not produced conclusive results.

If you are concerned about a patient the appropriate testing should be done to verify your diagnosis. Upon confirmation you should report the condition to the communicable disease section at the Yakima or Benton-Franklin Health Districts depending on your patient's county of residence. Environmental Health personnel at each district should be able to assist you with water quality information, if available, as well as assist the family with sampling of their water as needed.

Yakima County Health District Communicable Disease Report Line: 509-249-6521; for information about water quality, treatment, options, call be

Environmental Health help desk at 509-249-6508. Benton-Franklin Health District: 509-460-4200.

We hope you will consider discussing the drinking-water conditions of your patients as you treat them, especially if they reside in the Lower Yakima Valley and exhibit symptoms of methemoglobinemia.

Suspected sources of nitrate contamination are from a variety of land uses, including commercial fertilizers for crop production, animal manures, septic systems and land application of waste water.

More information about the Lower Yakima Valley Ground Water Management Area is available online at: http://www.yakimacounty.us/gwma/

Sincerely,

Andre Fresco, Administrator
District Officer

Yakima County Health District

Amy D. Person, M.D.,
Benton-Franklin Health District

attachments: Methemoglobinemia in infants

YVGWMA Vicinity Map

Questionnaire for Health Care Providers

Nitrate contamination of drinking water is a growing concern in the United States and around the world. The Lower Yakima Valley has a history of elevated nitrates in groundwater wells that sometimes exceed drinking water standards. In 2011, the Lower Yakima Valley Groundwater Management Area (GWMA) was formed to address nitrate contamination.. The most pressing health issue related to elevated nitrate levels in drinking water is methemoglobinemia in very young children. You can help us gather critical information by completing and returning this questionnaire. We understand that confidentiality prevents sharing of patient information and ask that you provide general information only. Thank you very much for sharing your time and expertise.

1. During the past five years have you cared for infants with signs and symptoms of methemoglobinemia, such as cyanosis in the absence of heart and lung pathology? YES NO

Comments:

_____

_____

2. Are you aware of the relationships between methemoglobinemia and

   a. infants (<6 mo.) and well water contaminated with nitrates? YES NO

   b. diarrhea in infants? YES NO

   c. sepsis in infants? YES NO

3. Do you question about the use of well water when dealing with infants <6 mo. YES NO

4. Do you question about the use of well water when dealing with pregnant women? YES NO

5. Do you encourage families with a newborn to have their well tested for bacteria and nitrates to find out if it's safe before using it to mix formula for their new infant? YES NO

6. How would you like to learn more about nitrate related problems?

Questionnaire for Health Care Providers

ON-LINE _____ WORKSHOPS _____ WRITTEN SELF STUDY _____HEALTH DEPARTMENT

MAILING _____ OTHER (Please describe) _____

7. Please share your thoughts on this subject

_____

_____

(END OF SURVEY)

If you wish to receive additional information on the Lower Yakima Valley Groundwater Management Area, you may either visit www.yakimacounty.us/GWMA/ or provide the following:

Name: _____

Mailing Address: _____

Phone: _____

E-mail: _____

Thank you for participating in this survey.

Please return this survey to: Lower Yakima Valley Groundwater Management Area, c/o Yakima County Public Services, 128 N 2nd St, Fourth Floor, Yakima WA 98901.

METHEMOGLOBINEMIA

IN INFANTS < 6 MONTHS OF AGE

SYMPTOMS/SIGNS:

Bluish discoloration of skin (cyanosis): fails to respond to inhaled O2

Fatigue/lethargy Shortness of breath/tachypnea

Nausea Diaphoresis

Mental status changes

In severe intoxication (50-70% methemoglobin): shock, seizures, acidosis, death

DIAGNOSIS:

Methemoglobin level: normal <1% bluish/chocolate brown blood

Arterial blood gas: usually normal PO2 in the face of cyanosis

Pulse oximetry: usually inaccurate in the face of methemoglobinemia

O2 saturation: usually low but inaccurate in the face of methemoglobinemia

ETIOLOGY:

Nitrates/nitrites in water supply (Sources: fertilizer, manure, damaged well heads, leaking septic systems): EPA recommends <10 ppm

Infants who have diarrhea, sepsis, or other infections may have increased endogenous production of nitrites. Infants already exposed to nitrates in their water source would be at greater risk for methemoglobinemia with these infections.

TREATMENT:

1% Methylene blue: 1-2mg/kg IV (beware of risks with G6PD deficiency)

ascorbic acid

oxygen

exchange transfusion

WEBSITES:

http://www.ncbi.nlm.nih.gov/pubmedhealth/PMH0001588/

http://www.nap.edu/catalog.php?record_id=4795

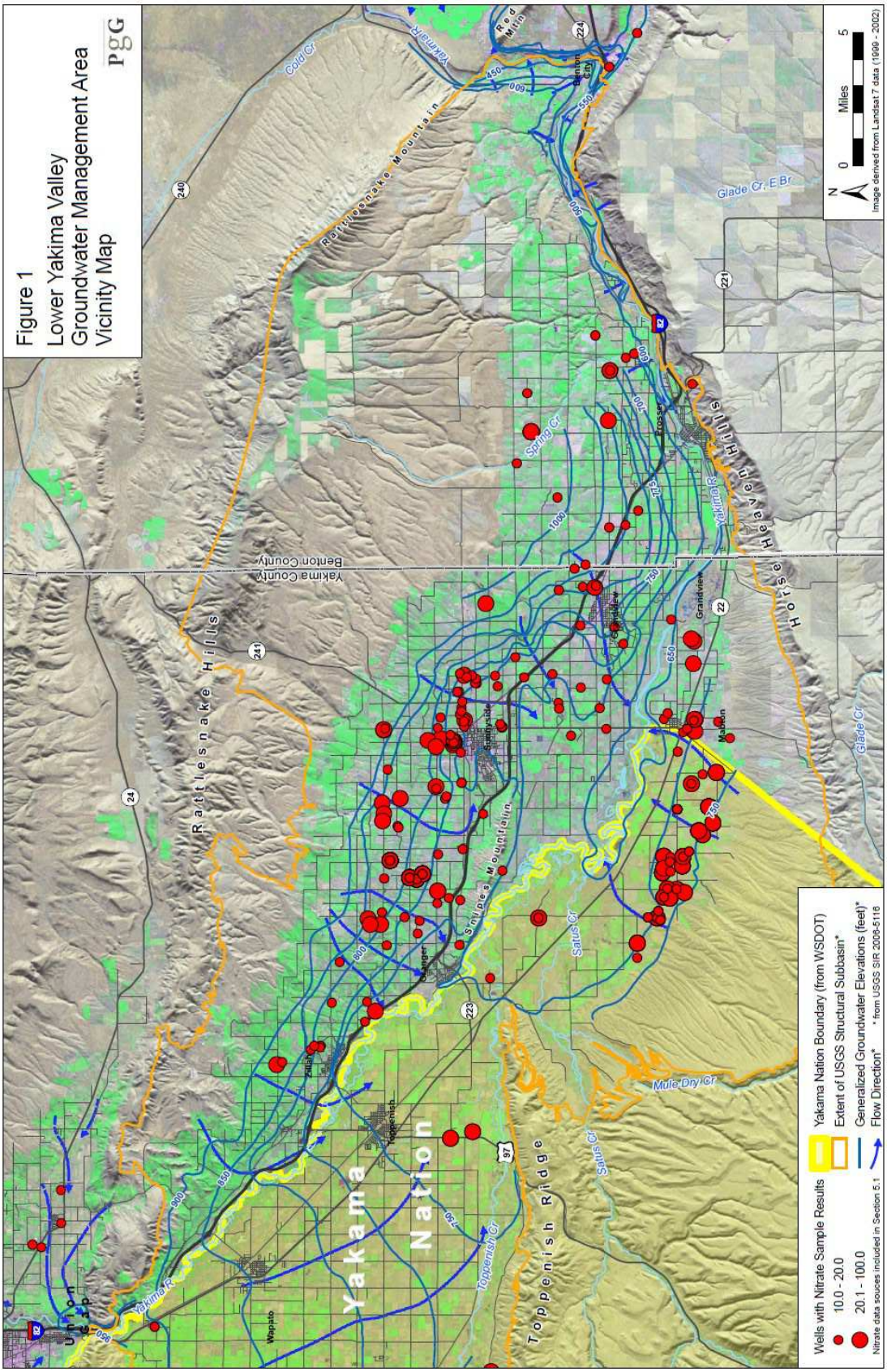


Figure 1
Lower Yakima Valley
Groundwater Management Area
Vicinity Map
PGG
Yakima County
Benton County
Rattlesnake Hills
Rattlesnake Mountain
Horse Heaven Hills
Yakama Nation
Toppenish Ridge
Simpkins Mountain
Cold Cr
Spring Cr
Satus Cr
Toppenish Cr
Mule Dry Cr
Glade Cr
Glade Cr. E Br
Yakima R
Red Mtn
Union Gap
Wapato
Toppenish
Zillah
Granger
Sunnyside
Grandview
Prosser
Benton City
Mabton
Yakama Nation Boundary (from WSDOT)
Extent of USGS Structural Subbasin*
Generalized Groundwater Elevations (feet)*
Flow Direction*
* from USGS SIR 2008-5116
Wells with Nitrate Sample Results
10.0 - 20.0
20.1 - 100.0
Nitrate data souces included in Section 5.1
N
0
5
Miles
Image derived from Landsat 7 data (1999 - 2002)

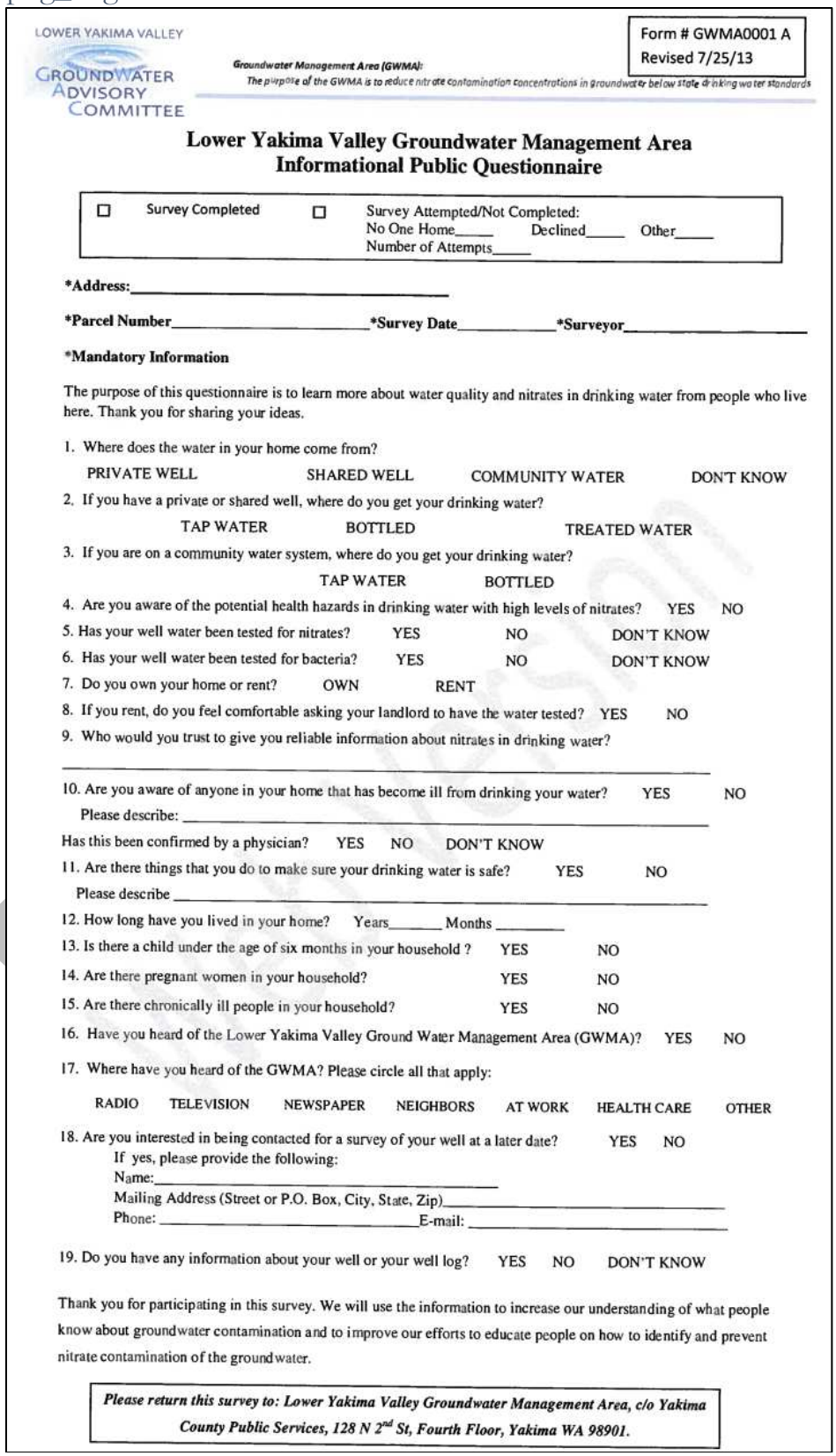
5 GWAC Public Opinion Survey Summary Report_2013_0927_ke v5.xls - Survey Question Answers.docx

#9	#11
Who would you trust to give you reliable information about nitrates in drinking water?	**Are there things that you do to make sure your drinking water is safe?**
18 Responses: County	42 Responses: Filter
14 Responses: Health Department	6 Responses: Test
10: Doctor	4: Purchase drinking water
9: Don't know	4-Reverse Osmosis
6: Government Agency	Have it checked
6: Independent Company	Inspection
3: Department of Health	Lab
2: Lab	A person was coming in that specializes in water treatment.
2: Testing Service	Refrigerator treats water
2: himself	Soft water tester
City	Buy Culligan
Culligan	Water Softener
Cascade Testing/Independent	Water system
Ask Owner	Whole house filter, considering upgrading (well drilled in 2009)
Down town	Zero test often number low
Drinking water Kinetico Personnel	
EPA	
Fed water	
Central Washington University	
Heritage University Students	
Local School	
Clean water in Tri Cities, from the fair	
4 years tested	
Labon Yakima	
My own research (not counting on 2nd hand info.)	
myself	
Nobody	
Anyone knows	
People who know about it	
Professionals who test the water	
Rain Water in Sunnyside	
Reputable servicer	
Service who tests water	
Somebody who test for nitrates	
Son	
Water officials @ clinic	
Water system facility	
Whoever his landlord tells him	
Yes but she/he lives in Texas	
Don't care	

	LOWER YAKIMA VALLEY GROUNDWATER MANAGEMENT AREA INFORMATIONAL PUBLIC QUESTIONNAIRE							
		Number	**Percentage**	**TOTAL**				
	Number of Households in Survey			**300**				
	Number of Surveys Completed	136	45%					
	Number of households Not Possible (dogs, gates, etc)	88	29%					
	Number of Households Declining	60	20%					
	Number of Households Not Attempted	16	5%					
	TOTAL	**300**	**100%**					
	QUESTION	**YES**	**DON'T KNOW**	**NO**	**NOT ANSWERED**	**TOTAL**		
#1	Where does the water in your home come from?	**PRIVATE WELL**	**SHARED WELL**	**COMM. WELL**	**DON'T KNOW**			
		122	5	2	7	136		
		90%	4%	1%	5%			
#2	If you have a private or shared well, where do you get your drinking water?	**TAP WATER**	**BOTTLED WATER**	**TREATED WATER**	**NOT ANSWERED**			
		69	24	41	2	136		
		51%	18%	30%	1%			
#3	If you are on a community water system, where do you get your drinking water	**TAP WATER**	**BOTTLED WATER**	**TREATED WATER**	**NOT ANSWERED**			
		1	0	0	1	2		
		50%		50%				
		YES	**DON'T KNOW**	**NO**	**NOT ANSWERED**	**TOTAL**		
#4	Are you aware of the potential health hazards in drinking water with high levels of nitrates?	94	35		7	136		
		69%	26%		5%			
#5	Has your well water been tested for nitrates?	73	23	40		136		
		54%	17%	29%				
#6	Has your well water been tested for bacteria?	45	28	63		136		
		33%	21%	46%				
		OWN	**RENT**					
#7	Do you own your home or rent?	115	17					
		85%	12%					
#8	If you rent, do you feel comfortable asking your landlord to have the water tested.	12		5		17		
		71%		29%				
#9	Who would you trust to give you reliable information about nitrates in drinking water? (answers on p.2)							

#10	Are you aware of anyone in your homes that has become ill from drinking your water?	6		125	5	136		
		4%		92%				
#11	Are there things you do to make sure your drinking water is safe? (answers on p. 2)	81	39	16	0	136		
		59%	29%	12%	0%			
#12	How long have you lived in your home							
	Less than a year	8						
	1-10years	50						
	10-15years	24						
	15-20year	13						
	20-43years	21						
	Not Answered	20						
#13	Is there a child under the age of six months in your household?	1		134	1	136		
		<1.0%		99.0%	<1.0%			
#14	Are there pregnant women in your household?	1		134	1	136		
		<1.0%		99%	<1.0%			
#15	Are there chronically ill people in your household?	7		128	1	136		
		5%		94%	<1.0%			
#16	Have you heard of the Lower Valley GWMA?	57		73	6	136		
		42%		54%	4%			
					Percentages rounded to the nearest			
#17	Where have you heard of the Lower Yakima Valley Ground Water Management Area (GWMA)	**RADIO**	**TV**	**NEWSPAPER**	**AT WORK**	**HEALTH CARE**	**OTHER**	**NOT ANSWERED**
		8	4	24	1	2	18	79
		5%	2%	17%	0%	0%	13.0%	58.0%
#18	Are you interested in being contacted for a survey of your well at a later date?	45		76	15	136		
		33%		56%	11%			
#19	Do you have any information about your well or your well log?	17	24	81	14	136		
		13%	18%	59%	10%			

5a_GWAC Public Opinion survey_(Eng) public questionnaire-FINALpng_Page1



LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE

Form # GWMA0001 A
Revised 7/25/13

Groundwater Management Area (GWMA):
The purpose of the GWMA is to reduce nitrate contamination concentrations in groundwater below state drinking water standards

Lower Yakima Valley Groundwater Management Area
Informational Public Questionnaire

☐ Survey Completed ☐ Survey Attempted/Not Completed:
No One Home_____ Declined_____ Other_____
Number of Attempts_____

***Address:**_____

Parcel Number**_____Survey Date**_____***Surveyor**_____

***Mandatory Information**

The purpose of this questionnaire is to learn more about water quality and nitrates in drinking water from people who live here. Thank you for sharing your ideas.

1. Where does the water in your home come from?
   PRIVATE WELL SHARED WELL COMMUNITY WATER DON'T KNOW
2. If you have a private or shared well, where do you get your drinking water?
   TAP WATER BOTTLED TREATED WATER
3. If you are on a community water system, where do you get your drinking water?
   TAP WATER BOTTLED
4. Are you aware of the potential health hazards in drinking water with high levels of nitrates? YES NO
5. Has your well water been tested for nitrates? YES NO DON'T KNOW
6. Has your well water been tested for bacteria? YES NO DON'T KNOW
7. Do you own your home or rent? OWN RENT
8. If you rent, do you feel comfortable asking your landlord to have the water tested? YES NO
9. Who would you trust to give you reliable information about nitrates in drinking water?
   _____
10. Are you aware of anyone in your home that has become ill from drinking your water? YES NO
    Please describe: _____
    Has this been confirmed by a physician? YES NO DON'T KNOW
11. Are there things that you do to make sure your drinking water is safe? YES NO
    Please describe _____
12. How long have you lived in your home? Years_____ Months _____
13. Is there a child under the age of six months in your household ? YES NO
14. Are there pregnant women in your household? YES NO
15. Are there chronically ill people in your household? YES NO
16. Have you heard of the Lower Yakima Valley Ground Water Management Area (GWMA)? YES NO
17. Where have you heard of the GWMA? Please circle all that apply:
    RADIO TELEVISION NEWSPAPER NEIGHBORS AT WORK HEALTH CARE OTHER
18. Are you interested in being contacted for a survey of your well at a later date? YES NO
    If yes, please provide the following:
    Name:_____
    Mailing Address (Street or P.O. Box, City, State, Zip)_____
    Phone: _____E-mail: _____
19. Do you have any information about your well or your well log? YES NO DON'T KNOW

Thank you for participating in this survey. We will use the information to increase our understanding of what people know about groundwater contamination and to improve our efforts to educate people on how to identify and prevent nitrate contamination of the groundwater.

Please return this survey to: Lower Yakima Valley Groundwater Management Area, c/o Yakima County Public Services, 128 N 2nd St, Fourth Floor, Yakima WA 98901.

5b GWAC Public Opinion SURVEY- (Sp) GWMA Public_Heritage Door-To-Door _FINAL.doc

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE

Forma # GWMA0001 A
Refrito 7/25/13

Groundwater Management Area (GWMA):
The purpose of the GWMA is to reduce nitrate contamination concentrations in groundwater below state drinking water standards

Lower Yakima Valley Groundwater Management Area
Informational Public Questionnaire

☐ Encuesta terminada ☐ Se intentó hacer la encuesta/No se hizo:
No había nadie en casa_____ No se quiso hacer_____
Otra razón_____ Número de intentos_____

***Domicilio:**_____

Número de parcela**_____Fecha de la encuesta**_____***Encuestador**_____

***Información requerida**
El propósito de este cuestionario es saber más de los nitritos y la calidad del agua potable según las personas que viven en esta propiedad. Gracias por atendernos y compartir sus comentarios.

1. ¿De donde viene el agua de su casa?
   POZO PRIVADO POZO COMPARTIDO AGUA DE LA COMUNIDAD NO SÉ
2. Si usted tiene un pozo privado o compartido ¿de donde toma el agua para beber?
   DE LA LLAVE EMBOTELLADA AGUA TRATADA
3. Si usted recibe su agua de un sistema comunitario ¿de donde toma el agua para beber?
   DE LA LLAVE EMBOTELLADA
4. ¿Sabe usted los riesgos potenciales de tomar agua que contenga altos niveles de nitritos? SI NO
5. ¿Se le ha hecho prueba de nitritos a su agua? SI NO NO SÉ
6. ¿Se le ha hecho prueba de bacteria a su agua? SI NO NO SÉ
7. ¿Vive en casa propia o de renta? PROPIA DE RENTA
8. Si usted renta ¿podría usted pedirle al dueño de la propiedad que le haga pruebas al agua? SI NO
9. ¿A quién le confiaría usted que le dé información confiable acerca de nitritos en el agua?
   _____
10. ¿Sabe usted si alguien se ha enfermado por tomar el agua potable de su casa? SI NO
    Por favor describa: _____
    ¿Se ha confirmado esto con un médico? SI NO NO SÉ
11. ¿Hace usted algo para asegurarse de que su agua sea segura para tomarse? SI NO
    Por favor describa: _____
12. ¿Por cuánto tiempo ha vivido en su casa? Años _____ Meses _____
13. ¿Vive en su casa algún niño menor de seis meses? SI NO
14. ¿Vive alguna mujer embarazada en su casa? SI NO
15. ¿Hay alguna persona en su casa con alguna enfermedad crónica? SI NO
16. ¿Había escuchado usted del área de manejo de agua subterránea del valle bajo de Yakima o Lower Yakima Valley Ground Water Management Area (GWMA)? SI NO
17. ¿Dónde había escuchado de GWMA? Por favor circule todos los que corresponden:
    RADIO TELEVISIÓN PERIÓDICO VECINOS EN EL TRABAJO EN LA CLÍNICA OTROS
18. ¿Está usted interesado de que le visitemos en una fecha futura para evaluar su pozo? SI NO
    Si así es, por favor indique lo siguiente:
    Nombre:_____
    Domicilio de correo (calle o P.O. Box, Ciudad, Estado, Código postal)_____
    Teléfono: _____Correo electrónico:_____
19. ¿Usted tiene otra información de su pozo o archivos de lecturas de su pozo? SI NO NO SÉ

Gracias por participar en esta encuesta. Utilizaremos esta información para poder entender mejor lo que la gente sabe acerca de la contaminación del agua subterránea y para mejorar nuestros esfuerzos para informar a la gente a identificar y prevenir la contaminación de nitritos en el agua subterránea.

Lower Yakima Valley Groundwater Management Area

Informational Public Questionnaire

Por favor devuelva esta encuesta a: Lower Yakima Valley Groundwater Management Area, c/o Yakima County Public Services, 128 N 2nd St, Fourth Floor, Yakima WA 98901.

5c_Handout Updated Certified Laboratories 7-23-13_v1.xls

Lower Yakima Valley GWMA Program
Certified Testing Laboratories
(Updated July 23, 2013)

Laboratory Name	Address	Phone	Web Site	Approximate Cost
Ag Health Laboratories, Inc.	445 Barnard Boulevard Sunnyside, WA	(509) 836-2020	www.aghealthlabs.com	Nitrate - $30 Coliform - $21
Benton-Franklin Health District Lab	7102 West Okanogan Place Kennewick, WA	(509) 460-4206	www.bfhd.wa.gov	Nitrate - $24 Coliform - $24
Cascade Analytical Inc. - Yakima	1008 West Ahtanum Road, #2 Yakima, WA	(509) 452-7707	www.cascadeanalytical.com	Nitrate - $27.50 Coliform - $25
Mukang Labs, Inc.	2526 E. Saint Helens Street Pasco, WA	(509) 544-2159	www.mukanglabs.com	Nitrate - $18.50 Coliform - $20
Northwest Agricultural Consultants, Inc.	2545 West Falls Ave. Kennewick, WA	(509) 783-7450	www.nwag.com	Nitrate - $17.50 Coliform - NA
Valley Environmental Laboratory	201 East D Street Yakima, WA	(509) 575-3999	http://www.valleylab.net/	Nitrate - $35 Coliform - $25

All of the above laboratories are certified by the Washington State Department of Ecology to test for nitrate in drinking water. Ag Health Laboratories, Benton-Franklin Health District, Cascade Analytical, Mukang Labs and Valley Environmental Laboratory are also certified to test for coliform in drinking water.

Costs shown for nitrate and coliform tests are approximate and subject to change.

Lower Yakima Valley GWMA Program
Laboratorios Certificados

Nombre del laboratorio	Dirección	Teléfono	Web Site	Costo aprox.
Ag Health Laboratories, Inc.	445 Barnard Boulevard Sunnyside, WA	(509) 836-2020	www.aghealthlabs.com	Nitratos - $30 Coliforme - $21
Benton-Franklin Health District Lab	7102 West Okanogan Place Kennewick, WA	(509) 460-4206	www.bfhd.wa.gov	Nitratos - $24 Coliforme - $24
Cascade Analytical Inc. - Yakima	1008 West Ahtanum Road, #2 Yakima, WA	(509) 452-7707	www.cascadeanalytical.com	Nitratos - $27.50 Coliforme - $25
Mukang Labs, Inc.	2526 E. Saint Helens Street Pasco, WA	(509) 544-2159	www.mukanglabs.com	Nitratos - $18.50 Coliforme - $20
Northwest Agricultural Consultants, Inc.	2545 West Falls Ave. Kennewick, WA	(509) 783-7450	www.nwag.com	Nitratos - $17.50 Coliforme - NA
Valley Environmental Laboratory	201 East D Street Yakima, WA	(509) 575-3999	http://www.valleylab.net/	Nitratos - $35 Coliforme - $25

Todos los laboratorios en éste documento están certificados por el Departamento de Ecología del Estado de Washington para probar nitratos en el agua potable Los laboratorios Ag Health Laboratories, Benton-Franklin Health District, Cascade Analytical, Mukang Labs, y Valley Environmental Laboratory también están certificados para probar la presencia de coliformes en el agua potable.

El costo por la prueba de nitratos y coliforme es aproximado y sujeto a cambio.

Agua de Pozos Privados

Información sobre las bacterias coliformes y el nitrato para usuarios de pozos privados

¿Por qué debería hacer un análisis del agua de mi pozo?

Beber agua contaminada es un riesgo para la salud. Algunos contaminantes no se pueden ver, oler ni notar por el sabor. Dos de los contaminantes más comunes del agua potable son las bacterias coliformes y el nitrato, los cuales pueden ser nocivos.

¿Quién debería analizar el agua de mi pozo?

Usted o su arrendador. Los usuarios de pozos privados son responsables de analizar su propia agua. Si usted no es propietario de su vivienda pero utiliza un pozo privado, hable con su arrendador para analizar el agua o ver los resultados más recientes. Siempre podrá tomar una muestra de agua usted mismo y hacerla analizar.

¿Qué debería buscar en el análisis y con qué frecuencia?

El Departamento de Salud recomienda que analice el agua de pozo privado todos los años para verificar que no existan bacterias coliformes y nitrato.

También deberá analizar el agua cuando:

- Note un cambio en el agua, tal como el sabor, color y olor.*
- El pozo se haya inundado.
- Reemplace cualquier parte de su sistema de pozo.
- Alguna mujer de su hogar esté embarazada, amamantando o tenga una enfermedad inexplicable y usted sospeche de que el agua puede estar en riesgo.
- Escuche que el agua de su vecino está contaminada.
- Viva cerca de zonas industriales o agrícolas.*

*Estos casos pueden requerir un análisis para evitar la existencia de otros elementos distintos de las coliformes o el nitrato.

Si ha tenido problemas de contaminación previos o está preocupado por contaminantes específicos, usted debería analizar el agua del pozo con mayor frecuencia.

¿Dónde me dirijo para analizar el agua?

Los laboratorios de análisis de agua potable certificados se encuentran en todo el estado. El laboratorio que seleccione o el departamento de salud local podrán ayudarlo a decidir qué buscar en el análisis, cómo tomar las muestras y cómo interpretar los resultados. Estos análisis tienen un costo. Los costos de este año (2010) van desde los $20 a los $25 por análisis de bacterias coliformes, y desde los $30 a los $42 para el análisis de nitrato. La mayoría de los laboratorios prefieren proporcionar sus propios recipientes para muestra.

El nivel del nitrato es *menor de* 10 ppm, ¿qué debo hacer?

Los niveles de nitrato pueden variar a lo largo del año, por lo tanto si el nivel es de 5 ppm o mayor, deberá volver a tomar una prueba dentro de seis meses.

El nivel de nitrato es *mayor de* 10 ppm, ¿qué debo hacer?

Si su análisis de nitrato muestra niveles mayores a 10 partes por millón, busque un suministro de agua potable diferente y más seguro. Lo primero que debe hacer es comenzar a utilizar agua embotellada para beber y cocinar. No hierva agua con altos niveles de nitrato. Hervir el agua puede incrementar el nivel de nitrato, ¡empeorando el problema!

Otra opción es instalar un dispositivo o filtro diseñado para eliminar el nitrato del agua. Estos dispositivos se instalan con frecuencia en los grifos de la cocina, donde las personas toman agua para beber y cocinar. El nitrato no se absorbe a través de la piel, por lo tanto es seguro utilizar esta agua para limpiar y bañarse.

Otras soluciones a largo plazo incluyen:

- Cavar un pozo más profundo en una fuente diferente de aguas subterráneas;
- Conectarse a un sistema de agua público; o
- Trabajar con otras personas de su comunidad para desarrollar un nuevo sistema público de agua para su hogar y los vecinos de la zona.

Los resultados de mi análisis indican coliformes en el agua, ¿qué debo hacer?

Los análisis de coliformes por lo general indican SATISFACTORIO o NO SATISFACTORIO. Si recibe un informe SATISFACTORIO, significa que su agua no contiene estas bacterias al momento de tomar la muestra. Asegúrese de realizar este análisis de coliformes todos los años.

Si recibe un informe NO SATISFACTORIO, el agua podría estar contaminada. No beba el agua hasta que el análisis sea SATISFACTORIO. Busque un suministro de agua potable distinto y seguro. Lo primero que debe hacer es comenzar a utilizar agua embotellada o hervida para beber y cocinar. Además, debe utilizarla para preparar hielo o café, lavarse los dientes y lavar frutas y verduras que come crudas. Hervir el agua durante un minuto por lo general mata las bacterias.

El laboratorio y el departamento de salud local pueden ayudarlo a determinar si debe volver a tomar una muestra, desinfectar el pozo o tomar otras medidas basadas en el resultado.

¿Qué son las bacterias coliformes y por qué debería tener cuidado?

Las bacterias coliformes son organismos que están en el medio ambiente y en las heces de humanos y animales. Las bacterias coliformes probablemente no causan enfermedades, pero su presencia en el agua potable indica que también puede haber organismos causantes de enfermedades.

¿Qué es el nitrato?

El Nitrógeno es un químico que se encuentra en la mayoría de los fertilizantes, en estiércol de animales y en los tanques sépticos. Las bacterias naturales de la tierra pueden cambiar el nitrógeno a nitrato. El agua de lluvia y el agua de riego pueden arrastrar el nitrato por debajo de la tierra hacia las aguas subterráneas.

¿Qué me puede hacer el nitrato?

El exceso de nitrato en el cuerpo dificulta el transporte de oxígeno que deben realizar los glóbulos rojos. Aunque muchas personas no noten la diferencia, esto puede ser muy peligroso para los bebés y las mujeres embarazadas. Los bebés expuestos a grandes cantidades de nitrato pueden desarrollar el "síndrome del bebé azul," una enfermedad extraña pero que puede ser fatal.

¿Cuáles son los síntomas del síndrome del bebé azul?

Los síntomas se pueden confundir con los de otras enfermedades. Un bebé con el síndrome del bebé azul leve a moderado puede tener diarrea, vómitos y estar apático.

En casos más graves el bebé puede tener:

- piel que cambia a color gris, café oscura o azul, o
- labios, dedos o las uñas de los pies de color azulado; o
- problemas para respirar.

Los resultados de mi análisis indican *tanto* coliformes *como* nitrato, ¿qué debo hacer?

Busque un suministro de agua potable distinto y seguro. Lo primero que debe hacer es comenzar a utilizar agua embotellada para beber y cocinar. Hervir el agua mata las bacterias coliformes, pero no elimina el nitrato. NO hierva agua con coliformes y nitrato. Puede incrementar el nivel de nitrato, ¡empeorando el problema! Consulte otras opciones bajo nitrato y coliformes más arriba.

Los resultados del análisis indican que está bien, pero no me gusta el sabor/olor/la apariencia del agua. ¿Qué está pasando?

Algunos contaminantes hacen que el agua no tenga buen olor, sabor o apariencia pero no son nocivos para su salud. Su laboratorio y el departamento de salud local pueden ayudarlo a determinar si necesita analizar o tratar su agua.

¿Qué son las unidades domésticas de tratamiento de agua? He escuchado que son útiles.

Los sistemas de filtro en el punto de uso (POU) tratan el agua en un sólo grifo. Los sistemas de filtro en el punto de entrada (POE) tratan el agua utilizada por toda la vivienda.

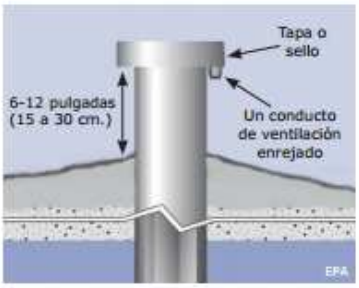
Los tres tipos de sistemas que peuden eliminar el nitrato del agua son:

- Unidad de ósmosis inversa
- Unidad de destilación
- Unidad de intercambio iónico

Importante: Todos los sistemas de filtro POU y POE o las unidades de tratamiento requieren mantenimiento para funcionar bien. Si no reciben el mantenimiento adecuado, los contaminantes se podrían acumular en las unidades y empeorar el agua. Además, algunos vendedores podrían declarar su efectividad aunque no esté basado en la ciencia. EPA no analiza ni certifica las unidades de tratamiento, pero sí lo hacen dos organizaciones: la NSF International y el Underwriters Laboratory.

¿Cómo puedo proteger el agua de mi pozo de la contaminación?

Asegúrese que la boca del pozo se extienda entre 6 a 12 pulgadas (15 a 30 cm.) por encima de la superficie del suelo y que esté tapado para que no entren los contaminantes. Selle el suelo alrededor de la boca del pozo y hágalo en declive para que el agua no se acumule y filtre dentro del pozo.



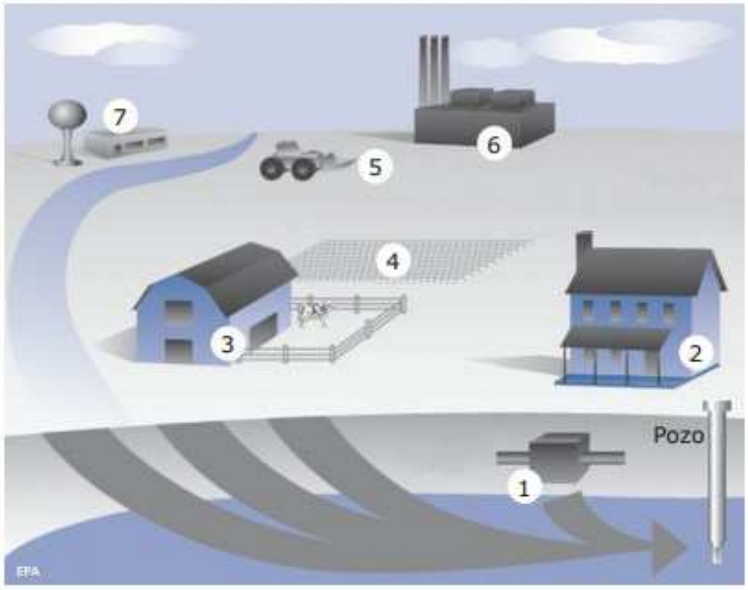
Es importante mantener el pozo protegido de contaminantes potenciales que pueden estar alrededor de su vivienda. Cuánto más lejos de las fuentes de contaminación, mucho mejor.

Los expertos sugieren que el pozo debe estar al menos:

- a 50 pies (15 metros) del tanque séptico,
- a 100 pies (30 metros) del borde de un campo de drenaje, tanque de combustible, graneros y cualquier depósito de fertilizantes y pesticidas, y
- a 250 pies (75 metros) de un montículo de estiércol.

Fuentes potenciales de contaminación del agua de pozos

1. Tanque séptico
2. Residuos domésticos
3. Residuos de animales
4. Pesticidas y fertilizantes
5. Vertedero
6. Industria local
7. Tanques de almacenamiento subterráneo



Recursos adicionales (información en inglés)

Departamentos de salud locales
www.doh.wa.gov/LHJMap/LHJMap.htm

Laboratorios certificados en su zona
www.ecy.wa.gov/apps/eap/acclabs/labquery.asp

Organizaciones certificadoras de unidades domésticas de tratamiento de agua
NSF International (Anteriormente, Fundación de Sanidad Nacional), www.nsf.org
Underwriters Laboratory, www.ul.com

Publicaciones del Centro para el Control y la Prevención de Enfermedades
Pozos privados, www.cdc.gov/healthywater/drinking/private/wells/location.html
Desinfección de emergencia de pozos, http://emergency.cdc.gov/disasters/wellsdisinfect.asp

Publicaciones de la Agencia de Protección Ambiental
Pozos domésticos, www.epa.gov/safewater/privatewells/pdfs/household_wells.pdf
Estándares secundarios, www.epa.gov/safewater/consumer/2ndstandards.html
Folleto sobre datos de filtración, www.epa.gov/safewater/faq/pdfs/fs_healthseries_filtration.pdf
Protección de fuente de agua, http://cfpub.epa.gov/safewater/sourcewater

Washington State Department of Health
DOH 333-171 mayo 2010

Para personas con discapacidades, este documento está disponible en otros formatos. Por favor llame al 1-800-525-0127 (TTY/TDD 1-800-833-6388).

Private Well Water

Coliform Bacteria and Nitrate Information for Private Well Users

Why should my well water be tested?

Drinking contaminated water is a health risk. Some contaminants cannot be seen, smelled, or tasted. Two of the most common contaminants in drinking water are coliform bacteria and nitrate and they can be harmful.

Who should be testing my well water?

You or your landlord. Private well users are responsible for testing their own water. If you don't own your home but you use a private well, talk with your landlord about getting your water tested or seeing the most recent results. You can always take a water sample yourself and have it tested.

What should I test for and how often?

The Department of Health recommends that you test your private well water every year for coliform bacteria and nitrate.

You should also test your water when:

- You notice a change in your water, such as taste, color, or smell.*
- Your well has been flooded.
- You replace any part of your well system.
- Someone in your household is pregnant, nursing, or has an unexplained illness and you suspect your water may be at risk.
- You hear that a neighbor's water is contaminated.
- You live near industrial or agricultural activities.*

*These may require testing for something other than coliform or nitrate.

If you have had previous contamination problems or are concerned about specific contaminants, you may want to test your well water more often.

Where do I go to get my water tested?

Certified drinking water labs are located across the state. The lab you select or your local health department can help you decide what to test for, how to collect samples, and how to understand results. There is a cost for these tests. Costs this year (2010) range from $20 to $25 per test for coliform bacteria, and $30 to $42 per test for nitrate. Most labs like to provide their own sample bottles.

My nitrate level is *less than* 10 ppm, what should I do?

Nitrate levels can vary throughout the year, so if your level is 5 ppm or higher, you may want to re-sample in six months.

My nitrate level is *more than* 10 ppm, what should I do?

If your nitrate test shows levels higher than 10 parts per million, find a different and safe drinking water supply. The quickest thing to do is to begin using bottled water for drinking and food preparation. Do NOT boil water with high nitrate. Boiling water may actually increase the nitrate level, making the problem worse!

Another option is to install a device or filter designed to remove nitrate from your water. These devices are often installed on kitchen faucets, where people get their water for drinking and cooking. Nitrate is not absorbed through the skin, so it is safe to clean and bathe with it.

Other, longer term solutions include:

- Drilling a deeper well into a different groundwater source;
- Connecting to a public water system; or
- Working with others in your community to develop a new public water system to serve your home and nearby neighbors.

My test results came back with coliform in the water, what should I do?

Coliform tests usually come back as SATISFACTORY or UNSATISFACTORY. If you receive a SATISFACTORY report, it means your water was free of these bacteria at the time of the sample. Be sure to test every year for coliform bacteria.

If you receive an UNSATISFACTORY report, it may be contaminated. Do not drink the water until it tests SATISFACTORY. Find a different and safe drinking water supply. The quickest thing to do is either begin using bottled water or boil all water for drinking and food preparation. This also includes water used for making ice or coffee, brushing teeth, and washing fruits and vegetables you eat raw. Boiling water rapidly for one minute usually kills bacteria.

Your lab and local health department can help you determine if you should resample, disinfect your well, or take other action based on your results.

What are coliform bacteria and why should I care?

Coliform bacteria are organisms that are present in the environment and in the feces of humans and animals. Coliform bacteria will not likely cause illness, but their presence in drinking water indicates disease-causing organisms may also be present.

What is nitrate?

Nitrogen is a chemical found in most fertilizers, animal manure, and in septic tanks. Natural bacteria in the soil can change nitrogen into nitrate. Rain water and irrigation water can carry nitrate down through the soil into the groundwater.

What can nitrate do to me?

Too much nitrate in your body makes it harder for red blood cells to carry oxygen. While many people do not notice a difference, this can be very dangerous for infants and pregnant women. Infants exposed to high amounts of nitrate may develop "blue –baby syndrome," a condition that is rare but can be fatal.

What are the symptoms of blue-baby syndrome?

Symptoms can be confused with other illnesses. An infant with mild to moderate blue-baby syndrome may have diarrhea, vomiting, and be lethargic.

In more serious cases, the infant may have:

- skin that becomes gray, darker brown, or blue, or
- lips, finger or toe nails with a blue-like color, or
- trouble breathing.

My test results came back with *both* coliform and nitrate, what should I do?

Find a different and safe drinking water supply. The quickest thing to do is to begin using bottled water for drinking and food preparation. Boiling water kills coliform bacteria, but does not remove nitrate. Do NOT boil water with both coliform and nitrate. It may increase the nitrate level, making the problem worse! See other options under nitrate and coliform above.

My test results came back OK, but I don't like the taste/smell/ appearance of my water. What is wrong with it?

Some contaminants make water smell, taste, or look bad but are not harmful to your health. Your lab and local health department can help you determine if you need to test or treat your water.

What about Home Water Treatment Units? I've heard that these can help.

Point of use (POU) filter systems treat water at a single tap. Point of entry (POE) filter systems treat water used throughout the house.

Three types of systems that can remove nitrate from your water are:

- Reverse Osmosis Unit
- Distillation Unit
- Anion Exchange Unit

Important: All POU and POE filter systems or treatment units need maintenance to operate effectively. If they are not maintained properly, contaminants may accumulate in the units and make your water worse. In addition, some vendors may make claims about their effectiveness that are not based on science. The EPA does not test or certify treatment units, but two organizations that do are NSF International and Underwriters Laboratory.

