Public Services

128 North Second Street · Fourth Floor Courthouse · Yakima, Washington 98901
(509) 574-2300 · 1-800-572-7354 · FAX (509) 574-2301 · www.co.yakima.wa.us
VERN M. REDIFER, P.E., Director

October 10, 2018

David Bowen
Department of Ecology, Central Region Office
1250 West Alder Street
Union Gap, WA 98903

Re: **Lower Yakima Valley GWMA - 2018 Third Quarter Report (IAA No. C 1200235)**

Dear David:

Enclosed please find one (1) copy of Yakima County's third-quarter report as required under Attachment A, Statement of Work, Agreement No. C 1200235 between the State of Washington Department of Ecology and Yakima County.

This report addresses deliverables 1.1 and 2.2 as required under the agreement.

Deliverable 2.1, invoices, to be sent separately.

If you have any questions, please let me know.

Thank you.

Lisa H. Freund, Administrative Manager
Yakima County Public Services

enclosure

IAA No. C 1200235 – Third Quarter 2018 Report
Lower Yakima Valley GWMA
September 30, 2018

TASK 1 - ADMINISTRATIVE FUNCTIONS
DELIVERABLES

1.1 Meeting Records

For each meeting of the GWAC, submit a copy of the agenda, minutes, attendance and public meeting notice at the end of each quarter.

Attachment [A] includes the agenda and draft GWAC meeting summary of August 9, 2018. No working groups met in this quarter.

TASK 2 - PROGRAM FUNCTIONS
DELIVERABLES

2.2 Status Report

Submit written quarterly status reports summarizing GWAC plans, activities and work products, and describing any interlocal agreements or other contracts by the end of each quarter.

The GWAC held one meeting in the third quarter.

Consideration/Approval of Program. The GWAC met on August 9 to consider approval of the August 9, 2018 version of the GWMA Program. Following a discussion of proposed edits, the group agreed to table a decision on the Program until the proposed edits were made and the committee met again.

Accordingly, the Program was returned to Yakima County to address the comments made at the August 9 meeting. Following completion of that work, the Program was forwarded to the Department of Ecology for technical review. As of this writing, the technical review is still in process.

2018 Nitrogen Availability Assessment (NAA). Also at the August 9 meeting, a member asked the committee to consider rejecting the 2018 NAA. There was no support for this proposal.

Attachment [B] includes the draft Lower Yakima Valley Groundwater Management Program Volumes I and II reviewed by the GWAC on August 9, 2018.

Ambient Groundwater Monitoring Network (AMN)

Background. At the November 2016 GWAC meeting the group agreed to proceed with Pacific Groundwater Group's (PGG) Ambient Monitoring Network of purpose-built wells, and to allocate money for its implementation. They further agreed to authorize Vern Redifer to contact contractors and develop a sample plan to monitor common water supply and develop a sampling Quality Assurance Project Plan (QAPP). On January 9, 2018, an agreement with PGG was executed to update project plans, field-proof well locations, support the County in the procurement of a drilling contractor, install wells, and conduct well tests and collect initial water level measurements (see Q1 2018, BOCC6-2018).

On September 11, 2018, the Board of Yakima County Commissioners awarded the monitoring wells project bid to Yellow Jacket Drilling Services in the amount of $177,862.36. The agreement was executed on October 2, 2018.

Resolution 308-2018 awarding the bid is included as Attachment [C]. The contract is included as Attachment [D].

Working Group Activities

No working groups met in the second quarter.

GWMA Website

The GWMA website continued to be updated in real time.

Contracts and Interlocal Agreements

BOCC214-2018: Amendment Number 2 to Agreement C1600074 between the Department of Ecology and Yakima County was executed on September 18, 2018. The amounts in Tasks 1, 2 and 3 were amended to reflect actual project expenses to complete the LYV-GWMA program development. The total grant amount of $1,614,000 remained unchanged.

BOCC232-2018: Agreement with Yellow Jacket Drilling Services, LLC for the FC3463 LYV-GWMA Monitoring Wells project was executed on October 2, 2018.

The amendment and agreement are included as Attachment [D].

Attachment A

- Draft GWAC meeting summary of August 9, 2018
- GWAC agenda and public meeting notices for August 9, 2018
- GWAC attendance roster record for August 9, 2018
- There were no Working Group meetings

YAKIMA VALLEY GROUNDWATER MANAGEMENT AREA ADVISORY COMMITTEE (GWAC)

MEETING SUMMARY

Thursday, August 9, 2018 – 5:00 p.m. – 7:00 p.m.

Denny Blaine Boardroom
Sunnyside School District No. 201
810 E. Custer Ave
Sunnyside, WA 98944

Note: This document is only a summary of issues and actions of this meeting. It is not intended to be a transcription of the meeting, but an overview of points raised and responses from Yakima County and Groundwater Advisory Committee members. It may not fully represent the ideas discussed or opinions given. Examination of this document cannot equal or replace attendance.

I. Call to Order: This meeting was called to order at 5:02 PM by Chairman Rand Elliott.

Member	Seat	Present	Absent
Stuart Turner	Agronomist, Turner and Co.,	✓	
Chelsea Durfey			✓
Bud Rogers	Lower Valley Community Representative Position 1	✓	
Kathleen Rogers	Lower Valley Community Representative Position 1 (alternate)	✓	
Patricia Newhouse	Lower Valley Community Representative Position 2		✓
Sue Wedam	Lower Valley Community Representative Position 2 (alternate)	✓	
Doug Simpson	Irrigated Crop Producer	✓	
Jean Mendoza	Friends of Toppenish Creek	✓	
Eric Anderson	Friends of Toppenish Creek (alternate)		✓
Jan Whitefoot	Concerned Citizens of the Yakama Reservation		✓
Jim Dyjak	Concerned Citizens of the Yakama Reservation (alternate)	✓	
Steve George	Yakima County Farm Bureau	✓	
Frank Lyall	Yakima County Farm Bureau (alternate)	✓	
Jason Sheehan	Yakima Dairy Federation	✓	
Dan DeGroot	Yakima Dairy Federation (alternate)	✓	
Ron Cowin	Roza-Sunnyside Joint Board of Control	✓	

	Roza-Sunnyside Joint Board of Control (alternate)		
Laurie Crowe	South Yakima Conservation District	✓	
Rodney Heit	South Yakima Conservation District (alternate)		✓
John Van Wingerden III	Port of Sunnyside	✓	
Rand Elliott	Yakima County Board of Commissioners	✓	
Vern Redifer	Yakima County Board of Commissioners (alternate)		✓
Myers, Holly	Yakima Health District		✓
Ryan Ibach	Yakima Health District (alternate)	✓	
Dr. Troy Peters	WSU Irrigated Agriculture Research and Extension Center	✓	
Lucy Edmondson	U.S. Environmental Protection Agency	✓	
Nick Peak	U.S. Environmental Protection Agency (alternate)		✓
Elizabeth Sanchey	Yakama Nation		✓
Stuart Crane	Yakama Nation (alternate)	✓	
Gary Bahr	WA Department of Agriculture	✓	
Perry Beale	WA Department of Agriculture (alternate)		✓
Andy Cervantes	WA Department of Health	✓	
Sheryl Howe	WA Department of Health (alternate)		✓
David Bowen	WA Department of Ecology	✓	
Sage Park	WA Department of Ecology (alternate)	✓	
Lino Guerra	Hispanic Community Representative	✓	
Rick Perez	Hispanic Community Representative (alternate)		✓
Jessica Black	Heritage University	✓	
Matt Bachmann	USGS		✓
Robert Black	USGS	✓	

Welcome, Meeting Overview and Introductions: Chairman Rand Elliott welcomed the group. After the customary introductions, Rand reviewed the agenda.

II. Committee Business: The May 17, 2018 and the June 21, 2018 meeting summaries were approved as presented.

III. Consideration of Approval of the GWMA Program: Rand thanked everyone for their work and noted that he would like to see the Program adopted before he leaves office in December. He asked for a motion to approve the Program "as is." Ryan Ibach made a motion to approve the program "as is." Lucy Edmondson seconded the motion. A member asked which version they were being asked to approve: the online version distributed

August 2, or the hard copy at table. Jim Davenport confirmed that they were considering the copy on the table.

Jean Mendoza requested to add an agenda item: to reject WSDA's Nitrogen Availability Assessment (NAA). The item was added to the agenda.

Lucy stated that the most recent Program version had technical errors and that some of the edits EPA had already provided were not reflected in the current draft. More review time was also needed. Accordingly, she could not approve the Program as written.

David Bowen noted that Ecology had reviewed it and had found technical issues that needed to be addressed. He added that subjectivity in the text should be removed. The program is required to be grounded in objectivity.

Jean Mendoza stated that the Friends of Toppenish Creek (FOTC) had technical concerns to be addressed.