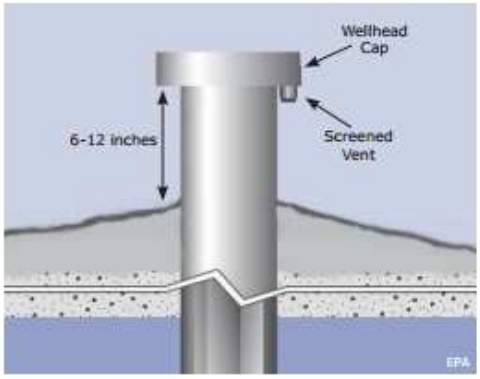
How can I protect my well water from contamination?

Make sure your wellhead extends 6 to 12 inches above the surface of the ground and is capped to keep contaminants out. Seal the ground around the wellhead and slope it away so water does not collect and seep into the well.

It is important to keep your well safe from potential contaminants that may be around your home. The further away from contamination sources, the better.

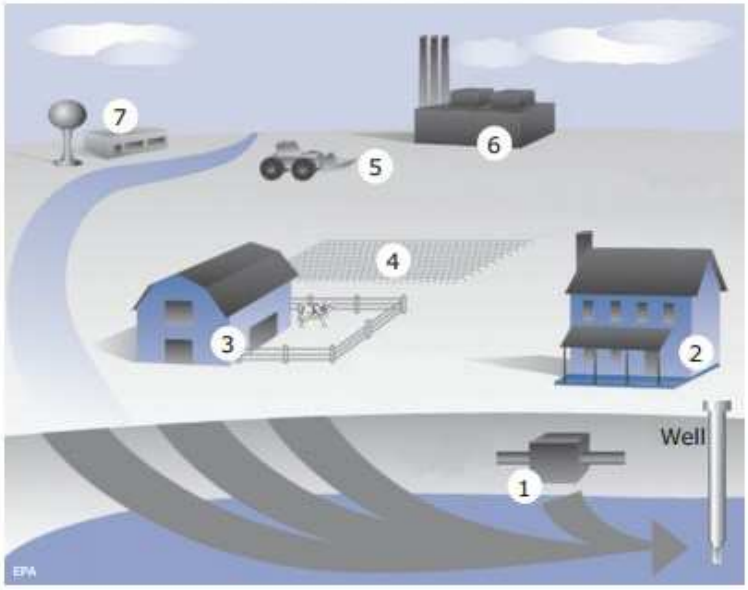
Experts suggest your well should be at least:

- 50 feet from a septic tank,
- 100 feet from the edge of a drainfield, fuel tank, barn, and any storage shed for fertilizers and pesticides, and
- 250 feet from a manure stack.



Potential Well Contaminants

1. Septic Tank
2. Household Wastes
3. Livestock Wastes
4. Pesticides and Fertilizers
5. Landfills
6. Local Industries
7. Underground Storage Tanks



Additional Resources

Local Health Departments
www.doh.wa.gov/LHJMap/LHJMap.htm

Certified Labs in Your Area
www.ecy.wa.gov/apps/eap/acclabs/labquery.asp

Certifying Organizations for Home Water Treatment Units
NSF International (Formerly National Sanitation Foundation), www.nsf.org
Underwriters Laboratory, www.ul.com

Center for Disease Control and Prevention Publications
Private Wells, www.cdc.gov/healthywater/drinking/private/wells/location.html
Emergency disinfection of wells, http://emergency.cdc.gov/disasters/wellsdisinfect.asp

Environmental Protection Agency Publications
Household wells, www.epa.gov/safewater/privatewells/pdfs/household_wells.pdf
Secondary Standards, www.epa.gov/safewater/consumer/2ndstandards.html
Filtration Facts booklet, www.epa.gov/safewater/faq/pdfs/fs_healthseries_filtration.pdf
Source Water Protection, http://cfpub.epa.gov/safewater/sourcewater

Washington State Department of Health
DOH 333-171 May 2010

For persons with disabilities, this document is available in other formats.
To make a request, call 1-800-525-0127 or 1-800-833-6388 (TTY/TDD).

Julio 2013
DOH 331-214s
Revisado

Preguntas y Respuestas

Nitratos en el agua potable

El nitrato es un químico que se encuentra en la mayoría de los fertilizantes, estiércol, y residuos líquidos que se liberan de los tanques sépticos. Las bacterias naturales del suelo pueden convertir nitrógeno al nitrato. La lluvia o agua de irrigación puede llevar el nitrato a través del suelo hasta las aguas subterráneas. Su agua potable puede contener nitrato si su pozo saca agua de tales aguas subterráneas.

El nitrato es un contaminante que puede ocasionar enfermedades agudas, lo que significa que una sola exposición puede afectar a la salud de alguien.

¿Cómo afecta a la salud el nitrato?

El nitrato reduce la capacidad de los glóbulos rojos para llevar oxígeno. En la mayoría de los adultos y niños, estos glóbulos rojos se normalizan rápidamente. Sin embargo, en los lactantes, los glóbulos rojos pueden demorar más tiempo para normalizarse. Los lactantes que beben agua con altos niveles de nitrato (o comen alimentos hechos con agua contaminada con nitrato) pueden desarrollar una enfermedad seria debido a la falta de oxígeno. Esta enfermedad se llama metahemoglobinemia o "síndrome del bebé azul." Algunos científicos piensan que la diarrea puede empeorar este problema.

¿Está regulado por el estado el nitrato en el agua?

Sí. La ley estatal requiere que los sistemas de agua pública hagan pruebas para muchas contaminantes incluyendo el nitrato con regularidad. Nuestra norma para calidad del agua es 10 miligramos por litro (mg/L). Los sistemas de agua pública que contienen niveles de nitrato por encima de 10 mg/L deben notificar a las personas quien recibe agua de ellos.

Los niveles bajos de nitrato en el agua no tendrán un efecto de largo plazo en su bebé. Si su bebé no tiene ningunos de los signos del síndrome del bebé azul, no es necesario que su doctor le examine por la enfermedad de metahemoglobinemia.

¿Cuáles son los signos del síndrome del bebé azul?

El síndrome del bebé azul **moderado a serio** puede causar un tono de piel café-azulado dado la falta de oxígeno. Esta condición puede ser difícil de detectar en lactantes con piel oscura. Para bebés con piel oscura, busca un color azulado dentro de la nariz y la boca, en los labios, o la piel debajo de las uñas de las manos o los pies.

El síndrome del bebé azul **suave a moderado** puede causar signos parecidos a un resfriado u otra infección (irritado, cansado, con diarrea o vómitos). Aunque existe una prueba de sangre para ver si un lactante tiene el síndrome del bebé azul, es posible que los médicos no hagan esta prueba para los bebés con síntomas suaves a moderados.

¿Qué debo hacer si mi bebé tiene el síndrome del bebé azul?

Lleve el bebé al hospital de inmediato si el tono de la piel tiene un color café-azulado o tiene un color azulado en los labios, la lengua, las encías, la piel debajo de las uñas y la nariz. Un medicamento llamado "azul de metileno" normalizará rápidamente la sangre del bebé.

Washington State Department of Health
Environmental Public Health
Office of Drinking Water

HELPING TO ENSURE SAFE AND RELIABLE DRINKING WATER

¿Puedo prevenir el síndrome del bebé azul?

Si. No dé a los bebés menores de 12 meses de edad agua potable con niveles de nitrato más alto de 10 mg/L. No les dé verduras con alto contenido en nitrato como la remolacha, brócoli, zanahorias, coliflor, ejotes o judías, espinaca, y nabos hasta que el bebé tenga más de siete meses de edad.

Los niveles de nitrato en el agua de pozo pueden variar a través del año. Si usted tiene un pozo privado y no está seguro de la calidad del agua, es posible que desee usar agua en botella para preparar la comida y bebidas de su bebé. Aunque hervir el agua elimina las bacterias, no remueve químicos como el nitrato. De hecho, hirviendo causa la evaporación del agua que puede resultar en el incremento del nivel de nitrato.

¿Puede la lactancia materna ocasionar el síndrome del bebé azul?

Se ha encontrado bajos niveles de nitrato en la leche materna, pero los niveles no son bastantes altos para causar el "síndrome del bebé azul."

¿Puede el nitrato afectar a los adultos?

Aunque las células rojas vuelven rápidamente a la normalidad, las condiciones de salud de algunas personas las hacen más susceptible a los problemas de salud por nitrato. Las personas con las siguientes condiciones de salud no deberían beber agua con más de 10 mg/L de nitrato:

- Las personas que no tienen suficientes ácidos estomacales.
- Las personas con pérdida hereditaria de la enzima que convierte los glóbulos rojos afectados en células normales (metahemoglobina reductasa).
- Las mujeres embarazadas o que están tratando de quedar embarazadas. Alto contenido de nitratos puede incrementar el riesgo de aborto espontáneo o ciertos defectos de nacimiento.

¿Cómo puedo saber si mi agua de pozo tiene nitrato?

Los pozos poco profundos, mal sellados o construidos o los pozos que extraen agua de acuíferos poco profundos tienen riesgo más alto de tener agua contaminada con nitrato. El abono (estiércol) y los desechos de un tanque séptico pueden también contener bacterias y virus que causan enfermedades.

Si usted es el dueño de un pozo privado nosotros recomendamos que analice el agua por bacterias y nitrato cada año. El departamento de salud de su condado puede decirle donde puede obtener el análisis de su agua y pudiera tener recomendaciones específicas para el análisis. Muchos laboratorios certificados cobran entre $20 a $40 por análisis. Si el resultado del análisis de nitrato es de 5 mg/L o más alto, recomendamos que vuelva a hacer otro análisis en 6 meses.

¿Dónde puedo obtener más información?

Si usted obtiene agua de un sistema público, llame a su servicio de agua o al Departamento de Salud del Estado de Washington, Oficina de Agua Potable, al número de teléfono (800) 521-0323 o visítenos en línea en: http://www.doh.wa.gov/CommunityandEnvironment/DrinkingWater.aspx

Si tiene un pozo privado, llame al departamento de salud local. También puede encontrar información en **Pozos Privados: Información para los propietarios (331-349s)** una publicación disponible en Inglés y Español https://fortress.wa.gov/doh/eh/dw/publications/publications.cfm

Para una lista de laboratorios certificados, visite en línea al Departamento de Ecología de Washington en: http://www.ecy.wa.gov/apps/eap/acclabs/labquery.asp. Bajo "Location" seleccione su estado, ciudad y condado. En la parte baja de la página haga click en "Show results." Haga click en el nombre de un laboratorio para ver qué tipo de análisis hace. Llame al laboratorio para asegurarse que esté acreditado para hacer análisis de nitrato.

Si usted necesita esta publicación en un formato diferente, llame al 800-525-0127. Para TTY/TDD, llame al 800-833-6388.

May 2012
DOH 331-214
Revised

Questions & Answers

Nitrate in Drinking Water

Nitrate is a chemical found in most fertilizers, manure, and liquid waste discharged from septic tanks. Natural bacteria in soil can convert nitrogen into nitrate. Rain or irrigation water can carry nitrate down through the soil into groundwater. Your drinking water may contain nitrate if your well draws from this groundwater.

Nitrate is an acute contaminant. That means one exposure can affect a person's health.

How does nitrate affect health?

It reduces the ability of red blood cells to carry oxygen. In most adults and children, these red blood cells rapidly return to normal. However, in infants it can take much longer for the blood cells to return to normal. Infants who drink water with high levels of nitrate (or eat foods made with nitrate-contaminated water) may develop a serious health condition due to the lack of oxygen. This condition is called methemoglobinemia or "blue baby syndrome." Some scientists think diarrhea makes this problem worse.

Does the state regulate nitrate in drinking water?

Yes. State law requires public water systems to sample for many contaminants, including nitrate, on a regular basis. Our drinking water quality standard for nitrate is 10 milligrams per liter (mg/L). Public water systems with nitrate levels over 10 mg/L must notify people who receive water from them.

Low levels of nitrate in water will not have a long-lasting effect on your baby. If your baby doesn't have any of signs of blue baby syndrome, you do not need to have a doctor test for methemoglobinemia.

What are the signs of blue baby syndrome?

Moderate to serious blue baby syndrome may cause brownish-blue skin tone due to lack of oxygen. This condition may be hard to detect in infants with dark skin. For infants with dark skin, look for a bluish color inside the nose and mouth, on the lips, or fingernail and toenail beds.

Mild to moderate blue baby syndrome may cause signs similar to a cold or other infection (fussy, tired, diarrhea or vomiting). While there is a blood test to see if an infant has blue baby syndrome, doctors may not think to do this test for babies with mild to moderate symptoms.

What should I do if my infant has blue baby syndrome?

Take a baby who has brownish-blue skin tone or a bluish color to the lips, tongue, gums, nail beds, or nose to a hospital immediately. A medication called "methylene blue" will quickly return the baby's blood to normal.

Washington State Department of Health
Environmental Public Health
Office of Drinking Water

HELPING TO ENSURE SAFE AND RELIABLE DRINKING WATER

Can I prevent blue baby syndrome?

Yes. Do not give infants younger than 12 months drinking water with nitrate levels above 10 mg/L. Do not offer high-nitrate vegetables such as beets, broccoli, carrots, cauliflower, green beans, spinach, and turnips until the baby is at least seven months old.

Nitrate levels in well water can vary throughout the year. If you have a private well and you're not sure about your water quality, you may want to use bottled water to prepare your baby's food and drinks. Although boiling water kills bacteria, it will not remove chemicals such as nitrate. In fact, boiling may actually increase the nitrate level.

Will breast-feeding give my infant blue baby syndrome?

Low levels of nitrate have been found in breast milk, but the levels are not high enough to cause blue baby syndrome.

Can nitrate affect adults?

Although red blood cells quickly return to normal, some health conditions can make people more susceptible to health problems from nitrate. Individuals with the following health conditions should not drink water with more than 10 mg/L of nitrate:

- Individuals who don't have enough stomach acids.
- Individuals with an inherited lack of the enzyme that converts affected red blood cells back to normal (methemoglobin reductase).
- Women who are pregnant or trying to become pregnant. Some studies have found an increased risk of spontaneous abortion or certain birth defects.

How can I tell if my well water has nitrate?

Shallow wells, poorly sealed or poorly constructed wells, and wells that draw from shallow aquifers are at greatest risk of nitrate contamination. Manure and septic tank waste may also contain disease-causing bacteria and viruses.

If you own a private well, we recommend that you test for coliform bacteria and nitrate every year. Your county health department can tell you where you can get your water tested and may have specific recommendations for testing. Many certified labs in Washington charge $20 to $40 per test. If your nitrate test results are 5 mg/L or higher, you may want to re-sample in six months.

Where can I get more information?

If you get your water from a public water system, call your water utility or the state Department of Health at 800-521-0323. You can also visit online at http://www.doh.wa.gov/CommunityandEnvironment/DrinkingWater.aspx

If you have a private well, call your local health department. You can also find information in *Private Wells: Information for owners* (331-349) a publication available in English and Spanish at https://fortress.wa.gov/doh/eh/dw/publications/publications.cfm

For a list of certified labs, visit the state Department of Ecology online at http://www.ecy.wa.gov/apps/eap/acclabs/labquery.aspUnder "Location," select your state, city, and county. Scroll down and click on "Show results." Click on the name of a lab to see the tests it performs. Call the lab to make sure it's accredited to analyze for nitrate in drinking water.

PUBLIC HEALTH
ALWAYS WORKING FOR A SAFER AND HEALTHIER WASHINGTON

If you need this publication in an alternate format, call 800-525-0127. For TTY/TDD, call 800-833-6388.

NITRATES, METHEMOGLOBINEMIA, AND DRINKING WATER: A Factsheet for Clinicians

PEHSU Pediatric Environmental Health Specialty Units

Nitrates are chemicals that occur naturally in drinking water and also result from human activities. In some areas private wells are contaminated with nitrates. Excessive nitrates can cause acquired methemoglobinemia in young infants. This severe syndrome of inadequate tissue oxygenation is potentially fatal; prompt clinical recognition and treatment is vital. Families should be counseled on nitrate safety.

Nitrate Background

- Nitrates and nitrites are naturally occurring inorganic nitrogen ions found in soil, water, and some foods. They are a natural part of the human diet. However, excessive consumption (e.g. drinking water or eating food from areas where ground water has become contaminated by excessive nitrate from fertilizers or improper manure management) can cause serious adverse health effects.

Nitrate Sources

- Drinking water
  - Nitrates occur naturally in water at low concentrations. Nitrates are also present as a result of human activities, such as the use of fertilizers and manure on irrigated farm fields that can run off and seep into wells. Nitrate-contaminated water can also be due to improper management of farm animal (i.e. cow) waste, leaky sewage pipes, and septic system failures.
  - Large suppliers of public water sources are required to monitor nitrate concentrations regularly, but private wells are not. In some areas private wells are contaminated with nitrates.
  - The American Academy of Pediatrics (AAP) consensus panel recommends that all prenatal and well-infant visits need to include questions about the home water supply.
  - The only way to know if the nitrate level in well water is at a safe level is to have the well water tested by a certified laboratory. All private wells should be tested before use and once per year for nitrates. Families should contact their state health department for assistance with selecting a certified laboratory.
  - Regulations and water testing frequency:
    - The United States Environmental Protection Agency's (EPA) Maximum Contaminant Level (MCL) for nitrates is 10 mg/L (or 10 parts per million, 10 ppm). The 10 mg/L standard was set to protect infants from nitrates. When a nitrate water test result is 10 mg/L or less, the water is considered safe for infant use.
    - Nitrates may change seasonally or randomly throughout the year. If the nitrate concentration is between 5 – 10 mg/L, monitor more closely and test the well drinking water every 3 months to confirm the water is still safe. When nitrates are present, pesticides or bacteria may also be present and additional water tests may be needed. Families should contact their local health department for guidance.
- Food
  - Nitrates can also be a problem in some vegetables, including spinach, beets, lettuce, cabbage, green beans, squash, carrots, and turnips. Because these vegetables may contain higher amounts of nitrates, recommend other foods until infants are over 6 months old.

Infant Nitrate Exposure

- Infants are exposed to nitrates when they drink contaminated well water or when contaminated well water is used to make infant formula or baby food.
- Nitrates in water are not significantly absorbed through the skin.
- Breastfeeding is safe even if a mother drinks water polluted with nitrates.

Methemoglobinemia and Other Health Effects

- Hemoglobin in blood contains iron normally found in the Fe2+ (ferrous) state. Excessive nitrates or nitrites can alter the iron in hemoglobin to the Fe3+ (ferric) state, forming methemoglobin (an abnormal form of hemoglobin

which cannot bind oxygen). Methemoglobinemia (an excess of methemoglobin) results in poor tissue oxygenation and anoxia.

- Methemoglobinemia, also known as "blue baby syndrome", can be inherited or acquired. The acquired form, such as from excessive nitrate exposure, is a serious medical emergency. Among the reported cases of acquired methemoglobinemia in US infants, most have been attributed to the use of nitrate contaminated well water for preparation of infant formula.
- Infants less than 1 year old are physiologically vulnerable to the development of methemoglobinemia due to several factors:
    - Their higher gastric pH favors nitrate-reducing bacteria that convert ingested nitrate into methemoglobin-producing nitrite.
    - Fetal hemoglobin, the predominant form in infants up to 3 months of age, is oxidized more readily to methemoglobin by nitrite than is adult hemoglobin.
    - The activity of the red blood cell enzyme systems that reduce methemoglobin back to normal hemoglobin is reduced by about half in infants compared with adults.
    - Gastroenteritis can increase the risk of developing methemoglobinemia.
- **Women who are thinking about pregnancy or who are pregnant should avoid water contaminated with nitrates. Women considering pregnancy or who are pregnant should drink water from public water supplies, water that has been tested and has safe nitrate levels, or bottled water.** While not conclusive due to study limitations, epidemiological data suggest an association between maternal ingestion of nitrate from drinking water and preeclampsia, spontaneous abortion, intrauterine growth restriction, and various birth defects. A few studies have hinted at a role for childhood nitrate intake in the risk for later developing diabetes mellitus.

METHEMOGLOBINEMIA CLINICAL MANAGEMENT

Clinical presentation

- In children and adults with acute acquired methemoglobinemia, methemoglobin levels >20% are associated with clinical symptoms.
- Early methemoglobinemia symptoms include nonspecific headache, fatigue, dyspnea, and lethargy. In infants, this may present as unusual fussiness, decreased alertness, diarrhea, vomiting, shortness of breath, and increased work of breathing.
- At higher methemoglobin levels, cyanosis becomes visible. A brownish-blue skin tone may be present due to anoxia. This condition may be harder to detect in infants with dark skin- look for a bluish color of the nasal or oral mucosa, lips, or nail beds.
- Respiratory depression, altered consciousness, shock, seizures, and death may occur. Acquired methemoglobinemia is life threatening when methemoglobin comprises more than 30% of total hemoglobin and mortality rates are high when methemoglobin levels exceed 40%.

Diagnosis

- Initial diagnosis is based on history and exam findings. In addition, the presence of methemoglobin should be suspected with 1) clinical cyanosis despite normal arterial pO2, or 2) a significant difference between the oxygen saturations measured by pulse oximetry and by arterial blood gas analysis ("saturation gap").
- A diagnosis of methemoglobinemia should be confirmed by laboratory analysis, to be done in the emergency setting (i.e. not in primary care). Hemoximetry, also called co-oximetry, is recommended way for measuring methemoglobin. Most current blood gas analyzers have incorporated the ability to do hemoximetry
- A fresh blood specimen (venous is fine) should always be obtained as methemoglobin levels tend to increase with storage.
- Note that routine pulse oximetry is inaccurate for monitoring oxygen saturation when methemoglobin is present, and should not be used for diagnosis.

Treatment

- Acute onset of acquired methemoglobinemia should be considered a medical emergency and requires immediate treatment in the ER setting.
- When the patient is symptomatic or the methemoglobin level is >20%, intravenous methylene blue (MB, dosed at 1 to 2 mg/kg over five minutes) can be life-saving and is considered the treatment of choice. Blood transfusion or

exchange transfusion may be helpful in patients who are in shock. See appropriate clinical guidelines for more detailed treatment and monitoring guidance.

Prevention and Advice for Families

- **Only use water from public water supplies, water that has been tested and confirmed as safe, or bottled water.**
- **Test well water for nitrates to ensure it is safe to drink. A nitrate test is around $50.**
- **Don't use nitrate-contaminated well water to make baby formula or to make baby food.**
- **Don't let infants drink nitrate-contaminated water.**
- **Women who are pregnant or trying to get pregnant should not drink nitrate-contaminated well water.**
- **Breastfeeding is safe even if the mother drinks water contaminated with nitrates.**
- **Because some vegetables may contain higher amounts of nitrates, choose other solid foods until infants are over 6 months old.**

Reporting

- Methemoglobinemia is not currently a mandatory notifiable condition in Washington State. However new passive surveillance has been initiated by the Yakima Health District under the supervision of Health Officer Dr. Chris Spitters. Yakima Health District requests notification of laboratory-confirmed methemoglobinemia by calling (509) 249-6541 within three days of diagnosis. Please include an exposure history and your clinical impression regarding etiology, if known.

Resources and References

For acute poisoning assistance contact your state poison center at 1-800-222-1222.
For additional non-urgent clinical and public health assistance, contact the NW PEHSU. The University of Washington based Pediatric Environmental Health Specialty Unit (PEHSU) serves medical and public health professionals in Alaska, Washington, Idaho, and Oregon. For more information contact us at 1–877–543-2436 (1-877-KID-CHEM) or pehsu@uw.edu. Visit our website http://www.depts.washington.edu/pehsu.

- ATSDR ToxFAQsTM for Nitrates and Nitrites: http://www.atsdr.cdc.gov/toxfaqs/tf.asp?id=1186&tid=258
- ATSDR Case Studies in Environmental Medicine (CSEM): Nitrate/Nitrite Toxicity (course: WB2342): http://www.atsdr.cdc.gov/csem/csem.asp?csem=28&po=0
- Brender JD, et al. Prenatal nitrate intake from drinking water and selected birth defects in offspring of participants in the National Birth Defects Prevention Study. Environ Health Perspect. 2013 121:1083 – 1089.
- Karr C. Children's Environmental Health in Agricultural Settings. Journal of Agromedicine. 2012 April; 17(2), 127-139.
- Greer FR, Shannon M. American Academy of Pediatrics Committee on Nutrition; American Academy of Pediatrics Council on Environmental Health. Infant methemoglobinemia: the role of dietary nitrate in food and water. Pediatrics. 2005 Sep;116(3):784-6.
- Hord NG, Tang Y, Bryan NS. Food sources of nitrates and nitrites: the physiologic context for potential health benefits. Am J Clin Nutr. 2009 Jul;90(1):1-10.
- Rogan WJ et al. Drinking Water from Private Wells and Risks to Children. Pediatrics. 2009 Jun;123(6):1599-605.
- Washington State Department of Health: Nitrate in Drinking Water WEB site. Last accessed March 31, 2014. http://www.doh.wa.gov/CommunityandEnvironment/DrinkingWater/Contaminants/Nitrate.aspx
- Yakima Health District Drinking Water WEB site last accessed March 31, 2014. http://yakimacounty.us/yakimahealthdistrict/drinking_water.php

Authors: N. Beaudet, MS, CIH; A. Otter, DNP, ARNP; C. Karr, MD, PhD; S. Sathyanarayana, MD, MPH, A. Perkins, BA. Last updated July 2014.

Disclaimer: PEHSU funding was made possible (in part) by the cooperative agreement award number UTI Grant Number U61 TS000118 from the Agency for Toxic Substances and Disease Registry (ATSDR). The views in this guidance do not necessarily reflect the official policies of the Department of Health and Human Services; nor does mention of trade names, commercial practices, or organizations imply endorsement by the U.S. Government.
Acknowledgement: The U.S. Environmental Protection Agency (EPA) supports the PEHSU by providing funds to ATSDR under Inter-Agency Agreement number DW-75-92301301-0. Neither EPA nor ATSDR endorse the purchase of any commercial products or services mentioned in PEHSU publications.

GWMA Mission

Groundwater Management Area (GWMA):

The goal of the Lower Yakima Valley GWMA is to reduce nitrate contamination concentrations in groundwater below state drinking water standards.

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE

Groundwater Management Area (GWMA)

Background

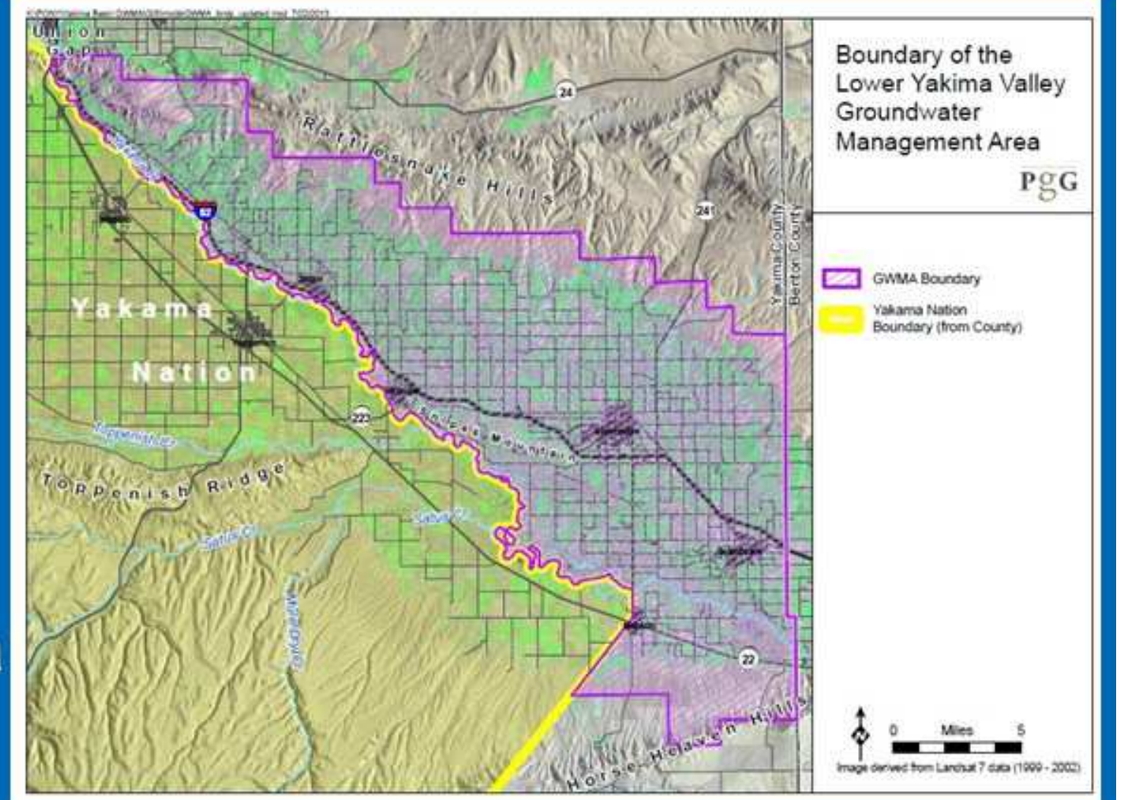
- In 2011, the Lower Yakima Valley Groundwater Management Area (GWMA) was formed to address nitrate contamination in groundwater.
- The GWMA is a response to the elevated nitrate levels found in the Lower Yakima Valley which exceed the state standard of 10.0 mg/L.
- Private drinking water wells with nitrate levels higher than the state standard, pose a greater health risk to those individuals susceptible to elevated nitrate in their drinking water.

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE

Groundwater Management Area (GWMA)

GWMA Boundaries

The GWMA boundaries extend west from Union Gap east to County Line Road, minus the Yakama Nation.



The GWMA encompasses 175172.66 acres or 273.7 square miles.

http://www.yakimacounty.us/1617/Ground-Water-Management-Area

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE

Groundwater Management Area (GWMA)

What the GWMA Intends to Do:

Yakima County requested Dept of Ecology to recognize the GWMA and provide assistance for helping reduce the nitrate level in the groundwater. Objectives include:

- Data Collection, Monitoring and Analysis.
- Public Education and Outreach.
- Problem Identification.
- Potential Measures or Practices for Reducing Groundwater Contamination.

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE

Groundwater Management Area (GWMA)

GWMA GroundWater Advisory Committee

- The Lower Yakima Valley Groundwater Management Area Committee (GWAC) is responsible for developing the (GWMA) plan.

- The GWAC is a multi-agency and citizen-based group with 22 primary members and alternates.

- To learn about their progress or to attend a meeting, please visit: http://www.yakimacounty.us/agendacenter

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE

Groundwater Management Area (GWMA)

GWMA GroundWater Advisory Committee Membership

Commissioner Rand Elliott,

Yakima County Board of Commissioners

Vern Redifer, P.E. (alternate),

Yakima County Public Services

Lower Yakima Valley GWAC Members and Alternates

http://www.yakimacounty.us/541/Ground-Water-Management-Area

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE

Groundwater Management Area (GWMA)

GWMA Working Groups:

http://yakimacounty.us/583/Working-Groups

Livestock / CAFO
Chair: David Bowen

Irrigated Agriculture
Chair: Dr. Troy Peters

Residential, Commercial, Industrial, Municipal
Chair: Dan DeGroot

Data Collection, Characterization, Monitoring
Chair: Melanie Redding

Regulatory Framework
Chair: Jean Mendoza

Education & Public Outreach
Chair: Lisa Freund

Funding
Chair: Pending

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE

Groundwater Management Area (GWMA)

GWAC Working Groups

Working groups were convened to provide focused information and plans for the objectives identified in the request.

The GWMA website offers reference material and guides users to agency partners who have additional information.

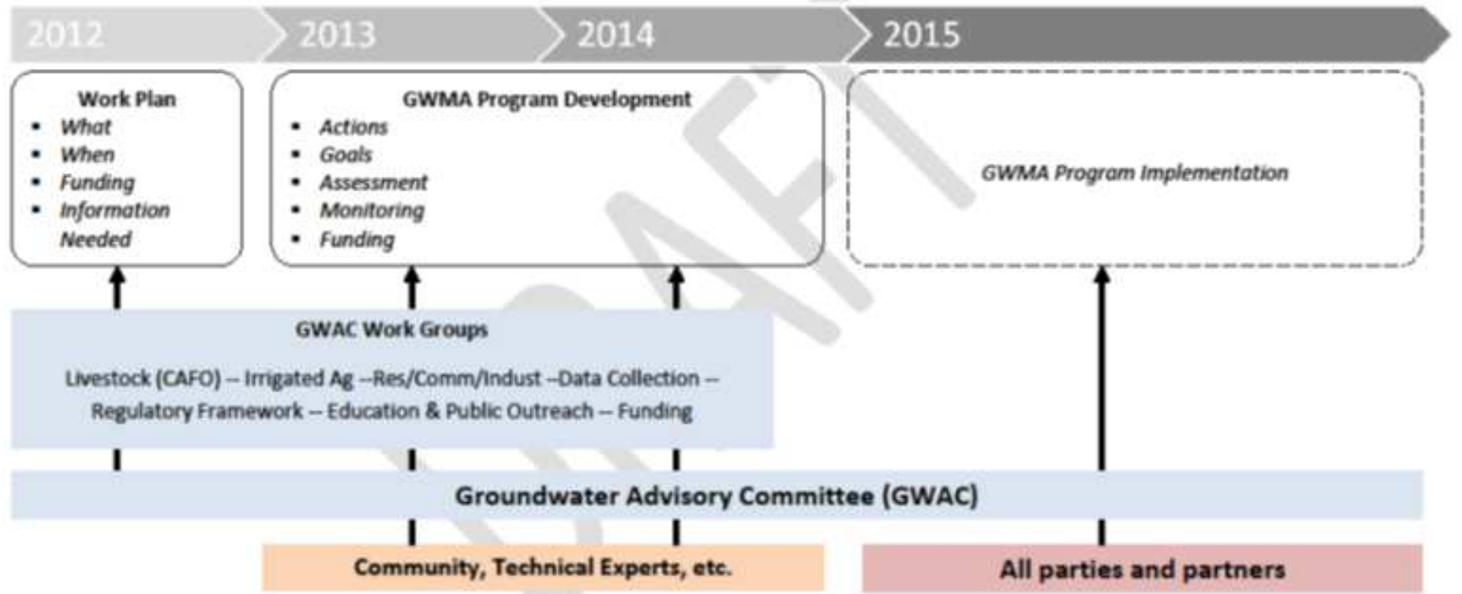
The working group meetings are posted on the website and are open to the public just like the committee meetings.

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE

Groundwater Management Area (GWMA)

GWMA Timeline

Groundwater Management Area (GWMA) Timeline and Schedule of Activities and Input



December 2012

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE

Groundwater Management Area (GWMA)

Citizen-Based Pollution Prevention

Pollution prevention will be a guiding principle for all work.

A coordinated effort to address groundwater contamination in the Yakima Basin.

Seeks credibility with the general public, the farming community, stakeholders, and special interest groups.

Multiple approaches including education, technical assistance and accountability strategies.

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE

Groundwater Management Area (GWMA)

How To Get It Done?

Identify the primary sources of nitrate contamination using scientific data.

Identify or develop practices that will minimize nitrate contamination of groundwater

Develop a plan that recommends strategies for implementing improved practices

Provide appropriate education and outreach on health risks and how to prevent exposure.

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE

Groundwater Management Area (GWMA)

How To Get It Done?

Citizen surveys.

Multi-language media outreach.

Health community education, awareness and participation.

Partnerships with Agricultural businesses and employers, farming community, special interest groups, medical organizations, and other interested stakeholders.

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE

Groundwater Management Area (GWMA)

Summary

The goal of the LYV GWMA is the reduction of nitrate levels in the groundwater to below state standards.

Previous studies conducted by EPA and others, have shown a significant problem with elevated nitrate in the shallow aquifer.

Nitrate is an Acute contaminant which can affect those residents at higher risk from nitrate rather quickly, and from a single exposure.

The biggest threat is to the private wells, that are shallow, poorly constructed, poorly located, and rarely tested.

Surveys within the LYV with residents may continue as a tool for providing outreach to residents.

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE

Groundwater Management Area (GWMA)

Contact

Who do I report suspected nitrate contamination to?

Yakima County Health District Communicable Disease Report Line: 509-249-6521

For information about water quality, treatment, options, call the Environmental Health help desk at 509-249-6508

On the Yakama Nation

Indian Health Services -Environmental Health

Shawn Blackshear 509-865-1776

Shawn.blackshear@ihs.gov

For more information on the Lower Yakima Valley Groundwater Management Area or the Groundwater Advisory Committee, please visit: http://www.yakimacounty.us/541/Ground-Water-Management-Area

Thank you for your interest.

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE

Groundwater Management Area (GWMA)

6 Phase I High Risk Well Testing_media talking points

Results of the 2014 Free Well Testing
Offered by the Lower Yakima Valley Groundwater Advisory Committee (GWAC)
Lower Yakima Valley Groundwater Management Area (GWMA)

Background

- The Lower Yakima Valley Groundwater Management Area (GWMA) was formed in 2011 to address nitrate contamination in groundwater.
- The GWMA is a response to elevated nitrate levels found in the lower Yakima Valley.
- The GWMA boundaries extend west from Union Gap east to County Line Road, minus the Yakama Nation. (273.7 mi.^{2})
- Its goal is to reduce nitrate in groundwater to below state drinking water standards (below 10 mg/L).
- The GWAC is a multi-agency and citizen-based group with 21 primary members and alternates. It is responsible for developing the GWMA Program.
- The GWMA Program will be a comprehensive program designed to protect groundwater quality in the Lower Yakima Valley.

Why was the well testing conducted?

- To help private well owners learn about the health of their drinking water and how to protect themselves against possible contamination.
- To remind well owners to test their well at least once a year.
- To spread the word about the GWAC's work and the LYV Groundwater Management Area.

What did you test for?
Nitrate and coliform.

Who participated?

- Households on private or shared wells in the Lower Yakima Valley GWMA were invited to participate.

How many wells were tested?
172 private and shared wells

What did you learn?

Of the 172 wells tested:

- 59% (101) had little or no nitrates (0-4.99 mg/L)
- 25% (43) had moderate (still acceptable) amounts of nitrate (5.0-9.99 mg/L)
- 16% (28) had nitrates at or above 10 mg/L

What will you do with this information?

While the sample size is too small to draw meaningful conclusions, we did learn we have a lot of work ahead of us:

- Many people don't know that they should test their wells regularly.
- They don't know who is at risk from elevated nitrates for how to protect themselves.

We will use these results to help educate well owners and to prepare for the next round of the free well testing, which we expect to conduct later this year.

Is there anything else you'd like to add?

Yes. If you missed out on our free well testing, we will be offering it again soon. Please call 509-574-2300 to sign up for this year's free testing.

6a Phase I High Risk Survey Instrument

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE

Form #GWMA0002 A
Revised 10/16/2013

Assessment Of Health Risk - Water Supply Well - Lower Yakima Valley (GWMA 2013)

☐ Survey Completed ☐ Survey Attempted/Not Completed:

☐ No One Home ☐ Declined ☐ Other _____Number of Attempts

Date Survey Completed_____

Parcel #_____Surveyor_____

Name Of Person Surveyed_____

Address_____City_____State_____ Zip_____

Email_____

Home Phone_____Cell Phone_____

Answers to the following questions will help assess the potential health risk for private well owners. Specifically, those risks associated with high levels of nitrate in their well. A potential High Public Health Risk (HPHR) is identified with a yellow highlight and a heavy border around the checkbox. A potential Public Health Risk (PHR) is only identified with a yellow highlight in the checkbox. . Water supply wells found with a potential HPHR will be given recommendations for testing, repairs, or maintenance of their well.

As a general rule the Washington Departments of Health and Ecology recommend private groundwater wells be tested for nitrate every three years and bacteria every year.

Classify the surrounding area as	☐ Farm	☐ Rural	☐ Rural Community Sub-Division	☐ Suburb
Does the home have a treatment system installed?			☐ Yes	☐ No
If yes what kind?	☐ POU	☐ POE	☐ Ion Exchange (Water Softener)	☐ Other
Does the home have bottled water?			☐ Yes	☐ No
Sample Scheduled or Taken?	☐ Nitrate	☐ Nitrate Test Strip	☐ Coliform	☐ Other
GPS Coordinates	**X:**		**Y:**	

High Risk: (80% of PHR and HPHR boxes checked) Possible contamination of the water supply and for the long term may need testing, improvements, repairs, or replacement. You should test your water immediately. If tests are positive for Fecal or E.Coli bacteria or have a nitrate level higher than 10 mg/L, you should consider using an alternative source of drinking water for daily uses, until the observed risk(s) can be corrected. If you believe you or your family is experiencing health effects associated with your drinking water, you should discuss the test results with your health care provider.

Moderate Risk: (60% of PHR and HPHR boxes checked) Your well may be a potential health threat to anyone consuming the water and may be susceptible to contamination. Recommend regular maintenance of the well and frequent water tests for nitrate and coliform bacteria.

Low Risk: Recommend regular maintenance of the well and water tests for nitrate and coliform bacteria.

Section Summary		**Boxes Checked** HPHR	PHR
1	☐ Yes ☐ No		
2	☐ Yes ☐ No		
3	☐ Yes ☐ No		
4	☐ Yes ☐ No		
Total	Yes:_____ No:_____		
☐ High	☐ Moderate	☐ Low	

Section 1: General Population Questions	**Yes**	**No**	**Unk**	**Comments**
1. How many residents live in your household?				