At this point the group turned to Volume I dated August 9, 2018 before them and began to make specific edits and comments as described below.

Jean Mendoza:

- Page viii Executive Summary. The GWAC did not meet monthly.
- Page x Executive Summary. There are erroneous statements regarding 1) the GIS tool and 2) consensus. 1) *"GIS tool that combines surface and subsurface physical conditions, nitrogen sources in land use within the LYVGWMA,"* is incorrect. 2) *"the GWAC discussed each strategy and reached consensus on a set of 66 strategies…"*. Consensus was not reached;
- Jean cannot go on record as agreeing to the 66 recommendations.

Rand noted that the group had reached consensus on the recommendations.

Lucy Edmondson

- "EPA 2012" report is still referenced in the Program. Please reflect the most current program, "EPA 2013," where appropriate.

- **Health Effects to People**, pages 103-104. This contains an inaccurate "WebMD" description. Please Use EPA or DOH language.

- **Appendix G-NAA Chart** entitled "Scott's Opinion." Who is Scott and what does this mean. Please clarify.

Jim Davenport clarified that it refers to Scott Stephens, who participated in the Irrigated Ag working group meetings and provided his professional opinion.

Figures 25 (Total Nitrogen Availability) and 26 (Nitrogen Availability and USGS Wells), pages 134 and 135. There was discussion regarding the figures' legends, specifically the units (tons). **It was agreed that Jim would correct the figures' legends.**

Table 14 (Total Available N from All Sources Studied in WSDA 2018) and Table 15 (Total Acreage for N Availability Computations), page 130.

- Acreage is wrong; correct the title. Following discussion, **it was agreed that Jim Davenport would work on a better title for the table.**
- Atmospheric deposition is missing from Table 14. A member made a request for correction. Note: It was pointed out that Figure 23-Nitrogen Available by Specific Source (Page 131) addressed atmospheric deposition.

David Bowen

- **Septic Tanks and lagoons** (page 142). Source locations- volume of septic tanks versus volume of lagoons-David observed this was never discussed nor agreed to by the GWAC. He cautioned to avoid subjective information and use objectivity and the data of the group. **Recommendation: delete language on page 142.**

Recommendation for Recharge Study (Page 134). David did not recall this being discussed by the GWAC. Jim Davenport explained that it was discussed by the GWAC which generally agreed that if the subject were remodeled, different, more current information would be considered. David couldn't recall consensus and noted that Ecology would like it deleted.

Executive Summary

There was discussion regarding the executive summary: its purpose, content, who would read it, and finding a balance between brevity (2-3 pages) and the risk of submitting a longer, detailed summary (3-5 pages) that a legislator or funder might not read.

Melanie Redding observed that the summary should highlight the GWAC's work: PGG's QAPP, Request for Identification, Long-Term Monitoring Plan, and USGS's Report. The group discussed whether to cut and paste the Recommended Actions (Page 146) into the executive summary. Rand suggested moving the recommendations to the front of the document before the Table of Contents. **The group agreed to Rand's suggestion.**

Sue Wedam added that the document needed clear statements on why specific issues are significant. Stu Turner added the importance of acknowledging legacy nitrates, which may comprise 85 percent of the current loading. Jim Davenport replied that legacy nitrates are noted in the history section.

Monitoring System for Evaluation of Effectiveness of Recommended Action, page 164. Jean stated that this section is incomplete. It does not meet the criteria as defined under WAC 173-100 for evaluation of effectiveness.

Ambient Monitoring Wells. Jean expressed concern about the number of monitoring wells, stating that the original number had been more than 35. She reluctantly agreed when the number was lowered to 30. The current number – 20 – is unacceptably low. Nor does the group know where the wells will be placed.

Biosolids language. David Bowen requested that proposed language be consistent with Ecology's biosolids expert.

Rand asked Lisa to read all the changes the group had discussed thus far. She read the list aloud; several corrections were made.

Lucy Edmondson requested a disclaimer be added to the front of the document, along the lines of "… This program reflects the collective effort of the GWAC and does not reflect individual opinions of the members." She offered to send specific language to Jim Davenport to insert in the program. Other GWAC members nodded in support of this suggestion.

Jessica Black stated she believed the EPA experts should have time to review the document, fact check and respond.

David Bowen explained the public process under the WAC, should the group vote to approve the program. After SEPA review, the WAC calls for the Department of Ecology to hold a public hearing on the program. Affected jurisdictions (Ecology, Yakima County, Yakima Health District, etc.) then prepare findings. The lead agency consolidates the findings and presents them back to the advisory committee. Assuming concurrence of the program, the GWAC would submit the Program to Ecology, which certifies consistency with the intent of the chapter. The Board of County Commissioners then considers adopting the program.

Rand asked if there were any more member comments. Hearing none, he requested the original motion be changed to "approve the plan with changes incorporated that have been discussed tonight."

Bob Black, USGS

Surface Water Quality, page 106. USGS has reports other than USGS 2009a that have stronger suggestions regarding the "*…hydrologic connection between the surface water within the Yakima River and the groundwater beneath lands adjacent to the river.*"

- The suggestion was made to revise the following sentence as follows:
  The USGS report did not ~~establish~~ study any direct correlation between nitrogen in groundwater and nitrogen in the Yakima River. **The group agreed to this revision.**
- Bob offered to provide a suggested change to this section following the meeting.

Jean objected that there's no mention of the dairy cluster in the Program adding, "dairies are the leading cause in my opinion." Members responded that the program should rely on data, not personal opinions. The objecting member later clarified she meant the dairy cluster research (not her opinion) should be included in the Program. The group did not respond to this request.

Motion One. Rand called for a motion to amend Ryan Ibach's earlier primary motion to approve the GWMA Program "as is," so that the primary motion would approve the GWMA Program with the suggestions made, documented, and read aloud this evening added to the Program. Ryan Ibach restated the amendment to the motion. David Bowen seconded it. The group voted with 17 "yes" votes and 5 "no" votes. **Motion carried.**

Jason Sheehan asked how members would know what changes were made after this meeting unless they reviewed the document again before approving it. Many of the comments expressed tonight were opinions, not fact. Will the 11th hour opinions be added to the Program? Steve George agreed, stating that was why he had voted "no" to the motion to approve the program [without a final review by the GWAC].

Motion Two. Rand returned to consideration of Ryan Ibach's primary motion. Jason Sheehan moved to table the primary motion to a time when this group meets again. Ryan Ibach seconded the motion to table. A vote was taken and **approved unanimously**.

Minority Reports: Jim observed that this agenda subject was moot given this evening's discussion. Accordingly, it was not discussed.

Rejection of WSDA's 2018 NAA: New agenda item (Jean Mendoza). Jean stated that this committee's charge is to ensure the NAA is technically sound. Members provided comments in 2017; however, she believes her (and others') comments were ignored. **Motion.** Jean made a motion for the group to consider rejecting the 2018 NAA. There was no second. Accordingly, no discussion followed.

Jean asked Rand Elliott a question regarding the 2015 ILA Scope of Work between WSDA and Yakima County for the Nitrogen Loading Assessment (later renamed NAA). The member felt that Yakima County agreed to pay itself $12,000 for the RCIM study, and that Yakima County had failed to deliver on parts of the study. She wanted to know if, under the Administrative Procedures Act, Yakima County would investigate itself for noncompliance.

Rand said he was not prepared tonight to reply to her allegations; however, he would research it and provide her an answer.

IV. Public Comment: Frank Lyall stated that he agreed with Jean Mendoza's contention that the NAA is flawed. He believes this group is incapable of creating an accurate NAA. Kathleen Rogers asked the group how many people present were born in the lower Valley. She wanted to know the [historic] application of nitrate. She wants the Program developed, observing that the "bad" player should be kept in line.

A member of the audience requested that the members use their microphones so the audience can hear them.

Next Meeting: To Be Determined. Jim Davenport stated he cannot schedule a date for the next meeting until he's had a chance to talk to Ecology, EPA and others who had requested technical review and/or changes.

V. Next Steps: Lucy Edmondson will submit disclaimer language to Jim Davenport. Andy Cervantes will send corrected summary of health effects. Scott's opinion-Gary Bahr will change wording. Robert Black will submit clarifying language to the Surface Water Quality section (page 106). Jim Davenport will reach out to Ecology, EPA and others who requested edits to obtain clarity on their requests.

The meeting was adjourned at approximately 6:50 PM.

VI. Meeting Summary approved by the GWAC on ______________________________.

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

Meeting Time and Location

Thursday, August 9, 2018 5:00 p.m. – 7:00 p.m.