LOWER YAKIMA VALLEY
GROUNDWATER ADVISORY COMMITTEE

Form #GWMA0002 A
Revised 10/16/2013

Assessment Of Health Risk - Water Supply Well - Lower Yakima Valley (GWMA 2013)

2. Are there very young children less than 1-yr old in your household?	☐	☐	☐	
3. Are there pregnant women in your household?	☐	☐	☐	
4. Women who can possibly become pregnant in your household?	☐	☐	☐	
5. Are there chronically ill people in your household?	☐	☐	☐	
6. Would you be willing to provide your household income?				
7. What is the primary language spoken in your home?				
Total High Risk Boxes Checked:	At Risk Population:	Yes: ☐		No: ☐

Section 2: General Water Quality Questions	Yes	No	Unk	Comments
8. Has the well been tested for Total Coliform (Bacteria)?	☐	☐	☐	
a. Answered yes to previous question, was the sample positive for Total Coliform?	☐	☐	☐	
b. Answered yes to previous question, was the sample positive for Fecal or E. Coli?	☐	☐	☐	
9. Has the well been tested for nitrate?	☐	☐	☐	
a. Answered yes to previous question (9), was the sample lower than 5.0 mg/L?	☐	☐	☐	
b. Answered no to previous question (9a), was the sample higher than 10.0 mg/L?	☐	☐	☐	
10. Does the well water have an unusual taste, odor, or color?	☐	☐	☐	
Total High Risk Boxes Checked:	Potential Public Health Risk(s):	Yes: ☐		No: ☐

Section 3: Sanitary Control Area Risk Factors	Yes	No	Unk	Comments
11. Does the owner live on a small lot with an onsite septic system (less than 1-acre)?	☐	☐	☐	
a. Is the well within 50 ft of a septic tank or 100 ft of a drainfield?	☐	☐	☐	
b. Have you had your septic tank pumped recently?	☐	☐	☐	
c. Do neighbors live on small lots with onsite septic systems?	☐	☐	☐	
12. Is there surface water within 100 feet of the well? (like ponds, lagoons, rivers, unlined irrigation ditches)	☐	☐	Surface Water Type	
a. Is there surface water within 200 feet of the well?	☐	☐	Surface Water Type	
13. Do you use the area surrounding the well as a pasture or have structures to house personal animals?	☐	☐	Type:_____ How Many:_____	
a. Does your neighbor use the area surrounding the well as a pasture or have structures for housing personal animals?	☐	☐	Type:_____ How Many:_____	
14. Do you see large mounds of manure near your well, within 100-ft?	☐	☐	Owner:_____ Neighbors:_____	
a. Do you see large mounds of manure near your well, within 200-ft?	☐	☐	Owner:_____ Neighbors:_____	
15. Have you seen manure spreading near your well, within 100-ft?	☐	☐	How Often:	
a. Have you seen manure spreading near your well, within 200-ft?	☐	☐	How Often:	
16. Is your well located within 100-ft of any type of agricultural field or orchard?	☐	☐	Crop:_____ Distance:_____	
a. Is your well located within 200-ft of any type of agricultural field or orchard?	☐	☐	Crop:_____ Distance:_____	

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE

Form #GWMA0002 A
Revised 10/16/2013

Assessment Of Health Risk - Water Supply Well - Lower Yakima Valley (GWMA 2013)

17. Have you sprayed or seen sprayed any chemicals within 100-ft of your well?	☐	☐	How Often:_____ How Close:_____
a. Have you sprayed or seen sprayed any chemicals within 200-ft of your well?	☐	☐	How Often:_____ How Close:_____

Total High Risk Boxes Checked:		Well Susceptible to Surface Contamination:	Yes: ☐ No: ☐

Section 4: Well Construction	Yes	No	Unk	Comments
18. Do you have a copy of the well log?	☐	☐	☐	_____-yr
19. Do you know how old your well is?	☐	☐	☐	
20. Do you know the depth of your well?	☐	☐	☐	_____-ft
21. Is it a hand dug well?	☐	☐	☐	
22. Is it a driven well (sand point)?	☐	☐	☐	
23. Does the well appear poorly maintained (condition of wellhead or pump house)?	☐	☐	☐	
24. Does the well appear to have a broken wellhead seal or holes in the casing?	☐	☐	☐	
25. Is the wellhead subject to flooding?	☐	☐	☐	

Total High Risk Boxes Checked:		Well Vulnerable to Surface Contamination:	Yes: ☐ No: ☐

Section 5: Long Term Monitoring Consideration

26. Type of Well:	☐ Domestic	☐ Public Supply	☐ Industrial	☐ Irrigation
27. Describe Wellhead Completion (pitless adapter, wellhouse, etc.): _____				
28. Record the Ecology UWID if tagged on the wellhead or noted on the well log:	__ __ __ - __ __ __			
29. GPS Latitude of the Wellhead (valid coordinates must be positive and from 45-47, must be a minimum of 4 decimal places):				
30. GPS Longitude of the Wellhead (valid coordinates must be negative and from -119 to -121, must be a minimum of 4 decimal places):				
31. Depth to Water (ft below Measuring Point, MP):				
a. MP Description:				
b. DTW Method Description (e.g. well log, measured, etc.):				
32. Is Type of Pump Known?	☐ Yes	☐ No	☐ Unknown	
a. Pump Is (e.g. Submersible, Suction-lift, Jet pump, Line Shaft Turbine):				
33. Is Sampling Port available downstream (before water enters) treatment system, holding tanks, or pressure tanks?	☐ Yes	☐ No	☐ Unknown	
a. Description of sampling port (location, type):				

LOWER YAKIMA VALLEY
GROUNDWATER ADVISORY COMMITTEE

Form #GWMA0002 A
Revised 10/16/2013

Assessment Of Health Risk - Water Supply Well - Lower Yakima Valley (GWMA 2013)

34. Is Participant interested in having their well considered for Long-Term Monitoring?	☐ **Yes**	☐ **No**	☐ **Unknown**
a. Directions for gaining access to the site (notification request, allowed if owner/resident not present, etc.):			
b. Special tools or materials to access/open sampling port or to manage purge water:			
c. Safety considerations for samplers (e.g. domestic animals, rodents):			

Section 5: Graphics (Required)

Site Sketches and Photos: Must include sufficient detail and scale to enable field personnel unfamiliar with the site to readily locate the well from the driveway or street. Include land cover/use features from Section 3 (septic, agriculture, etc.). Compass directions and horizontal scale required.

a. Site Sketch is on additional page(s) attached to this Survey form:	☐ **Yes**	☐ **No**
b. Digital Photos of the site taken (if camera does not have GPS capabilities, first photo in series at individual site must clearly document Site ID):	☐ **Yes**	☐ **No**

LOWER YAKIMA VALLEY
GROUNDWATER ADVISORY COMMITTEE

Form #GWMA0002 A
Revised 10/16/2013

Assessment Of Health Risk - Water Supply Well - Lower Yakima Valley (GWMA 2013)

Wellhead Sketches and Photos: Must include sufficient detail and scale to enable field personnel unfamiliar with the well to readily locate the sampling port and water level measuring point if applicable.		
a. Wellhead Sketch is on additional page(s) attached to this Survey form:	☐ **Yes**	☐ **No**
b. Digital Photos of the wellhead taken (if camera does not have GPS capabilities, first photo in series at individual site must clearly document Site ID):	☐ **Yes**	☐ **No**

LOWER YAKIMA VALLEY
GROUNDWATER ADVISORY COMMITTEE

Form #GWMA0002 A
Revised 10/16/2013

Assessment Of Health Risk - Water Supply Well - Lower Yakima Valley (GWMA 2013)

6 Well Assessment Survey Test Results thru 2_15-16.pdf

Well Assessment Survey Test Results

Through February 15, 2016

Nitrate Test Results

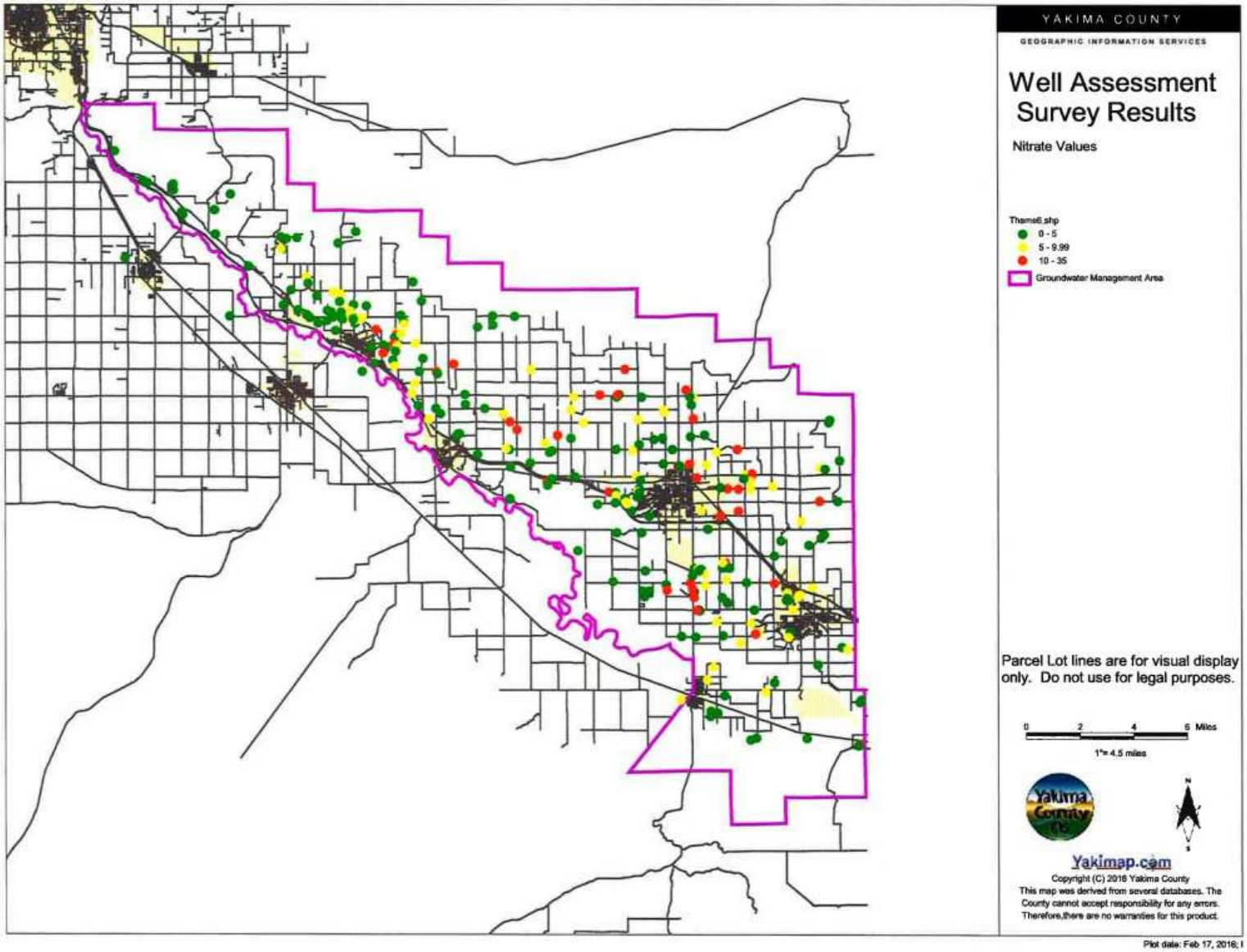
Nitrate Range	Number of Wells	Percent
0 to 5.0	172	60%
5.01 to 9.99	76	26%
10.0 to 35	40	14%
Grand Total	288	100%

Bacteria Test Results

Result	Number of Wells		
	Bacteria Present	Ecoli Present	Fecal Present
Satisfactory	228	286	288
Unsatisfactory	60	2	0
Grand Total	288	288	288

Nitrate and Bacteria Test Results

Nitrate Range	Number of Wells	Bacteria Present	Ecoli Present	Fecal Present
0 to 5.0	172	40	2	0
5.01 to 9.99	76	14	0	0
10.0 to 35	40	6	0	0
Grand Total	288	60	2	0


YAKIMA COUNTY
GEOGRAPHIC INFORMATION SERVICES
Well Assessment Survey Results
Nitrate Values
Theme6.shp
0 - 5
5 - 9.99
10 - 35
Groundwater Management Area
Parcel Lot lines are for visual display only. Do not use for legal purposes.
0 2 4 6 Miles
1"= 4.5 miles
Yakimap.com
Copyright (C) 2016 Yakima County
This map was derived from several databases. The County cannot accept responsibility for any errors. Therefore,there are no warranties for this product.
Plot date: Feb 17, 2016; I

6b All results letters-variables & enclosures list.docx

High Risk Well Assessment Letters-Variables

Where:

Nitrate Results Are	And Coliform Results Are	And	Letter is
N is 0-4.9 mg/L	Satisfactory	N/A	Letter #1
N is 0-4.9 mg/L	Unsatisfactory	N/A	Letter #1 with coliform variation
N is 5-9.9 mg/L	Satisfactory	N/A	Letter #2
N is 5-9.9 mg/L	Unsatisfactory	N/A	Letter #2 with coliform variation
N is 10 mg/L or greater	Satisfactory	N/A	Letter #3
N is 10 mg/L or greater	Unsatisfactory	E-Coli Not present	Letter #3 with coliform variation
N is ???	Unsatisfactory	E-Coli Present	Letter #?? With disinfect message

# of pages	Letter #1 Enclosures	Letter #2 enclosures	Letter #3 enclosures
1 (single)	Lab results	Lab results	Lab results
1 (single)	2A_Certified Lab List (English/Spanish)	2A_Certified Lab List (English/Spanish)	2A_Certified Lab List (English/Spanish)
1 (double)	2B_DOH Coliform 331-79 Q&A	2B_DOH Coliform 331-79 Q&A	2B_DOH Coliform 331-79 Q&A
1 (double)	2B_(Sp) DOH Coliform 331-79 Q&A	2B_(Sp) DOH Coliform 331-79 Q&A	2B_(Sp) DOH Coliform 331-79 Q&A
1 (double)	2C_DOH Nitrate in Drinking Water 331-214	2C_DOH Nitrate in Drinking Water 331-214	2C_DOH Nitrate in Drinking Water 331-214
1 (double)	2C_(Sp) DOH Nitrate in Drinking Water 331-214	2C_(Sp) DOH Nitrate in Drinking Water 331-214	2C_(Sp) DOH Nitrate in Drinking Water 331-214
			Emergency disinfect

6bi ltr 1 (Eng) well survey _satisfactor N results and what they mean.docx

LOWER YAKIMA VALLEY
GROUNDWATER ADVISORY COMMITTEE

Groundwater Management Area (GWMA):
The purpose of the GWMA is to reduce nitrate contamination concentrations in groundwater below state drinking water standards

May 2015

Parcel number
Name
Address
City State Zip

Dear Resident:

Thank you for participating in the 2014 Lower Yakima Valley Groundwater Management Area (LYV GWMA) High Risk Well Assessment Survey. A certified lab analyzed the water quality samples taken from your home or well during the survey. These samples included an inorganic sample for Nitrate and a bacteriological sample for Coliform.

We enclosed a copy of the lab results for your drinking water.

* The Nitrate level detected was fill in here mg/L. These results are normal and well within the acceptable range for nitrate.

* The coliform results were satisfactory.

We recommend you continue sampling for nitrate each year, even though your nitrate levels are within an acceptable range (less than 10 mg/L).

We also enclosed fact sheets on Nitrate, Coliform, and websites (links) that you may find helpful. These websites have more information about many drinking water contaminants, Maximum Contaminant Levels, treatment options, as well as proper maintenance for your well. For example:

* You may enter your results into the Ohio Watershed Interpretation Tool at (http://ohiowatersheds.osu.edu/well-educated-ohio/well-water-interpretation-tool) for a detailed explanation of your results for any drinking water contaminant sampled and possible treatment recommendations, or

* Go to Well Owner.org http://www.wellowner.org/water-quality/water-testing/, for information on private wells, recommended testing, treatment, maintenance, and so on.

Why was my well water tested for Nitrate and Coliform?
The Lower Yakima Valley Groundwater Advisory Committee (GWAC) is a multi-agency and citizen-based group coordinating efforts to reduce nitrate contamination in drinking water in the Lower Yakima Valley. To learn more about the GWAC, please visit: http://www.yakimacounty.us/gwma/. Our interest in the study was to inform residents and homeowners served by private or shared wells in the Lower Yakima Valley of the potential health risks associated with their drinking water. We were also interested in gathering more information about the Nitrate level in your drinking water.

Can I be of more help?
Yes, and again we are very grateful for the assistance you have already given us. There is more funding available for doing more tests and surveys on homes served by private wells. Our interest is to get the word out to more residents of the Lower Yakima Valley. Please give us a call at (509) 574-2300 or email us at PSWebContacts@co.yakima.wa.us if you know a neighbor or friend in the area who is interested in having their well tested and the survey completed. As part of our effort to evaluate the levels of nitrate in the LYV, we may be looking for permanent ongoing monitoring sites. Please call
(509) 574-2300 if you want us to consider your well for part of this effort.

Sincerely,

J. Rand Elliott, Chairman
Lower Yakima Valley Groundwater Advisory Committee (GWAC)

Enclosures

LOWER YAKIMA VALLEY
GROUNDWATER ADVISORY COMMITTEE

Groundwater Management Area (GWMA):
The purpose of the GWMA is to reduce nitrate contamination concentrations in groundwater below state drinking water standards

May 2015

Parcel number
Name
Address
City State Zip

Dear Resident:

Thank you for participating in the 2014 Lower Yakima Valley Groundwater Management Area (LYV GWMA) High Risk Well Assessment Survey. A certified lab analyzed the water quality samples taken from your home or well during the survey. These samples included an inorganic sample for Nitrate and a bacteriological sample for Coliform.

We enclosed a copy of the lab results for your drinking water.

* The Nitrate level detected was fill in here mg/L. These results are normal and well within the acceptable range for nitrate.

* The coliform results were satisfactory.

We recommend you continue sampling for nitrate each year, even though your nitrate levels are within an acceptable range (less than 10 mg/L).

We also enclosed fact sheets on Nitrate, Coliform, and websites (links) that you may find helpful. These websites have more information about many drinking water contaminants, Maximum Contaminant Levels, treatment options, as well as proper maintenance for your well. For example:

* You may enter your results into the Ohio Watershed Interpretation Tool at (http://ohiowatersheds.osu.edu/well-educated-ohio/well-water-interpretation-tool) for a detailed explanation of your results for any drinking water contaminant sampled and possible treatment recommendations, or

* Go to Well Owner.org http://www.wellowner.org/water-quality/water-testing/, for information on private wells, recommended testing, treatment, maintenance, and so on.

Why was my well water tested for Nitrate and Coliform?
The Lower Yakima Valley Groundwater Advisory Committee (GWAC) is a multi-agency and citizen-based group coordinating efforts to reduce nitrate contamination in drinking water in the Lower Yakima Valley. To learn more about the GWAC, please visit: http://www.yakimacounty.us/gwma/. Our interest in the study was to inform residents and homeowners served by private or shared wells in the Lower Yakima Valley of the potential health risks associated with their drinking water. We were also interested in gathering more information about the Nitrate level in your drinking water.

Can I be of more help?
Yes, and again we are very grateful for the assistance you have already given us. There is more funding available for doing more tests and surveys on homes served by private wells. Our interest is to get the word out to more residents of the Lower Yakima Valley. Please give us a call at (509) 574-2300 or email us at PSWebContacts@co.yakima.wa.us if you know a neighbor or friend in the area who is interested in having their well tested and the survey completed. As part of our effort to evaluate the levels of nitrate in the LYV, we may be looking for permanent ongoing monitoring sites. Please call
(509) 574-2300 if you want us to consider your well for part of this effort.

Sincerely,

J. Rand Elliott, Chairman
Lower Yakima Valley Groundwater Advisory Committee (GWAC)

Enclosures

6bii ltr 2 well survey_5-9 N results and what they mean1b.docx

LOWER YAKIMA VALLEY
GROUNDWATER ADVISORY COMMITTEE

Groundwater Management Area (GWMA):
The purpose of the GWMA is to reduce nitrate contamination concentrations in groundwater below state drinking water standards

May 2015

parcel #
name
address
city state zip

Dear Resident:

Thank you for participating in the 2014 Lower Yakima Valley Groundwater Management Area (LYV GWMA) High Risk Well Assessment Survey. A certified lab analyzed the water quality samples taken from your home or well during the survey. These samples included an inorganic sample for Nitrate and a bacteriological sample for Coliform.

We enclosed a copy of the lab results for your drinking water.

* The Nitrate level detected was fill in here mg/L. A score between 5 - 9 mg/L shows the nitrate levels are high but still acceptable. However, they may be rising to an unacceptable range.
* The bacteria (Total Coliform) results were satisfactory.

Because your Nitrate level is approaching the State Standard of 10.0 mg/L, we recommend you consider sampling your well for Nitrate once every 3 to 6 months.

We also enclosed fact sheets on Nitrate, Coliform, and websites (links) that you may find helpful. These websites have more information about many drinking water contaminants, Maximum Contaminant Levels, treatment options, as well as proper maintenance for your well. For example:

* You may enter your results into the Ohio Watershed Interpretation Tool at (http://ohiowatersheds.osu.edu/well-educated-ohio/well-water-interpretation-tool) for a detailed explanation of your results for any drinking water contaminant sampled and possible treatment recommendations, or

* Go to Well Owner.org http://www.wellowner.org/water-quality/water-testing/, for information on private wells, recommended testing, treatment, and maintenance.

Why was my well water tested for Nitrate and Coliform?
The Lower Yakima Valley Groundwater Advisory Committee (GWAC) is a multi agency and citizen-based group coordinating efforts to reduce nitrate contamination in drinking water in the Lower Yakima Valley. To learn more about the GWAC, please visit: http://www.yakimacounty.us/gwma/. Our interest in the study was to inform residents and homeowners served by private or shared wells in the Lower Yakima Valley of the potential health risks associated with their drinking water. We were also interested in gathering more information about the Nitrate level in your drinking water.

Can I be of more help?
Yes, and again we are very grateful for the assistance you have already given us. There is more funding available for doing more tests and surveys on homes served by private wells. Our interest is to get the word out to more residents of the Lower Yakima Valley. Please give us a call at (509) 574-2300 or email us at PSWebContacts@co.yakima.wa.us if you know a neighbor or friend in the area who is interested in having their well tested and the survey completed. As part of our effort to evaluate the levels of nitrate in the LYV, we may be looking for permanent ongoing monitoring sites. Please call (509) 574-2300 if you want us to consider your well for part of this effort.

Sincerely,

J. Rand Elliott, Chairman
Lower Yakima Valley Groundwater Advisory Committee (GWAC)

Enclosures

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE

Groundwater Management Area (GWMA):
The purpose of the GWMA is to reduce nitrate contamination concentrations in groundwater below state drinking water standards

Mayo, 2015

parcel #
name
address
city state zip

Estimado residente:

Gracias por su participación en la Encuesta de Evaluación de Pozos de Alto Riesgo del Área de Manejo de Agua Subterránea del Valle Bajo de Yakima (LYV GWMA), 2014. Un laboratorio certificado analizó la calidad de las muestras de agua que se tomaron de su casa o pozo durante la encuesta. Las muestras se sometieron a una muestra inorgánica para Nitrato y una muestra bacteriológica para Coliforme.

Adjuntamos en esta carta una copia de los resultados de laboratorio de su agua para beber.

* El nivel de Nitrato detectado fue de fill in here mg/L. Un resultado entre 5 y 9 mg/L indica que los niveles de nitrato son altos, pero continúan siendo aceptables. Sin embargo, pudiera ser que los niveles estén en aumento y pudieran llegar a un rango inaceptable.

* Los resultados para bacteria (Coliforme Total) fueron Satisfactorios.

Debido a que su nivel de Nitrato se está acercando al Estándar Estatal de 10.0 mg/L, le recomendamos que considere hacer pruebas por Nitrato a su pozo de cada 3 a 6 meses.

También adjuntamos hojas con factores acerca del Nitrato, Coliforme y sitios en el internet (enlaces) que pudieran ser útiles. Estos sitos en el internet tienen más información acerca de muchos contaminantes en el agua para beber, Niveles Máximos de Contaminación, opciones de tratamiento y también del mantenimiento apropiado de su pozo. Por ejemplo:

* Para obtener una explicación detallada de sus resultados para cualquier contaminante al que se le haya echo la prueba a su agua para beber y recomendaciones para un tratamiento posible, usted puede ingresar sus resultados en la Ohio Watershed Interpretation Tool en: (http://ohiowatersheds.osu.edu/well-educated-ohio/well-water-interpretation-tool), o

* Para información sobre pozos privados, pruebas que se recomiendan, tratamientos y mantenimiento vaya a Well Owner.org http://www.wellowner.org/water-quality/water-testing/.

¿Por qué se hicieron pruebas por Nitrato y Coliforme al agua de mi pozo?
El grupo GWAC del Valle Bajo de Yakima es un grupo formado de varias agencias y ciudadanos que está coordinando esfuerzos para reducir la contaminación por nitrato en el agua para beber en el Valle Bajo de Yakima. Para más información acerca de GWAC, por favor visite: http://www.yakimacounty.us/gwma/. Nuestro interés en el estudio fue informar a los residentes y propietarios de casas que usan el agua de pozos privados o compartidos en el Valle Bajo de Yakima de los riesgos potenciales de salud asociados con su agua para beber. También estamos interesados en reunir más información sobre el nivel de Nitrato en su agua para beber.

¿Puedo ayudar en algo?
Si, y una vez más, estamos muy agradecidos por la asistencia que ya nos ha brindado. Existen más fondos disponibles para hacer más pruebas y encuestas en casas que usan pozos privados. Nuestro interés es pasar la palabra a más residentes del Valle Bajo de Yakima. Por favor, si conoce a un vecino o amigo en el área que esté interesado en que se le hagan pruebas a su pozo y en hacer la encuesta, llámenos al (509) 574-2300 ó envíe un email a: PSWebContacts@co.yakima.wa.us. Como parte de nuestro esfuerzo para evaluar los niveles de nitrato en el Valle Bajo de Yakima, quizás busquemos lugares permanentes para monitoreo continuo. Por favor, si desea que consideremos su pozo para parte de este esfuerzo llámenos al (509) 574-2300.

Atentamente,

J. Rand Elliott, Presidente
Comité Asesor de Aguas Subterráneas del Valle Bajo de Yakima (GWAC)

Adjuntos

6bii ltr 2_(Sp) well survey_5-9 N results and what they mean1bdocx.docx

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE

Groundwater Management Area (GWMA):
The purpose of the GWMA is to reduce nitrate contamination concentrations in groundwater below state drinking water standards

May 2015

parcel #
name
address
city state zip

Dear Resident:

Thank you for participating in the 2014 Lower Yakima Valley Groundwater Management Area (LYV GWMA) High Risk Well Assessment Survey. A certified lab analyzed the water quality samples taken from your home or well during the survey. These samples included an inorganic sample for Nitrate and a bacteriological sample for Coliform.

We enclosed a copy of the lab results for your drinking water.

* The Nitrate level detected was fill in here mg/L. A score of 10 mg/L or greater indicates a high unacceptable nitrate level that exceeds the State Standard of 10.0 mg/L.
* The bacteria (Total Coliform) results were fill in here [satisfactory or unsatisfactory].

Because your Nitrate level is at 10.0 mg/L or above, we recommend you have your well tested every three months for nitrate. You should also consider installing a treatment system to remove excess nitrate or use bottled water for drinking and cooking if a member of your household is:

* An infant less than one year of age
* Pregnant
* May become pregnant or
* Has certain blood disorders

We also enclosed fact sheets on Nitrate, Coliform, and websites (links) that you may find helpful. These websites have more information about many drinking water contaminants, Maximum Contaminant Levels, treatment options, as well as proper maintenance for your well. For example:

* You may enter your results into the Ohio Watershed Interpretation Tool at (http://ohiowatersheds.osu.edu/well-educated-ohio/well-water-interpretation-tool) for a detailed explanation of your results for any drinking water contaminant sampled and possible treatment recommendations, or
* Go to Well Owner.org http://www.wellowner.org/water-quality/water-testing/, for information on private wells, recommended testing, treatment, maintenance, and so on.

Why was my well water tested for Nitrate and Coliform?
The Lower Yakima Valley Groundwater Advisory Committee (GWAC) is a multi agency and citizen-based group coordinating efforts to reduce nitrate contamination in drinking water in the Lower Yakima Valley. To learn more about the GWAC, please visit: http://www.yakimacounty.us/gwma/. Our interest in the study was to inform residents and homeowners served by private or shared wells in the Lower Yakima Valley of the potential health risks associated with their drinking water. We were also interested in gathering more information about the Nitrate level in your drinking water.

Can I be of more help?
Yes, and again we are very grateful for the assistance you have already given us. There is more funding available for doing more tests and surveys on homes served by private wells. Our interest is to get the word out to more residents of the Lower Yakima Valley. Please give us a call at (509) 574-2300 or email us at PSWebContacts@co.yakima.wa.us if you know a neighbor or friend in the area who is interested in having their well tested and the survey completed. As part of our effort to evaluate the levels of nitrate in the LYV, we may be looking for permanent ongoing monitoring sites. Please call at (509) 574-2300 if you want us to consider your well for part of this effort.

Sincerely,

J. Rand Elliott, Chairman
Lower Yakima Valley Groundwater Advisory Committee (GWAC)

Enclosures

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE

roundwater Management Area (GWMA):
The purpose of the GWMA is to reduce nitrate contamination concentrations in groundwater below state drinking water standards

Mayo, 2015

parcel #
name
address
city state zip

Estimado residente:

Gracias por su participación en la Encuesta de Evaluación de Pozos de Alto Riesgo del Área de Manejo de Agua Subterránea del Valle Bajo de Yakima (LYV GWMA), 2014. Un laboratorio certificado analizó la calidad de las muestras de agua que se tomaron de su casa o pozo durante la encuesta. Las muestras se sometieron a una muestra inorgánica para Nitrato y una muestra bacteriológica para Coliforme.

Adjuntamos en esta carta una copia de los resultados de laboratorio de su agua para beber.

* El nivel de Nitrato detectado fue de fill in here mg/L. Un resultado mayor de 10 mg/L indica niveles altos no aceptables de nitrato que exceden el estándar Estatal de 10.0 mg/L.

* Los resultados para bacteria (Coliforme Total) fueron Satisfactorios.

Debido a que su nivel de Nitrato se encuentra en los 10.0 mg/L o lo excede, le recomendamos que hagan pruebas a su pozo por Nitrato cada 3 meses. También, debería considerar la instalación de un sistema especial para retirar el exceso nitrato o el uso de agua embotellada para tomar y cocinar si en su hogar vive alguien con las siguientes condiciones:

* Infante menor a un año de edad
* Embarazo
* Pudiera embarazarse
* Algún trastorno sanguíneo

También adjuntamos hojas con factores acerca del Nitrato, Coliforme y sitios en el internet (enlaces) que pudieran ser útiles. Estos sitos en el internet tienen más información acerca de muchos contaminantes en el agua para beber, Niveles Máximos de Contaminación, opciones de tratamiento y también del mantenimiento apropiado de su pozo. Por ejemplo:

* Para obtener una explicación detallada de sus resultados para cualquier contaminante al que se le haya echo la prueba a su agua para beber y recomendaciones para un tratamiento posible, usted puede ingresar sus resultados en la Ohio Watershed Interpretation Tool en: (http://ohiowatersheds.osu.edu/well-educated-ohio/well-water-interpretation-tool), o

* Para información sobre pozos privados, pruebas que se recomiendan, tratamientos y mantenimiento vaya a Well Owner.org http://www.wellowner.org/water-quality/water-testing/.

¿Por qué se hicieron pruebas por Nitrato y Coliforme al agua de mi pozo?
El grupo GWAC del Valle Bajo de Yakima es un grupo formado de varias agencias y ciudadanos que está coordinando esfuerzos para reducir la contaminación por nitrato en el agua para beber en el Valle Bajo de Yakima. Para más información acerca de GWAC, por favor visite: http://www.yakimacounty.us/gwma/. Nuestro interés en el estudio fue informar a los residentes y propietarios de casas que usan el agua de pozos privados o compartidos en el Valle Bajo de Yakima de los riesgos potenciales de salud asociados con su agua para beber. También estamos interesados en reunir más información sobre el nivel de Nitrato en su agua para beber.

¿Puedo ayudar en algo?
Si, y una vez más, estamos muy agradecidos por la asistencia que ya nos ha brindado. Existen más fondos disponibles para hacer más pruebas y encuestas en casas que usan pozos privados. Nuestro interés es pasar la palabra a más residentes del Valle Bajo de Yakima. Por favor, si conoce a un vecino o amigo en el área que esté interesado en que se le hagan pruebas a su pozo y en hacer la encuesta, llámenos al (509) 574-2300 ó envíe un email a: PSWebContacts@co.yakima.wa.us. Como parte de nuestro esfuerzo para evaluar los niveles de nitrato en el Valle Bajo de Yakima, quizás busquemos lugares permanentes para monitoreo continuo. Por favor, si desea que consideremos su pozo para parte de este esfuerzo llámenos al (509) 574-2300.

Atentamente,

J. Rand Elliott, Presidente
Comité Asesor de Aguas Subterráneas del Valle Bajo de Yakima (GWAC)

Adjuntos

6biiii ltr 4 well survey _unsatisfactor coliform and what they mean1a.docx

LOWER YAKIMA VALLEY
GROUNDWATER ADVISORY COMMITTEE

Groundwater Management Area (GWMA):
The purpose of the GWMA is to reduce nitrate contamination concentrations in groundwater below state drinking water standards

May 2015

Parcel #
Name
Address
City, State Zip

Dear Resident:

Thank you for participating in the 2014 Lower Yakima Valley Groundwater Management Area (LYV GWMA) High Risk Well Assessment Survey. A certified lab analyzed the water quality samples taken from your home or well during the survey. These samples included an inorganic sample for Nitrate and a bacteriological sample for Coliform.

We enclosed a copy of the lab results for your drinking water.

* The Nitrate level detected was fill in here mg/L. These results are normal and well within the acceptable range for nitrate.

  We recommend you continue sampling for nitrate each year, even though your nitrate levels are within an acceptable range (less than 10 mg/L).

* The coliform results were UNSATISFACTORY.

Your coliform sample was Unsatisfactory. An Unsatisfactory result means Total Coliform was found in your sample. The presence of this bacteria indicate there is a breach in your well or pipes where dirt is getting into your pipes. We recommend having another coliform sample taken to the lab for analysis.

We also enclosed fact sheets on Nitrate, Coliform, and websites (links) that you may find helpful. These websites have more information about many drinking water contaminants, Maximum Contaminant Levels, treatment options, as well as proper maintenance for your well. For example:

* You may enter your results into the Ohio Watershed Interpretation Tool at (http://ohiowatersheds.osu.edu/well-educated-ohio/well-water-interpretation-tool) for a detailed explanation of your results for any drinking water contaminant sampled and possible treatment recommendations, or

* Go to Well Owner.org http://www.wellowner.org/water-quality/water-testing/, for information on private wells, recommended testing, treatment, maintenance, and so on.

Why was my well water tested for Nitrate and Coliform?
The Lower Valley GWAC is a multi agency and citizen-based group coordinating efforts to reduce nitrate contamination in drinking water in the Lower Yakima Valley. To learn more about the GWAC, please visit: http://www.yakimacounty.us/gwma/. Our interest in the study was to inform residents and homeowners served by private or shared wells in the Lower Yakima Valley of the potential health risks associated with their drinking water. We were also interested in gathering more information about the Nitrate level in your drinking water.

Can I be of more help?
Yes, and again we are very grateful for the assistance you have already given us. There is more funding available for doing more tests and surveys on homes served by private wells. Our interest is to get the word out to more residents of the Lower Yakima Valley. Please give us a call at (509) 574-2300 or email us at PSWebContacts@co.yakima.wa.us if you know a neighbor or friend in the area who is interested in having their well tested and the survey completed. As part of our effort to evaluate the levels of nitrate in the LYV, we may be looking for permanent ongoing monitoring sites. Please call
(509) 574-2300 if you want us to consider your well for part of this effort.

Sincerely,

J. Rand Elliott, Chairman
Lower Yakima Valley Groundwater Advisory Committee (GWAC)

enclosure: copy of lab results
Fact Sheets

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE

Groundwater Management Area (GWMA):
The purpose of the GWMA is to reduce nitrate contamination concentrations in groundwater below state drinking water standards

Mayo, 2015

parcel #
name
address
city state zip

Estimado residente:

Gracias por su participación en la Encuesta de Evaluación de Pozos de Alto Riesgo del Área de Manejo de Agua Subterránea del Valle Bajo de Yakima (LYV GWMA), 2014. Un laboratorio certificado analizó la calidad de las muestras de agua que se tomaron de su casa o pozo durante la encuesta. Las muestras se sometieron a una muestra inorgánica para Nitrato y una muestra bacteriológica para Coliforme.

Adjuntamos en esta carta una copia de los resultados de laboratorio de su agua para beber.

* El nivel de Nitrato detectado fue de fill in here mg/L. Este resultado es normal y el pozo está dentro de los niveles aceptables por nitrato.

  Aunque los niveles de Nitrato estén dentro de un rango aceptable (menos de 10.0 mg/L), le recomendamos que continúe haciendo pruebas por Nitrato a su pozo cada año.

* Los resultados para bacteria Coliforme fueron INSATISFACTORIOS.

Los resultados para la bacteria coliforme fueron INSATISFACTORIOS. Un resultado Insatisfactorio significa que en su muestra se encontró bacteria Coliforme Total. La presencia de esta bacteria indica que en su pozo o tuberías existe alguna ruptura que permite que entre tierra al sistema. Le recomendamos tome otra muestra para que la analicen en el laboratorio.

También adjuntamos hojas con factores acerca del Nitrato, Coliforme y sitios en el internet (enlaces) que pudieran ser útiles. Estos sitos en el internet tienen más información acerca de muchos contaminantes en el agua para beber, Niveles máximos de Contaminación, opciones de tratamiento y también del mantenimiento apropiado de su pozo. Por ejemplo:

* Para obtener una explicación detallada de sus resultados para cualquier contaminante al que se le haya echo la prueba a su agua para beber y recomendaciones para un tratamiento posible, usted puede ingresar sus resultados en la Ohio Watershed Interpretation Tool en: (http://ohiowatersheds.osu.edu/well-educated-ohio/well-water-interpretation-tool), o
* Para información sobre pozos privados, pruebas que se recomiendan, tratamientos y mantenimiento vaya a Well Owner.org http://www.wellowner.org/water-quality/water-testing/.

¿Por qué se hicieron pruebas por Nitrato y Coliforme al agua de mi pozo?
El grupo GWAC del Valle Bajo de Yakima es un grupo formado de varias agencias y ciudadanos que está coordinando esfuerzos para reducir la contaminación por nitrato en el agua para beber en el Valle Bajo de Yakima. Para más información acerca de GWAC, por favor visite: http://www.yakimacounty.us/gwma/. Nuestro interés en el estudio fue informar a los residentes y propietarios de casas que usan el agua de pozos privados o compartidos en el Valle Bajo de Yakima de los riesgos potenciales de salud asociados con su agua para beber. También estamos interesados en reunir más información sobre el nivel de Nitrato en su agua para beber.

¿Puedo ayudar en algo?
Si, y una vez más, estamos muy agradecidos por la asistencia que ya nos ha brindado. Existen más fondos disponibles para hacer más pruebas y encuestas en casas que usan pozos privados. Nuestro interés es pasar la palabra a más residentes del Valle Bajo de Yakima. Por favor, si conoce a un vecino o amigo en el área que esté interesado en que se le hagan pruebas a su pozo y en hacer la encuesta, llámenos al (509) 574-2300 ó envíe un email a: PSWebContacts@co.yakima.wa.us. Como parte de nuestro esfuerzo para evaluar los niveles de nitrato en el Valle Bajo de Yakima, quizás busquemos lugares permanentes para monitoreo continuo. Por favor, si desea que consideremos su pozo para parte de este esfuerzo llámenos al (509) 574-2300.

Atentamente,

J. Rand Elliott, Presidente
Comité Asesor de Aguas Subterráneas del Valle Bajo de Yakima (GWAC)

Adjuntos

6bv ltr 5 (Sp) well survey _unsatisfactor coliform_E-Coli and what they mean1a.docx

LOWER YAKIMA VALLEY
GROUNDWATER ADVISORY COMMITTEE

Groundwater Management Area (GWMA):
The purpose of the GWMA is to reduce nitrate contamination concentrations in groundwater below state drinking water standards

Mayo, 2015

Parcel #
Name
Address
City, State Zip

Estimado residente:

Gracias por su participación en la Encuesta de Evaluación de Pozos de Alto Riesgo del Área de Manejo de Agua Subterránea del Valle Bajo de Yakima (LYV GWMA), 2014. Un laboratorio certificado analizó la calidad de las muestras de agua que se tomaron de su casa o pozo durante la encuesta. Las muestras se sometieron a una muestra inorgánica para Nitrato y una muestra bacteriológica para Coliforme.

Adjuntamos en esta carta una copia de los resultados de laboratorio de su agua para beber.

* El nivel de Nitrato detectado fue de fill in here mg/L. Este resultado es normal y el pozo está dentro de los niveles aceptables por nitrato.

  Aunque los niveles de Nitrato estén dentro de un rango aceptable (menos de 10.0 mg/L), le recomendamos que continúe haciendo pruebas por Nitrato a su pozo cada año.

* Los resultados para bacteria coliforme fueron INSATISFACTORIOS.

Los resultados para bacteria coliforme fueron INSATISFACTORIOS. Un resultado Insatisfactorio significa que en su muestra se encontró bacteria Coliforme Total. Además al evaluarse la muestra más a fondo se encontró E. Coli (Fecal) (Presente / No Presente). La presencia de esta bacteria indica que en su pozo o tuberías existe alguna ruptura que permite que entre tierra al sistema. Le recomendamos que revise la hoja de factores adjunta para que realice los procedimientos de desinfección de emergencia y que tome otra muestra para que la analicen en el laboratorio.

También adjuntamos hojas con factores acerca del Nitrato, Coliforme y sitios en el internet (enlaces) que pudieran ser útiles. Estos sitos en el internet tienen más información acerca de muchos contaminantes en el agua para beber, Niveles máximos de Contaminación, opciones de tratamiento y también del mantenimiento apropiado de su pozo. Por ejemplo:

* Para obtener una explicación detallada de sus resultados para cualquier contaminante al que se le haya echo la prueba a su agua para beber y recomendaciones para un tratamiento posible, usted puede ingresar sus resultados en la Ohio Watershed Interpretation Tool en: (http://ohiowatersheds.osu.edu/well-educated-ohio/well-water-interpretation-tool),

* Para información sobre pozos privados, pruebas que se recomiendan, tratamientos y mantenimiento vaya a Well Owner.org http://www.wellowner.org/water-quality/water-testing/.

¿Por qué se hicieron pruebas por Nitrato y Coliforme al agua de mi pozo?
El grupo GWAC del Valle Bajo de Yakima es un grupo formado de varias agencias y ciudadanos que está coordinando esfuerzos para reducir la contaminación por nitrato en el agua para beber en el Valle Bajo de Yakima. Para más información acerca de GWAC, por favor visite: http://www.yakimacounty.us/gwma/. Nuestro interés en el estudio fue informar a los residentes y propietarios de casas que usan el agua de pozos privados o compartidos en el Valle Bajo de Yakima de los riesgos potenciales de salud asociados con su agua para beber. También estamos interesados en reunir más información sobre el nivel de Nitrato en su agua para beber.

Puedo ayudar en algo?
Si, y una vez más, estamos muy agradecidos por la asistencia que ya nos ha brindado. Existen más fondos disponibles para hacer más pruebas y encuestas en casas que usan pozos privados. Nuestro interés es pasar la palabra a más residentes del Valle Bajo de Yakima. Por favor, si conoce a un vecino o amigo en el área que esté interesado en que se le hagan pruebas a su pozo y en hacer la encuesta, llámenos al (509) 574-2300 ó envíe un email a: PSWebContacts@co.yakima.wa.us. Como parte de nuestro esfuerzo para evaluar los niveles de nitrato en el Valle Bajo de Yakima, quizás busquemos lugares permanentes para monitoreo continuo. Por favor, si desea que consideremos su pozo para parte de este esfuerzo llámenos al (509) 574-2300.

Atentamente,

J. Rand Elliott, Presidente
Comité Asesor de Aguas Subterráneas del Valle Bajo de Yakima (GWAC)

Adjuntos

6bv ltr 5 well survey _unsatisfactor coliform_E-Coli and what they mean1a.docx

LOWER YAKIMA VALLEY
GROUNDWATER ADVISORY COMMITTEE

Groundwater Management Area (GWMA):
The purpose of the GWMA is to reduce nitrate contamination concentrations in groundwater below state drinking water standards

May 2015

Parcel #
Name
Address
City, State Zip

Dear Resident:

Thank you for participating in the 2014 Lower Yakima Valley Groundwater Management Area (LYV GWMA) High Risk Well Assessment Survey. A certified lab analyzed the water quality samples taken from your home or well during the survey. These samples included an inorganic sample for Nitrate and a bacteriological sample for Coliform.

We enclosed a copy of the lab results for your drinking water.

* The Nitrate level detected was fill in here mg/L. These results are normal and well within the acceptable range for nitrate.

  We recommend you continue sampling for nitrate each year, even though your nitrate levels are within an acceptable range (less than 10 mg/L).

* The coliform results were UNSATISFACTORY.

Your coliform sample was Unsatisfactory. An Unsatisfactory result means Total Coliform was found in your sample. In addition, further testing found E. coli (Fecal) present. The presence of this bacteria indicate there is a breach in your well or pipes where dirt is getting into your pipes. We recommend reviewing the enclosed fact sheet for emergency disinfection procedures and having another coliform sample taken to the lab for analysis.

We also enclosed fact sheets on Nitrate, Coliform, and websites (links) that you may find helpful. These websites have more information about many drinking water contaminants, Maximum Contaminant Levels, treatment options, as well as proper maintenance for your well. For example:

* You may enter your results into the Ohio Watershed Interpretation Tool at (http://ohiowatersheds.osu.edu/well-educated-ohio/well-water-interpretation-tool) for a detailed explanation of your results for any drinking water contaminant sampled and possible treatment recommendations, or

* Go to Well Owner.org http://www.wellowner.org/water-quality/water-testing/, for information on private wells, recommended testing, treatment, maintenance, and so on.

Why was my well water tested for Nitrate and Coliform?
The Lower Valley Groundwater Advisory Committee (GWAC) is a multi agency and citizen-based group coordinating efforts to reduce nitrate contamination in drinking water in the Lower Yakima Valley. To learn more about the GWAC, please visit: http://www.yakimacounty.us/gwma/. Our interest in the study was to inform residents and homeowners served by private or shared wells in the Lower Yakima Valley of the potential health risks associated with their drinking water. We were also interested in gathering more information about the Nitrate level in your drinking water.

Can I be of more help?
Yes, and again we are very grateful for the assistance you have already given us. There is more funding available for doing more tests and surveys on homes served by private wells. Our interest is to get the word out to more residents of the Lower Yakima Valley. Please give us a call at (509) 574-2300 or email us at PSWebContacts@co.yakima.wa.us if you know a neighbor or friend in the area who is interested in having their well tested and the survey completed. As part of our effort to evaluate the levels of nitrate in the LYV, we may be looking for permanent ongoing monitoring sites. Please call
(509) 574-2300 if you want us to consider your well for part of this effort.

Sincerely,

J. Rand Elliott, Chairman
Lower Yakima Valley Groundwater Advisory Committee (GWAC)

enclosure: copy of lab results
Fact Sheets

7 NewMomNitratesFactSheet__EnglishSpanish_FINAL_2014_0715.pdf

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE

How to Keep Your Baby Safe from Nitrates in Drinking Water

Groundwater Management Area (GWMA):
The purpose of the GWMA is to reduce nitrate contamination concentrations in groundwater below state drinking water standards

Nitrates are chemicals that occur naturally in drinking water and also result from human activities. Some private wells in the Yakima Valley are contaminated with nitrates. Nitrates can cause babies less than one year old to become sick. A symptom of nitrate exposure is your baby's skin turning brown or blue. You might see this inside the nose or mouth, the lips, or the fingernail and toenail beds. Contact a doctor immediately if you see these changes in a baby.

Tips to Reduce Exposure

- Test your well water for nitrates and bacteria to ensure it is safe to drink for your baby. Information on testing well water is offered below.
- Do not use nitrate-contaminated well water to make baby formula.
- Do not let baby drink nitrate-contaminated water.
- If you have city water it should be safe to use for baby, or use well water that has been tested and is safe, or bottled water for baby.
- Nitrates can be a problem in some vegetables. Try to choose commercially prepared vegetable baby foods until the baby is 7 months old. Doctors recommend no solid foods before 4-6 months old.
- If you are pregnant, or plan to get pregnant, do not drink nitrate-contaminated well water
- Breast milk is safe for baby even if the mother drinks water contaminated with nitrates.