Denny Blaine Boardroom
Sunnyside School District No. 201
810 E. Custer Ave.
Sunnyside, WA 98944

Agenda

	Topic	
	Welcome, Meeting Overview and Introductions: • Committee members • Others attending the meeting	Jim Davenport, Facilitator
	Consideration of Approval of the GWMA Program	Jim Davenport
	Submission of Minority Reports	Jim Davenport
	Committee Business • Approve the May 17 and June 21, 2018 GWAC Meeting Summaries	Jim Davenport
	Public Comments	
	Adjourn	

Committee Members

Stuart Turner, agronomist, Chelsea Durfey (alternate)	Turner and Co.
Bud Rogers, Kathleen Rogers (alternate)	Lower Valley Community Representative Position 1
Patricia Newhouse, Sue Wedam (alternate)	Lower Valley Community Representative Position 2
Doug Simpson	Irrigated Crop Producer
Dr. Jessica Black, Dr. Alex Alexiades (alternate)	Heritage University
Jean Mendoza, Eric Anderson (alternate)	Friends of Toppenish Creek
Jan Whitefoot, Jim Dyjak (alternate)	Concerned Citizens of the Yakama Reservation
Steve George, Frank Lyall (alternate)	Yakima County Farm Bureau
Jason Sheehan, Dan DeGroot (alternate)	Yakima Dairy Federation
Ron Cowin	Sunnyside-Roza Joint Board of Control
Laurie Crowe, Rodney Heit (alternate)	South Yakima Conservation District
John Van Wingerden III, (alternate)	Port of Sunnyside
Rand Elliott, Vern Redifer (alternate)	Yakima County Commission
Holly Myers, Ryan Ibach (alternate)	Yakima Health District
Dr. Troy Peters	WSU Irrigated Agriculture Research and Extension Center
Lucy Edmondson, Nick Peak (alternate)	U.S. Environmental Protection Agency
Elizabeth Sanchey, Stuart Crane (alternate)	Yakama Nation
Gary Bahr, Perry Beale (alternate)	Washington Department of Agriculture
Andy Cervantes, Sheryl Howe (alternate)	Washington Department of Health
David Bowen, Sage Park (alternate)	Washington Department of Ecology
Lino Guerra, Rick Perez (alternate)	Hispanic Community Representative
Matt Bachmann	U.S. Geological Survey

Committee Ground Rules:

- Come to committee meetings prepared
- Treat one another with civility
- Respect each other's perspectives
- Listen actively

- Participate actively
- Honor time frames
- Silence electronic devices during meetings
- Speak from interests, not positions.

2018 Meeting Dates:

~~January 4~~
~~January 18~~
~~February 1~~
February 15
March 1
~~March 15~~
April 5
~~April 19~~
May 3
May 17
~~June 7~~
June 21
~~July 19~~
August 9
August 16

Meeting Materials:

Name	Date Provided	From
2018_05_17 GWAC Draft Meeting Summary	6/14/2018 & 8/2/2018	chriss@co.yakima.wa.us Lisa.freund@co.yakima.wa.us
2018_06_21 GWAC Draft Meeting Summary	8/2/2018	Lisa.freund@co.yakima.wa.us
2018_08_09 Agenda	8/2/2018	Lisa.freund@co.yakima.wa.us
LYVGWMA Program Volume I Aug. 2, 2018 https://www.yakimacounty.us/DocumentCenter/View/17745/Volume-I--8-2-2018	8/2/2018 & At Table	Lisa.freund@co.yakima.wa.us
LYVGWMA Program Volume II Aug. 2, 2018 https://www.yakimacounty.us/DocumentCenter/View/17731/Volume-II-8-2-2018	8/2/2018 & At Table	Lisa.freund@co.yakima.wa.us

YAKIMA HERALD REPUBLIC

Affidavit of Publication

STATE OF WASHINGTON,)
)
COUNTY OF YAKIMA)

Jackie Chapman, being first duly sworn on oath deposes and says that she/he is the Accounting clerk of Yakima Herald-Republic, Inc., a daily newspaper. Said newspaper is a legal newspaper approved by the Superior Court of the State of Washington for Yakima County under an order made and entered on the 13th day of February, 1968, and it is now and has been for more than six months prior to the date of publication hereinafter referred to, published in the English language continually as a daily newspaper in Yakima, Yakima County, Washington. Said newspaper is now and has been during all of said time printed in an office maintained at the aforesaid place of publication of said newspaper.

That the annexed is a true copy of a:
Yakima County Notice of Public Meeti

it was published in regular issues (and not in supplement form) of said newspaper once each day and for a period of 1 times, the first insertion being on 08/01/2018 and the last insertion being on 08/01/2018

Yakima Herald-Republic 08/01/18
YakimaHerald.com 08/01/18

and the such newspaper was regularly distributed to its subscribers during all of the said period. That the full amount of the fee charged for the foregoing publication is the sum of $116.16

Jackie Chapman

Accounting Clerk

LISA M DRIPPS NOTARY My Comm. Expires April 05, 2021 PUBLIC STATE OF WASHINGTON

Sworn to before me this 1st day of, August 2018

Lisa M Dripps

Notary Public in and for the
State of Washington,
residing at Yakima

Yakima County

**Notice of Public Meeting
Lower Yakima Valley
Groundwater Advisory
Committee**

NOTICE IS HEREBY GIVEN that Yakima County is holding a public meeting of the Lower Yakima Valley Groundwater Advisory Committee on Thursday, August 9, 2018, at 5:00 PM at Denny Blaine Boardroom, Sunnyside School District No. 201, 810 E. Custer, Sunnyside, WA 98944 pursuant to Chapter 173-100-080 WAC Ground Water Management Areas and Programs.

For Additional Information
To learn more about the Lower Yakima Valley Groundwater Management Area, the Groundwater Advisory Committee, and its goals and objectives, please see the Lower Yakima Valley Groundwater Management Area on the County webpage at: http://www.yakimacounty.us/gwma/

For more information about the meeting, please contact Lisa Freund, Yakima County Public Services Administrative Manager at 574-2300.

If you are a person with a disability who needs any accommodation in order to participate in this program, you may be entitled to receive certain assistance at no cost to you. Please contact the ADA Coordinator at Yakima County no later than forty-eight (48) hours prior to the date service is needed.

Yakima County ADA Coordinator
128 N. 2nd Street, Room B27
Yakima, WA 98901
(509) 574-2210
7-1-1 or 1-800-833-6384
(Washington Relay Services for deaf and hard of hearing)

Dated this Tuesday, July 31, 2018

(829496) August 1, 2018

Courtesy of Yakima Herald-Republic

[redacted]

YAKIMA HERALD REPUBLIC

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PUBLIC SERVICES
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YAKIMA WA 98901

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Funding Control FC3463-100-120

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Date Authorized 8/7/18

[redacted]

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		Total Due	56.25

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Authorized By [signature]

Date Authorized 8/16/18

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AUG 09 2018
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Yakima County
Notice of Public Meeting
Lower Yakima Valley Groundwater Advisory Committee

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(509) 574-2210
7-1-1 or 1-800-833-6384 (Washington Relay Services for deaf and hard of hearing)

Dated this Tuesday, July 31, 2018
PUBLISH: DAILY SUN NEWS
August 1, 2018

Affidavit of Publication

STATE OF WASHINGTON
ss.
County of Yakima

Andrew J. McNab, being first duly sworn on oath deposes and says that he is the Publisher of the DAILY SUN NEWS, a daily newspaper.

That said newspaper is a legal newspaper and it is now and has been for more than six months prior to the date of publication hereinafter referred to, published in the English language continually as a daily newspaper in the city of Sunnyside, YAKIMA County, Washington, and it is now and during all of said time printed in an office maintained at the afforsaid place of of publication of said newspaper, and that the said Daily Sun News was on the 4th Day of April, 1969 approved as a legal newspaper by the Superior Court of said Yakima County.

That the annexed is a true copy of a LEGAL PUBLICATION –
Yakima County Public Services
FC3463–100–120

published in regular issues (and not in supplemental forms) of said newspaper once each week for a period of 1 consecutive issue(s) commencing 08/01/18 and ending on 08/01/18, both dates inclusive, and that such newspaper was regularly distributed to its subscribers during all of said period. That the full amount of the fee charged for the foregoing publication is the sum of $56.25, amount has been paid in full, at the rate of $7.75 per column inch per insertion.