Children over one year old have the ability to break down nitrates so they're not at risk. To keep babies safe, women who are pregnant or thinking of getting pregnant should not drink water with elevated nitrates.

Test your drinking water. All private wells should be tested before use and once per year for nitrates and bacteria. Nitrate concentrations change randomly throughout the year in the Yakima Valley. If nitrates are present in well water, other contaminants may also be present such as pesticides or bacteria.

Certified laboratories in the Yakima area that will test well drinking water for nitrates and bacteria:

- Cascade Analytical, Inc., 1008 W. Ahtanum, Yakima, WA 98903, (509) 452-7707
- Valley Environmental Laboratory, 201 E. "D" St., Yakima, WA 98901, (509) 575-3999
- Ag Health Laboratories, 445 Barnard Blvd, Sunnyside, WA 98944, (509) 836-2020

The total cost for nitrates and bacteria tests is between $52 and $70. Follow the directions provided by the laboratory – this is important to get good test results.

If a nitrate water test result is 10 mg/L or less the drinking water is safe. This means the water is safe for infants to drink and the water can be used to make formula for infants. The water is also safe for women who are pregnant or thinking about getting pregnant.

For more information about nitrates contact: Yakima Health District Help Line at (509)249-6508.

For clinician diagnosis and treatment guidance or other health effects: University of Washington (UW) PEHSU (Pediatric Environmental Health Specialty Unit) at 1-800-543-2436.

For more children's health information: www.epa.gov/children and ATSDR at http://www.atsdr.cdc.gov/csem/csem.asp?csem=28&po=0

Benton County: Benton Franklin Health District (509) 460-4200

Yakama Nation: Indian Health Services - Environmental Health (509) 865-1776

Map: http://www.yakimacounty.us/gwma/documents/GWMA_Boundary.pdf

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE

Cómo Mantener Seguro a su Bebé de los Nitratos en el Agua Potable

Área de Manejo de Agua Subterránea (GWMA):

El propósito de GWMA es reducir la concentración de contaminación por nitrato en el agua subterránea a niveles por debajo de los estándares del estada para el agua potable.

Los nitratos son químicos que se dan de manera natural en el agua potable pero también pueden ser el resultado de las actividades humanas. Algunos pozos privados en el Valle de Yakima están contaminados con nitratos. Los nitratos pueden causar que se enfermen los bebés menores de un año de edad. Un síntoma de exposición a nitrato es la piel de su bebé cambia de color café o azul. Es posible que vea esto dentro de la boca y la nariz, los labios o en las uñas de las manos y de los pies. Si ve estos cambios de coloración en su bebé, comuníquese inmediatamente con su doctor.

Recomendaciones para reducir la exposición

- Haga la prueba por nitratos y bacteria al agua de su pozo para asegurar que es segura que su bebé la beba. En este folleto encontrará información para la prueba al agua de su pozo.
- No utilice agua de pozo contaminada con nitratos para preparar la fórmula del bebé.
- No permita que su bebé beba agua contaminada con nitratos.
- Si Ud. recibe agua de la ciudad debe ser seguro de usar para el bebé. Para el bebé sólo use agua de pozo que ha sido probado y es segura o use agua embotellada.
- Los nitratos pueden ser un problema para algunas verduras. Escoja alimentos para bebés con verduras preparadas comercialmente hasta que su bebé tenga 7 meses de edad. Los doctores no recomiendan que los bebés coman alimentos sólidos antes de tener de 4 a 6 meses de edad.
- Si usted está embarazada o planea quedarse embarazada, no beba agua de pozo contaminada con nitratos.
- La leche materna es segura para el bebé aun cuando la madre beba agua contaminada con nitratos.

Los niños mayores de un año de edad tienen la capacidad de descomponer los nitratos y por lo tanto no están en riesgo. Para mantener seguros a los bebés, las mujeres embarazadas o las que planean quedarse embarazadas no deben beber agua con niveles altos de nitratos.

Haga la prueba a su agua para beber. A todos los pozos privados se les debería hacer la prueba por nitratos y bacteria antes de usarslos y una vez al año después. En el Valle de Yakima, la concentración de nitrato varía durante el año. Si en el agua de su pozo hay nitratos presentes, también pudiera haber presentes otros contaminantes como pesticidas o bacteria.

Los laboratorios certificados en el área de Yakima que realizan la prueba para nitratos y bacteria al agua de pozo son:

- Cascade Analytical, Inc., 1008 W. Ahtanum, Yakima, WA 98903, (509) 452-7707
- Valley Environmental Laboratory, 201 E. "D" St., Yakima, WA 98901, (509) 575-3999
- Ag Health Laboratories, 445 Barnard Blvd, Sunnyside, WA 98944, (509) 836-2020

El costo total de las pruebas por nitrato y bacteria es entre $52 a $70 dólares. Siga las instrucciones proveídas por el laboratorio seleccionado. Esto es especialmente importante para obtener buenos resultados en la prueba.

Si el resultado de la prueba por nitrato es de 10 mg/L o menos, el agua es segura para beber. Esto significa que el agua es segura para que la beban los bebés y para utilizar en preparar la fórmula del bebé. Este nivel también indica que el agua es segura para mujeres embarazadas o aquellas que piensan quedarse embarazadas.

Para más información acerca de los nitratos comuníquese a: línea de asistencia de Yakima Health District (509)249-6508.

Para diagnosis clínico y guía de tratamiento u otro efecto en la salud: University of Washington (UW) PEHSU (Pediatric Environmental Health Specialty Unit) al 1-800-543-2436.

Más información sobre la salud de los bebés: www.epa.gov/children y ATSDR http://www.atsdr.cdc.gov/csem/csem.asp?csem=28&po=0

Benton County: Benton Franklin Health District (509) 460-4200

Yakama Nation: Indian Health Services - Environmental Health (509) 865-1776
Mapa: http://www.yakimacounty.us/gwma/documents/GWMA_Boundary.pdf

NITRATES, METHEMOGLOBINEMIA, AND DRINKING WATER: A Factsheet for Clinicians

PEHSU Pediatric Environmental Health Specialty Units

Nitrates are chemicals that occur naturally in drinking water and also result from human activities. In some areas private wells are contaminated with nitrates. Excessive nitrates can cause acquired methemoglobinemia in young infants. This severe syndrome of inadequate tissue oxygenation is potentially fatal; prompt clinical recognition and treatment is vital. Families should be counseled on nitrate safety.

Nitrate Background

- Nitrates and nitrites are naturally occurring inorganic nitrogen ions found in soil, water, and some foods. They are a natural part of the human diet. However, excessive consumption (e.g. drinking water or eating food from areas where ground water has become contaminated by excessive nitrate from fertilizers or improper manure management) can cause serious adverse health effects.

Nitrate Sources

- Drinking water
  - Nitrates occur naturally in water at low concentrations. Nitrates are also present as a result of human activities, such as the use of fertilizers and manure on irrigated farm fields that can run off and seep into wells. Nitrate-contaminated water can also be due to improper management of farm animal (i.e. cow) waste, leaky sewage pipes, and septic system failures.
  - Large suppliers of public water sources are required to monitor nitrate concentrations regularly, but private wells are not. In some areas private wells are contaminated with nitrates.
  - The American Academy of Pediatrics (AAP) consensus panel recommends that all prenatal and well-infant visits need to include questions about the home water supply.
  - The only way to know if the nitrate level in well water is at a safe level is to have the well water tested by a certified laboratory. All private wells should be tested before use and once per year for nitrates. Families should contact their state health department for assistance with selecting a certified laboratory.
  - Regulations and water testing frequency:
    - The United States Environmental Protection Agency's (EPA) Maximum Contaminant Level (MCL) for nitrates is 10 mg/L (or 10 parts per million, 10 ppm). The 10 mg/L standard was set to protect infants from nitrates. When a nitrate water test result is 10 mg/L or less, the water is considered safe for infant use.
    - Nitrates may change seasonally or randomly throughout the year. If the nitrate concentration is between 5 – 10 mg/L, monitor more closely and test the well drinking water every 3 months to confirm the water is still safe. When nitrates are present, pesticides or bacteria may also be present and additional water tests may be needed. Families should contact their local health department for guidance.
- Food
  - Nitrates can also be a problem in some vegetables, including spinach, beets, lettuce, cabbage, green beans, squash, carrots, and turnips. Because these vegetables may contain higher amounts of nitrates, recommend other foods until infants are over 6 months old.

Infant Nitrate Exposure

- Infants are exposed to nitrates when they drink contaminated well water or when contaminated well water is used to make infant formula or baby food.
- Nitrates in water are not significantly absorbed through the skin.
- Breastfeeding is safe even if a mother drinks water polluted with nitrates.

Methemoglobinemia and Other Health Effects

- Hemoglobin in blood contains iron normally found in the Fe^{2+} (ferrous) state. Excessive nitrates or nitrites can alter the iron in hemoglobin to the Fe^{3+} (ferric) state, forming methemoglobin (an abnormal form of hemoglobin

which cannot bind oxygen). Methemoglobinemia (an excess of methemoglobin) results in poor tissue oxygenation and anoxia.

- Methemoglobinemia, also known as "blue baby syndrome", can be inherited or acquired. The acquired form, such as from excessive nitrate exposure, is a serious medical emergency. Among the reported cases of acquired methemoglobinemia in US infants, most have been attributed to the use of nitrate contaminated well water for preparation of infant formula.
- Infants less than 1 year old are physiologically vulnerable to the development of methemoglobinemia due to several factors:
    - Their higher gastric pH favors nitrate-reducing bacteria that convert ingested nitrate into methemoglobin-producing nitrite.
    - Fetal hemoglobin, the predominant form in infants up to 3 months of age, is oxidized more readily to methemoglobin by nitrite than is adult hemoglobin.
    - The activity of the red blood cell enzyme systems that reduce methemoglobin back to normal hemoglobin is reduced by about half in infants compared with adults.
    - Gastroenteritis can increase the risk of developing methemoglobinemia.
- **Women who are thinking about pregnancy or who are pregnant should avoid water contaminated with nitrates. Women considering pregnancy or who are pregnant should drink water from public water supplies, water that has been tested and has safe nitrate levels, or bottled water.** While not conclusive due to study limitations, epidemiological data suggest an association between maternal ingestion of nitrate from drinking water and preeclampsia, spontaneous abortion, intrauterine growth restriction, and various birth defects. A few studies have hinted at a role for childhood nitrate intake in the risk for later developing diabetes mellitus.

METHEMOGLOBINEMIA CLINICAL MANAGEMENT

Clinical presentation

- In children and adults with acute acquired methemoglobinemia, methemoglobin levels >20% are associated with clinical symptoms.
- Early methemoglobinemia symptoms include nonspecific headache, fatigue, dyspnea, and lethargy. In infants, this may present as unusual fussiness, decreased alertness, diarrhea, vomiting, shortness of breath, and increased work of breathing.
- At higher methemoglobin levels, cyanosis becomes visible. A brownish-blue skin tone may be present due to anoxia. This condition may be harder to detect in infants with dark skin- look for a bluish color of the nasal or oral mucosa, lips, or nail beds.
- Respiratory depression, altered consciousness, shock, seizures, and death may occur. Acquired methemoglobinemia is life threatening when methemoglobin comprises more than 30% of total hemoglobin and mortality rates are high when methemoglobin levels exceed 40%.

Diagnosis

- Initial diagnosis is based on history and exam findings. In addition, the presence of methemoglobin should be suspected with 1) clinical cyanosis despite normal arterial pO2, or 2) a significant difference between the oxygen saturations measured by pulse oximetry and by arterial blood gas analysis ("saturation gap").
- A diagnosis of methemoglobinemia should be confirmed by laboratory analysis, to be done in the emergency setting (i.e. not in primary care). Hemoximetry, also called co-oximetry, is recommended way for measuring methemoglobin. Most current blood gas analyzers have incorporated the ability to do hemoximetry
- A fresh blood specimen (venous is fine) should always be obtained as methemoglobin levels tend to increase with storage.
- Note that routine pulse oximetry is inaccurate for monitoring oxygen saturation when methemoglobin is present, and should not be used for diagnosis.

Treatment

- Acute onset of acquired methemoglobinemia should be considered a medical emergency and requires immediate treatment in the ER setting.
- When the patient is symptomatic or the methemoglobin level is >20%, intravenous methylene blue (MB, dosed at 1 to 2 mg/kg over five minutes) can be life-saving and is considered the treatment of choice. Blood transfusion or

exchange transfusion may be helpful in patients who are in shock. See appropriate clinical guidelines for more detailed treatment and monitoring guidance.

Prevention and Advice for Families

- **Only use water from public water supplies, water that has been tested and confirmed as safe, or bottled water.**
- **Test well water for nitrates to ensure it is safe to drink. A nitrate test is around $50.**
- **Don't use nitrate-contaminated well water to make baby formula or to make baby food.**
- **Don't let infants drink nitrate-contaminated water.**
- **Women who are pregnant or trying to get pregnant should not drink nitrate-contaminated well water.**
- **Breastfeeding is safe even if the mother drinks water contaminated with nitrates.**
- **Because some vegetables may contain higher amounts of nitrates, choose other solid foods until infants are over 6 months old.**

Reporting

- Methemoglobinemia is not currently a mandatory notifiable condition in Washington State. However new passive surveillance has been initiated by the Yakima Health District under the supervision of Health Officer Dr. Chris Spitters. Yakima Health District requests notification of laboratory-confirmed methemoglobinemia by calling (509) 249-6541 within three days of diagnosis. Please include an exposure history and your clinical impression regarding etiology, if known.

Resources and References

For acute poisoning assistance contact your state poison center at 1-800-222-1222.
For additional non-urgent clinical and public health assistance, contact the NW PEHSU. The University of Washington based Pediatric Environmental Health Specialty Unit (PEHSU) serves medical and public health professionals in Alaska, Washington, Idaho, and Oregon. For more information contact us at 1–877–543-2436 (1-877-KID-CHEM) or pehsu@uw.edu. Visit our website http://www.depts.washington.edu/pehsu.

- ATSDR ToxFAQsTM for Nitrates and Nitrites: http://www.atsdr.cdc.gov/toxfaqs/tf.asp?id=1186&tid=258
- ATSDR Case Studies in Environmental Medicine (CSEM): Nitrate/Nitrite Toxicity (course: WB2342): http://www.atsdr.cdc.gov/csem/csem.asp?csem=28&po=0
- Brender JD, et al. Prenatal nitrate intake from drinking water and selected birth defects in offspring of participants in the National Birth Defects Prevention Study. Environ Health Perspect. 2013 121:1083 – 1089.
- Karr C. Children's Environmental Health in Agricultural Settings. Journal of Agromedicine. 2012 April; 17(2), 127-139.
- Greer FR, Shannon M. American Academy of Pediatrics Committee on Nutrition; American Academy of Pediatrics Council on Environmental Health. Infant methemoglobinemia: the role of dietary nitrate in food and water. Pediatrics. 2005 Sep;116(3):784-6.
- Hord NG, Tang Y, Bryan NS. Food sources of nitrates and nitrites: the physiologic context for potential health benefits. Am J Clin Nutr. 2009 Jul;90(1):1-10.
- Rogan WJ et al. Drinking Water from Private Wells and Risks to Children. Pediatrics. 2009 Jun;123(6):1599-605.
- Washington State Department of Health: Nitrate in Drinking Water WEB site. Last accessed March 31, 2014. http://www.doh.wa.gov/CommunityandEnvironment/DrinkingWater/Contaminants/Nitrate.aspx
- Yakima Health District Drinking Water WEB site last accessed March 31, 2014. http://yakimacounty.us/yakimahealthdistrict/drinking_water.php

Authors: N. Beaudet, MS, CIH; A. Otter, DNP, ARNP; C. Karr, MD, PhD; S. Sathyanarayana, MD, MPH, A. Perkins, BA. Last updated July 2014.

Disclaimer: PEHSU funding was made possible (in part) by the cooperative agreement award number UTI Grant Number U61 TS000118 from the Agency for Toxic Substances and Disease Registry (ATSDR). The views in this guidance do not necessarily reflect the official policies of the Department of Health and Human Services; nor does mention of trade names, commercial practices, or organizations imply endorsement by the U.S. Government.
Acknowledgement: The U.S. Environmental Protection Agency (EPA) supports the PEHSU by providing funds to ATSDR under Inter-Agency Agreement number DW-75-92301301-0. Neither EPA nor ATSDR endorse the purchase of any commercial products or services mentioned in PEHSU publications.

High Risk Well Assessment

Section 3 - Survey Questions

6. Do you drink your tap water — No / Yes

7. What is the main source of your drinking water? — Specify Below

- Tap water
- Bottled Water
- Other

8. Do you have a system to remove nitrates from your water? — No / Yes - Specify below

Where is it located? — Before the house / At the sink

What type is it? — R/O / Ion / Ultra-filtration / Other

9. Just a few questions about your household:

- # of people
- Children < Year
- Vulnerable Health Condition *[Script]*
- W Child bearing age
- Pregnant
- Household Income < $48,000

10. Has your well been tested within the past 3 years? — No / Yes - Specify below

- Coliform
- Fecal/E. coli
- Nitrate — mg/L

11. Are you familiar with your well? — No / Yes - Specify below

- Well log
- Age of well
- Depth of well

12. Is your well subject to flooding? — No / Yes

13. Has your on-site septic system been pumped in the last 5 years? — No / Yes / N/A

14. Has there been manure or any chemicals applied within 50 ft. of the well? — No / Yes - Specify below

- Manure — Frequency — By who
- Chemicals — Frequency — Type

15. Have you ever participated in a Yakima County well survey? — No / Yes / Return

High Risk Well Assessment

Section 1 - General Information

Parcel #: _____ **Date:** _____

Address: _____
Street *Apt. #*

_____
City *State* *Zip*

GPS: _____ N _____ W
° ' " ° ' "

Surveyor Name: _____

Resident Name: _____

Resident Type: ☐ Resident ☐ Owner ☐ Both

Primary Phone: _____ ☐ Home ☐ Work

Section 2 - Site Information

1. Is there an onsite septic system? ☐ **No** ☐ **Yes - Specify Below**

☐ Septic tank within 50 ft. of well ☐ Drain field within 100 ft. of well

2. Is there surface water within 100 ft. of the well? ☐ **No** ☐ **Yes - Specify Below**

☐ Ponds ☐ Lagoons ☐ Lined irrigation canal

☐ Unlined irrigation canal ☐ River ☐ Other

3. Are there animals/agriculture within 100 ft. of the well? ☐ **No** ☐ **Yes - Specify Below**

☐ Orchard/Field ☐ Structure/Animals Type/# _____

4. Are there large mounds of manure within 100 ft of the well? ☐ **No** ☐ **Yes - Specify Below**

☐ Owner ☐ Neighbor

5. Can you see the condition of the well and wellhead? ☐ **No** ☐ **Yes - Specify Below**

☐ Driven Well (sand point) ☐ Hand Dug ☐ Poorly Maintained

☐ Broken wellhead seal ☐ Holes in casing ☐ Other _____

Materials Requested _____

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE

Yakima Health District
Prevention is our Business

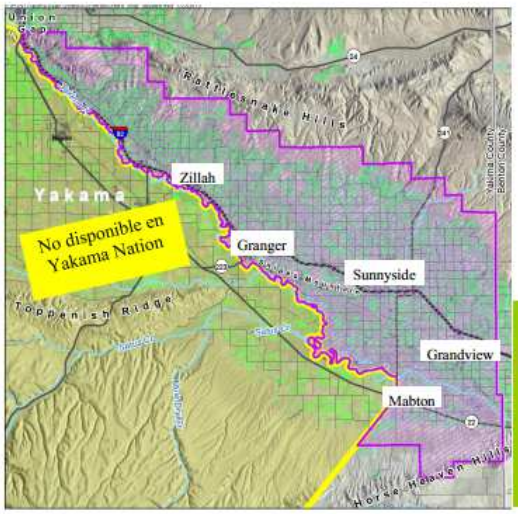
Comité Asesor del Área de Manejo de Agua Subterránea (GWMA):
El propósito de GWMA es reducir la concentración de contaminación por nitrato en el agua subterránea por debajo del estándar estatal para el agua potable.

¡Atención Residentes del VALLE BAJO!

¿El agua que usted bebe viene de un pozo privado?

SÓLO POR TIEMPO LIMITADO usted puede ser elegible para una
PRUEBA GRATIS DEL AGUA DE SU POZO
a través del
Comité Asesor de Agua Subterránea del Valle Bajo de Yakima (GWAC)

¿De qué se trata? Se evaluará por nitrato y bacteria a pozos de agua potable. Un empleado del Departamento de Salud de Yakima tomará la muestra de su pozo y se le invitará a participar en una encuesta corta. Usted puede consultar sobre cualquier preocupación que tenga del agua de su pozo y los resultados de las prueba estarán disponibles.



¿Qué puedo hacer para ser considerado para la prueba gratis?

Para ser considerado, usted debe vivir en el Valle Bajo de Yakima y obtener el agua que bebe de un pozo privado o de un pozo compartido.

Para más información o para participar, llame a la Línea de información del Departamento de Salud de Yakima

509.249.6508

Estas pruebas son posibles gracias a GWAC. Su participación ayudará al comité a entender mejor y a ayudar a encontrar soluciones a la posible contaminación en los pozos de agua potable. Para más información, visite:
http://www.yakimacounty.us/gwma/

12_Free Well Water Testing _Phase II_English_v2015.pdf

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE

Yakima Health District
Prevention is our Business

Groundwater Management Area (GWMA):
The purpose of the GWMA is to reduce nitrate contamination concentrations in groundwater below state drinking water standards

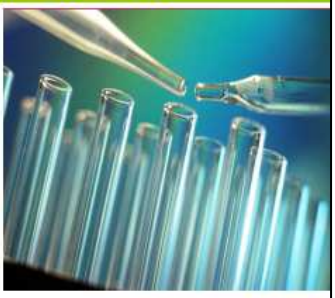
Attention LOWER VALLEY Residents!

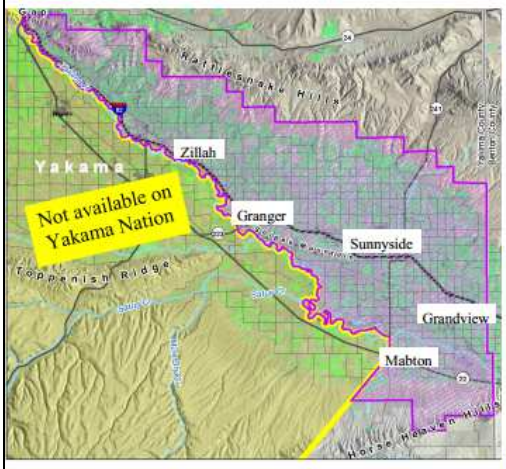
Does your drinking water come from a private well?

For a LIMITED TIME ONLY you may be eligible for
FREE WELL WATER TESTING
through the
Lower Yakima Valley Groundwater Advisory Committee (GWAC)

What's involved?

- Your drinking water well sampled for nitrates and bacteria for free
- A short survey by a Yakima Health District employee where you can share your concerns and learn about nitrates
- You receive sampling results to help you protect your drinking water and family





How can I be considered for free testing?

- You must live in the Lower Yakima Valley *and*
- Obtain your drinking water from a private or shared well

For more information or to participate, please call
The Yakima Health District Help Desk

509.249.6508

This sampling is made possible by the GWAC. Your participation will help the committee to better understand and help find some solutions to possible contamination in drinking water wells.
For more information, please visit: **http://www.yakimacounty.us/gwma/**

12_Free Well Water Testing _Phase II_English_v2015.pdf

Public Service Announcement
GWAC Lower Yakima Valley Well Sampling

The Lower Yakima Valley Groundwater Advisory Committee (GWAC) is offering free well water sampling to Lower Yakima valley residents beginning in September.

Drinking water wells will be sampled for nitrate and bacteria. A Yakima Health District employee will be available to discuss any concerns or questions with the survey or sample results with survey participants or the general public. This sampling will help the Committee to better understand and help find solutions to possible contamination in drinking water wells.

For more information and to participate, contact the Yakima Health District Help Desk at: 509-249-6508

12_Letter_invite to participate in well testing_Engl_2015_09_with signature.pdf

LOWER YAKIMA VALLEY
GROUNDWATER ADVISORY COMMITTEE

Groundwater Management Area (GWMA):
The purpose of the GWMA is to reduce nitrate contamination concentrations in groundwater below state drinking water standards

September 2015

Dear Resident:

The Lower Yakima Valley Groundwater Advisory Committee (GWAC) in partnership with the Yakima Health District is offering *free* nitrate and coliform samples for private and shared wells. This is part of an ongoing effort to help residents in the Lower Yakima Valley learn more about the water quality and impact to public health of the area's drinking water.

We are writing to encourage you to participate in our sampling program that should take about 30 minutes. This will be a quick look at conditions surrounding your well that may impact water quality and the health of your family. The samples will show if the water quality may also be a concern to your family's health. The short survey and samples will be completed by an environmental health specialist from the Yakima Health District.

The sampling will be paid for by state funds made available to Yakima County to address areas where there may be high levels of nitrate in drinking water. The survey will help us understand the conditions that exist around the wells and how to best help the residents. It is not our intention to collect personal data for any other use or purpose.

All information collected will be made available to you and will help you make informed decisions about your drinking water and your family's health.

To set up an appointment to participate, please call the Yakima Health District Help Desk at 509-249-6508.The sampling program will begin in September.

The Lower Yakima Valley GWAC is a multiagency and citizen-based group coordinating efforts to reduce nitrate contamination in drinking water in the Lower Yakima Valley. To learn more about the GWAC and this program, please visit: http://www.yakimacounty.us/gwma/.

We look forward to working with you.

Sincerely,

J. Rand Elliott, Yakima County Commissioner
Chairman
The Lower Yakima Valley Groundwater Management Area Advisory Committee

12_Letter_invite to participate in well testing_Spanish_2015 with signature.pdf.docx

LOWER YAKIMA VALLEY
GROUNDWATER ADVISORY COMMITTEE

Groundwater Management Area (GWMA):
The purpose of the GWMA is to reduce nitrate contamination concentrations in groundwater below state drinking water standards

Septiembre 2015

Estimado residente:

El Comité Asesor del Área de Manejo de Agua Subterránea del Valle Bajo de Yakima (GWAC) en asociación con el Distrito de Salud de Yakima está ofreciendo muestras *gratis* de nitrato y bacterias coliformes para los pozos privados y compartidos. Como parte de un esfuerzo continuo para ayudar a los residentes en el Valle Bajo de Yakima a informarse más sobre la calidad y el impacto que tiene el agua para beber del área en la salud pública.

Le escribimos para animarle a que participe en nuestro programa de muestreo que sólo debe durar aproximadamente 30 minutos. La encuesta es un vistazo rápido a las condiciones que rodean su pozo y que pueden afectar la calidad del agua y la salud de su familia. Las muestras mostrarán si la calidad del agua pudiera ser también una preocupación para la salud de su familia. La encuesta corta y las muestras serán tomadas por un especialista en salud ambiental del Distrito de Salud de Yakima.

Las muestras serán pagadas con fondos estatales disponibles para atender áreas del Condado de Yakima donde pudiera haber niveles altos de nitratos en agua para beber. La encuesta nos ayudará a entender las condiciones que existen alrededor de los pozos y la manera de apoyar mejor a los residentes. No es nuestra intención recolectar datos personales para ningún otro uso o propósito.

Toda la información recolectada estará disponible para usted y le ayudará a tomar decisiones informadas acerca de su agua para beber y la salud de su familia.

Para hacer una cita para participar, por favor llame a la línea de ayuda del Distrito de Salud de Yakima al 509-249-6508. El programa de muestreo iniciará este mes. El comité GWAC del Valle Bajo de Yakima es un grupo formado por varias agencias y ciudadanos que coordinan los esfuerzos para reducir la contaminación por nitrato en el agua para beber en el Valle bajo de Yakima. Para más información acerca de GWAC y de este programa, visite: http://www.yakimacounty.us/gwma/.

Esperamos poder trabajar con usted.

Atentamente,

J. Rand Elliott, Presidente de Comisionados del Condado de Yakima
Comité Asesor del Área de Manejo de Agua Subterránea del Valle Bajo de Yakima

Appendix J--"Research, (Long List) of Health Problems Related to Nitrates

Research (Long List) of Health Problems Related to Nitrates

Abu Naser AA, Ghbn N, Khoudary R. (2007) Relation of nitrate contamination of groundwater with methaemoglobin level among infants in Gasa East Mediterr Health J. 12(5) pp. 994-1004. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/18290391

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

Arbuckle, T.E., Sherman, G.J., Corey, P.N., Walters, D. & Lo, B. (1988) Water nitrates and CNS birth defects: a population-based case-control study. *Arch.Environ.Health 43*(2) pp. 162-167. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/3377550

Avery A.A. (1999) Infantile methemoglobinemia: reexamining the role of drinking water nitrates. *Environmental Health Perspectives 107*(7) pp. 583–6. Retrieved from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1566680/pdf/envhper00512-0111.pdf

Balazs, C., Morello-Frosch, R., Hubbard, A., & Ray, I. (2011). Social disparities in nitrate-contaminated drinking water in California's San Joaquin Valley. *Environmental Health Perspectives*, *119*(9), 1272. Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3230390/

Barrett, J. H., Parslow, R. C., McKinney, P. A., Law, G. R., & Forman, D. (1998). Nitrate in drinking water and the incidence of gastric, esophageal, and brain cancer in Yorkshire, England. *Cancer Causes and Control*, *9*(2), 153-159. Retrieved from

https://www.researchgate.net/profile/Graham_Law/publication/226280359_Nitrate_in_drinking_water_and_the_incidence_of_gastric_esophageal_and_brain_cancer_in_Yorkshire_England/links/54368e0d0cf2dc341db35c4f.pdf

Benini, D., Vino, L., & Fanos, V. (1998) Acquired methemoglobinemia: a case report. Pediatr Med Chir 20(6) pp. 411-413. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/10335542

Berlin G., Brodin B., Hilden J. (1985) Acute dapsone intoxication: a case treated with continuous infusion of methylene blue, forced diuresis, and plasma exchange. *J Toxicol Clin Toxicol* 22 pp. 537–48. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/6535846

Brender, J.D., Olive, J.M., Felkner, M., Suarez, L., Marckwardt, W., & Hendricks, K.A. (2004) Dietary nitrites and nitrates, nitrosatable drugs, and neural tube defects. *Epidemiology 15*(3) pp. 330-336. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/15097014

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

Bukowski, J., Somers, G., & Bryanton, J. (2001) Agricultural contamination of groundwater as a possible risk factor for growth restriction or prematurity. J.Occup.Environ.Med. 43(4) pp. 377-383. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/11322099

Bunin, G.R., Kuijten, R.R., Boesel, C.P., Buckley, J.D. & Meadows, A.T. (1993) Relation between maternal diet and subsequent primitive neuroectodermal brain tumors in young children. New England Journal of Medicine 19;329(8) pp. 536-541. http://www.ncbi.nlm.nih.gov/pubmed/8167265

Burkholder, J., Libra, B., Weyer, P., Heathcote, S., Kolpin, D., Thorne, P. S., & Wichman, M. (2007). Impacts of waste from concentrated animal feeding operations on water quality. *Environmental health perspectives*, *115*(2), 308. Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1817674/

Cantor, K. P. (1997). Drinking water and cancer. *Cancer Causes & Control*, *8*(3), 292-308.Retrieved from https://www.researchgate.net/profile/Kenneth_Cantor/publication/51297605_Drinking_water_and_cancer/links/548719ca0cf268d28f070c4f/Drinking-water-and-cancer.pdf

Cedergren, M.I., Selbing, A.J., Lofman, O., & Kallen, B.A. (2002) Chlorination byproducts and nitrate in drinking water and risk for congenital cardiac defects. *Environmental Research 89*(2) pp. 124-130. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/12123645

Center for Disease Control (1993) Methemoglobinemia in an infant - - Wisconsin, 1992 Morbidity & Mortality Weekly http://www.ncbi.nlm.nih.gov/pubmed/8450825

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

Center for Disease Control (1996) Spontaneous abortions possibly related to ingestion of nitrate-contaminated well water-LaGrange County, Indiana, 1991–1994. *MMWR 45* pp. 569–72. Retrieved from http://www.cdc.gov/mmwr/preview/mmwrhtml/00042839.htm

Center for Disease Control (1997) Methemoglobinemia Attributable to Nitrite Contamination of Potable Water Through Boiler Fluid Additives - New Jersey, 1992-1996. Morbidity and Mortality Weekly Report March 7, 1997. Retrieved from http://www.cdc.gov/mmwr/preview/mmwrhtml/00046656.htm

Chan, T.Y. (1996) Food-borne nitrates and nitrites as a cause of methemoglobinemia. *Southeast Asian J Trop Med Public Health 27*(1) Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/9031426

Chiu, H. F., Tsai, S. S., & Yang, C. Y. (2007). Nitrate in drinking water and risk of death from bladder cancer: an ecological case-control study in Taiwan. *Journal of toxicology and*

environmental Health, Part A, *70*(12), 1000-1004. Retrieved from https://www.tandfonline.com/doi/abs/10.1080/15287390601171801

Comly HH. Landmark article Sept 8, 1945: cyanosis in infants caused by nitrates in well-water. JAMA. 1987;257:2788–2792. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/3553637 or http://jama.jamanetwork.com/article.aspx?articleid=366259

Coss, A., Cantor, K. P., Reif, J. S., Lynch, C. F., & Ward, M. H. (2004). Pancreatic cancer and drinking water and dietary sources of nitrate and nitrite. *American Journal of Epidemiology*, *159*(7), 693-701. Retrieved from https://academic.oup.com/aje/article/159/7/693/71809

Craun, G.F., Greathouse, D.G. & Gunderson, D.H. (1981) Methaemoglobin levels in young children consuming high nitrate well water in the United States. Int.J.Epidemiol. 10(4) pp. 309-317. Retrieved from http://ije.oxfordjournals.org/content/10/4/309.abstract

Croen, L.A., Todoroff K., Shaw G.M. (2001) Maternal exposure to nitrate from drinking water and diet and risk of neural tube defects. *Am J Epidemiol 153* pp.325–31. Retrieved from http://aje.oxfordjournals.org/content/153/4/325.full.pdf

Crutchfield, S., Cooper, J., & Hellerstein, D. (2016). The Benefits of Safer Drinking Water: The Value of Nitrate Reduction. Retrieved from https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2736657

Dean B.S., Lopez G., Krenzelok E.P. (1992) Environmentally-induced methemoglobinemia in an infant. *Toxicol Clin Tociclo 30*(1) pp. 127-133 Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/1542142

De Roos, A. J., Ward, M. H., Lynch, C. F., & Cantor, K. P. (2003). Nitrate in public water supplies and the risk of colon and rectum cancers. *Epidemiology*, *14*(6), 640-649. Retrieved from http://journals.lww.com/epidem/Abstract/2003/11000/Nitrate_in_Public_Water_Supplies_and_the_Risk_of.4.aspx

Donahoe, W. E. (1949). Cyanosis in infants with nitrates in drinking water as cause. *Pediatrics*, *3*(3), 308-311. Retrieved from http://pediatrics.aappublications.org/content/pediatrics/3/3/308.full.pdf

Dorsch, M.M., Scragg, R.K., McMichael, A.J., Baghurst, P.A. & Dyer, K.F. (1984) Congenital malformations and maternal drinking water supply in rural South Australia: a case-control study. *Am.J.Epidemiol. 119*(4) pp. 473-486. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/6711537

Durosev, D. (1979) Toxic methemoglobinemia in newborns and infants. *Bilt Hematol Transfuz* http://www.ncbi.nlm.nih.gov/pubmed/552247

Dusdieker L.B., Getchell J.P., Liarakos T.M., Hausler W.J., Dungy C.I. (1994) Nitrate in baby foods: adding to the nitrate mosaic. *Arch Pediatric Adolesc Med 148* pp. 490–94. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/8180640

Dusdieker L.B., Dungy C.I. (1996) Nitrates and babies: A dangerous combination. *Contemp Pediatr 13*(11) pp. 91–102.

Eichholzer M., Gutzwiller F. (1998) Dietary nitrates, nitrites, and *N*-nitroso compounds and cancer risk: a review of the epidemiologic evidence. *Nutr Rev 56* pp.95–105. Retrieved from http://onlinelibrary.wiley.com/doi/10.1111/j.1753-4887.1998.tb01721.x/abstract

Environmental Protection Agency (2010) Yakima Valley Groundwater Contamination: Summary of EPA Sampling Activities. Retrieved from http://yosemite.epa.gov/r10/water.nsf/bb9c63e62d1ae1f8882564f4007da918/1ea7e8c810acb757882576470077b0e3/$FILE/Yakima%20Valley%20EPA%20Sampling%20Summary%20June%2022%202010.pdf

Environmental Working Group. (n.d.) *Pouring it on: the health effects of Nitrate Exposure*. Retrieved from http://www.ewg.org/node/7712

Eubank, W., Carpenter, J. D., Maltsberger, B. A., & Mancl, K. (1998). Nitrate in drinking water. Retrieved from https://mospace.umsystem.edu/xmlui/bitstream/handle/10355/52688/wq0103-1998.pdf?sequence=1

Fan A.M, Steinberg V.E. (1996) Health implications of nitrate and nitrite in drinking water: An update on methemoglobinemia occurrence and reproductive and development toxicity. *Regul Toxicol Pharmacol 23*(11) pp. 35–43. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/8628918

Felsot A.S. (1998) Re-examining the link between nitrates and "blue baby" syndrome: a necessary first step for managing ground water quality to protect public health. Agric Environ News. 150 pp. 1–14. Retrieved from http://aenews.wsu.edu/Oct98AENews/aenewsoctober98.htm#anchor545063

Fewtrell, L (2004) Drinking-Water Nitrate, Methemoglobinemia, and Global Burden of Disease Environmental Health Perspectives 112:1371-1374. Doi:10.1289/ehp.7216 http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1247562/pdf/ehp0112-001371.pdf

Freedman, D. M., Cantor, K. P., Ward, M. H., & Helzlsouer, K. J. (2000). A case-control study of nitrate in drinking water and non-Hodgkin's lymphoma in Minnesota. *Archives of Environmental Health: An International Journal*, *55*(5), 326-329. Retrieved from https://www.tandfonline.com/doi/abs/10.1080/00039890009604024

Gatseva, P. D., & Argirova, M. D. (2008). High-nitrate levels in drinking water may be a risk factor for thyroid dysfunction in children and pregnant women living in rural Bulgarian areas. *International journal of hygiene and environmental health*, *211*(5-6), 555-559. Retrieved from https://www.sciencedirect.com/science/article/pii/S1438463907001812

Gebara B., Goetting M.M. (1994) Life-threatening methemoglobinemia in infants with diarrhea and acidosis. *Clin Pediatr 33* pp. 370–3. Retrieved from http://cpj.sagepub.com/content/33/6/370.extract

Gulis, G., Czompolyova, M., & Cerhan, J. R. (2002). An ecologic study of nitrate in municipal drinking water and cancer incidence in Trnava District, Slovakia. *Environmental research*, *88*(3), 182-187. Retrieved from

https://www.researchgate.net/publication/11321531_An_Ecologic_Study_of_Nitrate_in_Municipal_Drinking_Water_and_Cancer_Incidence_in_Trnava_District_Slovakia

Gupta, S.K., Gupta, R.C., Seth, A.K., Gupta, A.B., Bassin, J.K. & Gupta, A. (1999) Adaptation of cytochrome-b5 reductase activity and methaemoglobinaemia in areas with a high nitrate concentration in drinking-water. Bull.World Health Organ 77(9) pp. 749-753. Retrieved from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2557725/pdf/10534899.pdf

Gupta, S. K., Gupta, R. C., Seth, A. K., Gupta, A. B., Bassin, J. K., Gupta, D. K., & Sharma, S. (1999). Epidemiological evaluation of recurrent stomatitis, nitrates in drinking water, and cytochrome b5 reductase activity1. *The American journal of gastroenterology*, *94*(7), 1808-1812. Available at https://www.sciencedirect.com/science/article/pii/S0002927099001884

Gupta, S.K., Gupta, R.C., Gupta, A.B., Seth, A.K., Bassin, J.K., Gupta, A. (2000) Recurrent acute respiratory tract infections in areas with high nitrate concentrations in drinking water. *Environ.Health Perspect. 108*(4) pp. 363-366. Retrieved from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1638033/

Gupta SK, Gupta RC, Seth AK, Gupta AB, Bassin JK, Gupta A. (2000) Methaemoglobinemia in areas with high nitrate concentration in drinking water. *Natl Med J India 12*(2) pp. 58-61 Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/10835850

Gupta, S.K., Gupta, R.C., Gupta, A.B., Seth, A.K., Bassin, J.K., Gupta, A. & Sharma, M.L. (2001) Recurrent diarrhea in children lining in areas with high levels of nitrate in drinking water. Arch of Environ Health 56(4) pp. 369 – 373. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/11572282

Hanukoglu A, Danon PN. (1996) Endogenous methemoglobinemia associated with diarrheal disease in infancy. J Pediatr Gastroenterol Nutr. *23* pp. 1–7. Retrieved from http://journals.lww.com/jpgn/Abstract/1996/07000/Endogenous_Methemoglobinemia_Associated_with.1.aspx

Harris J.C., Rumack B.H., Peterson R.G., McGuire B.M. (1979) Methemoglobinemia resulting from absorption of nitrates. *JAMA 242*(26) pp. 2869–71. Retrieved from http://jama.jamanetwork.com/article.aspx?articleid=368092

Hegesh E, Shiloah J. (1982) Blood nitrates and infantile methemoglobinemia. Clin Chim Acta. *125* pp. 107–115. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/7139953

Howe, G.R., Burch, D., Chiarelli, A.M., Risch, H.A. & Choi, B.C.K. (1989) An exploratory case-control study of brain tumors in children. Cancer Res. 49(15) pp. 4349-4352. Retrieved from http://cancerres.aacrjournals.org/content/49/15/4349.long

Infante-Rivard, C., Olson, E., & Ayotte, J.L. (2001) Drinking water contaminants and childhood leukemia. *Epidemiology 12*(1) pp. 13-19. http://www.ncbi.nlm.nih.gov/pubmed/11138808

Jensen, O. M. (1982). Nitrate in drinking water and cancer in northern Jutland, Denmark, with special reference to stomach cancer. *Ecotoxicology and environmental safety*, *6*(3), 258-267. Retrieved from https://www.sciencedirect.com/science/article/pii/0147651382900161

Johnson C.J., Kross B.C. (1990) Continuing importance of nitrate contamination of groundwater and wells in rural areas. *American Journal of Industrial Medicine 18*(4) pp. 449–56. Retrieved from http://onlinelibrary.wiley.com/doi/10.1002/ajim.4700180416/abstract

Jones, J.H., Sethney, H.T., Schoenhals, G.W., Grantham, R.N. & Riley, H.D. (1973) Grandmother's poisoned well: report of a case of methemoglobinemia in an infant in Oklahoma. *J.Okla.State Med.Assoc. 66*(2) pp. 60-66. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/4688467

Jones, R. R., Weyer, P. J., Dellavalle, C. T., Inoue-Choi, M., Anderson, K. E., Cantor, K. P., ... & Ward, M. H. (2016). Nitrate from drinking water and diet and bladder cancer among postmenopausal women in Iowa. *Environmental health perspectives*, *124*(11), 1751. Retrieved from https://ehp.niehs.nih.gov/wp-content/uploads/124/11/EHP191.alt.pdf

Kean-Cowdin, R., Pogoda, J.M., Lijinsky, W., Holly, E.A., Mueller, B.A. & Preston-Martin, S. (2003) Maternal prenatal exposure to nitrosatable drugs and childhood brain tumours. International Journal of Epidemiology 32(2) pp. 211-217. http://www.ncbi.nlm.nih.gov/pubmed/12714539 and http://ije.oxfordjournals.org/content/32/2/211.long

Keating JP, Lell ME, Strauss AW, Zarkowsky H, Smith GE. (1973) Infantile methemoglobinemia caused by carrot juice. N Engl J Med 288(16) pp. 824–6.Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/4693932

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

Kross B.C., Ayebo A.D., Fourtes L.J. (1992) Methemoglobinemia: nitrate toxicity in rural America. *American Family Physician 46* pp. 183–88 retrieved from http://ukpmc.ac.uk/abstract/MED/1621630

Kuijten, R.R., Bunin, G.R., Nass, C.C. & Meadows, A.T. (1990) Gestational and familial risk factors for childhood astrocytoma: results of a case-control study. *Cancer Res. 50*(9) pp. 2608-2612. http://www.ncbi.nlm.nih.gov/pubmed/2328486 and http://cancerres.aacrjournals.org/content/50/9/2608.long

Kumar, M., & Puri, A. (2012). A review of permissible limits of drinking water. *Indian journal of occupational and environmental medicine*, *16*(1), 40. Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3482709/

Kuo, H. W., Wu, T. N., & Yang, C. Y. (2007). Nitrates in drinking water and risk of death from rectal cancer in Taiwan. *Journal of Toxicology and Environmental Health, Part A*, *70*(20), 1717-1722. Retrieved from https://www.tandfonline.com/doi/abs/10.1080/15287390701457704

Laitinen, S., Virtanen, S.M., Rasanen, L. & Penttila, P.L. (1993) Calculated dietary intakes of nitrate and nitrite by young Finns" *Food Addit.Contam 10*(4) pp. 469-477. http://www.ncbi.nlm.nih.gov/pubmed/8405586

Law, G., Parslow, R., McKinney, P., & Cartwright, R. (1999) Non-Hodgkin's lymphoma and nitrate in drinking water: a study in Yorkshire, United Kingdom. *Journal of Epidemiological*

Community Health 53(6) pp. 383-384. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1756892/pdf/v053p00383.pdf

Lebby T., Roco J.J., Arcinue E.L. (1993) Infantile methemoglobinemia associated with acute diarrheal illness. *American Journal of Emergency Medicine 11* pp. 471–2. Retrieved from http://www.sciencedirect.com/science/article/pii/073567579390086Q

Loomis, J., Bell, P., Cooney, H., & Asmus, C. (2009). A comparison of actual and hypothetical willingness to pay of parents and non-parents for protecting infant health: the case of nitrates in drinking water. *Journal of Agricultural and Applied Economics*, *41*(3), 697-712. Retrieved from https://www.researchgate.net/profile/John_Loomis3/publication/46534234_A_Comparison_of_Actual_and_Hypothetical_Willingness_to_Pay_of_Parents_and_Non-Parents_for_Protecting_Infant_Health_The_Case_of_Nitrates_in_Drinking_Water/links/552d171f0cf2e089a3ad2de6.pdf

Lundberg J.O., Weitzberg E., Cole J.A., Benjamin N. (2004) Nitrate, bacteria and human health. *Nat Rev Microbiol 2*(7) pp. 593–602 Retrieved from http://www.nature.com/nrmicro/journal/v2/n7/full/nrmicro929.html

Manassaram, D.M., Backer, L.C. & Moll, D.M. (2006) A Review of Nitrates in Drinking water: Maternal Exposure and Adverse Reproductive and Developmental Outcomes. Environ Health Perspect. 2006 March; 114(3): 320–327. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1392223/

Mansouri A., Lurie A.A. (1993) Concise review: Methemoglobinemia. *American Journal of Hematology 42* pp. 7–12. http://www.ncbi.nlm.nih.gov/pubmed/8416301

McCredie, M., Maisonneuve, P. & Boyle, P. (1994) Antenatal risk factors for malignant brain tumours in New South Wales children. Int.J.Cancer 56(1) pp. 6-10. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/8262678

McKnight G.M., Duncan C.W., Leifert C., Golden M.H. (1999) Dietary nitrate in man: Friend or foe? *British Journal of Nutrition 81*(5) pp. 349–58. Retrieved from http://journals.cambridge.org/download.php?file=%2F16032_A63A7D5ABC20BC7365F40DBF4A377C7F_journals__BJN_BJN81_05_S000711459900063Xa.pdf&cover=Y&code=940bf72a94083432b5d589f01343f27cbf

Mensinga T.T., Speijers G.J.A., Meulenbelt J. (2003) Health implications of exposure to environmental nitrogenous compounds. Toxicol Rev 22(1) pp. 41–51. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/14579546 and http://adisonline.com/toxicology/Abstract/2003/22010/Health_Implications_of_Exposure_to_Environmental.5.aspx

Moller, H. (1997) Work in agriculture, childhood residence, nitrate exposure, and testicular cancer risk: a case-control study in Denmark. *Cancer Epidemiol.Biomarkers Prev. 6*(2) pp. 141-144. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/9037566

Moltchanova, E., Rytkonen, M., Kousa, A., Taskinen, O., Tuomilehto, J, & Karvonen, M. (2004) Zinc and nitrate in the ground water and the incidence of Type 1 diabetes in Finland. *Diabet.Med. 21*(3) pp. 256-261. Retrieved form http://www.ncbi.nlm.nih.gov/pubmed/15008836

Morales-Suarez-Varela, M. M., Llopis-Gonzalez, A., & Tejerizo-Perez, M. L. (1995). Impact of nitrates in drinking water on cancer mortality in Valencia, Spain. *European journal of epidemiology*, *11*(1), 15-21. Retrieved from

https://www.researchgate.net/profile/Maria_Morales-Suarez-Varela/publication/226070795_Impact_of_nitrates_in_drinking_water_on_cancer_mortality_in_Valencia_Spain/links/0fcfd50cb503af3128000000.pdf

Morris, R. D. (1995). Drinking water and cancer. *Environmental health perspectives*, *103*(Suppl 8), 225. Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1518976/pdf/envhper00368-0223.pdf

Mueller, B.A., Newton, K., Holly, E.A. & Preston-Martin, S. (2001) Residential water source and the risk of childhood brain tumors. *Environmental Health Perspectives 109*(6) pp. 551-556. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1240334/pdf/ehp0109-000551.pdf

Mueller, B.A., Searles Nielsen, S., Preston-Martin, S. Holly, E.A., Cordier, S., Filippinin, G., Peris-Bonet, R., Choi, N.W. (2004) Household water source and the risk of childhood brain tumours: results of the SEARCH International Brain Tumor Study. Int.J.Epidemiol. 33(6):1209-1216. http://www.ncbi.nlm.nih.gov/pubmed/15567873 and http://ije.oxfordjournals.org/content/33/6/1209.long

National Research Council, Committee on Toxicology. (1995) Nitrate and nitrite in drinking water. Washington, DC: National Academies Press

Nolan, B. T., & Hitt, K. J. (2006). Vulnerability of shallow groundwater and drinking-water wells to nitrate in the United States. *Environmental science & technology*, *40*(24), 7834-7840. Retrieved from https://pdfs.semanticscholar.org/9499/0f272fea508adcd5f21766d2fbe01a30178c.pdf

Nolan BT, Hitt KJ, Ruddy BC. (2002) Probability of nitrate contamination of recently recharged ground waters in the conterminous United States. U.S.G.S. Environ Sci Technol 36(10) pp. 2138–45. http://water.usgs.gov/nawqa/nutrients/pubs/est_v36_no10/ and http://water.usgs.gov/nawqa/nutrients/pubs/est_v36_no10/est_v36_no10.pdf

Odorog, C. M. (2016). Nitrates and drinking water. *Scientific Papers-Series A, Agronomy*, *59*, 122-126. Retrieved from http://agronomyjournal.usamv.ro/pdf/2016/Art20.pdf

Pacific Groundwater Group (2011) Request for identification Lower Yakima Valley Groundwater Management Area. WA State Department of Ecology. Retrieved from www.yakimacounty.us/NitrateProgram/English/Docs/Lower%20Yakima%20GWMA%20Request%20For%20Identification%20FINAL.pdf

Parslow R.C., McKinney P.A., Law G.R., Staines A., Williams R., Bodansky H.J. (1997) Incidence of childhood diabetes mellitus in Yorkshire, northern England, is associated with nitrate in drinking water: an ecological analysis. Diabetologia 40(5) pp. 550–6. Retrieved from http://www.springerlink.com/content/7d21fcmtmgjj54pt/ and http://www.springerlink.com/content/7d21fcmtmgjj54pt/fulltext.pdf

Pogoda, J.M., and Preston-Martin, S. (2001) Maternal cured meat consumption during pregnancy and risk of paediatric brain tumour in offspring: potentially harmful levels of

intake. *Public Health Nutr. 4(*2) pp. 183-189. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/11299090

Pollack, E.S. & Pollack, C.V. (1994) Incidence of subclinical methemoglobinemia in infants with diarrhea. Annals of Emergency Medicine. http://www.ncbi.nlm.nih.gov/pubmed/8092592

Preston-Martin, S., Yu, M.C., Benton, B., & Henderson, B.E. (1982) N-Nitroso compounds and childhood brain tumors: a case-control study. *Cancer Res. 42*(12) pp. 5240-5245. Retrieved from http://cancerres.aacrjournals.org/content/42/12/5240.abstract

Preston-Martin, S., Pogoda, J.M., Mueller, B.A., Holly, E.A., Lijinsky, W. & Davis, R.L. (1996) Maternal consumption of cured meats and vitamins in relation to pediatric brain tumors. *Cancer Epidemiol.Biomarkers Prev. 5*(8) pp. 599-605. Retrieved from http://cebp.aacrjournals.org/content/5/8/599.long

Reinik, M., Tamme, T., Roasto, M., Juhkam, K., Jurstenko. S., Tenno, T. & Kiis, A. (2005) Nitrites, nitrates and N-nitrosoamines in Estonian cured meat products: intake by Estonian children and adolescents. *Food Addit.Contam 22*(11) pp. 1098-1105. http://www.ncbi.nlm.nih.gov/pubmed/16332632

Reynolds K.A. (2002) The prevalence of nitrate contamination in the United States. *Water Conditioning and Purification 44*(1). Retrieved from http://www.wcponline.com/ArchiveNewsView.cfm?pkArticleID=1330&AT=T

Sadeq, M., Moe, C.L.,Attarassi, B., Cherkaouil, L., Elaaud, R., & Idrissi, L. (2008) Drinking water nitrate and prevalence of methemoglobinemia among infants and children ages 1-7 years in Moroccan areas. International Journal of Environmental Health http://www.ncbi.nlm.nih.gov/pubmed/18155958

Saito T., Takeichi S., Osawa M., Yukawa N., Huang X.L. (2000) A case of fatal methemoglobinemia of unknown origin but presumably due to ingestion of nitrate. *International Journal of Legal Med 113*(3) pp. 164–7. Retrieved from http://www.springerlink.com/content/34befl8dg6v6p9rr/

Sanchez J., Benito-Fernandez J., Mintegui-Raso S. (2001) Methemoglobinemia and consumption of vegetables in infants. *Pediatrics 107*(5) pp. 1024–8.Retrieved from http://pediatrics.aappublications.org/content/107/5/1024.abstract and http://content.ebscohost.com/pdf13_15/pdf/2001/PDT/01May01/4441433.pdf?T=P&P=AN&K=4441433&S=R&D=aph&EbscoContent=dGJyMNLr40SeprY4y9f3OLCmr0qeqLBSs6a4TLKWxWXS&ContentCustomer=dGJyMPGssk2xqLJNuePfgeyx44Hy

Sandor, J., Kiss, I., Farkas, O., & Ember, I. (2001). Association between gastric cancer mortality and nitrate content of drinking water: ecological study on small area inequalities. *European journal of epidemiology*, *17*(5), 443-447. Retrieved fromhttps://www.researchgate.net/publication/226891543_Association_between_gastric_cancer_mortality_and_nitrate_content_of_drinking_water_Ecological_study_on_small_area_inequalities

Sarasua, S., and Savitz. D.A. (1994) Cured and broiled meat consumption in relation to childhood cancer: Denver, Colorado (United States) *Cancer Causes Control 5*(2) pp. 141-148. http://www.ncbi.nlm.nih.gov/pubmed/8167261

Savino, F., Maccario, S., Guido, C., Castagno, E., Farinasso, D., Cresi, F., Silvestro, L., & Mussa, G.C. (2006) Methemoglobinemia caused by the ingestion of courgette soup given in order to resolve constipation in two formula-fed infants. *Ann Nutr.Metab 50*(4) pp. 368-371. http://www.ncbi.nlm.nih.gov/pubmed/16809905

Schmitz J.T. (1961) Methemoglobinemia—a cause of abortions? Preliminary report. Obstet Gynecol. 17 pp. 413–415. Retrieved from http://journals.lww.com/greenjournal/Citation/1961/04000/Methemoglobinemia_A_Cause_of_Abortions__.2.aspx

Scragg RK, Dorsch MM, McMichael AJ, Baghurst PA. (1982) Birth defects and household water supply. Epidemiological studies in the Mount Gambier region of South Australia. Med J Aust. *2* pp. 577–579. http://www.ncbi.nlm.nih.gov/pubmed/7162445

Shearer L.A., Goldsmith J.R., Young C., Kearns O.A., Tamplin B.R. (1972) Methemoglobin levels in infants in an area with high nitrate water supply. *American Journal of Public Health 62*(9) pp. 1174–80. Retrieved from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1530503/pdf/amjph00731-0006.pdf

Shuval H.I., Gruener N. (1992) Epidemiological and toxicological aspects of nitrates and nitrites in the environment. *American Journal of Public Health 62*(8):1045–52. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1530374/pdf/amjph00730-0007.pdf

Spalding, R. F., & Exner, M. E. (1993). Occurrence of nitrate in groundwater—a review. *Journal of environmental quality*, *22*(3), 392-402. Retrieved from https://nature.berkeley.edu/classes/espm-120/Website/Spalding1993.pdf

Super, M., Heese, H. D. V., MacKenzie, D., Dempster, W. S., Du Plessis, J., & Ferreira, J. J. (1981). An epidemiological study of well-water nitrates in a group of South West African/Namibian infants. *Water Research*, *15*(11), 1265-1270. Retrieved from http://www.sciencedirect.com/science/article/pii/0043135481901032

Tabacova S., Balabaeva L., Little R.E. (1997) Maternal exposure to exogenous nitrogen compounds and complications of pregnancy. *Arch Environ Health 52*(5) pp. 341–7. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/9546756

Tajtakova, M., Semanova, Z., Tomkova, Z., Szokeova, E., Majoros, J., RAdikova, Z., Sebokova, E. Klines, I, & Langer, P. (2006) Increased thyroid volume and frequency of thyroid disorders signs in schoolchildren from nitrate polluted area. *Chemosphere 62(*4) pp. 559-564. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/16095667

Tamme, T., Reinik, M., Roasto, M., Juhkam, K., Tenno, T., & Kiis, A. (2006) Nitrates and nitrites in vegetables and vegetable-based products and their intakes by the Estonian population. *Food Addit.Contam 23*(4) pp. 355-361. http://peer.ccsd.cnrs.fr/docs/00/57/75/75/PDF/PEER_stage2_10.1080%252F02652030500482363.pdf

Terblanche, A. P. S. (1991). Health hazards of nitrate in drinking water. *Water S. A.*, *17*(1), 77-82. Retrieved from http://www.wrc.org.za/Knowledge%20Hub%20Documents/Water%20SA%20Journals/Manuscripts/1991/WaterSA_1991_17_0612.PDF

Thorpe, N., and Shirmohammadi, A. (2005) Herbicides and nitrates in groundwater of Maryland and childhood cancers: a geographic information systems approach. *J Environ Sci Health C.Environ Carcinog.Ecotoxicol.Rev. 23*(2) pp. 261-278. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/16291529

Tirado, R. (2007). Nitrates in drinking water in the Philippines and Thailand. *Greenpeace Research Laboratories Technical Note*, *11*, 2007. Retrieved from http://www.greenpeace.to/publications/Nitrates_Philippines_Thailand.pdf

Tricker A.R., Preussmann R. (1991) Carcinogenic *N*-nitrosamines in the diet: occurrence, formation, mechanisms and carcinogenic potential. *Mutat Res 259* pp. 277–89. Retrieved from http://www.sciencedirect.com/science/article/pii/0165121891901234 and http://www.ncbi.nlm.nih.gov/pubmed/2017213

Tsezou, A., Kitsiou-Tzeli, S., Galla, A., Gourgiotis, D., Papageorgiou, J., Mitrou, S., Molybdas, P. A., Sinaniotis, C. (1996) High nitrate content in drinking water: cytogenetic effects in exposed children. *Arch.Environ.Health 51*(6) pp. 458-461. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/9012325

U.S. Department of Agriculture: Food Safety and Inspection Service. (2001) Fact Sheets: Food Labeling - Additives in Meat and Poultry Products. Retrieved from http://www.fsis.usda.gov/Fact_Sheets/Additives_in_Meat_&_Poultry_Products/index.asp

U.S. Environmental Protection Agency. (2006) 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) Drinking Water Contaminants. Retrieved from http://www.epa.gov/safewater/contaminants/index.html

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/

US Environmental Protection Agency. Consumer factsheet on: nitrates/nitrites. Washington, DC: US Environmental Protection Agency; 2004. Available from URL: http://www.epa.gov/safewater/dwh/c-ioc/nitr

US Environmental Protection Agency. Integrated Risk Information System (IRIS) database. Nitrate (CASRN 14797-55-8). Washington, DC: US Environmental Protection Agency. 2002. Available at URL: http://www.epa.gov/iris

U.S. Environmental Protection Agency. 2007. *Nitrates and Nitrites TEACH Chemical Summary.* Retrieved from http://www.epa.gov/teach/chem_summ/Nitrates_summary.pdf

U.S. Environmental Protection Agency (2012) Preliminary data Lower Yakima Valley well testing. Retrieved from ftp://ftp.epa.gov/reg10ftp/sites/yakima/groundwater_data/

U.S. Food and Drug Administration. (1998) A Fresh Look at Food Preservatives. Retrieved from http://www.cfsan.fda.gov/~dms/fdpreser.html

US Geological Survey. (1999) The quality of our nation's waters: nutrients and pesticides. Circular 1225. Reston, VA: US Department of the Interior. Retrieved from http://pubs.usgs.gov/circ/circ1225/

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

Van Grinsven, H. J., Ward, M. H., Benjamin, N., & De Kok, T. M. (2006). Does the evidence about health risks associated with nitrate ingestion warrant an increase of the nitrate standard for drinking water?. *Environmental Health*, *5*(1), 26. Retrieved from https://ehjournal.biomedcentral.com/articles/10.1186/1476-069X-5-26

Van Grinsven, H. J., Rabl, A., & de Kok, T. M. (2010). Estimation of incidence and social cost of colon cancer due to nitrate in drinking water in the EU: a tentative cost-benefit assessment. *Environmental health*, *9*(1), 58. Retrieved from https://ehjournal.biomedcentral.com/articles/10.1186/1476-069X-9-58

Van Leeuwen, J. A., Waltner-Toews, D., Abernathy, T., Smit, B., & Shoukri, M. (1999). Associations between stomach cancer incidence and drinking water contamination with atrazine and nitrate in Ontario (Canada) agroecosystems, 1987-1991. *International Journal of Epidemiology*, *28*(5), 836-840. Retrieved from https://oup.silverchair-cdn.com/oup/backfile/Content_public/Journal/ije/28/5/10.1093_ije_28.5.836/1/280836.pdf?Expires=1496077591&Signature=eJKIkjMC7~pHHeXuySz6qz6lisEhIYcisyAgnbw5rBzlcj4WlXuxcDd8zM9nF1REGBKq54N~-RG~OVN0~UFawShZMbJgkZji64HtsX~yzISDdNZqhXv6cevgsgIrHWffbRJ8dllRp8YS8FmiXlVTlxT7RaD62Az5FlSZKUGILgszWLsK13W18Pg3FewdgMxw0S6CfRzKH2I5fIq5RdLRfGpDdVy5UG7TUwhV5bYTVH6t0p1xHEBhD2CTqx462wGSFVqOh~C6KAgc-s5ei6xqfr~kJkb8bmuhb4gQ54mvCb52oQbH3nNSVNjHnCsdOcbU0mfM6FjLHFISf1zWaNQjnA__&Key-Pair-Id=APKAIUCZBIA4LVPAVW3Q

Van Loon A.J., Botterweck A.A., Goldbohm R.A., Brants H.A., van Klaveren J.D., van den Brandt P.A. (1998) Intake of nitrate and nitrite and the risk of gastric cancer: a prospective cohort study. *British Journal of Cancer 78* pp. 129–35. Retrieved from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2062934/pdf/brjcancer00001-0133.pdf

Van Maanen, J. M., Welle, I. J., Hageman, G., Dallinga, J. W., Mertens, P. L., & Kleinjans, J. C. (1996). Nitrate contamination of drinking water: relationship with HPRT variant frequency in lymphocyte DNA and urinary excretion of N-nitrosamines. *Environmental Health Perspectives*, *104*(5), 522. Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1469364/pdf/envhper00336-0070.pdf

van Maanen, J.M., Albering, H.J., de Kok, T.M., van Breda, S.G., Curfs, D.M., Vermeer, I. T., Ambergen, A.W., Wolffenbuttel, B.H., Klenjans, J.C. & Reeser, H.M. (2000) Does the risk of childhood diabetes mellitus require revision of the guideline values for nitrate in drinking water? *Environ.Health Perspect. 108*(5) pp. 457-461. Retrieved from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1638059/

van Maanen, J. M., van Dijk, A., Mulder, K., de Baets, M. H., Menheere, P. C., van der Heide, D., ... & Kleinjans, J. C. (1994). Consumption of drinking water with high nitrate levels causes hypertrophy of the thyroid. *Toxicology letters*, *72*(1-3), 365-374. Retrieved from

https://www.researchgate.net/publication/14996221_Consumption_of_drinking_water_with_high_nitrate_levels_causes_hypertrophy_of_the_thyroid

Venkateswari R, Ganesh R, Deenadayalan M, Mahender E, Ramachandran B, Janakiraman (2007) Transient Methemoglobinemia in an infant. *Indian Journal of pediatrics* 74(11). Pp. 1037-1038. Retrieved form http://www.ncbi.nlm.nih.gov/pubmed/18057688

Virtanen, S.M., Jaakkola, L., Rasanen. L., Ylonen, K., Aro, A., Lounamaa, R., Akerblom, H.K., & Tuomilehto, J. (1994) Nitrate and nitrite intake and the risk for type 1 diabetes in Finnish children. Childhood Diabetes in Finland Study Group. *Diabet.Med. 11*(7) pp. 656-662. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/7955990

Volkmer, B.G., Ernst, B., Simon, J., Kuefer, R., Bartsch, G., Bach, D., & Gschwend, J.E. (2005) Influence of nitrate levels in drinking water on urological malignancies: a community-based cohort study. *BJU.Int 95*(7) pp. 972-976. http://www.ncbi.nlm.nih.gov/pubmed/15839916

Walton G. (1951) Survey of literature relating to infant methemoglobinemia due to nitrate-contaminated water. Am J Public Health. 41 pp. 986–996. Retrieved from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1525621/pdf/amjphnation00426-0083.pdf

Ward M.H., Mark S.D., Cantor K.P., Weisenburger D.D., Correa-Villasenor A., Zahm S.H. (1996) Drinking water nitrate and the risk of non-Hodgkin's lymphoma. *Epidemiology7*(5) pp. 465–71. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/8862975

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 and http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1310926/pdf/ehp0113-001607.pdf

Ward, M. H., Cantor, K. P., Cerhan, J., Lynch, C. F., & Hartge, P. (2004). Nitrate in public water supplies and risk of cancer: Results from recent studies in the midwestern United States. *Epidemiology*, *15*(4), S214. Retrieved from http://journals.lww.com/epidem/Citation/2004/07000/Nitrate_in_Public_Water_Supplies_and_Risk_of.568.aspx

Ward, M. H., Heineman, E. F., Markin, R. S., & Weisenburger, D. D. (2008). Adenocarcinoma of the stomach and esophagus and drinking water and dietary sources of nitrate and nitrite. *International journal of occupational and environmental health*, *14*(3), 193-197. Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2797489/

Ward, L.B. Yakima Herald Republic. (2009) "Hidden Wells, Dirty Water"http://www.yakima-herald.com/stories/2008/10/11/hidden-wells-dirty-water

Washington State Dept. of Ecology (2010) *Lower Yakima Valley groundwater quality: preliminary assessment and recommendations document.* Retrieved from https://fortress.wa.gov/ecy/publications/publications/1010009.pdf

WA State Dept. of Health (2010) 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) Nitrate in Drinking Water – Questions and Answers (Spanish) Retrieved from http://www.doh.wa.gov/ehp/dw/Publications/331-214s.pdf

Wei-Hua, J., Qing-Hua, P., Hai-De, Q., Ya-Fei, X., Guo-Ping, S., Lina, C., Li-Zhen, C., Qi-Sheng, F., Ming-Huang, H., Yi-Xin, A., & Yin Yao, S. (2000) Dietary exposure to nitrite and nitrosamines and risk of nasopharyngeal carcinoma in Taiwan. *International Journal of Cancer 86*(5) pp. 603-609. http://carcin.oxfordjournals.org/content/30/12/2031.full

Weyer, P. J., Cerhan, J. R., Kross, B. C., Hallberg, G. R., Kantamneni, J., Breuer, G., ... & Lynch, C. F. (2001). Municipal drinking water nitrate level and cancer risk in older women: the Iowa Women's Health Study. *Epidemiology*, *12*(3), 327-338. Retrieved from http://s3.amazonaws.com/academia.edu.documents/42632538/Municipal_Drinking_Water_Nitrate_Level_a20160212-31872-gownru.pdf?AWSAccessKeyId=AKIAIWOWYYGZ2Y53UL3A&Expires=1497141341&Signature=2YyjqoK44lfKWXwMm3ycZObtXrU%3D&response-content-disposition=inline%3B%20filename%3DMunicipal_Drinking_Water_Nitrate_Level_a.pdf

Wiklund, G.M., Aastrup, L., Pousette, M., Thunholm, J., Saldeen, B., Wernroth, T., Zaren, & Holmberg, L. (2001) Incidence and geographical distribution of sudden infant death syndrome in relation to content of nitrate in drinking water and groundwater levels. *Eur.J.Clin.Invest 31*(12) pp. 1083-1094. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/11903496

World Health Organization. (2003). Nitrate and nitrite in drinking-water: background document for development of WHO guidelines for drinking-water quality. Retrieved from http://apps.who.int/iris/bitstream/handle/10665/75380/WHO_SDE_WSH_04.03_56_eng.pdf?sequence=1

World Health Organization. (2006) International Program on Chemical Safety, Environmental Health Criteria 5: Nitrates, Nitrites, and N-Nitroso Compounds. Retrieved from http://www.inchem.org/documents/pims/chemical/pimg016.htm

World Health Organization. (2008). *Guidelines for drinking-water quality: second addendum. Vol. 1, Recommendations*. World Health Organization. Retrieved from http://www.who.int/water_sanitation_health/dwq/secondaddendum20081119.pdf

World Health Organization. (2010). *Drinking water quality in the South-East Asia region* (No. SEA-EH-567). WHO Regional Office for South-East Asia. Retrieved from http://apps.who.int/iris/bitstream/handle/10665/204999/B4470.pdf?sequence=1&isAllowed=y

Wright R.O., Woolf A.D., Shannon M.W., Magnani B. (1998) *N*-acetylcysteine reduces methemoglobin in an in-vitro model of glucose-6-phosphate dehydrogenase deficiency. *Acad Emerg Med 5*(3) pp. 225–9. Retrieved from

http://onlinelibrary.wiley.com/doi/10.1111/j.1553-2712.1998.tb02617.x/abstract and http://www.ncbi.nlm.nih.gov/pubmed/9523930

Wright R.O., Lewander W.J., Woolf A.D. (1999) Methemoglobinemia: etiology, pharmacology, and clinical management. *Annals of Emergency Medicine 34*(5) pp. 646–56. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/10533013

Xu G, Song P, Reed P.I. (1992) The relationship between gastric mucosal changes and nitrate intake via drinking water in a high-risk population for gastric cancer in Moping County, China. Eur J Cancer Prev 1992; 1(6):437–43. http://journals.lww.com/eurjcancerprev/Abstract/1992/10000/The_relationship_between_gastric_mucosal_changes.7.aspx

Yakima County (2011) Nitrate Treatment Pilot Program – Final Report. Retrieved from http://www.yakimacounty.us/nitrateprogram/english/Docs/Nitrate%20Treatment%20Pilot%20Program.pdf

Yang, C. Y., Cheng, M. F., Tsai, S. S., & Hsieh, Y. L. (1998). Calcium, magnesium, and nitrate in drinking water and gastric cancer mortality. *Cancer Science*, *89*(2), 124-130. Retrieved from http://onlinelibrary.wiley.com/doi/10.1111/j.1349-7006.1998.tb00539.x/pdf

Yang, C. Y., Wu, D. C., & Chang, C. C. (2007). Nitrate in drinking water and risk of death from colon cancer in Taiwan. *Environment international*, *33*(5), 649-653. Retrieved from https://pdfs.semanticscholar.org/855d/857eea83aad377b815d3aff72cca3e8eedde.pdf

Zeman C.L., Kross B., Vlad M. (2002) A nested case-control study of methemoglobinemia risk factors in children of Transylvania, Romania. *Environmental Health Perspectives 110*(8) pp. 817–22. Retrieved from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1240955/pdf/ehp0110-000817.pdf

Zeman, C.L., Vlad, C.L., & Kross, B. (2002) Exposure methodology and findings for dietary nitrate exposures in children of Transylvania, Romania. *J.Expo.Anal.Environ.Epidemiol. 12*(1) pp. 54-63. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/11859433

Compiled by Jean Mendoza

Appendix K—Nitrate Pilot Project Well Samples

Nitrate Pilot Project Well Samples--Compiled by V. Redifer, arranged by J. Davenport						
ID #	Mg/L	Well Depth	Parcel #	Township / Range / Section	Sample #	Date Sampled
137	8.40	0	20110931410	T11N/R20E-09	20110931410	6/22/2011
138	27.40	100	20111334002	T11N/R20E-13	20111334002	1/20/2011
139	22.10	0	20111523405	T11N/R20E-15	20111523405	3/25/2011
140	1.98	0	20112141015	T11N/R20E-21	20112141015	6/23/2011
141	11.30	120	20112412403	T11N/R20E-24	20112412403	1/18/2011
142	14.30	120	20112421402	T11N/R20E-24	20112421402	4/19/2011
144	20.30	100	21100111415	T10N/R21E-01	21100111415	3/3/2011
145	21.30	0	21100111416	T10N/R21E-01	21100111416	5/11/2011
146	19.70	100	21100111422	T10N/R21E-01	21100111422	5/26/2011
147	10.20	0	21100123414	T10N/R21E-01	21100123414	3/16/2011
148	29.20	130	21100134003	T10N/R21E-01	21100134003	6/17/2011
149	35.20	0	21100134406	T10N/R21E-01	21100134406	6/17/2011
150	33.40	0	21100142406	T10N/R21E-01	21100142406	4/1/2011
151	36.20	0	21100144003	T10N/R21E-01	21100144003	6/17/2011
153	21.40	0	21100241401	T10N/R21E-02	21100241401	1/11/2011
155	11.75	175	21100514002	T10N/R21E-05	21100514002	1/21/2011
156	10.30	0	21100523016	T10N/R21E-05	21100523016	1/6/2011
157	47.90	0	21100531012	T10N/R21E-05	21100531012	2/3/2011
158	4.02	100	21100531401	T10N/R21E-05	21100531401	3/9/2011
159	5.32	77	21100531404	T10N/R21E-05	21100531404	6/22/2011
160	16.40	200	21100934002	T10N/R21E-09	21100934002	5/24/2011
161	11.50	100	21101011406	T10N/R21E-10	21101011406	2/9/2011
162	22.37	0	21101214002	T10N/R21E-12	21101214002	6/17/2011
163	22.67	0	21101214005	T10N/R21E-12	21101214005	6/17/2011
164	16.30	0	21101241007	T10N/R21E-12	21101241007	5/2/2011
165	17.60	0	21101421005	T10N/R21E-14	21101421005	5/10/2011
166	12.10	60	21101424402	T10N/R21E-14	21101424402	1/31/2011
167	10.35	0	21101444001	T10N/R21E-14	21101444001	3/7/2011
168	10.50	0	21102422005	T10N/R21E-24	21102422005	4/1/2011
169	8.59	0	21111922400	T11N/R21E-19	21111922400	3/14/2011
170	14.20	70	21113022003	T11N/R21E-30	21113022003	1/25/2011
171	37.70	0	21113023401	T11N/R21E-30	21113023401	6/2/2011
172	18.00	0	21113024405	T11N/R21E-30	21113024405	3/29/2011
173	17.65	220	21113024406	T11N/R21E-30	21113024406	3/9/2011
174	18.10	187	21113024407	T11N/R21E-30	21113024407	3/24/2011
175	15.90	0	21113024408	T11N/R21E-30	21113024408	3/22/2011
176	20.30	0	21113024410	T11N/R21E-30	21113024410	4/22/2011
177	20.30	0	21113024411	T11N/R21E-30	21113024411	4/27/2011

178	14.00	210	21113031422	T11N/R21E-30	21113031407	4/12/2011
179	5.28	200	21113031412	T11N/R21E-30	21113031412	3/7/2011
180	14.70	125	21113211401	T11N/R21E-32	21113211401	1/12/2011
181	33.60	0	21113321005	T11N/R21E-33	21113321005	6/8/2011
182	24.90	160	21113321401	T11N/R21E-33	21113321401	6/8/2011
183	13.60	0	21113321403	T11N/R21E-33	21113321403	6/17/2011
184	8.88	0	21113324002	T11N/R21E-33	21113324002	6/8/2011
185	13.60	0	21113324003	T11N/R21E-33	21113324003	6/8/2011
186	13.60	226	21113422401	T11N/R21E-34	21113422401	3/31/2011
189	22.80	0	22080131425	T08N/R22E-01	22080131425	1/12/2011
190	23.80	0	22080131428	T08N/R22E-01	22080131428	5/2/2011
191	23.80	0	22080131428	T08N/R22E-01	22080131428	5/2/2011
192	3.57	0	22090222005	T09N/R22E-02	22090222005	5/25/2011
193	9.75	0	22090232002	T09N/R22E-02	22090232002	6/22/2011
194	31.70	0	22090441007	T09N/R22E-04	22090441007	6/22/2011
195	8.28	0	22091311001	T09N/R22E-13	22091311001	6/8/2011
196	35.40	0	22091311003	T09N/R22E-13	22091311003	3/11/2011
197	17.40	65	22091312001	T09N/R22E-13	22091312001	3/4/2011
198	8.81	0	22091312400	T09N/R22E-13	22091312400	3/29/2011
199	25.30	0	22091331002	T09N/R22E-13	22091331002	4/4/2011
200	14.50	120	22091344013	T09N/R22E-13	22091344013	3/15/2011
201	6.63	35	22091513002	T09N/R22E-15	22091513002	1/13/2011
202	1.00	100	22091541003	T09N/R22E-15	22091541003	1/13/2011
203	3.02	0	22091621401	T09N/R22E-16	22091621401	5/13/2011
204	27.60	0	22100333402	T10N/R22E-03	22100333402	1/7/2011
205	28.60	0	22100443003	T10N/R22E-04	22100443003	6/20/2011
206	6.22	0	22100542001	T10N/R22E-05	22100542001	5/26/2011
207	14.90	0	22100822401	T10N/R22E-08	22100822401	6/20/2011
208	5.66	0	22100842403	T10N/R22E-08	22100842403	5/3/2011
209	29.10	175	22100911001	T10N/R22E-09	22100911001	4/19/2011
210	27.10	200	22100914001	T10N/R22E-09	22100914001	3/29/2011
211	10.00	0	22100931405	T10N/R22E-09	22100931405	1/18/2011
212	18.55	0	22100933001	T10N/R22E-09	22100933001	4/22/2011
213	20.80	0	22101031001	T10N/R22E-10	22101031001	1/28/2011
214	21.60	0	22101112006	T10N/R22E-11	22101112006	6/20/2011
215	13.10	210	22101121407	T10N/R22E-11	22101121407	2/18/2011
216	8.40	160	22101141405	T10N/R22E-11	22101141405	1/27/2011
219	17.20	0	22101232402	T10N/R22E-12	22101232402	5/24/2011
220	5.97	0	22101321401	T10N/R22E-13	22101321401	1/11/2011
221	21.05	65	22101342002	T10N/R22E-13	22101342002	3/4/2011

222	2.00	0	22101432408	T10N/R22E-14	22101432408	1/28/2011
223	25.20	220	22101542002	T10N/R22E-15	22101542002	4/29/2011
224	16.60	220	22101543002	T10N/R22E-15	22101543002	4/29/2011
225	10.55	0	22101544002	T10N/R22E-15	22101544002	1/11/2011
226	29.20	0	22101544003	T10N/R22E-15	22101544003	1/26/2011
227	2.77	100	22101724401	T10N/R22E-17	22101724401	1/24/2011
228	16.80	68	22101743400	T10N/R22E-17	22101743400	5/24/2011
229	5.09	141	22101743405	T10N/R22E-17	22101743405	5/26/2011
230	52.80	0	22101743406	T10N/R22E-17	22101743406	5/25/2011
231	13.90	0	22101743407	T10N/R22E-17	22101743407	5/24/2011
232	19.00	0	22101821401	T10N/R22E-18	22101821401	6/8/2011
233	8.00	0	22101824001	T10N/R22E-18	22101824001	5/24/2011
234	2.52	0	22101923400	T10N/R22E-19	22101923400	4/26/2011
235	2.25	0	22102144413	T10N/R22E-21	22102144413	1/28/2011
236	14.20	0	22102214007	T10N/R22E-22	22102214007	3/16/2011
237	13.40	0	22102222403	T10N/R22E-22	22102222403	3/22/2011
238	18.00	0	22102224001	T10N/R22E-22	22102224001	1/11/2011
239	13.85	70	22102244007	T10N/R22E-22	22102244007	1/19/2011
240	7.57	16	22102332401	T10N/R22E-23	22102332401	1/19/2011
241	23.25	45	22102412001	T10N/R22E-24	22102412001	2/4/2011
242	20.10	200	22102424020	T10N/R22E-24	22102424020	6/28/2011
243	51.50	0	22102431400	T10N/R22E-24	22102431400	1/10/2011
244	25.69	0	22102431403	T10N/R22E-24	22102431403	1/6/2011
245	37.00	0	22102431405	T10N/R22E-24	22102431405	1/7/2011
246	17.30	0	22102431409	T10N/R22E-24	22102431409	1/19/2011
247	11.70	0	22102433494	T10N/R22E-24	22102433494	4/6/2011
248	10.60	100	22102441427	T10N/R22E-24	22102441427	5/2/2011
249	21.00	0	22102442407	T10N/R22E-24	22102442407	6/27/2011
250	19.39	0	22102442415	T10N/R22E-24	22102442415	1/7/2011
251	17.40	0	22102442416	T10N/R22E-24	22102442416	1/25/2011
252	18.90	0	22102442425	T10N/R22E-24	22102442425	1/10/2011
253	20.60	60	22102442426	T10N/R22E-24	22102442426	6/13/2011
254	12.70	80	22102442428	T10N/R22E-24	22102442428	2/14/2011
255	11.35	0	22102442430	T10N/R22E-24	22102442430	1/10/2011
256	20.00	0	22102442433	T10N/R22E-24	22102442433	6/13/2011
257	20.60	60	22102442443	T10N/R22E-24	22102442443	1/10/2011
258	43.20	0	22102631531	T10N/R22E-26	22102631531	6/8/2011
259	19.50	135	22103113006	T10N/R22E-31	22103113006	1/12/2011
260	6.28	120	22103321005	T10N/R22E-33	22103321005	4/26/2011
261	13.70	70	22103321006	T10N/R22E-33	22103321006	3/7/2011

262	16.50	200	22113611002	T11N/R22E-36	22113611002	3/30/2011
264	1.00	129	23080321405	T08N/R23E-03	23080321405	1/18/2011
265	15.35	0	23080421401	T08N/R23E-04	23080421401	5/23/2011
266	8.62	0	23080424401	T08N/R23E-04	23080424401	3/4/2011
267	22.10	50	23080441002	T08N/R23E-04	23080441002	1/13/2011
268	22.00	0	23080541001	T08N/R23E-05	23080541001	6/13/2011
269	22.00	0	23080541001	T08N/R23E-05	23080541001	6/13/2011
270	3.46	0	23080611002	T08N/R23E-06	23080611002	1/7/2011
271	13.90	95	23080822406	T08N/R23E-08	23080822406	3/24/2011
272	19.85	80	23090243003	T09N/R23E-02	23090243003	3/15/2011
273	3.99	80	23090333002	T09N/R23E-03	23090333002	4/12/2011
274	8.71	0	23090711410	T09N/R23E-07	23090711410	4/19/2011
275	18.90	90	23090923005	T09N/R23E-09	23090923005	2/4/2011
276	14.80	0	23091211006	T09N/R23E-12	23091211002	6/16/2011
277	12.10	0	23091223004	T09N/R23E-12	23091223004	4/20/2011
278	29.40	0	23091334003	T09N/R23E-13	23091334003	1/18/2011
279	10.90	0	23091342005	T09N/R23E-13	23091342005	5/24/2011
280	8.97	0	23091414008	T09N/R23E-14	23091414008	1/25/2011
281	8.77	0	23091421402	T09N/R23E-14	23091421402	1/19/2011
282	5.50	0	23091514022	T09N/R23E-15	23091514022	4/5/2011
283	18.75	0	23091713401	T09N/R23E-17	23091713401	1/10/2011
284	35.90	0	23091911420	T09N/R23E-19	23091911420	3/8/2011
285	7.00	0	23091914003	T09N/R23E-19	23091914003	3/15/2011
286	5.58	0	23091922006	T09N/R23E-19	23091922006	3/21/2011
287	22.70	0	23091922018	T09N/R23E-19	23091922018	5/12/2011
288	18.60	55	23092014002	T09N/R23E-20	23092014002	3/1/2011
289	11.90	180	23092112002	T09N/R23E-21	23092112002	6/14/2011
291	12.08	0	23092133404	T09N/R23E-21	23092133404	6/2/2011
292	12.08	0	23092133422	T09N/R23E-21	23092133422	6/2/2011
293	19.40	40	23092421004	T09N/R23E-24	23092421004	3/4/2011
294	5.40	200	23092433008	T09N/R23E-24	23092433008	2/10/2011
295	3.01	0	23092511401	T09N/R23E-25	23092511401	6/22/2011
296	5.56	0	23093111004	T09N/R23E-31	23093111004	6/22/2011
297	10.25	150	23093131417	T09N/R23E-31	23093131417	1/26/2011
298	7.44	0	23093142419	T09N/R23E-31	23093142419	1/6/2011
299	9.07	0	23093142420	T09N/R23E-31	23093142420	1/20/2011
300	18.20	0	23100834401	T10N/R23E-08	23100834401	6/13/2011
301	18.20	0	23100834402	T10N/R23E-08	23100834402	6/13/2011
302	23.20	50	23101744005	T10N/R23E-17	23101744005	3/17/2011
303	19.00	101	23101921404	T10N/R23E-19	23101921404	2/2/2011

304	12.35	0	23101922403	T10N/R23E-19	23101922403	1/14/2011
305	14.40	0	23101941402	T10N/R23E-19	23101941402	6/2/2011
306	13.45	60	23101943003	T10N/R23E-19	23101943003	1/12/2011
307	10.30	0	23101943010	T10N/R23E-19	23101943010	1/13/2011
308	19.50	90	23101944002	T10N/R23E-19	23101944002	1/16/2011
309	52.10	0	23102011001	T10N/R23E-20	23102011001	3/3/2011
310	13.60	0	23102022008	T10N/R23E-20	23102022008	3/21/2011
311	13.70	0	23102022012	T10N/R23E-20	23102022012	3/21/2011
312	15.60	0	23102022015	T10N/R23E-20	23102022015	3/10/2011
313	12.45	80	23102034410	T10N/R23E-20	23102034003	2/28/2011
314	15.05	0	23102133005	T10N/R23E-21	23102133005	3/7/2011
315	16.10	0	23102224001	T10N/R23E-22	23102224001	6/2/2011
316	35.90	0	23102242401	T10N/R23E-22	23102242401	6/2/2011
317	10.60	0	23102534409	T10N/R23E-25	23102534409	4/14/2011
318	14.80	0	23102643001	T10N/R23E-26	23102643001	3/2/2011
319	20.10	0	23102733004	T10N/R23E-27	23102733004	6/8/2011
320	26.50	60	23102822008	T10N/R23E-28	23102822008	5/5/2011
321	44.30	0	23102911003	T10N/R23E-29	23102911003	5/26/2011
322	11.40	69	23102911411	T10N/R23E-29	23102911411	6/13/2011
323	15.15	0	23102942401	T10N/R23E-29	23102942401	1/13/2011
324	49.55	130	23103021022	T10N/R23E-30	23103021022	1/13/2011
325	14.20	0	23103021404	T10N/R23E-30	23103021404	1/18/2011
326	16.60	0	23103022011	T10N/R23E-30	23103022011	5/19/2011
327	12.60	0	23103022019	T10N/R23E-30	23103022019	5/5/2011
328	19.10	0	23103022401	T10N/R23E-30	23103022401	1/11/2011
329	5.11	0	23103122404	T10N/R23E-31	23103122404	2/28/2011
330	16.20	0	23103123433	T10N/R23E-31	23103123433	1/28/2011
353	3.01	0	23103133403	T10N/R23E-31	23103133403	4/26/2011
354	14.50	0	23103213405	T10N/R23E-32	23103213405	1/19/2011
355	6.20	0	23103231406	T10N/R23E-32	23103231406	2/2/2011
356	9.89	0	23103321010	T10N/R23E-33	23103321010	6/8/2011
357	17.60	60	23103343401	T10N/R23E-33	23103343401	1/11/2011
358	5.75	0	23103434002	T10N/R23E-34	23103434002	6/22/2011
11577	25.20	0	22101542002	T10N/R22E-15	22101542002	4/29/2011
11996	4.00	0	23092111413		23092111413	5/24/2011
11997	14.19	0	22100931403		22100931403	1/18/2011
11998	23.80	78	22081221004		22081221004	4/26/2011
11999	22.40	0	22100734401		22100734401	6/14/2011
12000	19.40	0	22080141403		22080141403	6/16/2011
12001	3.57	0	22091423405		22091423405	5/24/2011