Subscribed and sworn to before me 08/01/18

Debbie Guerrero

Notary Public in and for the State of Washington

DEBBIE GUERRERO
COMMISSION EXPIRES
NOTARY
PUBLIC
JUNE 17, 2020
STATE OF WASHINGTON

GWAC Attendance Roster

Member	9-Aug-2018
Stuart Turner	Present
Chelsea Durfey (alternate)	Absent
Bud Rogers	Present
Kathleen Rogers (alternate)	Present
Patricia Newhouse	Absent
Sue Wedam (alternate)	Present
Doug Simpson	Present
Jean Mendoza	Present
Eric Anderson (alternate)	Absent
Jan Whitefoot	Absent
Jim Dyjak (alternate)	Present
Steve George	Present
Frank Lyall (alternate)	Present
Jason Sheehan	Present
Dan DeGroot (alternate)	Present
Ron Cowin	Present
Laurie Crowe	Present
Rodney Heit (alternate)	Absent
John Van Wingerden	Present
Rand Elliott	Present
Holly Myers	Absent
Ryan Ibach (alternate)	Present
Dr. Troy Peters	Present
Lucy Edmondson	Present
Peter Contreras/Nick Peak (alternate)	Absent
Elizabeth Sanchey	Absent
Stuart Crane (alternate)	Present
Gary Bahr	Present
Perry Beale (alternate)	Absent
Andy Cervantes	Present
Sheryl Howe (alternate)	Absent
David Bowen	Present
Sage Park (alternate)	Absent
Lino Guerra	Present
Rick Perez (alternate)	Absent
Jessica Black	Present
Alexander V. Alexiades (alternate)	Absent
Matt Bachmann	Absent
Robert Black (alternate)	Present

Attachment B

- Draft Lower Yakima Valley Groundwater Management Program Volume I, reviewed August 9, 2018
- Draft Lower Yakima Valley Groundwater Management Program Volume II, reviewed August 9, 2018

Lower Yakima Valley Groundwater Management Program

Volume I

August 9, 2018

LOWER YAKIMA VALLEY
GROUNDWATER
ADVISORY
COMMITTEE

Primary Author: James H. Davenport, Attorney at Law, on behalf of, and with assistance of Yakima County Department of Public Services

Thank you in particular to Vern Redifer, Lisa Freund, Chris Saunders, Phil Rosenkranz, Bobbie Brady, Patty LeBlanc, Michael Martian, and Cynthia Kozma

This program was approved by the GWAC on XXX.

Groundwater Advisory Committee

Name	Affiliation
Rand Elliott	Yakima County Board of Commissioners
Vern Redifer	Yakima County Public Services
Elizabeth Sanchey	Yakama Nation
Stuart Crane	Yakama Nation
Steve George	Yakima County Farm Bureau
Frank Lyall	Yakima County Farm Bureau
Jason Sheehan	Yakima Dairy Federation
Dan DeGroot	Yakima Dairy Federation
Stuart Turner	Agronomist, Turner and Co.
Chelsea Durfey	Agronomist, Turner and Co.
Jean Mendoza	Friends of Toppenish Creek
Eric Anderson	Friends of Toppenish Creek
Jan Whitefoot	Concerned Citizens of the Yakama Reservation
Jim Dyjak	Concerned Citizens of the Yakama Reservation
Laurie Crowe	South Yakima Conservation District
Rodney Heit	South Yakima Conservation District
John Van Wingerden	Port of Sunnyside
Gary Bahr	WA Department of Agriculture
Perry Beale	WA Department of Agriculture
Andy Cervantes	WA Department of Health
Sheryl Howe	WA Department of Health
David Bowen	WA Department of Ecology
Sage Park	WA Department of Ecology
Lucy Edmondson	U.S. EPA
Nick Peak	U.S. EPA
Holly Myers	Yakima Health District
Ryan Ibach	Yakima Health District
Dr. Troy Peters	WSU Irrigated Agriculture Research and Extension Center
Ron Cowin	Roza-Sunnyside Joint Board of Control
Lino Guerra	Hispanic Community Representative
Rick Perez	Hispanic Community Representative
Doug Simpson	Irrigated Crop Producer
Bud Rogers	Lower Valley Representative Pos. 1
Kathleen Rogers	Lower Valley Representative Pos. 1
Patricia Newhouse	Lower Valley Representative Pos. 2
Sue Wedam	Lower Valley Representative Pos. 2
Dr. Jessica Black	Heritage University
Dr. Alex Alexiades	Heritage University
Matt Bachmann	USGS Washington Water Science Center

No Longer Participating:

Name	Affiliation
Helen Reddout	Community Association for Restoration of the Environment
Wendell Hannigan	Community Association for Restoration of the Environment
Bruce Perkins	Benton-Franklin Health District
Mark Nielson	Benton Conservation District
Heather Wendt	Benton Conservation District
Jaclyn Ford	WA Department of Agriculture
Tom Ring	Yakama Nation
Ginny Prest	WA Department of Agriculture
Charlie McKinney	Department of Ecology
Tom Tebb	Department of Ecology
Robert Farrell	Port of Sunnyside
Lonna Frans	USGS Washington Water Science Center
Robert Morales	Lower Valley Community Representative
Ramon Tobias	Hispanic Community Representative
Margarita Tobias	Hispanic Community Representative
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David Cole	Yakima Health District
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Marie Jennings	U.S. EPA
Bill Dunbar	U.S. EPA
Jim Newhouse	South Yakima Conservation District
Jim Trull	Sunnyside Valley Irrigation District

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Contents – Volume I

Executive Summary

The Lower Yakima Valley Groundwater Management Area (GWMA) was formed in 2012 to address the stated goal of reducing nitrate concentrations. Evaluations of historic data determined that 12% of the drinking water wells tested in the Lower Yakima Valley contained elevated nitrate concentrations exceeding the drinking water standard of 10 mg/L (PGG 2011). A recent groundwater study in the Lower Yakima Valley, which sampled over 150 private domestic wells in 2017, found that 26 percent of the wells had at least one of its six samples exceeding the drinking water standard. Nitrate was not detected in 13 percent of the wells sampled (USGS 2017). Nitrate impacts to groundwater are common in agricultural areas (Harter 2009). While many sources contribute to nitrates in groundwater, data from these wells indicate water has been affected by activities at the land surface.

In response, Yakima County established the Lower Yakima Valley Groundwater Management Area (LYVGWMA), and formed the Groundwater Advisory Committee (GWAC) in 2012. The goal of the GWAC was to develop a Program to recommend approaches to reduce nitrate levels in groundwater and meet state drinking water standards. This document is that Program, the report of the GWAC's completed work.

The GWAC was a large and diverse committee and included representatives from all identified groups affected by the state of groundwater, including: local, state and federal government agencies, farmers, local citizens, dairy producers, agronomists, irrigation districts, conservation district, environmental groups, and other vested parties. This committee, and its workgroups met monthly over the past six years.

The diversity of the committee members' interests often made for contentious discussions, but the members were committed to resolving the issues and continued to participate, and were usually respectful. This high level of commitment is demonstrated by the tremendous amount of work that was produced and the fact that the group was able to reach consensus on many issues.

Funding

Funding to support the development and planning stage of the Lower Yakima Valley GWMA was appropriated by the Washington State Legislature primarily through the efforts of Senator James Honeyford, of Sunnyside.

Program Content

This document focuses on the following elements: 1) a description of the issue, 2) the establishment of the Lower Yakima Valley Groundwater Management Area, 3) the goals and objectives for addressing elevated nitrate in groundwater, 4) characterization of the area, 5) sources of nitrate, 6) the regulatory environment, 7) environmental and health effects of nitrate, 8) an extensive list of all the work that has been conducted by the GWMA, and 9) a list of recommendations and alternative actions to reduce nitrate concentrations in groundwater during the implementation phase.

Workgroups

Several workgroups were established to discuss and resolve specific issues. These workgroups focused on 1) Education and Outreach; 2) Residential, Commercial, Industrial, and Municipal; 3) Irrigated Agriculture; 4) Livestock and CAFO; 5) Regulatory Framework; and 6) Data Analysis workgroup. These workgroups were highly functioning, typically meeting monthly, and were responsible for reporting to the Groundwater Management Advisory Committee (GWAC) on their work.

Initiatives Completed by the GWAC

The following initiatives were completed by the GWAC:

- Free well water testing
- Education and outreach
- Fact sheets produced in English and Spanish
- Billboards
- Deep soil sampling
- Drinking water sampling program
- Initial locations for 30 monitoring wells for the ambient groundwater monitoring program

- Nitrogen Availability Assessment
- Documents created by PGG (listed in Appendix F)
- Best Management Practices as defined by Irrigated Agriculture and Livestock/CAFO Workgroups
- Development of a GIS (geographic information system) database where all data is consolidated
- GIS tool that combines surface and subsurface physical conditions, nitrogen sources and land use within the LYVGWMA

Alternative Management Strategies

Through the workgroups and other contracted work, the GWAC identified a list of over 250 potential alternative management strategies that could reduce nitrate concentrations in groundwater. The GWAC discussed each strategy and reached consensus on a set of 66 strategies, in the following categories:

- Administration
- Public Health and Safety
- Residential, Commercial, Industrial, and Municipal
- Irrigated Agriculture
- Livestock/CAFO
- Data Collection, Characterization, and Monitoring
- Regulatory Framework

Recommendations

Considering the factors listed in WAC 173-100-100 (4), the GWAC members placed weighted values on each strategy. These values were totaled to determine the total support of the GWAC for each strategy. The final recommended actions are set forth in this Program.