12002	6.28	0	21100922412	21100922412	6/22/2011
12003	0.05	0	22090344007	22090344007	5/24/2011
12004	1.16	0	22091012408	22091012408	5/13/2011
12005	12.40	0	23081024402	23081024402	6/22/2011
12006	9.25	122	22101523407	22101523407	2/23/2011
12007	4.66	0	23092733004	23092733004	5/24/2011
12010	4.48	0	21101123402	21101123002	5/13/2011
12012	12.55	0	21100133001	21100133001	2/17/2011
12013	24.85	60	23102822007	23102822007	3/8/2011
12014	29.90	0	23103123416	23103123416	6/13/2011
12016	11.00	0	22080144408	22080144408	4/26/2011
12017	4.20	150	22101533401	22101533401	4/5/2011
12018	1.00	221	21101333404	21101333404	1/13/2011
12020	3.42	0	20112222026	20112222026	4/26/2011
12022	12.50	0	22080144405	22080144405	6/15/2011
12023	9.80	0	22102441456	22102441419	4/4/2011
12024	7.68	0	23103134403	23103134403	4/26/2011
12025	12.70	230	23100722003	23100722003	6/13/2011
12026	4.57	0	23090833001	23090833001	2/9/2011
12027	0.05	0	22090333004	22090333004	5/13/2011
12028	1.00	0	22102731007	22102731007	2/10/2011
12029	2.85	0	23091141002	23091141002	4/26/2011
12031	5.00	203	22101122010	22101122010	1/25/2011
12032	1.00	0	23081131400	23081131400	6/22/2011
12033	6.60	0	22101813402	22101813402	4/26/2011
12034	4.16	0	23092443006	23092443006	4/26/2011
12035	7.22	0	23092044404	23092044404	5/26/2011
12036	13.30	0	21113032402	21113032402	3/7/2011
12037	8.10	120	23090434403	23090434403	5/24/2011
12038	18.10	0	23080722404	23080722404	4/26/2011
12039	5.04	0	22102711007	22102711007	5/24/2011
12041	1.11	0	23080712004	23080712004	5/13/2011
12042	1.00	0	22091132401	22091132401	4/15/2011
12043	19.00	105	21100111421	21100111421	5/26/2011
12044	24.85	80	23102822009	23102822009	3/17/2011
12045	70.40	0	23102742003	23102742003	5/23/2011
12048	3.08	0	20110912419	20110912419	5/13/2011
12049	17.00	0	23101921004	23101921004	4/26/2011
12050	37.00	0	22080131426	22080131426	6/14/2011
12051	13.80	145	23093131416	23093131416	6/2/2011

12052	16.90	0	22102443484	22102443484	6/13/2011
12053	0.05	0	22102043462	22102043462	5/26/2011
12054	3.10	0	22102912434	22102912434	4/5/2011
12055	8.14	0	22100931404	22100931404	4/13/2011
12056	11.30	100	23090234400	23090234400	6/16/2011
12057	16.60	150	22080141404	22080141404	5/12/2011
12058	0.95	0	22091214403	22091214403	5/26/2011
12059	3.42	0	20112222032	20112222032	5/13/2011
12060	15.70	0	23080511400	23080511400	6/16/2011
12061	32.30	0	22101112402	22101112402	6/2/2011
12062	22.00	0	23080541001	23080541001	6/13/2011

Appendix L—LYVGWMA High Risk Well Assessment

LVYGWMA High Risk Well Assessment Compiled by V. Redifer, arranged by J. Davenport		
Parcel #	Mg/L	Date Sampled
22102441438	12.10	10/29/2015
22102442422	1.82	12/11/2013
22102623404	0.00	4/10/2014
22102632416	3.35	9/18/2015
22102714007	0.00	10/2/2015
22102732001	1.10	12/9/2015
22102732003	9.70	1/24/2014
22102733010	4.75	5/13/2014
22102734410	0.00	10/15/2015
22102741019	2.80	10/2/2015
22102741402	5.21	11/24/2015
22102743023	5.22	10/15/2015
22102841001	18.30	3/12/2014
22102912434	4.42	3/7/2014
22102921010	0.00	2/2/2016
22102921027	3.92	6/5/2014
22103012003	10.00	5/29/2014
22103012404	0.00	5/28/2014
22103013401	0.00	5/29/2014
22103321002	0.95	9/23/2015
22103412002	7.58	4/18/2014
22103413402	0.00	10/20/2015
22103524408	1.02	6/20/2014
22103544040	0.76	1/29/2016
22103631426	9.60	3/24/2016
22113412001	2.75	2/4/2016
23080114012	1.99	11/26/2013
23080124002	0.23	1/20/2016
23080131001	0.00	1/23/2014
23080131401	0.00	1/22/2016
23080141006	0.00	1/20/2016
23080141008	2.66	10/20/2015
23080414403	5.11	3/7/2016
23080421004	9.75	1/17/2014
23080514401	20.70	2/18/2016
23080611402	2.30	1/28/2014
23080634006	3.05	2/14/2014
23080634007	2.24	12/3/2013
23080643402	0.96	11/12/2015
23080822408	14.00	1/19/2016
23080841402	5.04	1/12/2016
23080844002	4.09	1/17/2014
23080844003	0.75	2/7/2014
23081041001	0.58	3/2/2016
23081044002	0.48	1/17/2014
23081143403	0.38	1/12/2016
23081311004	3.86	1/13/2016
23081311005	18.00	4/16/2014
23081312408	0.16	1/13/2016
23081312411	4.86	11/20/2013
23081411400	15.30	1/13/2016
23090211403	3.04	12/11/2013
23090211407	3.47	1/13/2014
23090211407	5.00	2/25/2016
23090214009	3.69	11/20/2013
23090333002	4.07	5/22/2014
23090334002	4.56	3/9/2016
23090434403	11.00	2/18/2016
23090543400	5.50	2/25/2016
23090711412	2.40	3/9/2016
23090732418	6.85	5/8/2014
23090732420	1.92	5/8/2014
23090732430	7.40	5/8/2014
23090732435	0.00	3/15/2016
23090732441	0.43	2/13/2014
23090823402	8.35	3/13/2014
23090823404	4.58	1/31/2014
23090823404	5.00	10/29/2015
23090823411	11.40	3/13/2014
23090823421	7.00	5/13/2014
23090823423	4.39	1/31/2014
23090823423	4.90	10/29/2015
23090823429	3.01	1/29/2016
23090823429	2.33	2/14/2014
23090824005	0.00	3/21/2014
23090833001	5.50	10/16/2015
23090943002	3.86	3/9/2016
23091231006	3.80	3/2/2016

23091331001	18.00	3/2/2016
23091333018	9.50	3/1/2016
23091421404	4.70	1/7/2014
23091421407	5.40	5/13/2014
23091513004	5.60	5/22/2014
23091514019	5.48	6/6/2014
23091522011	13.30	6/3/2014
23091524008	2.44	3/21/2014
23091524014	5.80	5/21/2014
23091531003	1.24	5/21/2014
23091531005	3.78	5/21/2014
23091541416	9.00	3/15/2016
23091541416	9.10	6/3/2014
23091542401	4.08	5/22/2014
23091622002	5.00	10/16/2015
23091623002	4.18	2/9/2016
23091633411	1.56	3/9/2016
23091633412	2.30	3/8/2016
23091634005	2.20	3/29/2016
23091732408	0.86	2/27/2014
23091741002	1.64	3/9/2016
23091821408	5.60	9/24/2015
23091823006	0.34	10/9/2015
23091832401	19.70	12/16/2015
23091833002	18.20	3/9/2016
23091914004	5.56	5/23/2014
23091922001	0.94	9/18/2015
23091922003	2.76	1/17/2014
23091922018	18.80	1/17/2014
23092033011	0.00	9/24/2015
23092121401	0.61	1/31/2014
23092132414	6.60	5/15/2014
23092133414	9.70	3/1/2016
23092134407	12.20	5/22/2014
23092134411	7.20	10/9/2015
23092144410	7.46	1/8/2016
23092212001	8.60	5/13/2014
23092243471	1.76	8/3/2014
23092344007	2.50	3/9/2016
23092413404	9.40	3/31/2016
23092434007	4.02	1/22/2016
23092513401	1.56	9/24/2015
23092522009	2.30	2/10/2016
23092532002	4.98	1/22/2016
23092541002	13.60	2/11/2016
23092541402	8.50	1/15/2016
23092541403	11.70	1/15/2016
23092541406	10.30	1/8/2016
23092542004	12.20	1/15/2016
23092542405	8.10	10/9/2015
23092612025	1.50	3/8/2016
23092613401	3.84	3/15/2016
23092633003	8.50	1/15/2016
23092643401	7.70	2/11/2016
23092712404	6.00	1/15/2014
23092712404	6.00	3/30/2016
23092722416	8.00	2/9/2016
23092722417	9.10	2/9/2016
23092722418	0.70	1/8/2016
23092811417	2.67	1/8/2016
23092811419	5.79	1/29/2016
23092813407	3.40	3/30/2016
23092913007	5.70	1/7/2014
23093022401	0.00	12/29/2015
23093111401	8.85	1/28/2014
23093142421	10.00	5/1/2014
23093144416	7.70	2/18/2016
23093211004	0.00	1/22/2016
23093223005	0.00	1/19/2016
23093341005	0.00	11/24/2015
23093511004	5.80	1/27/2016
23093512018	2.46	6/12/2014
23093512020	3.76	1/27/2016
23093524401	0.00	1/27/2016
23093541014	4.30	3/1/2016
23093614004	4.52	3/7/2016
23093614005	4.10	2/18/2016
23093632009	0.00	2/25/2016
23093634404	0.00	1/22/2015
23093641404	6.24	1/15/2016

23093641408	5.48	1/24/2014
23100722003	9.80	9/29/2015
23100722404	0.00	2/21/2014
23100733410	15.30	5/28/2014
23101232001	0.72	10/2/2015
23101234001	3.12	10/2/2015
23101824003	4.52	4/4/2014
23101911009	5.59	1/28/2014
23101923404	5.24	3/17/2016
23101942403	8.40	10/2/2015
23102012402	22.20	3/8/2016
23102012403	16.50	1/28/2014
23102012403	19.60	1/29/2016
23102023003	5.24	3/17/2016
23102023407	6.00	3/8/2016
23102023408	5.60	3/8/2019
23102044002	9.44	11/21/2013
23102134405	4.70	1/31/2014
23102134407	10.10	9/17/2015
23102134407	13.80	1/31/2014
23102344402	5.60	10/29/2015
23102344405	2.40	10/29/2015
23102424402	1.55	2/13/2014
23102531408	2.43	3/9/2016
23102533003	2.90	1/7/2014
23102643001	25.50	9/18/2015
23102723402	6.90	1/28/2014
23102723402	7.32	3/1/2016
23102732001	18.00	2/12/2016
23102822406	6.80	12/11/2013
23102832011	6.60	9/17/2015
23102833002	11.10	2/12/2016
23102841001	10.80	2/12/2016
23102843403	8.50	4/4/2016
23102911401	2.50	1/31/2014
23102911413	7.28	11/21/2013
23102922403	7.02	1/31/2014
23102923401	15.50	1/31/2014
23102931002	10.40	12/29/2015
23102942401	16.00	2/13/2014
23103022024	10.00	1/23/2014
23103123433	15.30	5/9/2014
23103124404	8.50	5/13/2014
23103131005	7.10	4/7/2016
23103133011	2.40	3/9/2016
23103134403	4.52	3/1/2016
23103143011	3.90	6/3/2014
23103143015	6.80	3/8/2016
23103213004	11.30	3/14/2014
23103234400	12.00	3/15/2016
23103242405	4.00	3/15/2016
23103532401	5.84	11/21/2013
19110122412	0.44	10/2/2015
19110122420	0.38	2/21/2014
19110944463	1.40	2/21/2014
19122134013	2.34	10/20/2015
19122743004	0.00	2/14/2014
19123214401	0.88	3/7/2016
19123412400	0.98	12/2/2015
19123512008	2.13	10/7/2015
19123513401	0.84	12/27/2015
20110143402	4.18	12/17/2015
20110443004	0.66	2/27/2014
20110634402	3.89	11/4/2015
20110911408	1.31	2/21/2014
20110914408	2.73	11/4/2015
20110922412	2.49	3/1/2016
20110923403	0.36	2/11/2016
20110942411	5.40	11/4/2015
20111021006	1.90	2/27/2014
20111034402	2.08	2/23/2016
20111114401	2.89	5/28/2014
20111134003	6.20	3/16/2016
20111144001	2.55	2/11/2016
20111144400	4.08	3/8/2016
20111312400	2.14	3/1/2016
20111432405	2.41	3/1/2016
20111444002	9.00	10/29/2015
20111513416	6.70	10/15/2015
20111533401	2.31	11/18/2015

20111534006	6.60	4/6/2015
20111534401	5.90	4/6/2016
20111541416	1.98	9/29/2015
20111643003	2.16	3/23/2016
20111712003	2.66	4/16/2014
20112014405	0.98	3/16/2016
20112141031	0.86	2/7/2014
20112144091	2.04	3/24/2016
20112144098	1.50	2/13/2014
20112212006	5.60	4/6/2016
20112231005	3.40	11/17/2015
20112243403	0.00	2/26/2014
20112243404	1.32	2/27/2014
20112243405	1.08	2/27/2014
20112311404	8.44	2/21/2014
20112312005	6.50	10/29/2015
20112313002	4.04	6/12/2014
20112322403	4.00	11/17/2015
20112331404	3.47	11/17/2015
20112343402	0.97	2/14/2014
20112343411	2.60	10/21/2015
20112343415	1.45	10/21/2015
20112344001	0.48	10/2/2015
20112344003	3.35	9/30/2015
20112423003	6.60	9/18/2015
20112431007	4.30	1/22/2014
20112433401	5.40	11/12/2015
20112434406	10.00	9/30/2015
20112434406	9.24	2/20/2014
20112434411	5.21	1/22/2014
20112441400	4.96	5/29/2014
20112441400	5.20	4/6/2016
20112443401	2.77	2/11/2016
20112444407	2.83	1/10/2014
20112511014	7.70	11/24/2015
20112512004	6.30	4/6/2016
20112512007	2.85	12/1/2015
20112512008	5.30	10/16/2015
20112512402	5.08	9/23/2015
20112512404	5.16	5/29/2014
20112521405	2.09	11/4/2015
20112521408	8.50	10/21/2015
20112522403	0.64	10/2/2015
20112522404	0.38	1/17/2014
20112522404	0.36	10/23/2015
20112614401	2.97	9/23/2015
20112621014	2.38	9/23/2015
20112622405	0.91	11/9/2015
20112642006	2.28	3/3/2016
20112711012	3.90	9/23/2015
20123044003	2.21	1/23/2014
20123114402	2.12	10/20/2015
20123134004	4.10	10/16/2015
21100333008	11.20	3/22/2016
21100334401	1.27	4/10/2014
21100412400	0.54	1/17/2014
21100412406	16.00	1/31/2014
21100431004	11.20	2/23/2016
21100434405	3.02	2/2/2016
21100511407	3.68	1/10/2014
21100512408	2.10	3/22/2016
21100513413	4.50	3/1/2016
21100522407	3.20	2/23/2016
21100524404	0.35	2/9/2016
21100531012	6.90	1/29/2014
21100542403	3.96	3/15/2016
21100542407	7.40	1/17/2014
21100543401	2.50	3/2/2016
21100811407	0.25	3/1/2016
21100814009	4.72	1/17/2014
21100814401	4.28	3/8/2016
21100923003	1.78	2/2/2016
21100924402	1.68	11/21/2013
21100933007	9.56	11/21/2013
21101011004	2.60	10/27/2015
21101012402	1.92	12/9/2015
21101012404	2.40	3/1/2016
21101124002	4.62	4/1/2014
21101131404	12.80	2/2/2016
21101134405	12.90	3/1/2016

21101141402	8.88	12/4/2015
21101231405	5.43	2/2/2016
21101232004	0.78	3/16/2016
21101233003	10.50	2/27/2014
21101241401	19.60	4/5/2016
21101324401	10.90	3/7/2014
21101333401	5.79	5/29/2014
21101333404	0.00	11/24/2015
21101344401	0.00	3/10/2016
21101344404	3.50	3/10/2016
21101444005	2.68	2/25/2016
21101523400	3.40	5/22/2014
21101524402	2.90	6/3/2014
21101524403	4.98	5/22/2014
21102431009	0.00	10/28/2015
21102441001	0.00	10/16/2015
21102441001	0.00	1/24/2014
21102522001	1.84	3/10/2016
21102534004	0.00	2/13/2014
21102534403	0.05	2/13/2014
21102641003	2.79	3/14/2016
21102642002	3.48	6/5/2014
21111741005	0.00	9/24/2015
21112014405	4.05	5/6/2014
21112032402	2.25	1/17/2014
21112521003	0.74	10/15/2015
21112612401	0.00	10/14/2015
21112613404	4.03	2/21/2014
21112623402	3.55	10/20/2015
21112921402	3.80	10/27/2015
21112924002	8.55	9/24/2015
21112932402	10.70	9/23/2015
21112932403	8.60	11/4/2015
21112932405	7.60	9/25/2015
21113023402	4.80	4/7/2016
21113024404	18.60	2/14/2014
21113044403	4.22	9/24/2015
21113111003	12.70	10/16/2015
21113112406	1.07	10/26/2015
21113112407	2.21	10/26/2015
21113113403	23.40	9/23/2015
21113122421	2.81	12/9/2015
21113132006	1.14	12/29/2015
21113134016	1.84	2/9/2016
21113141002	0.84	5/29/2014
21113144407	7.48	11/24/2015
21113144407	5.48	3/12/2014
21113212014	5.76	9/30/2015
21113222401	0.33	9/25/2015
21113222402	6.34	9/25/2015
21113241009	4.36	10/15/2015
21113321401	12.00	3/1/2016
21113432003	22.60	11/18/2015
22080114416	10.10	1/8/2016
22080131419	9.00	3/7/2016
22090222402	2.12	10/21/2015
22090322004	4.20	10/2/2015
22090543402	0.00	9/30/2015
22091022403	0.09	3/1/2016
22091031001	0.00	3/9/2016
22091031001	0.00	3/7/2016
22091033402	0.00	10/2/2015
22091044407	0.00	9/24/2015
22091132402	4.56	4/10/2014
22091144402	3.65	1/17/2014
22091241400	1.79	6/20/2014
22091241402	2.75	5/13/2014
22091244415	11.50	4/4/2014
22091311003	11.30	2/14/2014
22091312001	7.40	3/2/2016
22091323003	11.90	6/25/2014
22091344401	19.20	3/9/2016
22091412410	0.00	3/16/2016
22091412414	0.00	3/16/2016
22091423402	0.00	2/27/2014
22091424407	0.00	2/27/2014
22091432406	0.00	6/10/2014
22091442401	0.00	2/18/2016
22091443400	0.00	2/18/2016
22091534401	0.00	6/5/2014

22092443004	2.90	10/26/2015
22100312400	34.80	10/2/2015
22100333400	3.28	12/11/2013
22100333402	16.20	12/12/2013
22100424402	2.09	2/19/2016
22100441003	3.59	3/8/2016
22100443003	24.80	12/11/2013
22100622002	9.40	5/29/2014
22100714002	15.20	3/8/2016
22100733401	14.80	3/8/2016
22100812004	9.64	9/29/2015
22100824407	7.80	10/16/2015
22100831401	7.20	10/16/2015
22100833001	8.40	2/9/2016
22100844003	7.16	4/10/2014
22100922001	1.78	10/13/2015
22101022403	2.94	3/14/2014
22101041402	1.47	3/2/2016
22101044001	7.60	9/18/2015
22101122002	3.23	1/24/2014
22101141405	9.50	2/13/2014
22101141407	7.70	10/16/2015
22101211400	2.87	3/14/2014
22101321401	6.06	12/11/2013
22101333004	3.08	12/11/2013
22101341401	2.16	11/20/2013
22101341401	2.25	3/1/2016
22101424010	5.75	2/2/2016
22101433407	3.22	5/9/2014
22101441403	1.68	1/28/2014
22101442409	3.50	4/4/2014
22101523407	9.80	3/8/2016
22101544006	22.70	3/7/2016
22101731400	2.73	11/24/2015
22101743401	5.82	3/1/2016
22101743406	39.10	3/24/2016
22101813002	9.40	2/25/2016
22101814401	10.10	6/12/2014
22101843002	5.45	6/5/2014
22101911401	1.63	12/17/2015
22101912406	3.20	4/18/2014
22101912407	4.80	2/25/2016
22101922402	0.00	3/1/2016
22102011402	0.00	3/8/2016
22102021401	6.32	2/9/2016
22102033004	1.83	2/17/2016
22102211407	5.67	5/29/2014
22102214005	5.60	2/12/2016
22102222403	2.81	3/7/2014
22102244005	9.70	9/27/2015
22102314408	4.75	2/13/2014
22102331408	1.38	3/25/2016
22102334002	19.10	2/2/2016
22102344005	6.10	3/14/2016
22102424009	11.30	2/4/2016
22102431403	15.80	2/10/2014
22102431409	20.30	1/10/2014
22102441427	13.30	5/29/2014
22102441436	11.20	10/29/2015
22102441436	11.60	3/18/2016

Appendix M –USGS 2017 Well testing Data

Table 5. Nitrate concentrations in ground-water samples from drinking water wells collected April to December 2017.

[<; less than, --; no data, --*; sample tap winterized, --**; could not access property-no permission, R; result value reviewed and rejected,

Well No.	APRIL/MAY	MAY/JUNE	JULY	SEPT	OCT	DEC
08N/22E-11L02	16.1	14.3	14.2	13.6	15.7	15.4
08N/23E-01F02	0.247	0.292	0.53	0.594	0.936	0.522
08N/23E-01H02	0.443	1.15	1.41	1.94	1.83	4.1
08N/23E-01J01	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040
08N/23E-05G01	11.2	--	--	--	--	--
08N/23E-06H02	10.3	7.66	7.36	7.49	8.37	7.97
08N/23E-08E01	14.3	10.8	16.2	17.7	17.7	19.7
08N/23E-10G01	11	11.4	11.2	11.3	11.3	--*
08N/23E-11R01	0.681	1.37	2.27	1.75	1.16	0.715
08N/23E-13B01	2.6	3.54	4.12	4.93	5.19	3.67
09N/22E-01G02	11.5	10.9	10.8	10.5	11.1	11.6
09N/22E-02D01	2.28	2.18	2	2.04	2.29	2.36
09N/22E-03R01	4.77	4.56	4.54	4.58	6.94	9.13
09N/22E-04B01	2.37	1.05	2.55	1.02	0.79	0.739
09N/22E-05Q01	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040
09N/22E-09J02	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040
09N/22E-10A01	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040
09N/22E-10N03	--	0.47	0.322	0.075	<0.040	<0.040
09N/22E-10N04	--	--	<0.040	<0.040	<0.040	<0.040
09N/22E-11D01	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040
09N/22E-11M01	8.02	7.13	7.11	8.89	8.87	8.93
09N/22E-12R02	14.5	16.4	17.9	18	17.9	17.9
09N/22E-14B01	<0.040	0.057	<0.040	<0.040	<0.040	<0.040
09N/22E-22K01	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040
09N/22E-23J01	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040
09N/23E-01D01	2.27	2.18	2.16	2.23	2.34	2.57
09N/23E-04R01	4.42	4.44	4.4	4.62	4.51	4.49
09N/23E-04R02	4.17	4.12	4.12	4.25	4.2	4.2
09N/23E-05N01	5.39	5.29	5.29	5.45	5.31	5.42
09N/23E-06B01	17.3	17.4	17	17.3	16.9	--*
09N/23E-07M02	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040
09N/23E-08E02	7.19	7.42	7.62	7.92	7.87	7.8
09N/23E-09H01	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040
09N/23E-11K01	6.23	6.43	6.29	6.58	6.37	6.4
09N/23E-13C01	10.3	10.7	10.4	10.7	10.7	11.1
09N/23E-14G01	14.2	15.1	17.3	24.1	32.9	--**

09N/23E-15D03	12.8	13	12.8	12.7	12.8	12.8
09N/23E-15H03	5.87	5.27	4.54	5.6	5.57	5.73
09N/23E-16C01D	2.62	2.66	2.58	2.57	2.62	--*
09N/23E-17L01	R	19.2	19.3	20.7	19.8	--*
09N/23E-18C01	1.89	1.72	1.71	1.69	1.88	1.85
09N/23E-19D03	8.07	8.29	8.26	8.6	--	--
09N/23E-19Q01	2.42	2.19	2.13	2.36	2.38	2.44
09N/23E-20A01	5.02	4.73	3.92	3.57	3.61	3.62
09N/23E-21P01	9.3	9.5	9.47	10.1	10.3	10.4
09N/23E-24L01	8.2	5.26	5.13	7.52	7.69	8.25
09N/23E-25J01	12	12.3	13	11.1	10.1	12.8
09N/23E-26B01	2.51	3.92	4.1	4.64	2.67	2.58
09N/23E-27B02	6.13	5.94	5.6	5.41	5.34	5.65
09N/23E-28G01	3.58	3.68	3.75	3.93	3.9	3.84
09N/23E-29B02	4.56	4.66	4.57	4.78	4.73	4.89
09N/23E-31K01	8.41	7.98	8.63	10.7	10.7	10.6
09N/23E-34M01	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040
09N/23E-35K01	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040
09N/23E-36J01	9.84	5.54	5.36	7.19	6.25	--*
10N/21E-01G01	43.1	R	40.8	41.7	39.4	42.5
10N/21E-02N01	11.1	R	7.04	7.6	7.68	10.3
10N/21E-03D02	11.6	12.4	12.4	12.2	11.5	--*
10N/21E-04P02	3.72	R	3.58	3.79	3.75	3.88
10N/21E-05A01	4.63	4.05	4.36	5	4.67	5.28
10N/21E-09F01	2.56	1.7	2.18	2.73	2.58	2.88
10N/21E-11M01	11.1	8.27	8.63	8.76	8.26	11.3
10N/21E-12R01	15	15.7	15.5	16.2	15.6	15.9
10N/21E-13N01	<0.040	0.12	0.211	<0.040	<0.040	<0.040
10N/21E-15E01	2.87	R	3.05	3.19	3.01	3.14
10N/21E-16B01	14.8	R	15.5	15.5	13.2	12.7
10N/21E-16G02	10.8	10.5	9.82	9.87	9.98	10.7
10N/21E-23A01	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040
10N/21E-24J01	<0.040	R	<0.040	<0.040	<0.040	<0.040
10N/22E-01F01	4.77	3.94	4.02	4.24	4.2	--*
10N/22E-03B02	45.2	43.2	44	44.5	43.1	44.7
10N/22E-04J01	3.93	R	3.83	3.85	3.69	3.92
10N/22E-05P01	8.14	R	7.66	7.98	8.04	8.56
10N/22E-06A01	5.05	6.38	6	6.56	4.85	4.94
10N/22E-07N01	15.8	15.8	16.9	16.5	15.5	15.8
10N/22E-08F02	9.91	9.26	9.96	9.98	9.48	10.3

10N/22E-08H01	6.05	5.79	6.42	6.77	6.82	6.83
10N/22E-08K04	9.66	8.27	9.31	9.36	8.95	9.09
10N/22E-08L01	8.42	8.35	8.44	8.76	8.37	8.92
10N/22E-11J02	10.8	10.5	11	8.31	8.7	10.4
10N/22E-13E02	7.11	R	6.88	6.73	6.73	7.16
10N/22E-14K01	3.56	3.51	4.61	4.88	4.4	3.83
10N/22E-17C02	12.1	9.76	8.41	10.2	18.9	18.1
10N/22E-18G03	9.41	9.3	9.16	9.04	9.03	9.01
10N/22E-19L01	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040
10N/22E-20N02	<0.040	<0.040	<0.040	<0.040	--	--
10N/22E-21R02	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040
10N/22E-22P01	10.4	10.8	10.7	10.9	11	11
10N/22E-23H02	4.93	4.98	4.96	5.08	5.04	5
10N/22E-24M01	3.29	3.73	3.76	3.73	3.6	3.78
10N/22E-26C01	0.402	0.283	0.342	0.352	0.395	0.465
10N/22E-27M01	10.5	R	10.8	10.4	10.6	10.8
10N/22E-27N01	5.91	5.61	5.83	5.81	5.92	5.79
10N/22E-29D01	10.5	10.3	10.1	10.2	10.2	11.3
10N/22E-30B01	5.87	R	5.08	5.37	5.73	5.89
10N/22E-34B01	14.9	17.2	16.9	15.5	12.7	9.67
10N/22E-34B02	8.55	8.56	8.46	8.52	8.62	8.79
10N/22E-35F03	2.16	2.11	2.13	2.04	2.1	2.09
10N/22E-36K01	17	18.2	16.1	11.4	9.87	10.7
10N/23E-18D01	3.52	3.66	3.88	3.83	3.84	3.81
10N/23E-20G01	8.78	8.77	8.28	7.71	7.84	8.09
10N/23E-22L01	6.36	5.75	5.54	5.33	5.41	5.59
10N/23E-23R01	4.46	4.26	12.9	21.7	19.5	11.3
10N/23E-25J07	2.76	2.47	2.84	2.65	3.05	2.51
10N/23E-27N01	2.17	3.28	3.43	2.62	1.99	2.07
10N/23E-28F01	4.15	3.72	3.87	3.88	4.51	4.56
10N/23E-29A01	9.2	9.56	9.77	9.45	9.77	9.86
10N/23E-30A01	19.4	20.6	21.6	21.7	21	22.3
10N/23E-31E02	12.5	12.8	12.8	16	12.7	13.4
10N/23E-32K02	4.05	R	4.76	5.73	4.17	4.14
10N/23E-33D01	9.21	9.82	9.67	10.2	9.49	9.82
10N/23E-34A01	10.3	10.2	11.3	11.6	12.4	14.2
10N/23E-35M01	9.28	11.4	11.7	9.75	10.1	10.2
11N/20E-04Q03D	0.748	0.773	0.749	0.767	0.772	--*
11N/20E-06D01	7.24	7.31	7.56	8.1	7.63	7.6
11N/20E-07C01	3.29	3.13	3.27	3.17	3.57	3.44

11N/20E-07H03	2.46	2.43	2.39	2.34	2.4	2.55
11N/20E-08F01	4.72	4.42	4.28	3.91	4.17	--*
11N/20E-09D02	2.05	2.25	2.17	2.07	2.18	2.15
11N/20E-09L02	3.4	3.35	3.71	3.5	3.88	3.32
11N/20E-10C02	1.76	1.21	1.1	1.03	1.26	1.53
11N/20E-10P01	2.19	2.23	2.13	1.99	2.18	2.13
11N/20E-11R01	2.46	2.66	2.57	2.47	2.75	2.48
11N/20E-12P02	3.23	3.2	3.17	3.05	3.21	3.25
11N/20E-13J01	2	1.96	1.86	1.76	1.77	1.92
11N/20E-14M03	6.25	6.31	6.27	6.15	5.43	5.48
11N/20E-15B02	1.38	1.37	1.45	1.47	1.58	1.57
11N/20E-21B02	2.44	2.43	2.79	2.06	2.48	2.56
11N/20E-22Q01	1.35	1.33	1.34	1.29	1.38	--*
11N/20E-23Q02	1.64	1.69	1.56	1.46	1.53	1.66
11N/20E-24E02	7.4	7.29	7.38	7.5	7.38	7.41
11N/20E-24J03	5.08	4.95	4.92	4.63	4.9	4.99
11N/20E-24N01	5.44	5.31	5.34	4.99	5.4	5.56
11N/20E-24P03	5.01	4.77	5.27	4.96	5.6	5.53
11N/20E-24R01	--	2.86	2.87	2.61	2.72	2.75
11N/20E-25L01	3.91	3.95	3.96	3.56	4.04	4.07
11N/20E-26F01	--	2.32	2.28	2.13	2.23	--*
11N/21E-06R01D	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040
11N/21E-18G01	2.48	R	2.35	2.27	2.28	2.23
11N/21E-19J01	3.11	3.08	3.08	3.01	3.14	3.11
11N/21E-20N01	1.98	2.13	2.12	2.2	2.31	2.32
11N/21E-21N01	2.09	2.03	1.99	1.84	1.99	1.96
11N/21E-21N02	1.33	1.33	1.29	1.21	1.25	1.35
11N/21E-27A01	1.22	5.46	0.078	4.98	5.47	5.74
11N/21E-28H01	2.43	2.25	2.41	2.41	2.32	2.37
11N/21E-29M05	8.55	8.46	8.41	8.61	8.15	8.26
11N/21E-30F03	17.6	17.6	17.3	17.3	17.7	17.5
11N/21E-31D01	3.1	2.93	2.9	2.82	2.9	2.96
11N/21E-32N01	7.99	R	8.46	8.65	7.97	8.7
11N/21E-33C02	9.72	R	9.79	10	9.8	10.3
11N/21E-33M01	6.56	R	6.58	6.99	6.44	7.05
12N/19E-27Q01	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040
12N/19E-35E01	1.75	3.12	1.19	1.95	0.961	1.71
12N/19E-36D01	<0.040	R	<0.040	<0.040	<0.040	<0.040
12N/20E-31B02	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040
12N/20E-33Q02	--	0.856	0.762	0.772	0.733	0.678

Appendix N—Well Sample Statistics

Redifer				
Year	Well Samples	Minimum	Maximum	Mean
1973	17	0.010	5.800	0.602
1978	1	2.100	2.100	2.100
1979	6	0.200	3.500	1.133
1980	1	1.090	1.090	1.090
1981	13	0.200	9.000	3.646
1982	87	0.100	9.500	1.384
1983	63	0.100	9.800	0.819
1984	22	0.200	9.400	3.015
1985	16	0.200	7.900	1.816
1986	30	0.100	9.300	1.465
1987	16	0.100	9.200	2.298
1988	28	0.200	9.800	3.524
1989	19	0.100	9.000	1.912
1990	8	1.100	4.800	2.231
1991	36	0.050	9.600	3.640
1992	80	0.200	9.700	3.868
1993	48	0.100	9.900	2.583
1994	51	0.090	9.900	2.392
1995	32	0.500	9.800	2.283
1996	29	0.100	9.200	3.458
1997	42	0.200	9.300	3.262
1998	35	0.200	6.400	1.850
1999	40	0.070	8.000	2.623
2000	80	0.500	9.800	3.392
2001	135	0.000	9.900	2.667
2002	318	0.000	9.990	2.845
2003	164	0.050	9.510	3.447
2004	274	0.050	9.810	3.353
2005	158	0.050	9.550	4.568
2006	166	0.050	9.770	4.860
2007	174	0.050	9.410	4.245
2008	174	0.050	9.780	2.868
2009	171	0.050	9.530	2.726
2010	189	0.050	9.950	3.354
2011	427	0.000	9.890	3.357
2012	145	0.050	9.800	3.910
2013	33	0.070	24.800	5.862
2014	153	0.000	20.300	5.470
2015	119	0.050	34.800	4.899
2016	167	0.050	39.100	5.878