Implementation

The next phase of the GWMA is implementation. At one of its final meetings, the GWAC recommended, (by a vote of 14-1, 1 abstention, 1 not voting,) that Yakima County act as lead agency in future Lower Yakima Valley groundwater management programs, recognizing that the County's activity as lead agency would be subject to available funding from the State of Washington.

The body of work which the GWAC completed in the Assessment and Planning phase provides the foundation for this next phase, which is the Implementation Phase. This document, the work it represents, and its program recommendations, will facilitate implementing practices in order to meet the goal of reducing nitrate concentrations in groundwater.

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Introduction

The Problem

Groundwater in the Lower Yakima Valley has elevated nitrate concentrations. A number of groundwater studies have documented nitrate concentrations in excess of the Safe Drinking Water Act Maximum Contaminant Level of 10 mg/L. Between 1988 and 2008, 12 percent of wells tested in the area had nitrate concentrations above that level. Another 21 percent of wells tested were below this level but higher than 5 mg/L (reported in Ecology et al., 2010).[1]

These numbers raised concerns due to the potential impact to human health (Ecology et al., 2010). Nitrate is considered an acute contaminant and may cause serious health conditions in vulnerable populations. If the condition is left untreated in newborns, death is possible. In the Lower Yakima Valley, residents may be exposed to nitrate if they obtain their drinking water through a private or shared well—the typical source of drinking water for the 6100+ rural households not served by a public water system. Assuming 12 percent of private wells exceed the Safe Drinking Water Act Maximum Contaminant Level, up to 720 of those households would be exposed to nitrate-contaminated groundwater.

The Response

Grass roots organizations such as Community Association for Restoration of the Environment (CARE) and Concerned Citizens for the Yakama Reservation (CCYR) identified the problem in 1997. Articles entitled "Hidden Wells, Dirty Water" ran in the *Yakima Herald Republic* in 2008, detailing nitrate issues affecting public and private wells. The articles suggested that a lack of coordination between local, state, and federal agencies aggravated the problem. The county permits land use, Department of Agriculture permits most dairies and agricultural activities, and under authority delegated by EPA, the

[1]Further problem definition is contained in this Program below in the sections characterizing the GWMA, describing the land uses traditionally and currently conducted within the GWMA, and the data and observations made possible by the investigation and analysis conducted by the GWAC.

Department of Ecology oversees water quality programs and the permitting of some dairies. The EPA, along with other state and local agencies, responded by facilitating public meetings in December 2008, February and October 2009, and June 2010. In November 2009, the Yakima Valley was designated as an EPA Environmental Justice Community.

In January 2010, EPA issued a finding in support of the use of SDWA Section 1431 of the Safe Drinking Water Act to address the contamination. EPA found that groundwater in the Yakima Valley is an underground source of drinking water which is contaminated, and that this contamination may present an imminent and substantial endangerment to human health. Sampling was conducted by EPA in February and April 2010, under the authority of SDWA Section 1431.

The Washington State Department of Ecology along with four other county, state, and federal agencies published a report (Ecology, February 2010) titled Lower Yakima Valley Groundwater Quality Preliminary Assessment and Recommendations Document. The report summarized the nitrate and coliform issue in the Lower Yakima Valley and was based on earlier technical reports and technical data obtained by the Washington State Departments of Ecology, Agriculture, and Health, the Yakima County Public Works Department, and the U.S. Environmental Protection Agency. The report identified a number of regulatory options for addressing the elevated nitrate concentrations including establishment of a Groundwater Management Area (GWMA), Special Protection Area, Aquifer Protection Area, Sole Source Aquifer, Watershed Management Plan, and Total Daily Maximum Load (TDML). Of these options, the Yakima County Commissioners selected to establish a GWMA and signed an interagency agreement with Ecology in September 2010.

The Lower Yakima Valley Groundwater Management Area (LYVGWMA) was established in 2011, and the Groundwater Advisory Committee (GWAC) was established in 2012. The goal of the GWAC was to develop a GWMA Program to recommend approaches to reduce nitrate levels in groundwater to below state standards. Its membership reflected the coordinative nature of the effort. Citizen and agricultural industry representatives were appointed to bring knowledge of potential sources and concern about public acceptance of the committee's work. Representatives from Ecology, Washington State Department of Agriculture (WSDA), Washington State Department of Health (DOH), the US

Environmental Protection Agency (EPA), the Yakama Nation, the Yakima Health District, and Yakima County were appointed to the GWAC so as to gather all of the relevant regulatory aspects pertinent to the problem.

The GWAC tasked itself with identifying the primary sources of nitrate contamination using scientific data, and identifying or developing practices that would minimize nitrate concentration of groundwater. To accomplish its tasks, it developed a plan that would recommend strategies for implementing improved practices and providing appropriate education and outreach on health risks and how to prevent exposure (GWAC talking points, approved February 2013).

Its objectives included problem identification, data collection, monitoring and analysis; potential measures or practices for reducing groundwater contamination, and public education and outreach (GWAC talking points, approved February 2013).

At-Risk Populations and Public Education

As the GWAC began its work, it immediately initiated an education and outreach program to reach out to at-risk populations and their families served by private or shared wells in the LYVGWMA. Infants, pregnant women, women who may become pregnant, and individuals with certain blood disorders are all considered at high risk from exposure to elevated or high levels of nitrate. Accordingly, an outreach program was implemented to inform these populations and their families of the health risks of high nitrate, how to protect themselves, and how to protect the groundwater that their drinking water wells draw from. As Spanish is the primary language spoken in an estimated 60 percent of LYV GWMA households, a bilingual (Spanish/English) outreach program was implemented and ran concurrently with the GWMA Program development.

Meetings

The GWAC held its first meeting on June 5, 2012. Over the next six years it would meet more than 50 times to accomplish the work it identified. The GWAC initially also included representatives from Benton County. However, Benton County and the Benton County Conservation District withdrew from the LYVGWMA because they decided that it would provide their geographical area with a better approach if they took on the issue of nitrogen reduction in groundwater on their own. The makeup of the GWAC's membership adjusted over time, as people moved between professional and personal opportunities. The governmental entities and community interests represented remained the same throughout, although their personnel changed. Its subcommittees, or working groups, were tasked with the research, investigation and proposed recommendations within their area of expertise – Data Collection, Livestock/CAFO, Irrigated Agriculture, Residential, Commercial, Industrial and Municipal (RCIM), Regulatory Framework, Education and Public Outreach, and Funding. Working groups then brought their recommendations back to the GWAC for its consideration. The working groups would collectively hold over 200 meetings in the ensuing years.

Organization of the GWMA Program

The suggested content of a GWMA Program is defined by Chapter 173-100 WAC. The Program laid out in the following pages generally follows this structure. The Area Characterization describes the physical characteristics of the Lower Yakima Valley, the historic process by which it has been transformed from a semi-arid desert into an agricultural oasis, and how the land is used today. A section on demographics looks at who lives here and why. Ensuing chapters identify the GWAC's water quality goals and objectives, explore the sources of nitrogen and regulatory environment, and describe Yakima County's role in groundwater quality protection. The narrative then turns to the heart of the GWAC's work: its investigation and analysis of the sources of nitrate, the pros and cons of various recommendations, and finally, defining recommended actions at a variety of levels: legislative, state agencies, local government, and private individuals.

Boundary of the Groundwater Management Area

The Lower Yakima Valley Groundwater Management Area (LYVGWMA) is located within the Lower Yakima Valley, south of Union Gap, northeast of the Yakima River and west of the Yakima-Benton County line. Its total area is 175,161 acres. It lies in the southeastern portion of the Lower Yakima Valley north of Yakima River from Union Gap to the Benton County line, except for the southeastern end that extends south of the River onto the lower slopes of Toppenish Ridge. The Northern boundary generally lies on the southern slopes of Ahtanum Ridge several miles southwest of the Cold Creek Syncline.

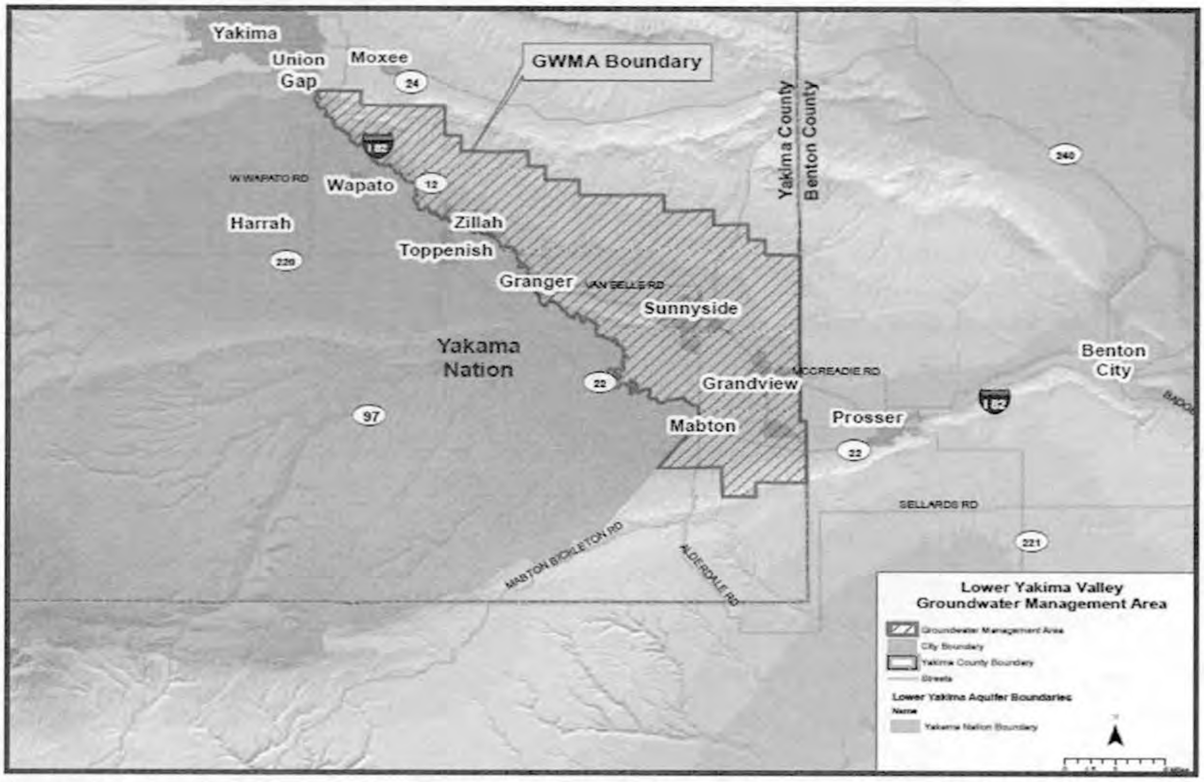

FIGURE 1 - GWMA BOUNDARY

The Groundwater Management Area addressed in this Program is essentially the same as the Western and Eastern Study Areas as identified within the 2010 *Preliminary Assessment.*[2] It includes the non-reservation lands along the northeastern side of the Yakima

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[2] *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

River south of Union Gap and the southeast Yakima Valley downstream of the confluence of Satus Creek and the Yakima River. Approximately 60 percent of the valley population resides in this area. The Groundwater Management Area includes the incorporated communities of Zillah, Sunnyside, Granger, Grandview, and Mabton and the rural settlements of Buena and Outlook.

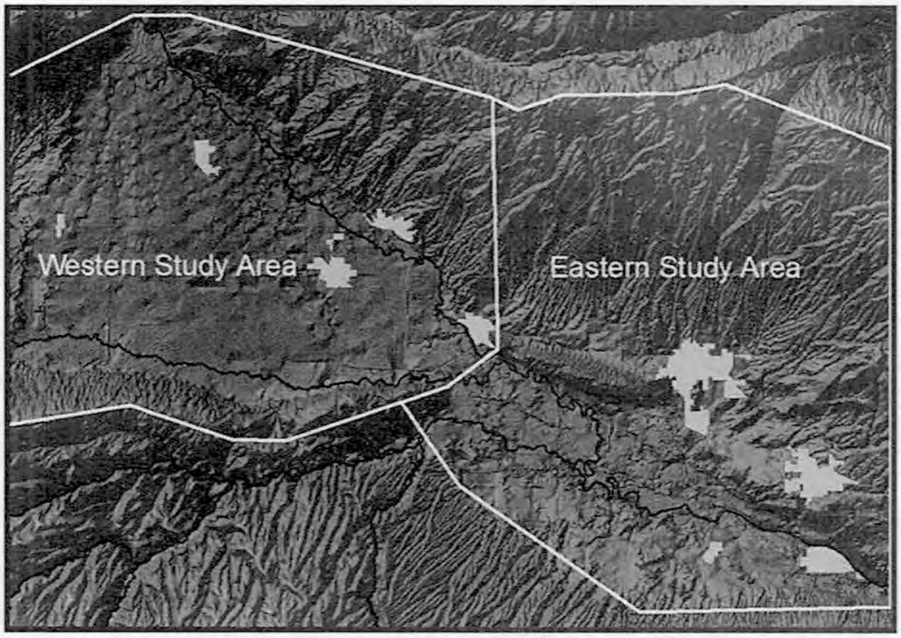


FIGURE 2 - AREAS OF PRELIMINARY ASSESSMENT

The *Preliminary Assessment* subdivided the study area in order to reflect geographic, geological, and geopolitical constraints; and corresponded to divisions reflected in the historical water quality data set.[3]

Agency, Ecology Publication No. 10-10-009, February 2010. (See Appendix A. for Administrative Background.)

[3] These two subareas roughly mirror the areas designated as upper and lower study areas in the 2002 Valley Institute for Research and Education groundwater study, and correspond to the Toppenish and Benton basins referenced in other studies. Both areas cover approximately 368,600 acres within Yakima County.