Figure 4 - Public Ownership

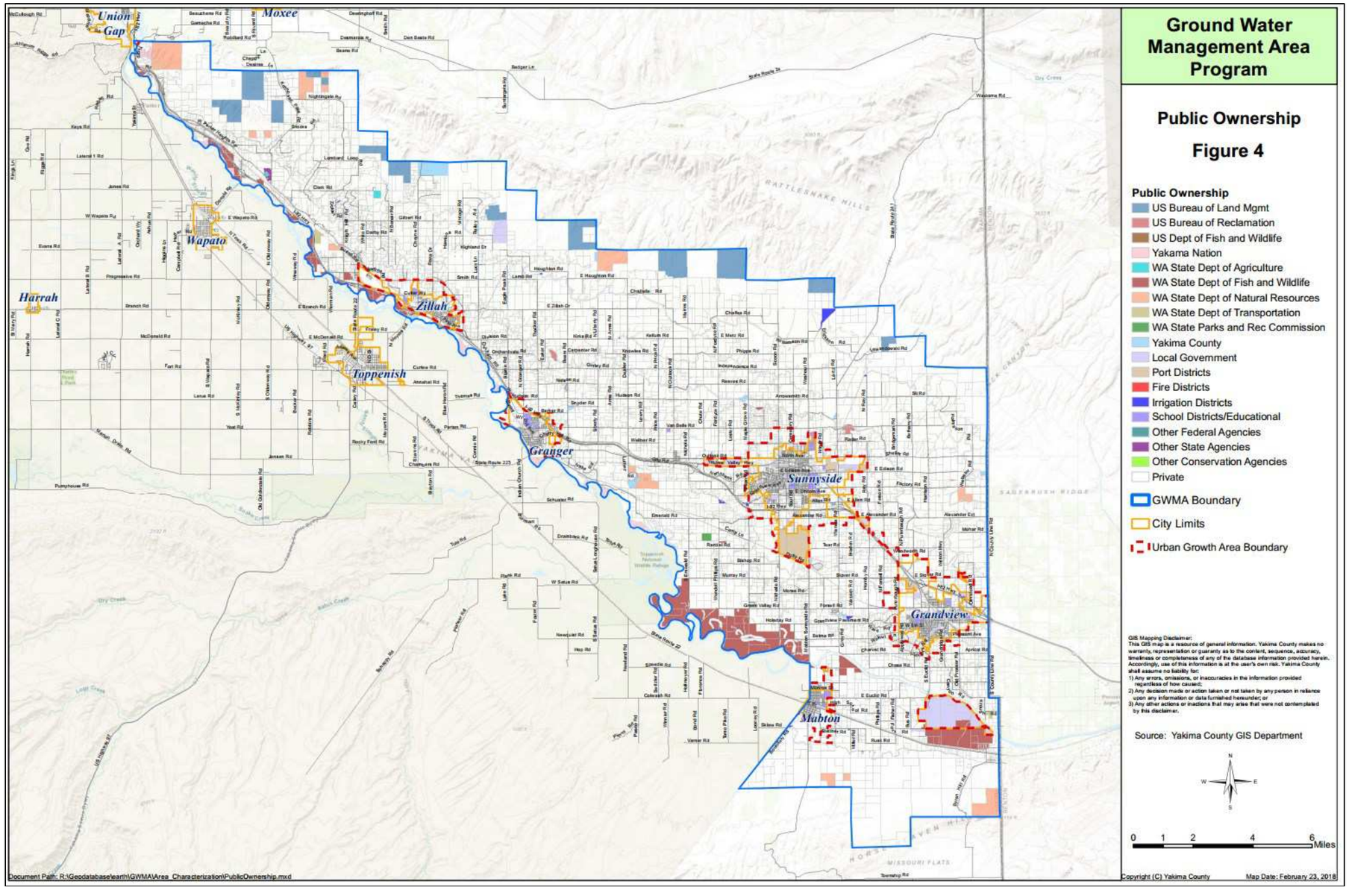


Figure 5 - Geology

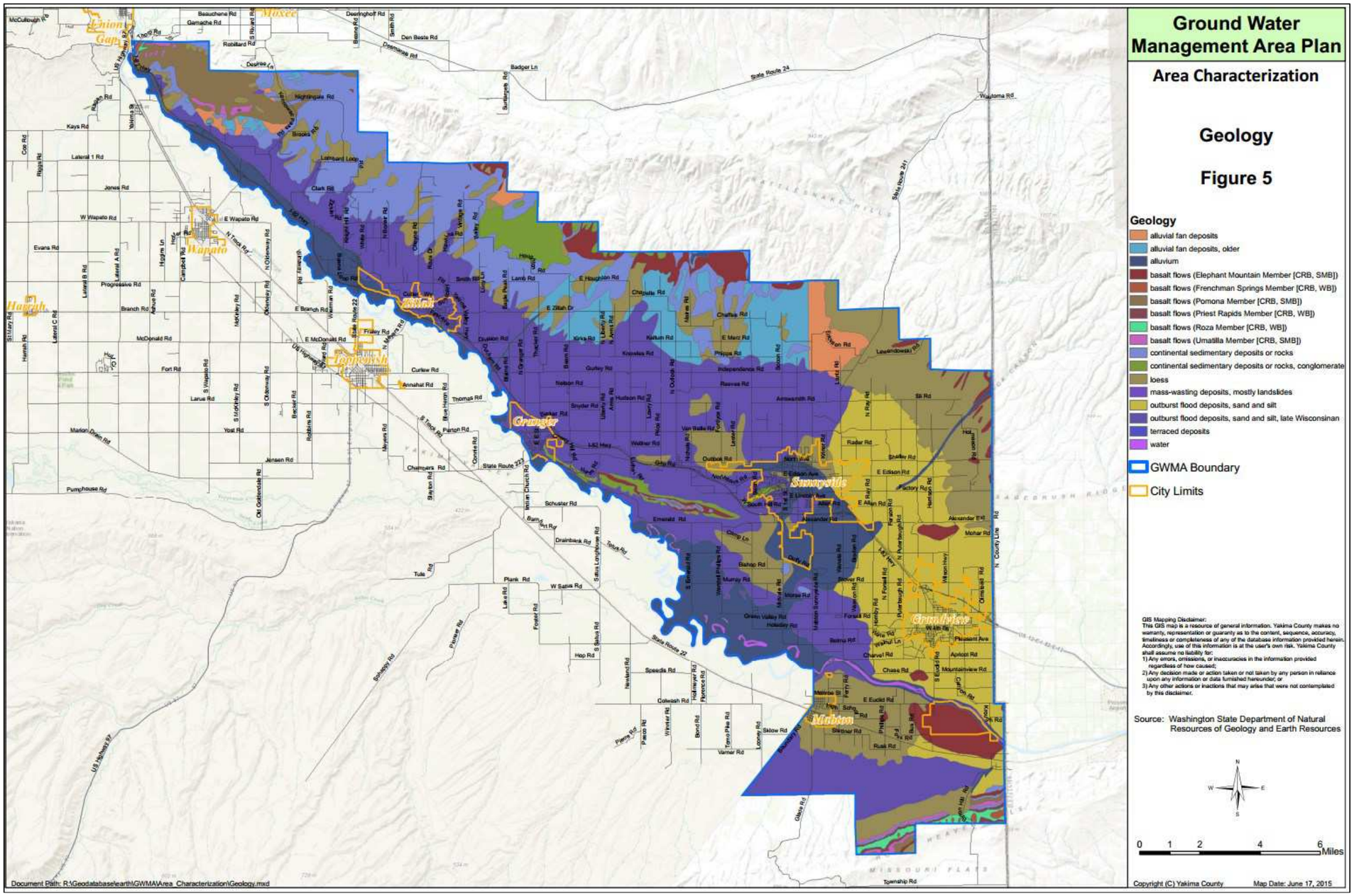


Figure 6 - Surficial Hydrogeolgic Units

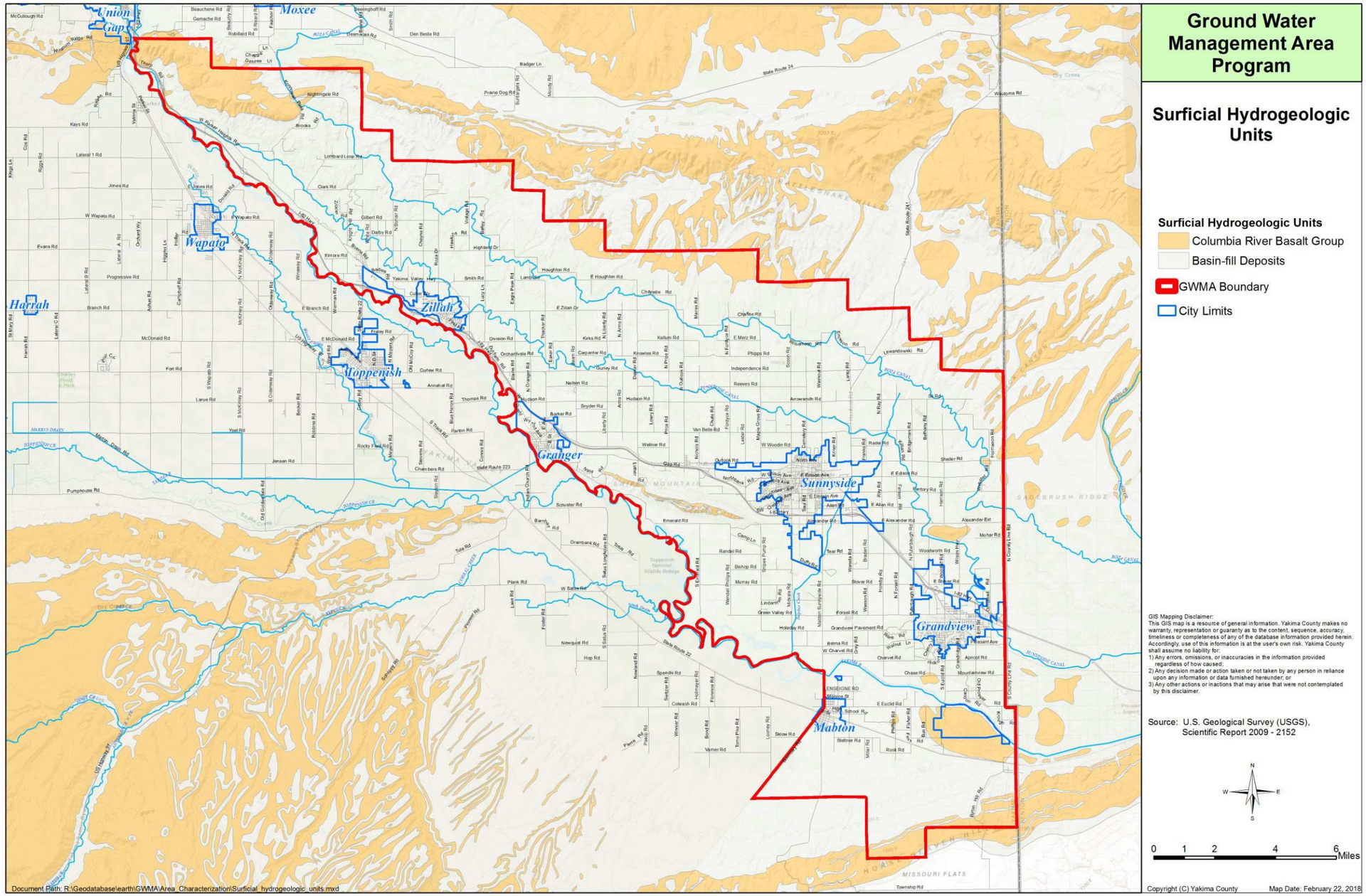


Figure 7 - Basins with Location of Springs

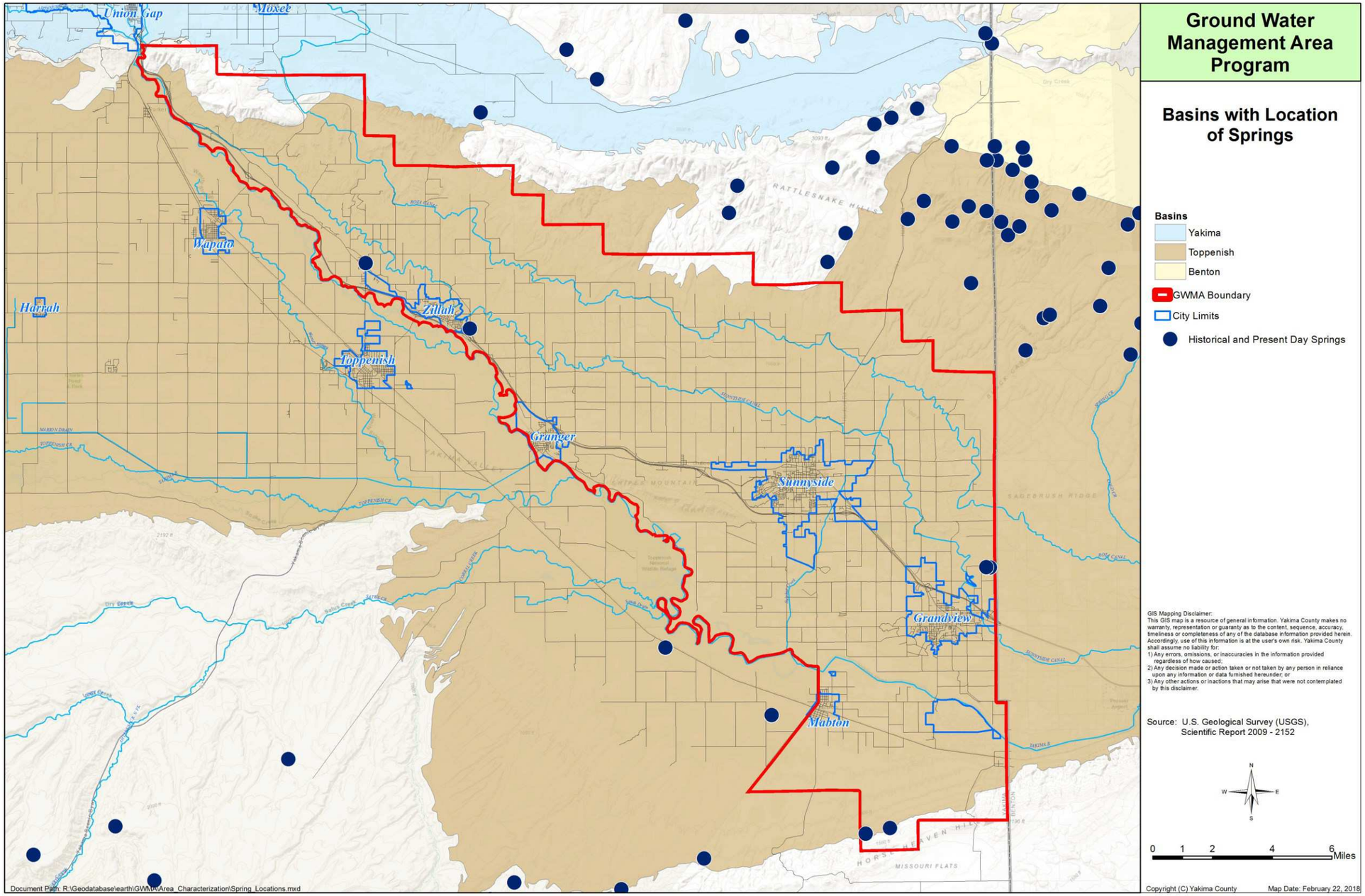


Figure 8 - Spatial Distribution of Mean Annual Recharge

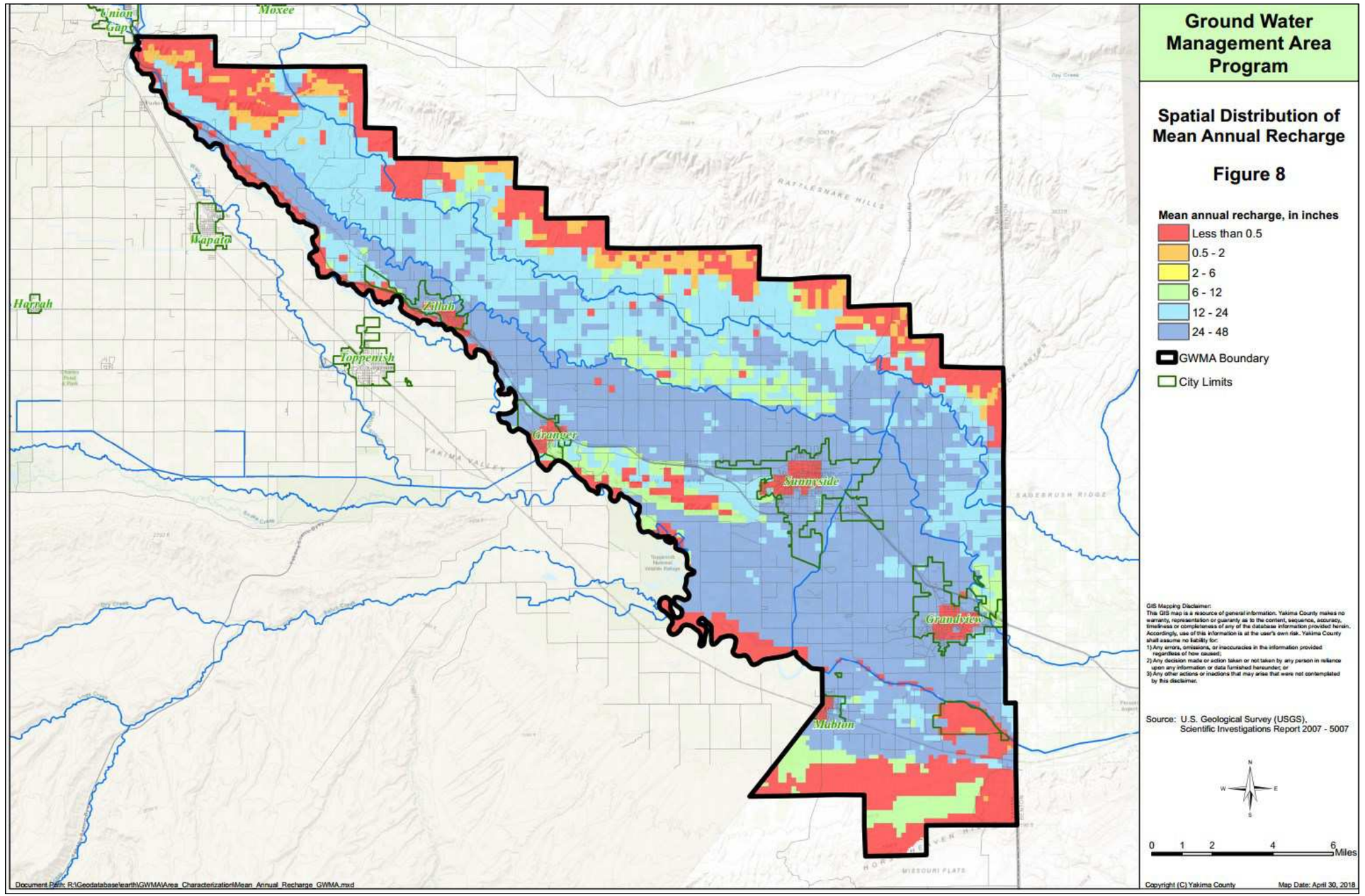


Figure 9 - Groundwater Contours

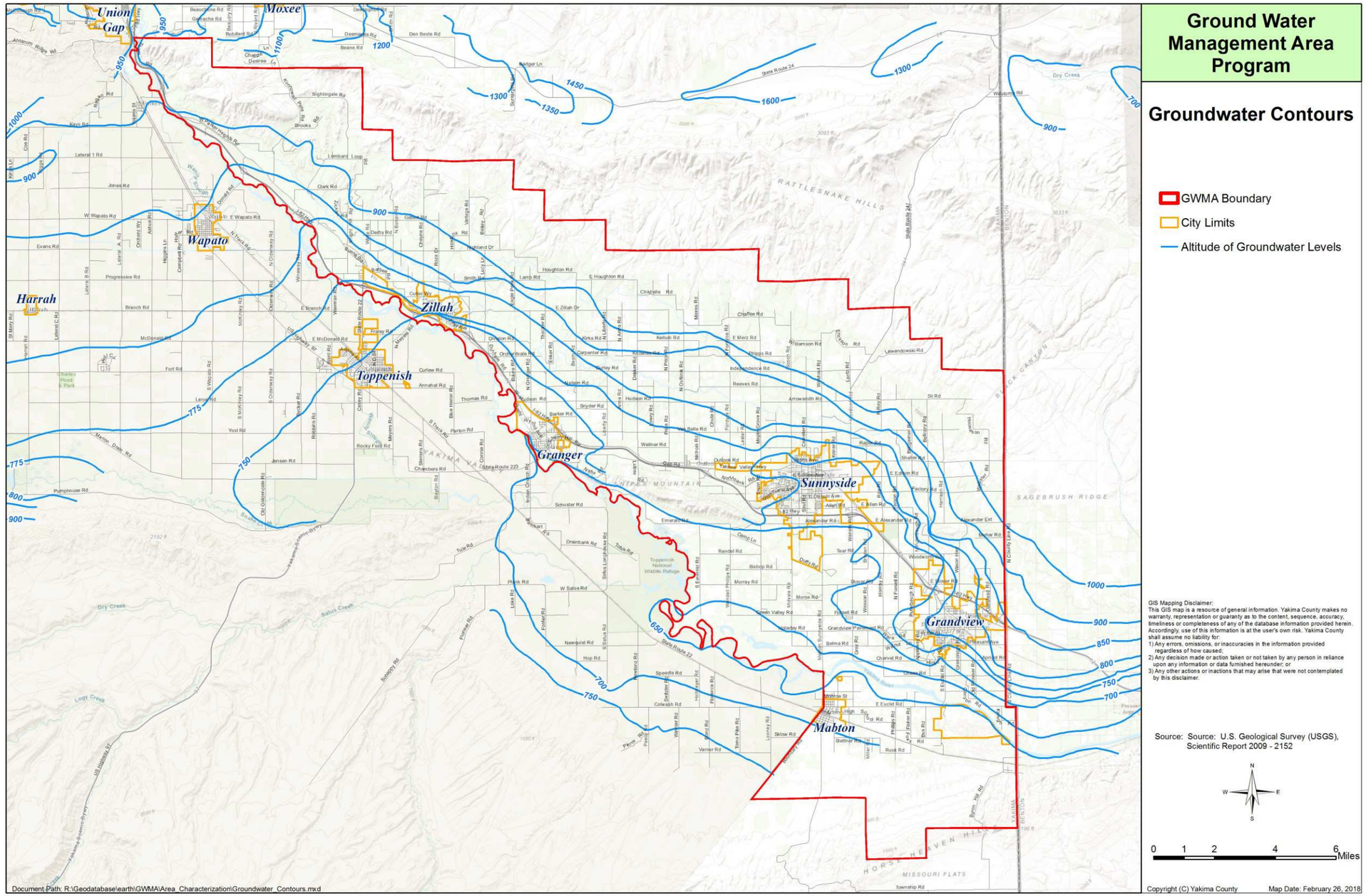


Figure 10 - Topography

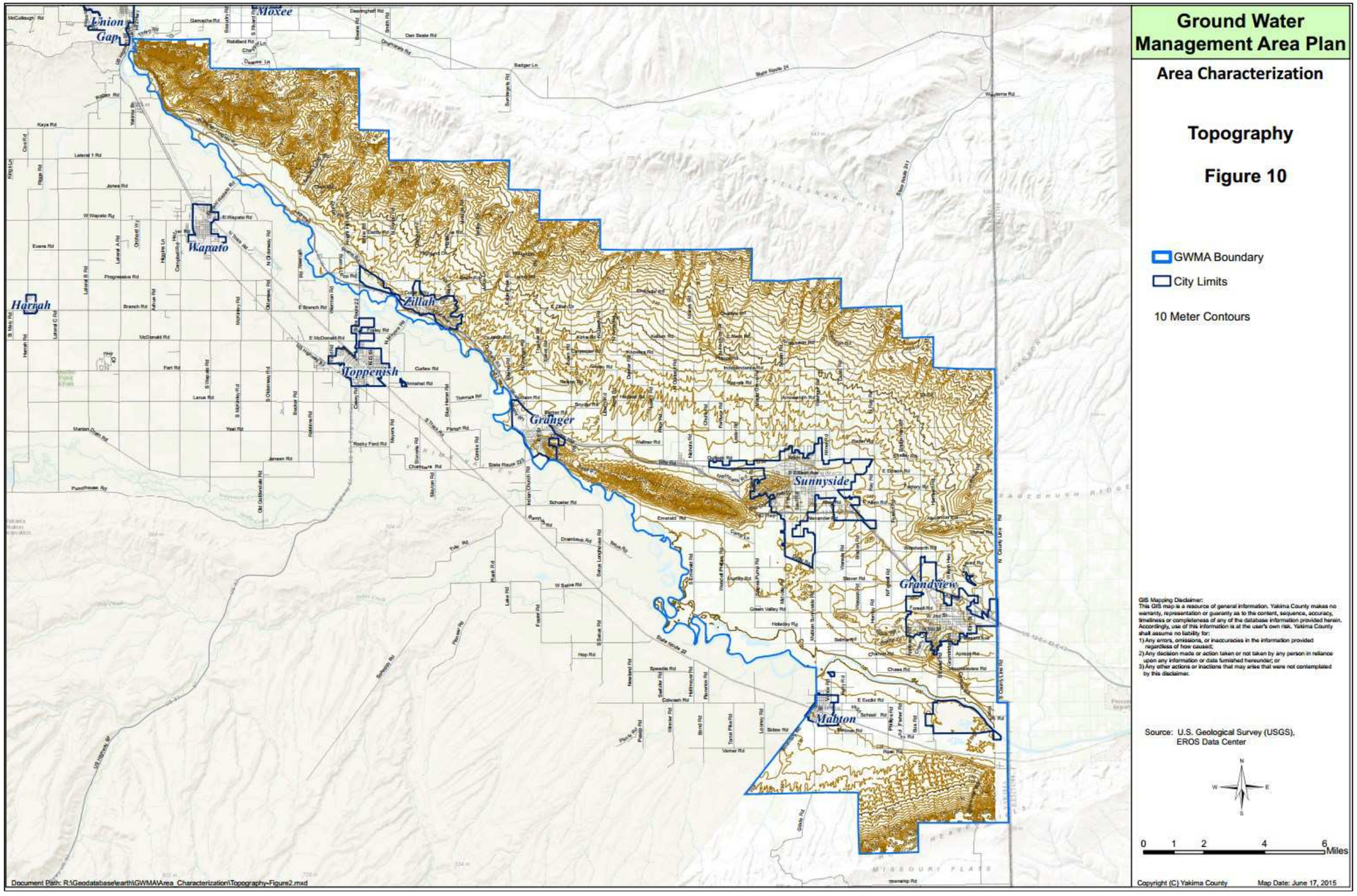


Figure 11 - Depth to Groundwater

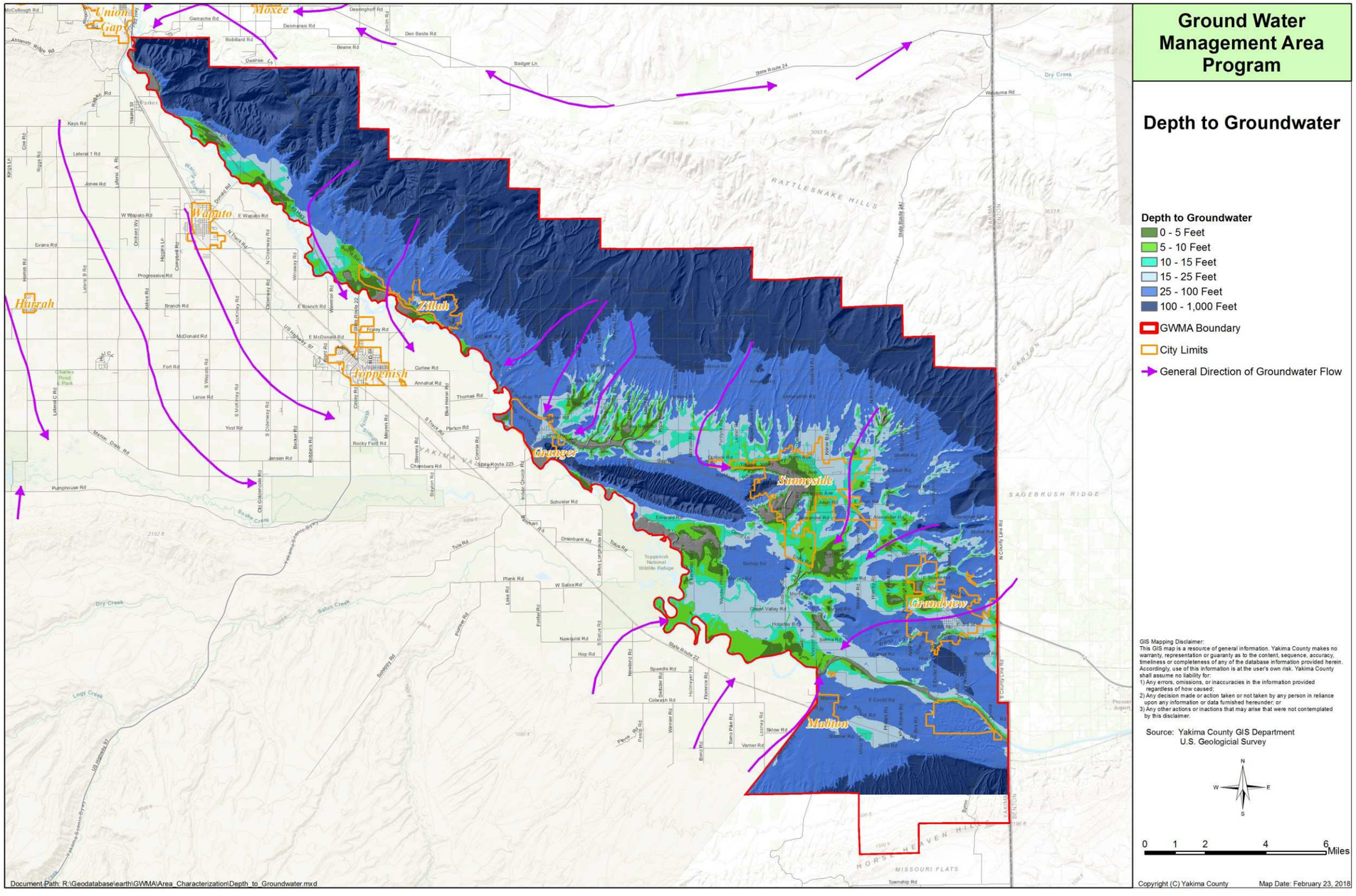


Figure 12 - Groundwater Flow Directions

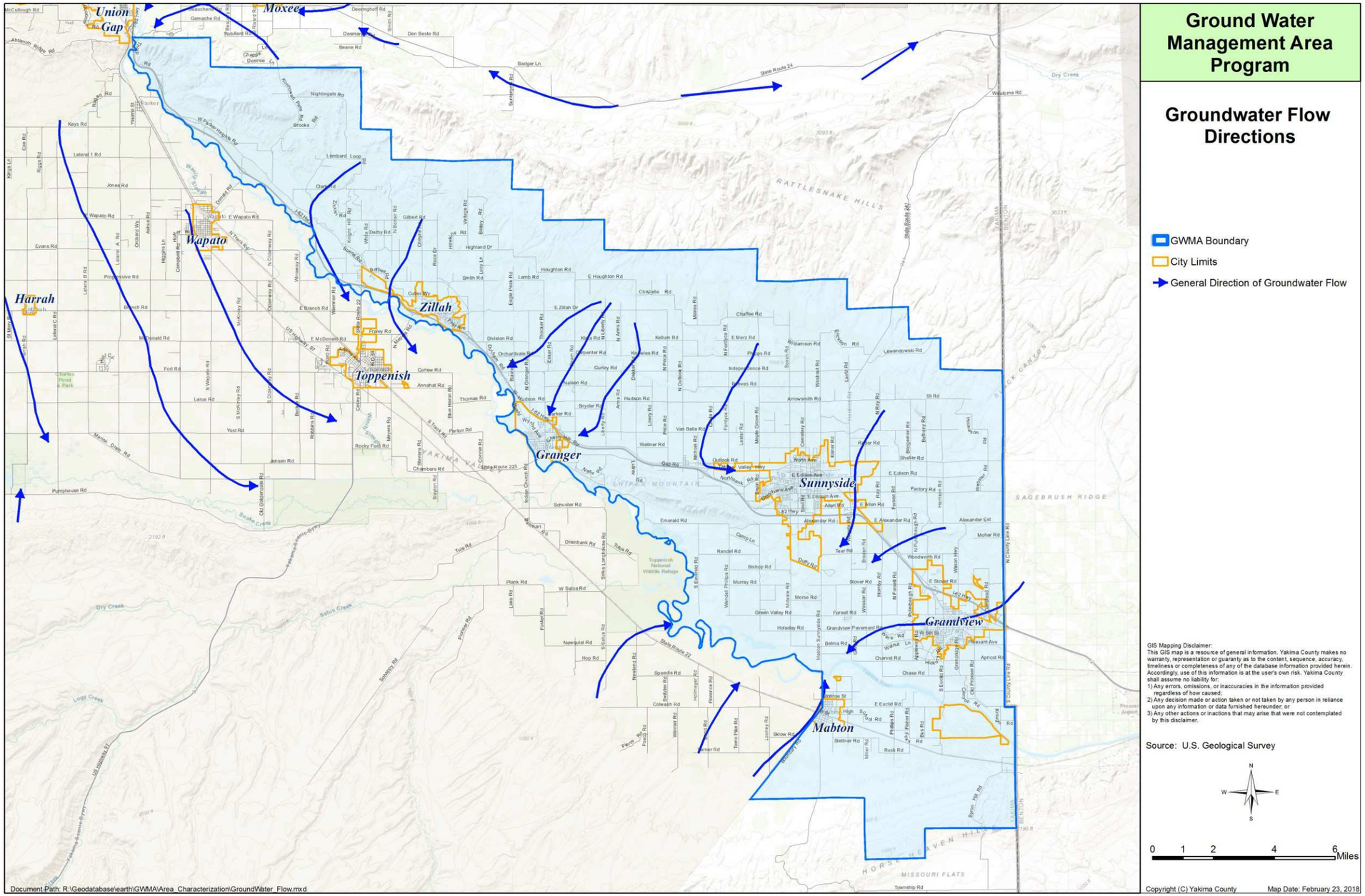


Figure 13 - Soils Key

Figure 13 - Soil Types

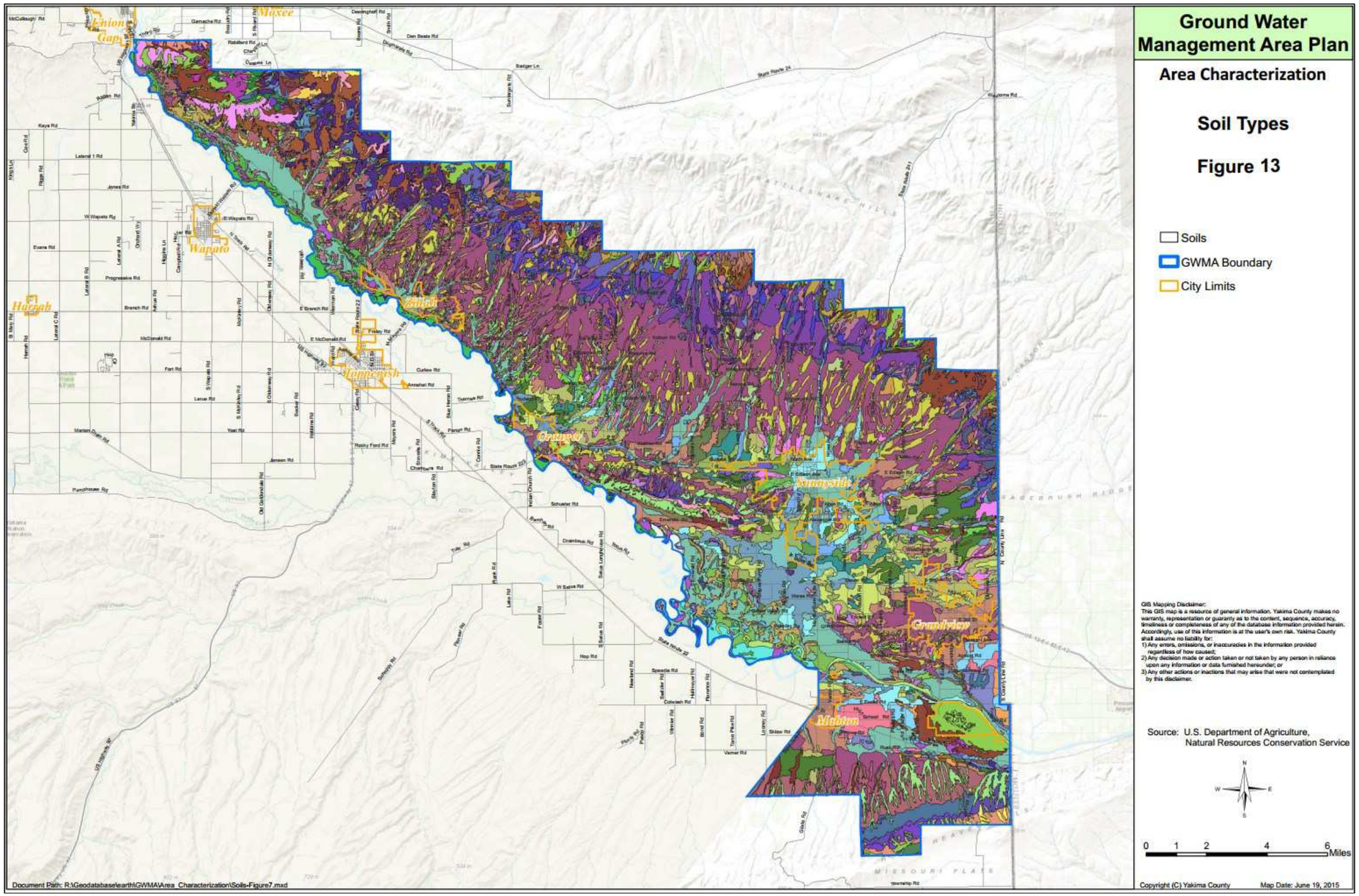


Figure 14 - Hydraulic Conductivity

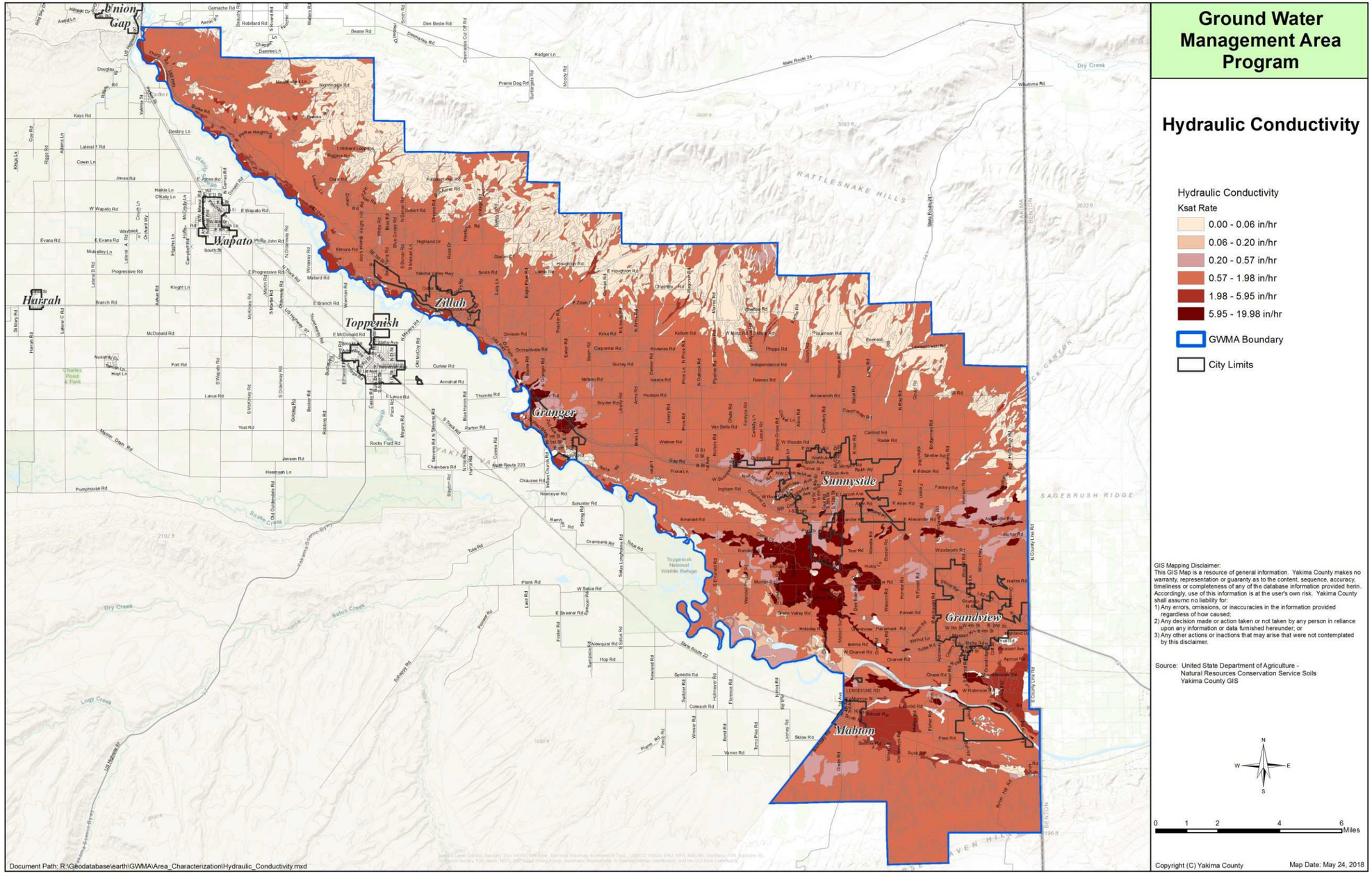


Figure 15 - Cropping Patterns

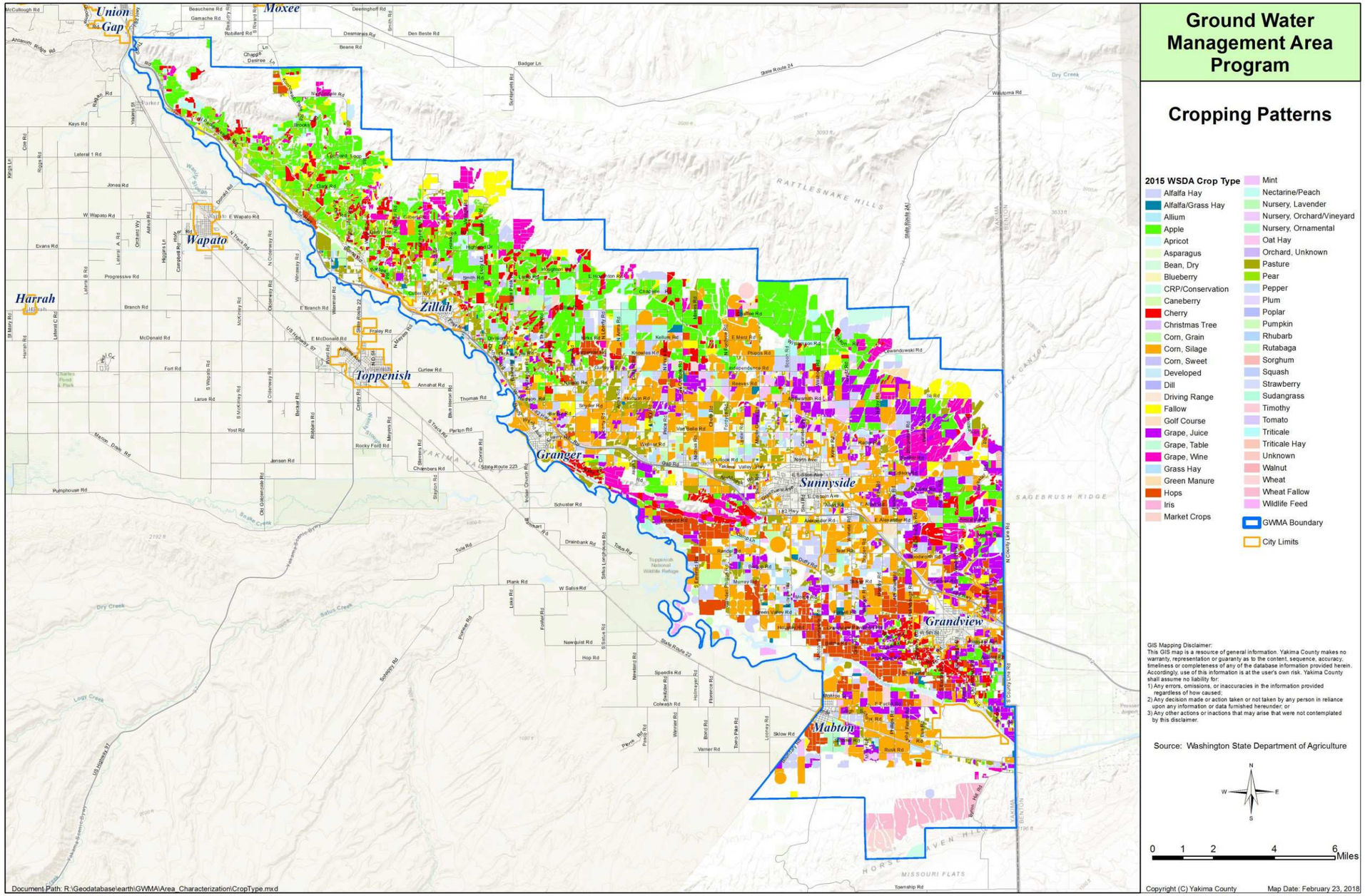


Figure 16 - Yakima County Zoning

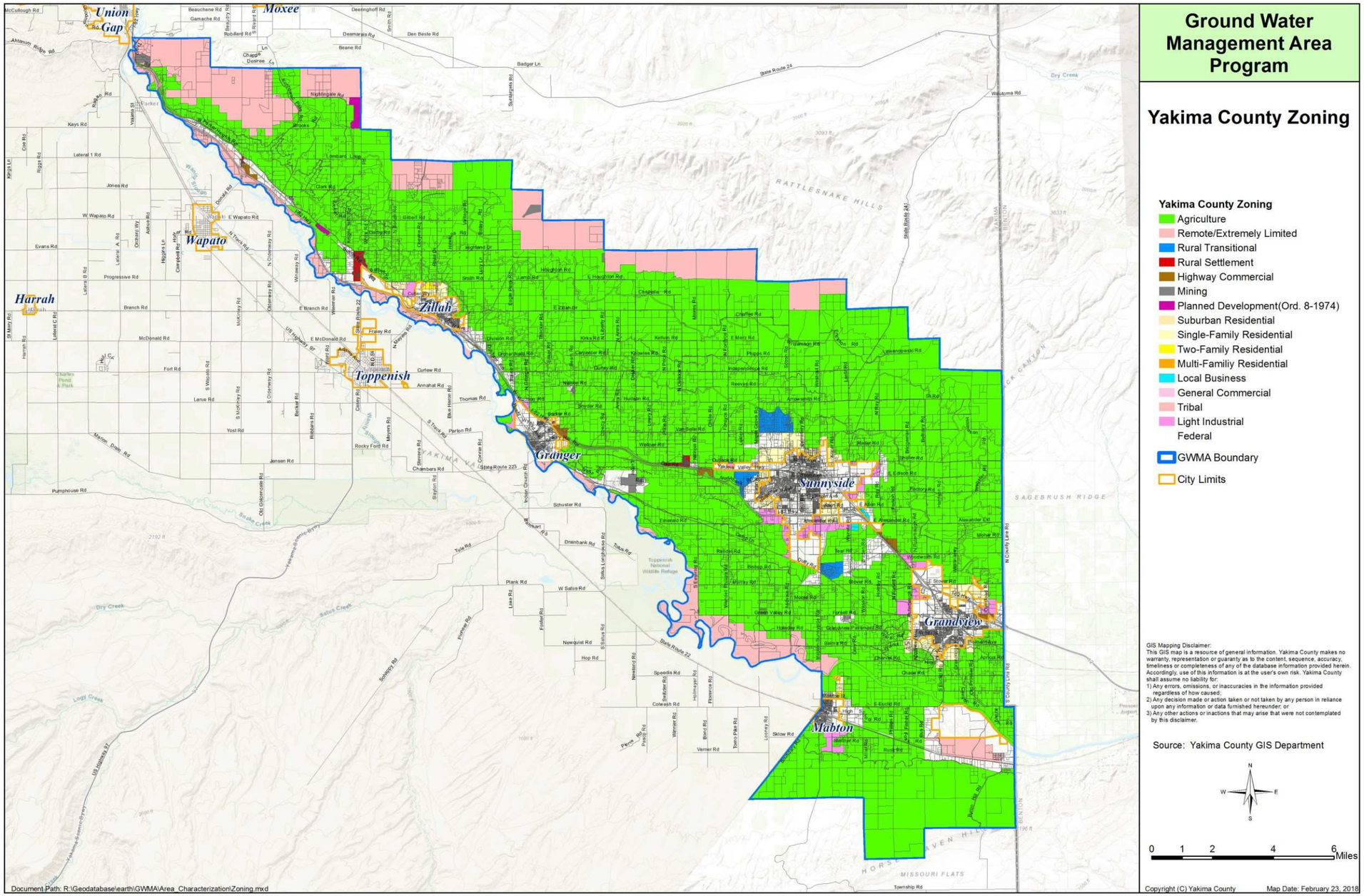


Figure 17 - Irrigation

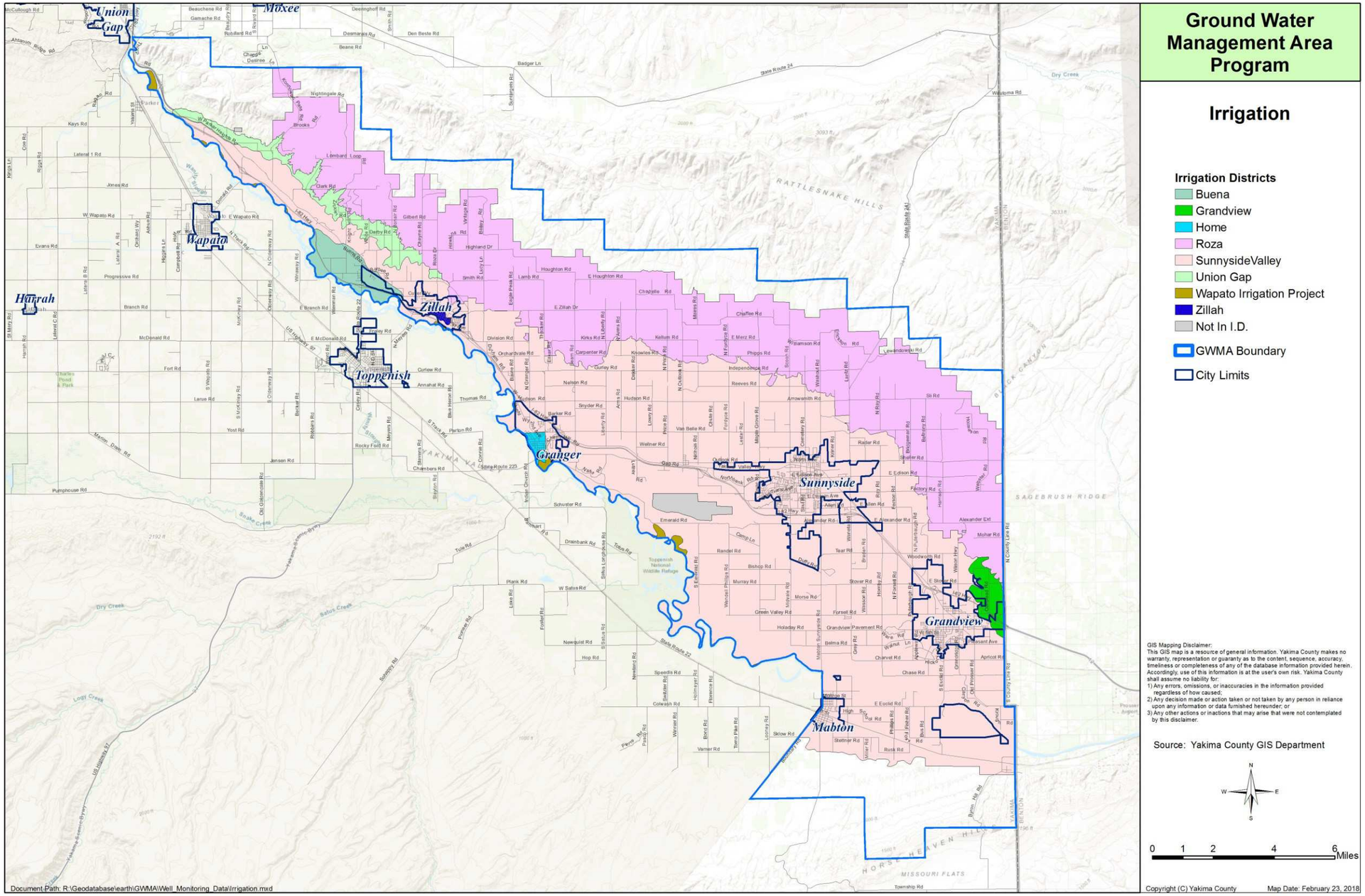


Figure 18 - Biosolids Application Sites

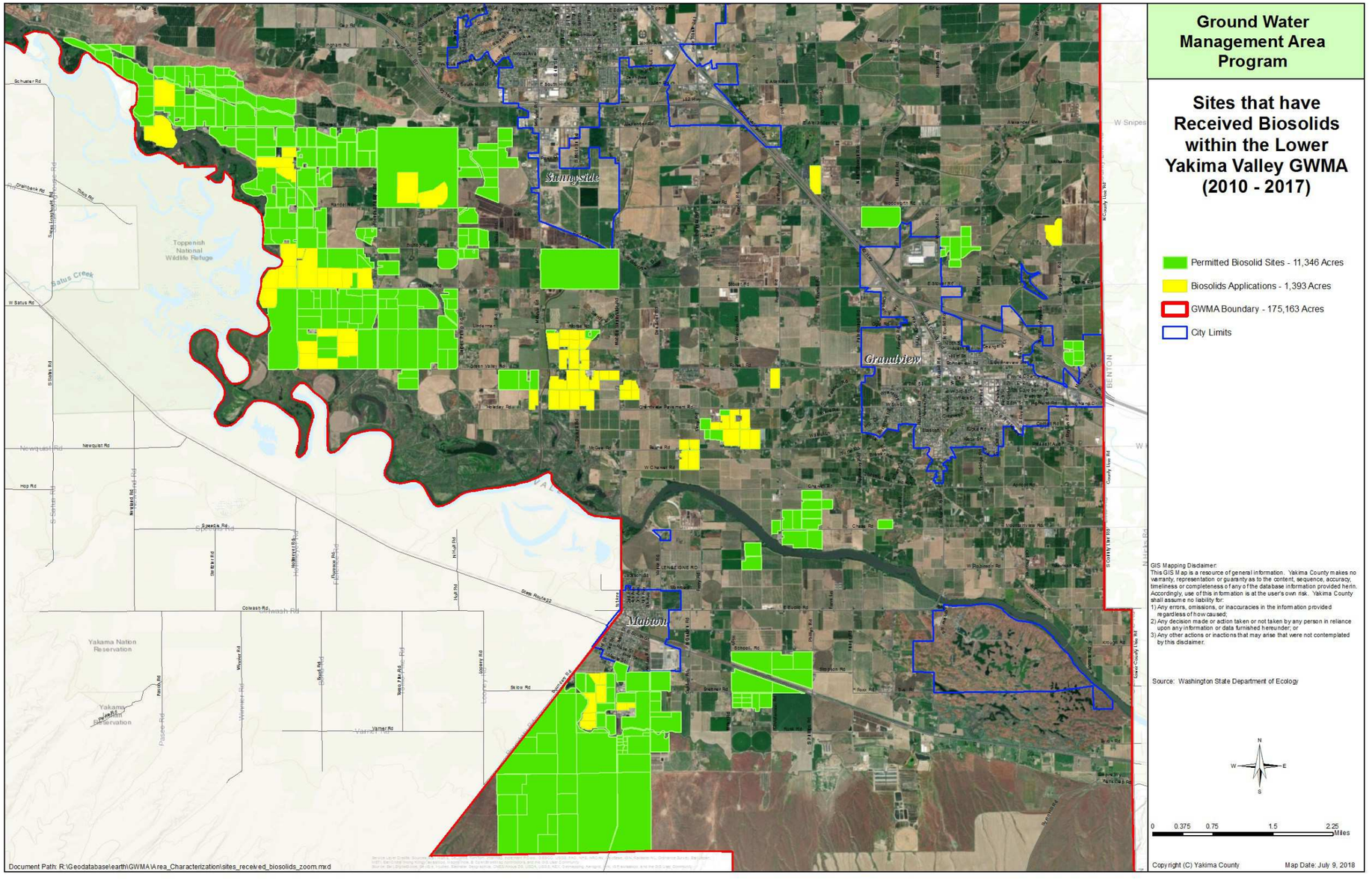