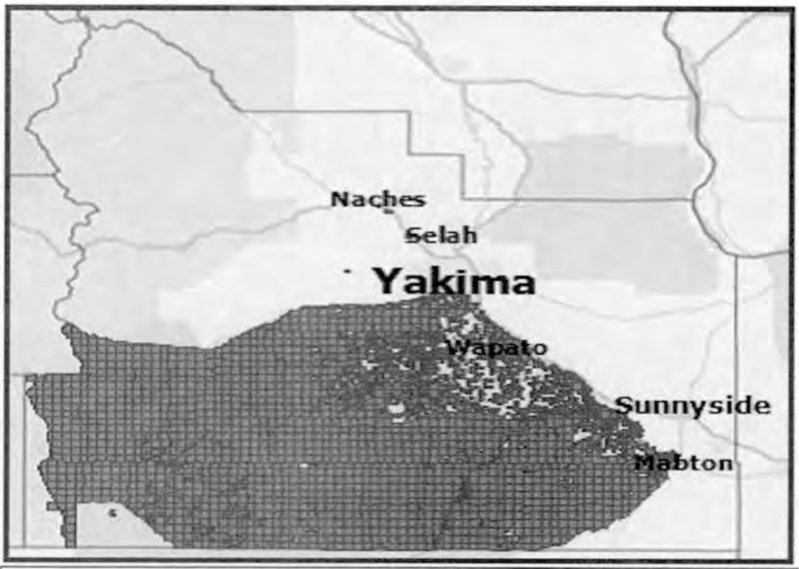


FIGURE 3 - YAKAMA INDIAN RESERVATION

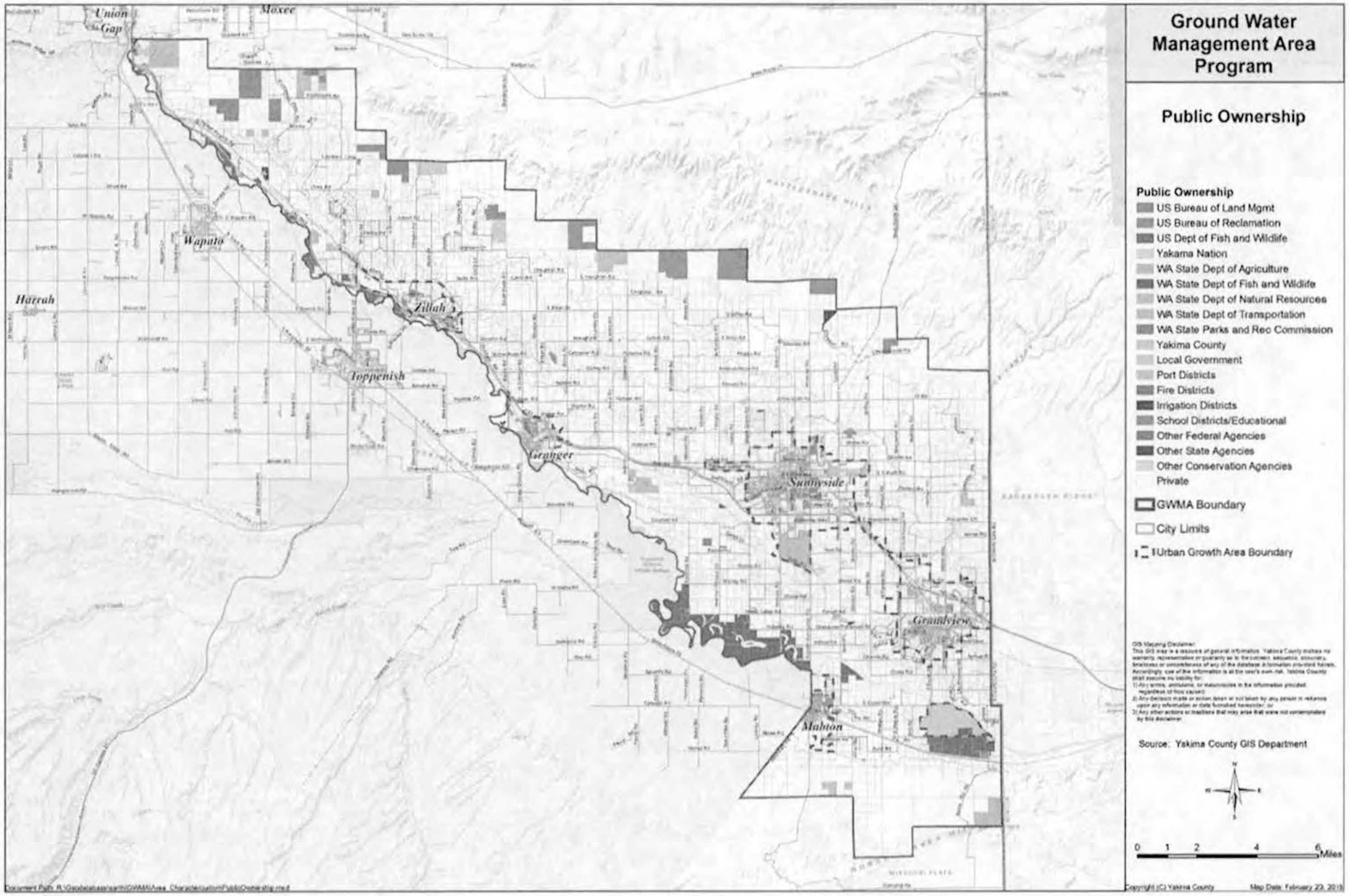
The Yakama Nation[4] elected not to participate in the deliberation of the Lower Yakima Valley Groundwater Advisory Committee, choosing to address nitrate levels independently, under the oversight of the Environmental Protection Agency.

Jurisdictional Boundaries: Federal, State, Local, Tribal

All the land within the GWMA is within the jurisdiction of Yakima County, with the exception of land within the municipalities of Zillah, Granger, Sunnyside, Grandview, and Mabton. While properties owned by the United States exist within the GWMA, they do not present relevant issue areas that relate to the nitrate problem addressed by this Program.

[4] Confederated Tribes and Bands of the Yakama Nation (Yakama Nation). The Yakama Indian Reservation lies along the southwest side of the Yakima River and extends beyond Yakima County boundaries into the northern edge of Klickitat County and Southeastern corner of Lewis County. It covers an area of approximately 1.3 million acres. The Yakama Nation has nearly 9,000 enrolled members from 14 bands and tribes.

FIGURE 4 - JURISDICTIONAL BOUNDARIES AND PUBLIC OWNERSHIP



Characterization of the Area

The following discussion describes the area as it currently exists. The information relates in some instances to Yakima County generally and in others to the LYVGWMA in particular. Caution should be exercised to notice the particular area under discussion as various information is presented. Investigations and analysis pursued during the process of the LYVGWMA are presented in a later section of this Program.

The Yakima River Basin

The Yakima River Basin is located in south-central Washington and includes three Washington State Water Resource Inventory Areas (WRIA—numbers 37, 38, and 39), part of the Yakama Nation lands, three eco-regions (Cascades, Eastern Cascades, and Columbia Basin), and touches parts of four counties: Klickitat, Kittitas, Yakima, and Benton (USGS 2006). Almost all of Yakima County and more than 80 percent of Kittitas County lie within the basin. About 50 percent of Benton County is in the basin. Less than one percent of the basin lies in Klickitat County, principally in an unpopulated upland area. Within the Yakima Basin, there are six structural sedimentary basins. The delineated sedimentary basins are from north to south, the Roslyn, Kittitas, Selah-Wenas, Yakima (Ahtanum-Moxee), Toppenish, and Benton Sedimentary Basins. All are clearly defined by the geologic structure in the Yakima River Basin. The LYVGWMA includes only parts of the Toppenish and Benton Sedimentary Basins.

The Toppenish Sedimentary Basin is fully contained within Yakima County. It is bordered on the north by the Ahtanum Ridge, on the south by the Toppenish Ridge, and bisected by the Wapato Syncline. The eastern boundary of this basin abuts the Benton Sedimentary Basin. Only the southeastern corner of the Toppenish Sedimentary Basin, northeast of the Yakima River, is included in the LYVGWMA boundaries.

The Benton Sedimentary Basin is bordered on the south by the Horse Heaven Hills structure. The northeast boundary generally follows the northern flank of the Cold Creek Syncline. The western boundary abuts the eastern boundary of the Toppenish Sedimentary

Basin and a small section of the Yakima Sedimentary Basin. Only the western portion of the Benton Sedimentary Basin, approximately a third, is in the LYVGWMA boundaries.

Geology

Stratrigraphy

<u>Basalt</u>

The Columbia River Basalt Group (CRBG) is a thick sequence of Miocene eruptive basalts, variously estimated several thousand feet thick, interbedded with a few minor sedimentary strata. It overlays the basalt rock unit, or bedrock, of the Yakima region. The total CRBG covers an area of more than 59,000 square miles (Tolan et al. 1989) and spanning parts of Washington, Oregon, and Idaho. It is subdivided into three primary units, or formations, designated the Saddle Mountains Basalt, the Wanapum Basalt, and the Grande Ronde Basalt (USGS 2009a, GSI 2009a, 2011d). The Saddle Mountains Basalt is often exposed at the surface. Its thicknesses ranges from 180 to 800 feet and averages more than 500 feet in the Yakima Basin. The Wanapum Basalt can be over 800 feet thick. The Grande Ronde Basalt underlies the Wanapum Basalt. These formations are further subdivided into several dozen members and hundreds of flows.

The uppermost basalt, the Saddle Mountains Basalt, is often visible at the bounding upland ridges of the Toppenish Basin such as the Rattlesnake Mountains, Ahtanum Ridge, Toppenish Ridge, and Horse Heaven Hills. It is made up of the Umatilla Member flows, the Wilbur Creek Member flows, the Asotin Member flows (13 million years ago), the Weissenfels Ridge Member flows, the Esquatzel Member flows, the Elephant Mountain Member flows (10.5 million years ago), the Bujford Member flows, the Ice Harbor Member flows (8.5 million years ago) and the Lower Monumental Member flows (6 million years ago). The underlying Wanapum Unit averages 600 feet thick. These units are separated by the Mabton Interbed, with an average thickness of 70 feet (EPA 2012).

Basalt is a dense rock, having a fine texture precluding identification of crystals without magnification. Basalt is resistant to erosion and weathering, and is a notable cliff-forming rock. Fresh, unweathered surfaces are black or dark gray; weathered surfaces range in color from gray to reddish brown. Basalt consists principally of small crystals of calcic labradorite, pyroxene, and olivine in a dense matrix of sodic labradorite, augite, and volcanic glass. Magnetite and apatite are common accessory minerals. Calcite, siderite, zeolites, opal, and chalcedony are common in veins and vesicles in the basalt (USGS 1962).

At the end of the Miocene Epoch, approximately 5.3 million years ago, an extended plain of basaltic lava covered most of eastern Washington (USGS 1962; USGS 2009a). The basaltic lava flows were extruded from fissures located in the eastern part of the Columbia Plateau (USGS 1962), most likely in the vicinity of Hells Canyon, Oregon. The extrusions of basaltic lava probably continued intermittently into the Pliocene Epoch (5.3-2.6 million years ago), covering sedimentary deposits, forming new basins of deposition, and changing stream courses (USGS 1962). This volcanic flow is called the Columbia Basin Basalt Group. The CRBG is that thick sequence of basaltic lava flows underlying southeastern Washington and extending into Oregon and Idaho (USGS 1962). The individual flows range in thickness from a few feet to more than 100 ft. The total basalt thickness in the central part of the plateau is estimated to be greater than 10,000 ft (USGS 1990b) and the maximum thickness in the Yakima River basin is more than 8,000 ft (USGS 1962).