Figure 19 - Nitrate Pilot Project Water Test Locations

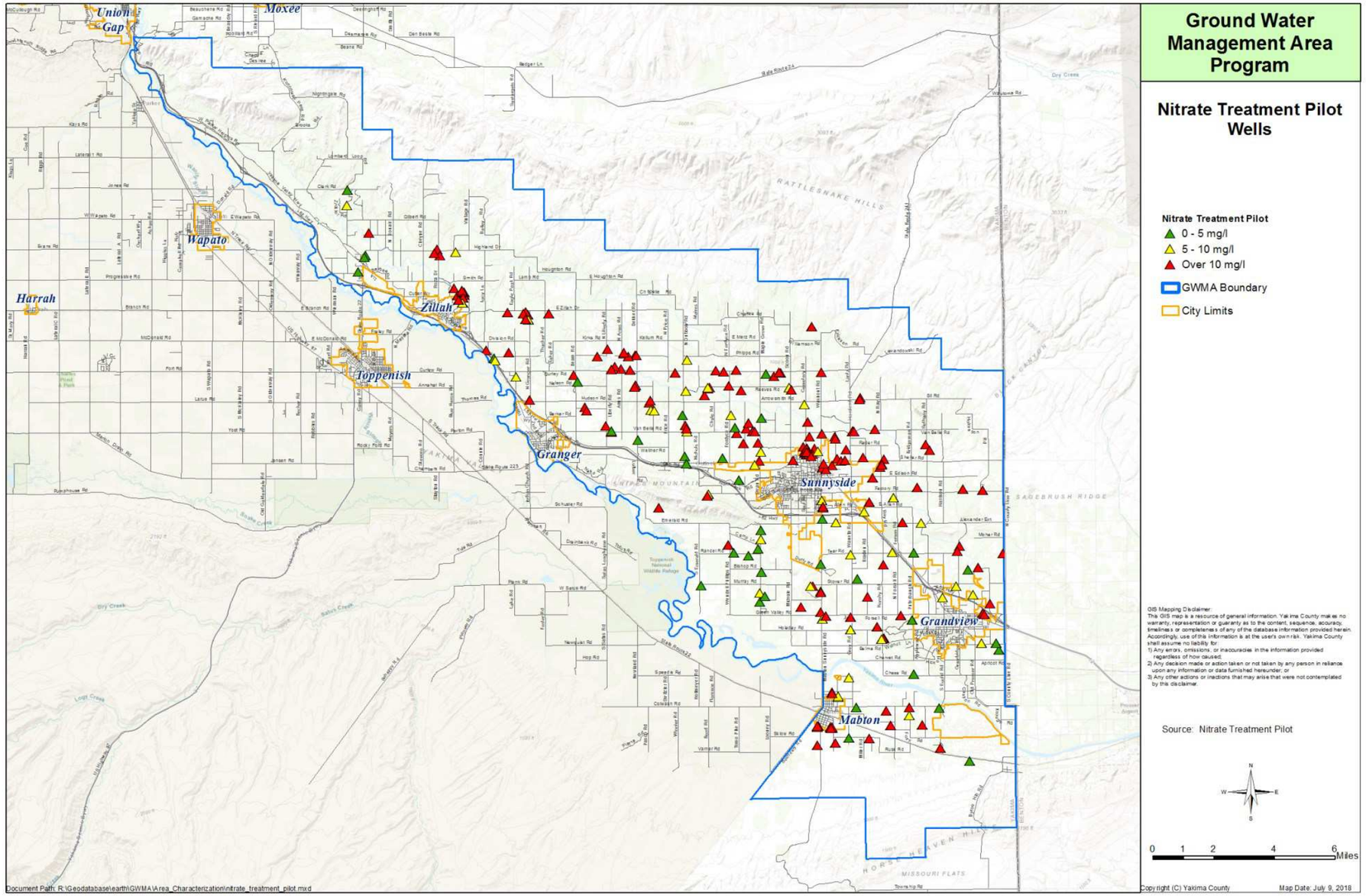


Figure 20 - High Risk Well Assessment test locations

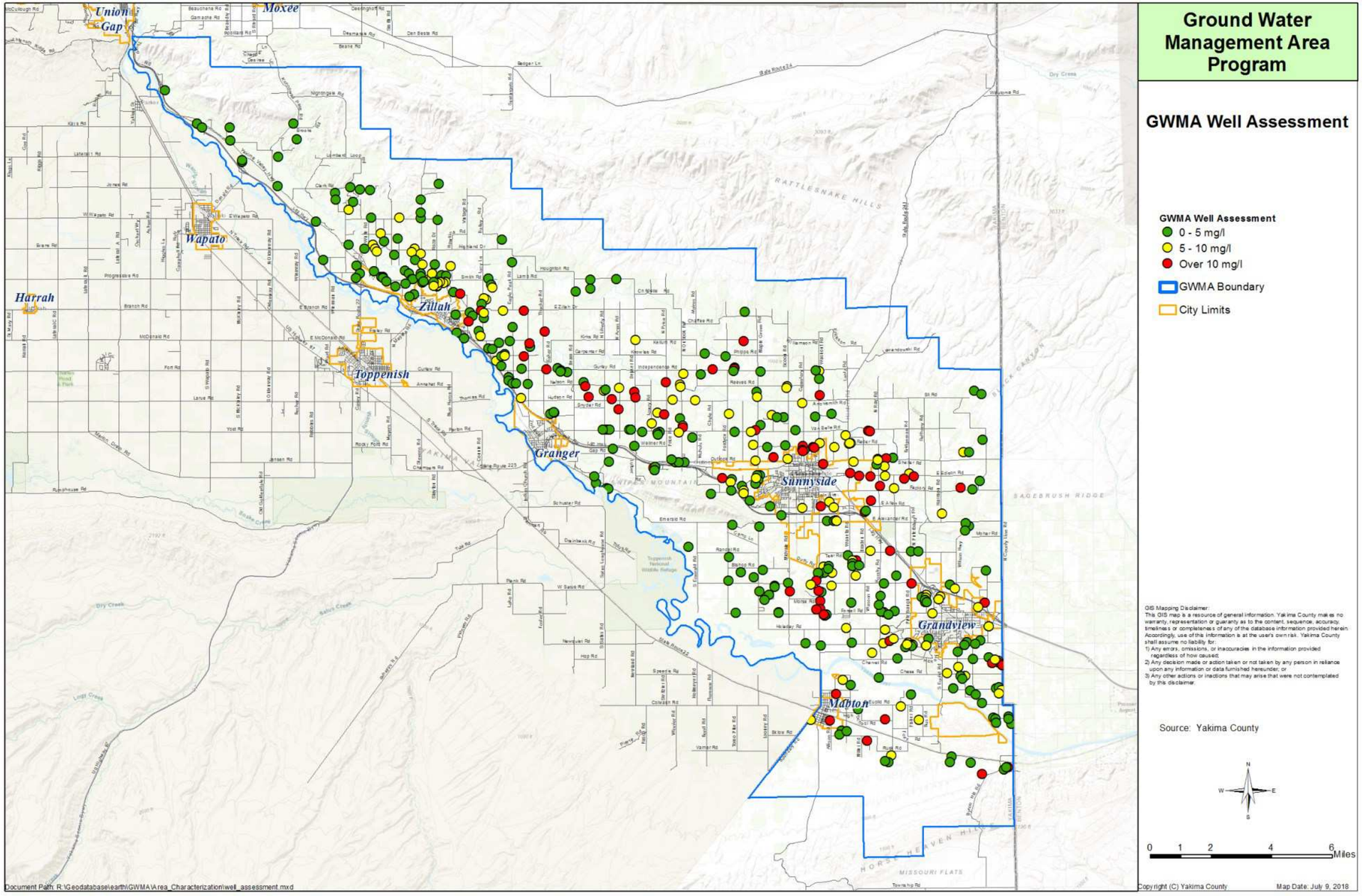


Figure 21 - USGS 2017 Groundwater Well Test Locations

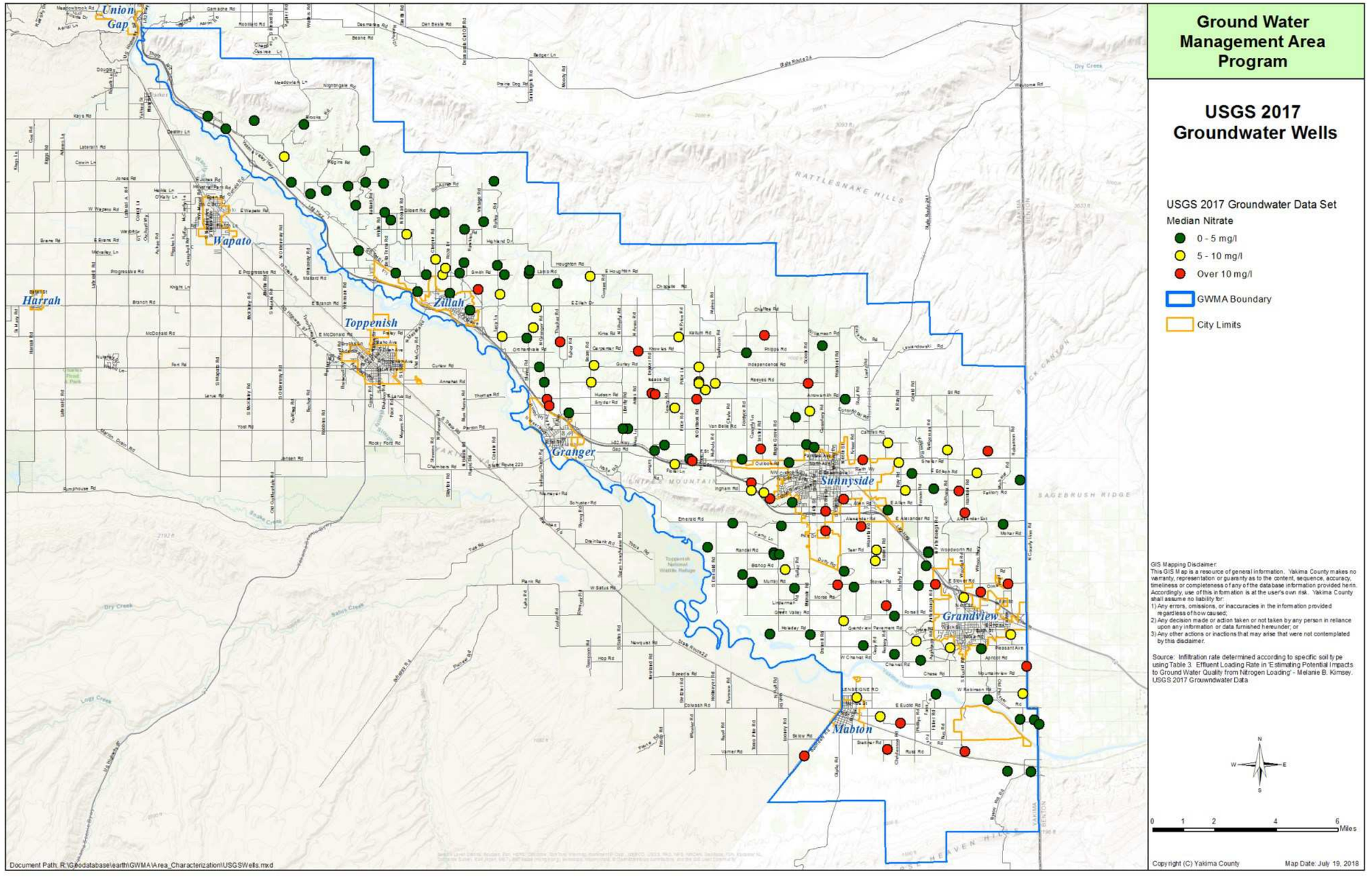


Figure 22 - All Water Quality Sampling Locations (3 Testing Programs)

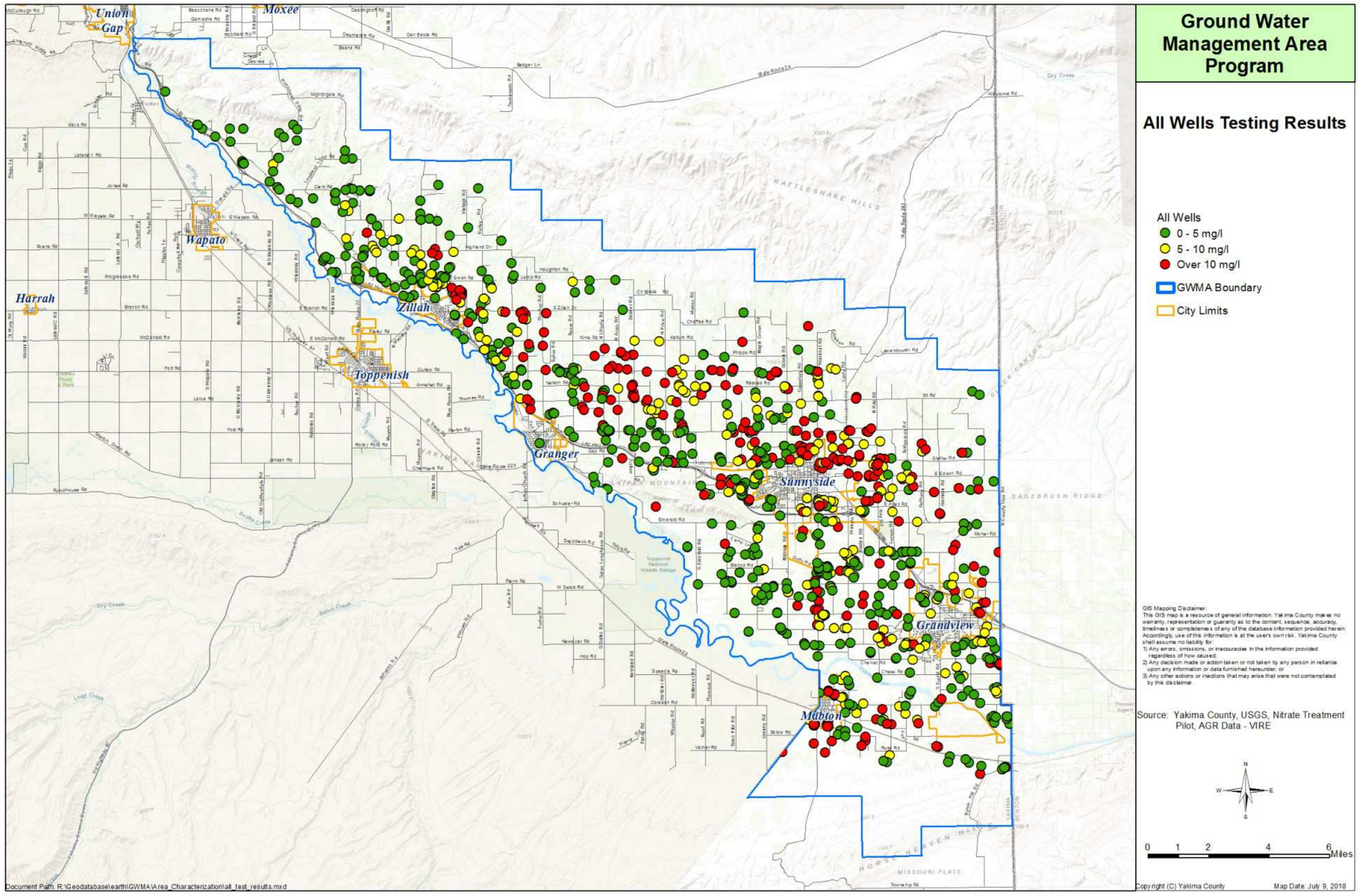


Figure 25 – Total Nitrogen Availability

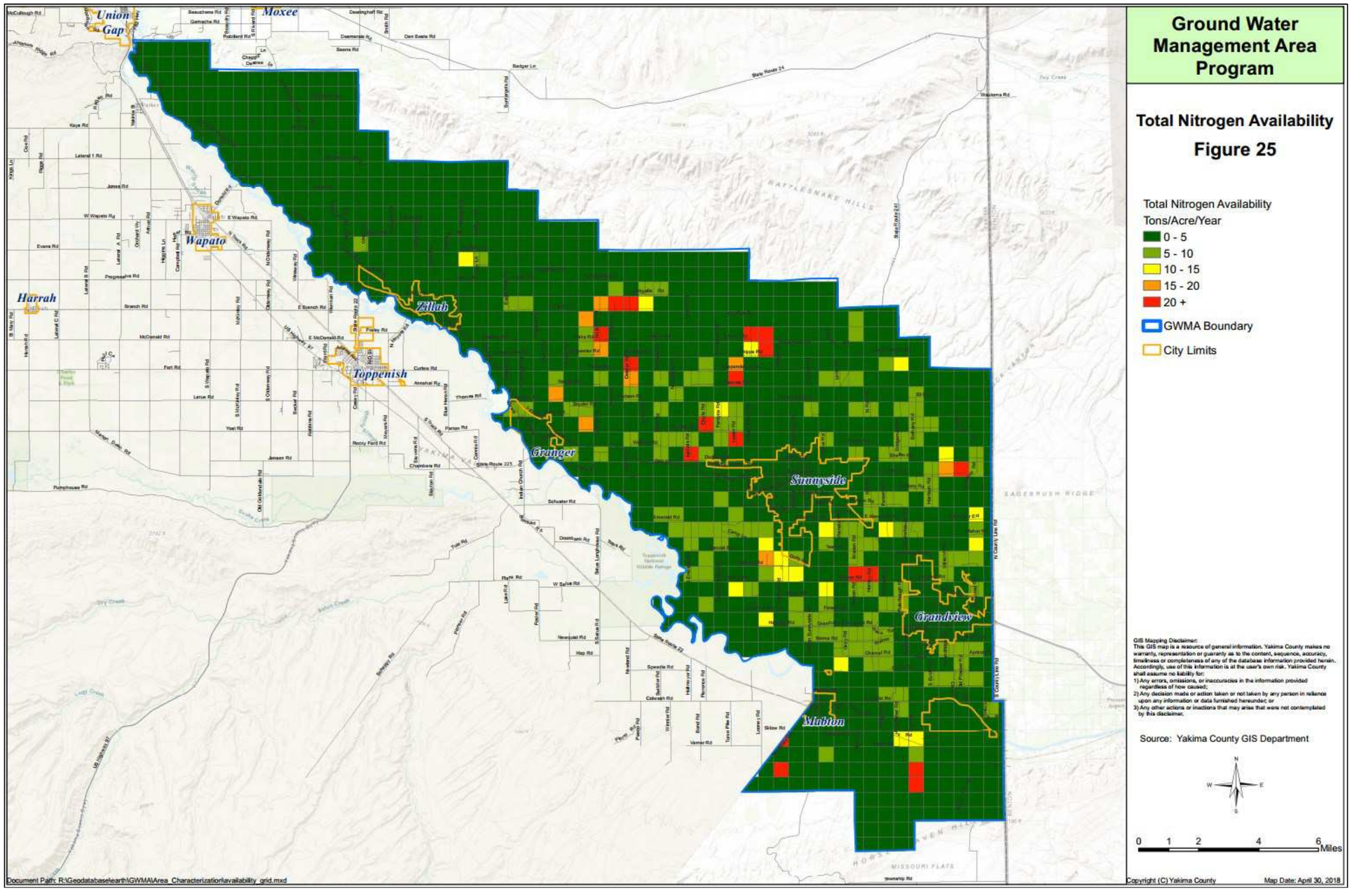


Figure 26 – Overlay of Total Nitrogen Availability and Groundwater Wells

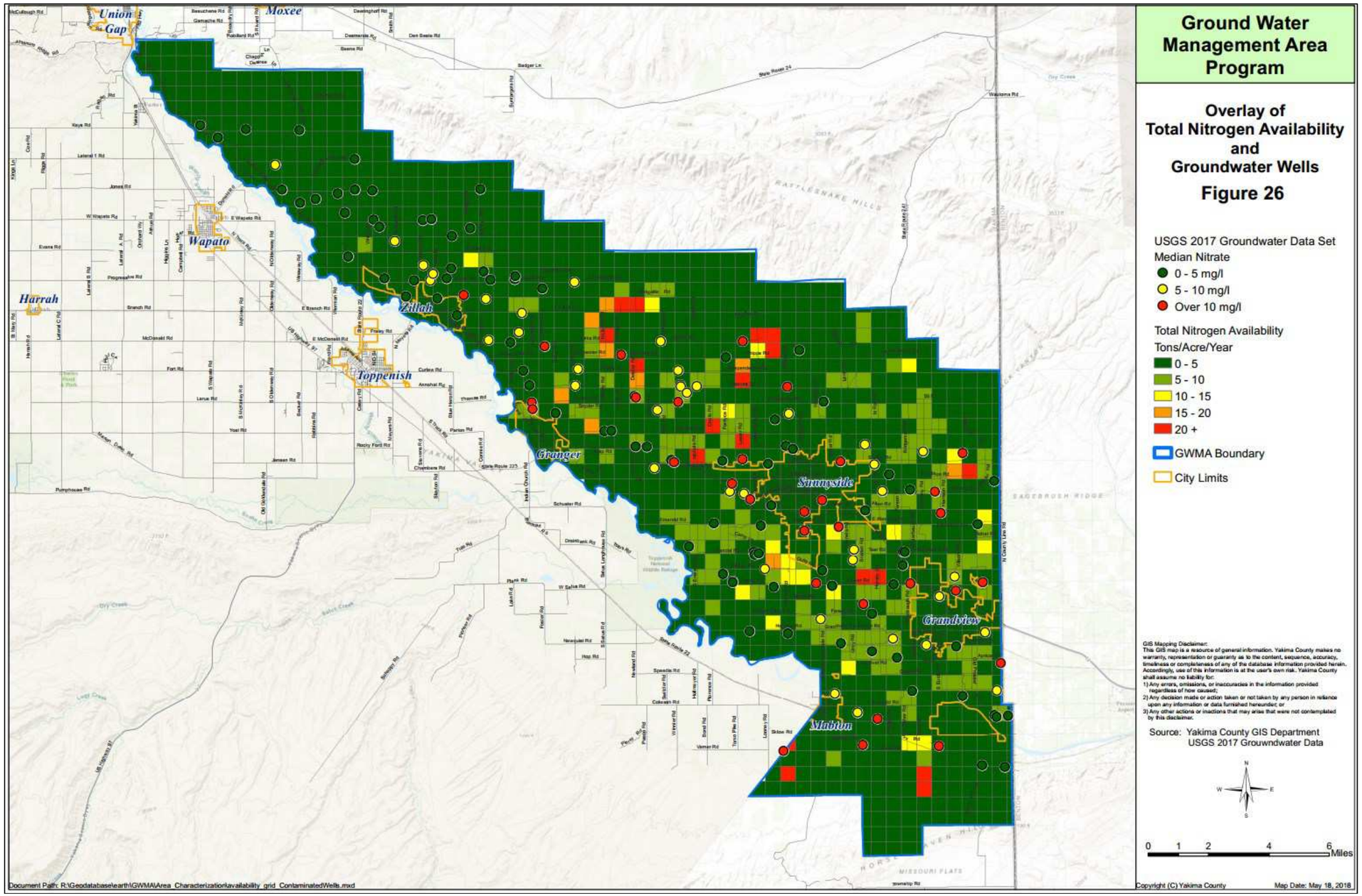


Figure 27 – Overlay of Soil Types and Groundwater Wells

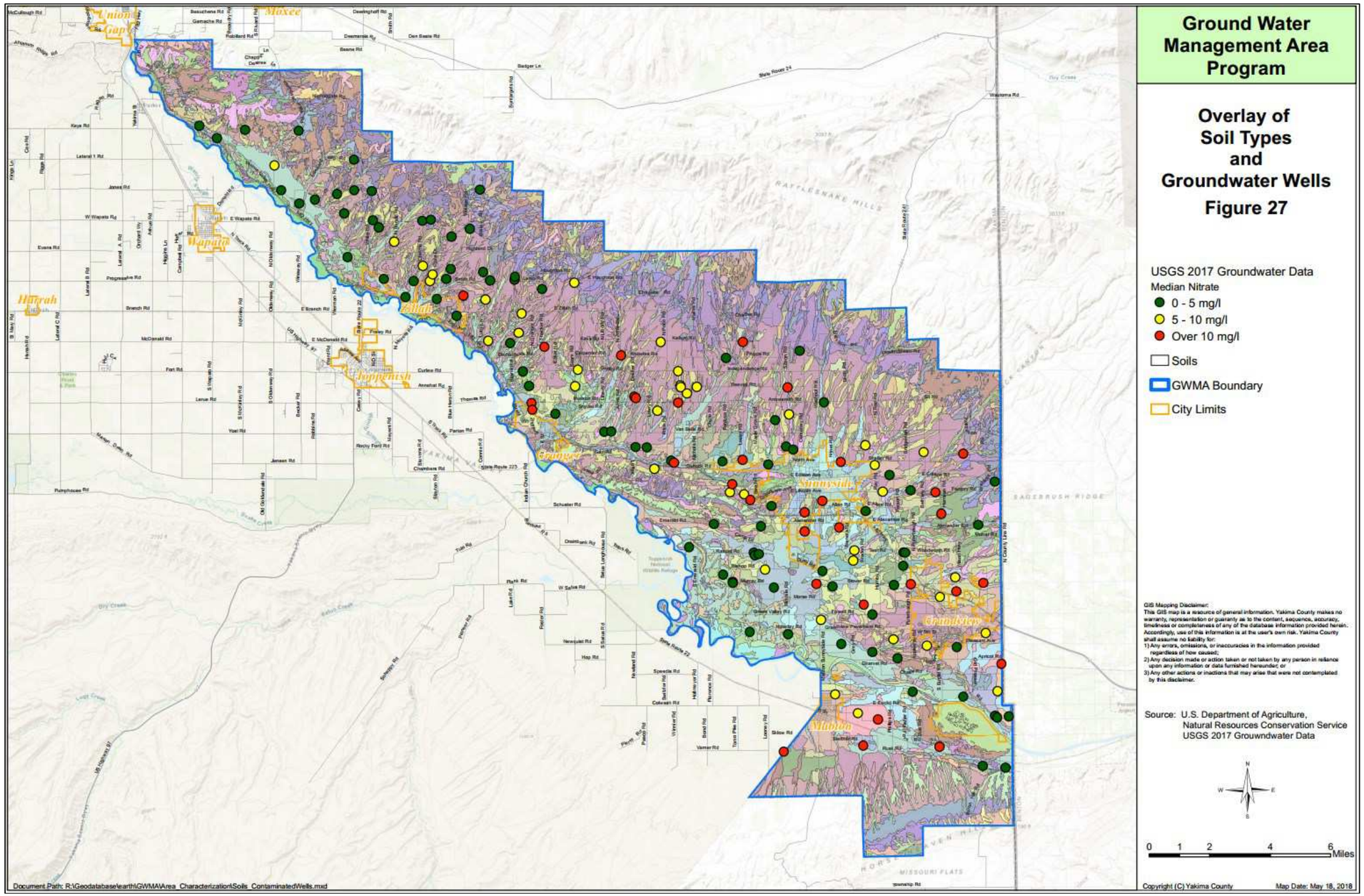


Figure 28 – Overlay of Hydraulic Conductivity and Groundwater Wells

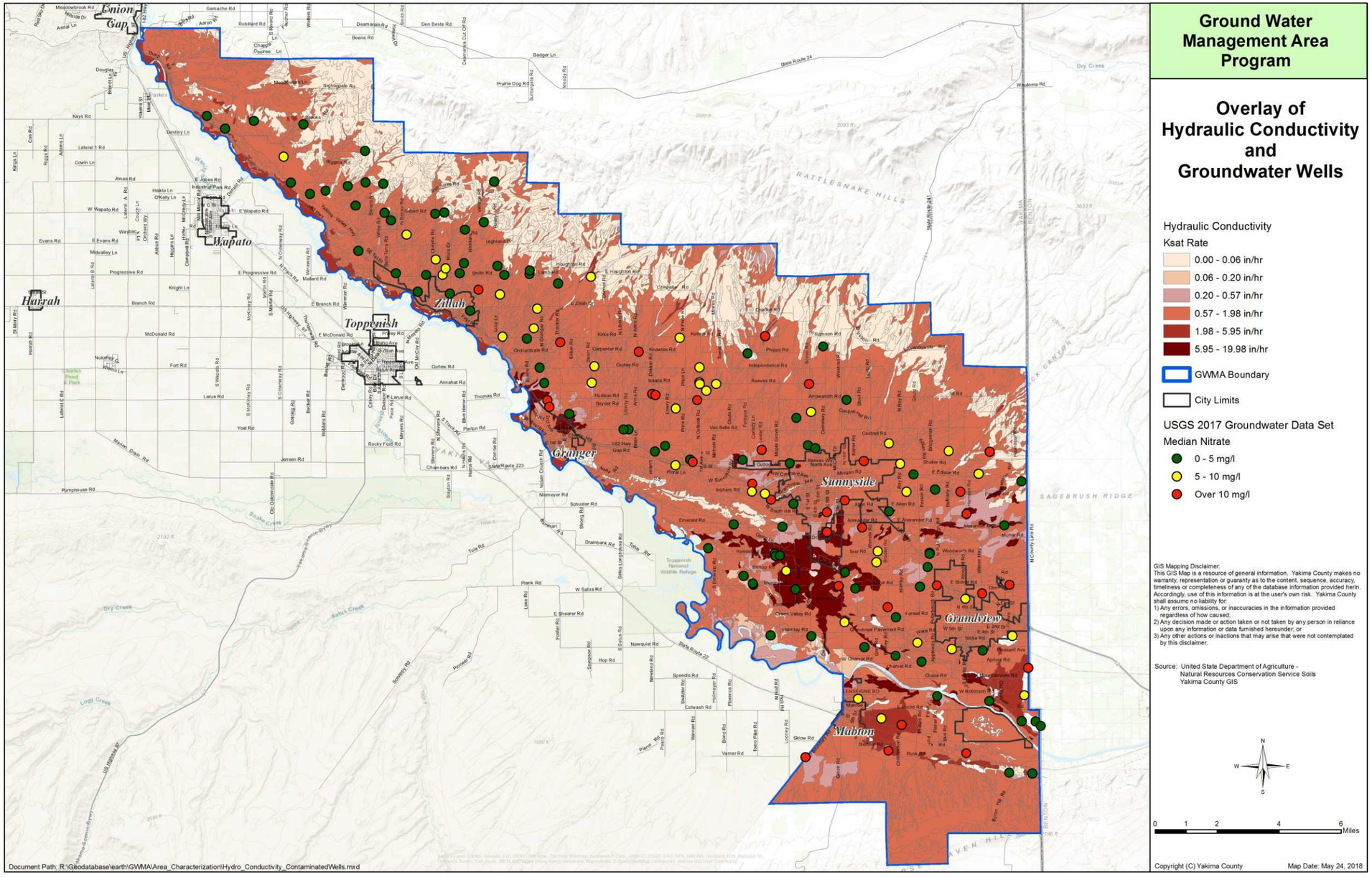


Figure 29 – Overlay of Canals and Drains with Groundwater Wells

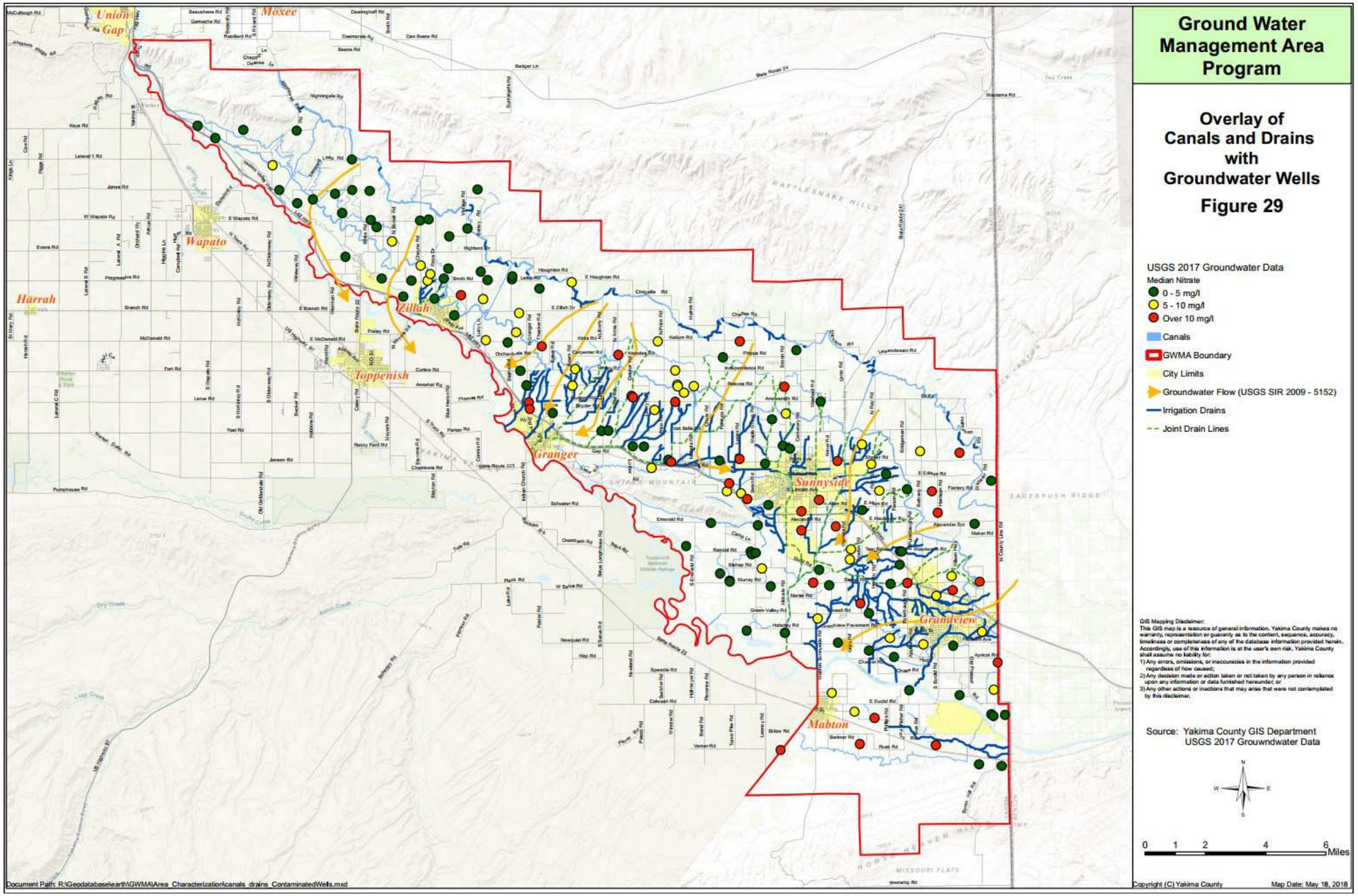


Figure 30 – Overlay of Cropping Patterns and Groundwater Wells

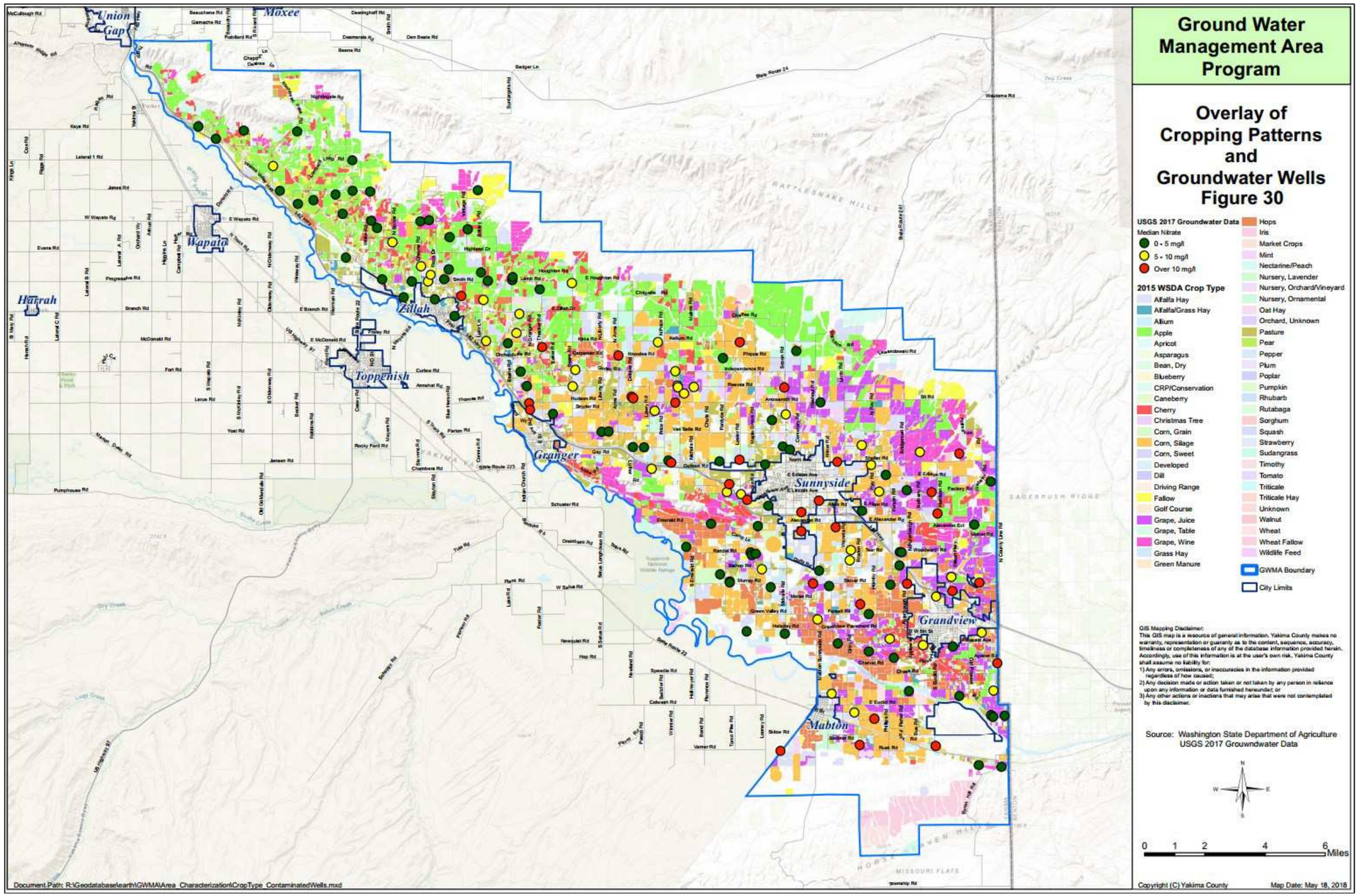


Figure 31 – Overlay of Point Sources and Groundwater Wells

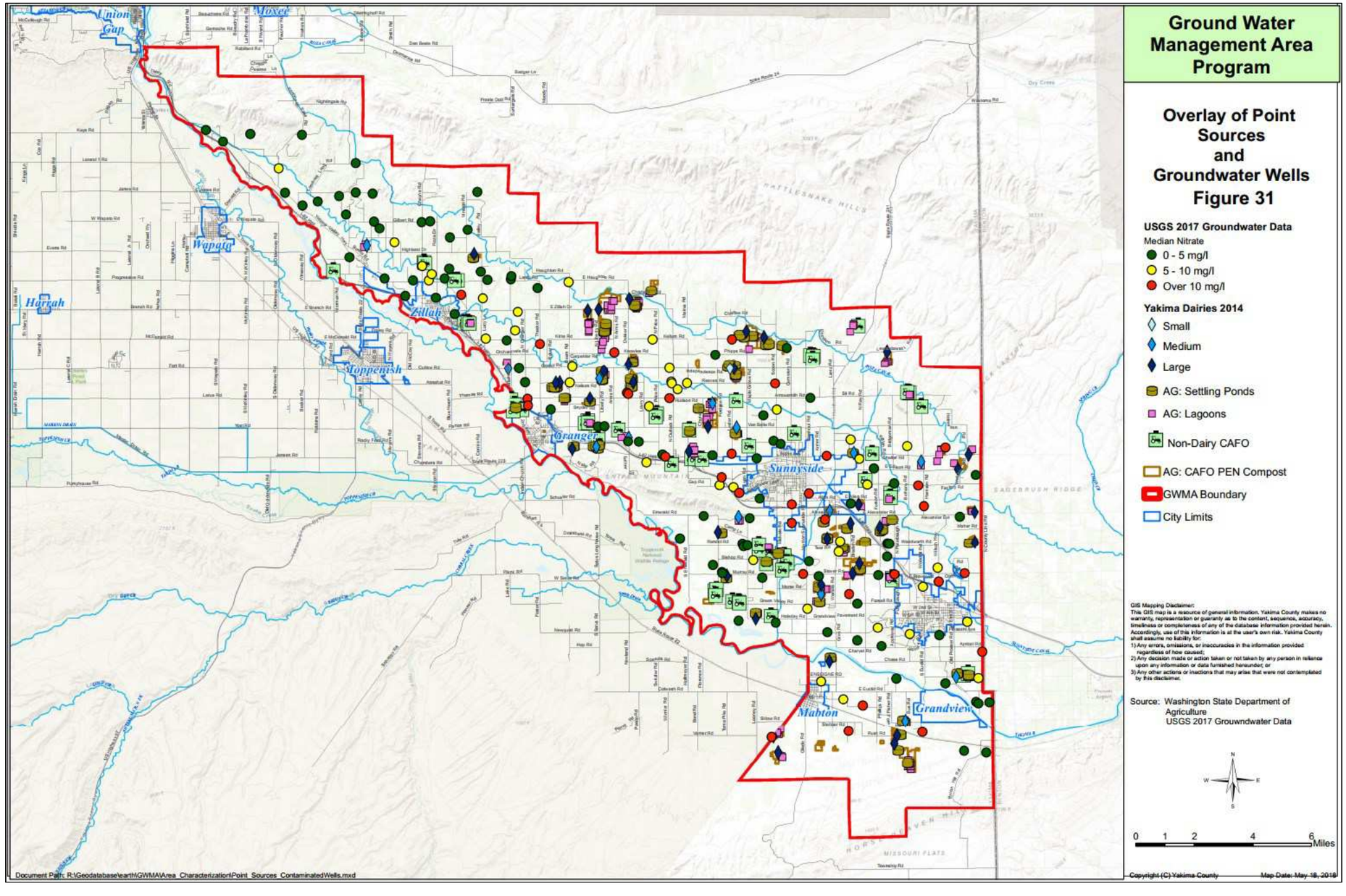


Figure 32 – Overlay of Residential Onsite Septic Systems and Groundwater Wells