Extrusions and flows of volcanic material now within the CRBG formation occurred intermittently over millions of years. Individual flow layers range from less than 20 to more than 200 feet in thickness. Individual flows may differ considerably in thickness from place to place (USGS 1962). Enough time elapsed between extrusions to allow considerable weathering of the uppermost frothy surfaces of lava flows and to allow development of thin soil zones, which were later buried by subsequent flows (USGS 1962). Bubbles of gases emitted from the solidifying molten lava created zones of abundant gas cavities (vesicles). The vesicles are sometimes filled with secondary minerals deposited by water percolating through the rocks. The vesicles are separated from each other by the encasing solid rock, except where they have been fractured or deeply weathered (USGS 1962). Natural gas was extracted from beneath the LYVGWMA between 1929 and 1941 (Alt/Hindman 2007).

<u>The Ellensburg Formation</u>

At the west side of the basaltic lava plain, approximately where the present Cascade Mountains now stand, there was a region of more intense volcanic activity before the period of basaltic lava extrusion ended. This volcanic activity was at an elevation somewhat higher than the lava plain but probably lower than the present Cascades. The volcanic debris created by this volcanic activity in those ancestral Cascade Mountains was the source of the sedimentary materials; which were subsequently deposited upon the lava plain, either transported by eastward flowing streams, in lakes, or aeolian processes moving ash and pumice, that together constitute the Ellensburg Formation (USGS 1962). The majority of the volcanic materials created by the volcanic activity was deposited upon the lava plain after these flows ceased and the Cascades continued to rise (USGS 1962; USGS 1999a).

The Ellensburg Formation consists of 85 to 95 percent semiconsolidated clay, silt, and sand with only 5 to 15 percent gravel and conglomerate. It often appears as sedimentary interbeds found between the various CRBG formations, members, and flow units. These interbeds vary in nature and composition, typically ranging between 1 and 100 feet thick. The color is predominantly gray, tan, and buff, although there are a few relatively thin rusty-brown sand and gravel strata. The clay and silt parts are massive at most places, but excellent bedding and shaly parting also are found. Some sand and gravel strata are crossbedded. The thickness of the individual beds ranges from a few feet to more than 100 feet; strata of clay, silt, and fine sand usually are somewhat thicker than strata of the coarser materials (USGS 1962). "More than 1,000 ft of course-grained volcanclastic sediment has accumulated over many parts of the Yakima River Basin." (USGS 1999a).

The Ellensburg formation is mostly tough and hard, although some sand and gravel strata are weakly cemented. The silt and sand are composed chiefly of pumice, volcanic ash, quartz, and scattered feldspar and hornblende particles. Clay-size particles consist mostly of finely divided pumice and ash. The gravel contains large amounts of tuff and a distinctive purple or gray tuffaceous hornblende andesite. Cementing material is mostly argillaceous (containing clay). Minor amounts of diorite, quartzite, and various granitic and metamorphic rock types also are found locally in the gravel; basaltic fragments are rare (USGS 1962).

Lower Yakima Valley Fill

A variety of fine and coarse-grained sediments, including and overlying the Ellensburg Formation and the underlying major basalt flows, also exists within the Toppenish Basin (EPA 2012). These sediments pinch out along the flanks of the ridges. They include Touchet Beds, loess, thick alluvial sands and gravels deposited by rivers and streams, including those within the Ellensburg Formation, and other unconsolidated and weakly consolidated valley-fill comprising glacial, glacio-fluvial, lacustrine, and alluvium deposits resulting from catastrophic glacial outburst floods that inundated the lower Yakima River Basin (USGS 1999a) (EPA 2012) (USGS 2009a) (USGS 1990b) (USGS 1962).

About 16,000 years ago these glacial outburst floods created "Lake Lewis" in what is today the Lower Yakima Valley and the LYVGWMA when the restricted flow of waters from periodic cataclysmic floods from Glacial Lake Missoula, pluvial Lake Bonneville, and perhaps from subglacial outbursts backed up through the constriction formed by the Wallula Gap in the Horse Heaven Hills. Water also backed up further downstream on the Columbia River between Washington and Oregon, delaying the drainage of Lake Lewis. The water remained for iterative undefined periods before the flood waters drained through Wallula Gap, permitted surfacious loess and basalt materials collected in the floods' transit southeast from the Spokane area to settle out to the lake's bottom, thus forming at least some of the fine grained gravelly and sandy materials extant today on the valley bottom of the Yakima River within the LYVGWMA. Lake Lewis intermittently reached an elevation of about 1,200 feet (370 m) above today's sea level before draining to the Columbia through Wallula Gap (Bjornstad 2006) (Alt 2001) (Carson/Pogue 1996).

Structural Geology

The Columbia Plateau has been informally divided into three physiographic subprovinces (Meyers and Price 1979; USGS 2009a). The western margin of the Columbia Plateau contains the Yakima Fold Belt subprovince.

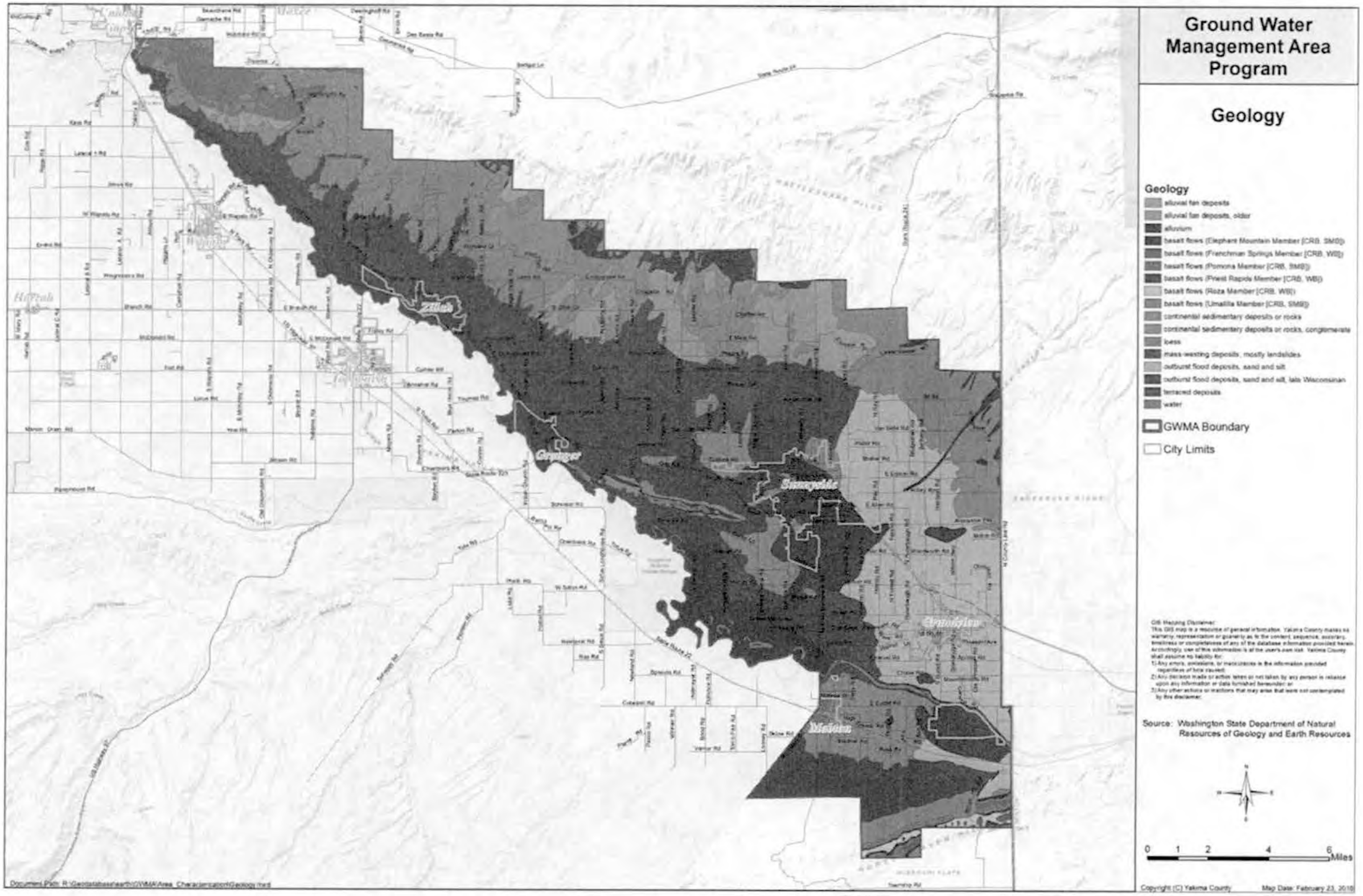
<u>The Yakima Fold Belt</u>

The LYVGWMA lies within the Yakima River Basin within the Yakima Fold Belt. The Fold Belt is a highly folded and faulted region underlain by various consolidated rocks ranging in age from the Precambrian Supereon to the Cenezoic Era's Miocene Epoch, and unconsolidated materials and volcanic rocks of the Quaternary Period's Pleistocene Epoch. Dominant geologic structures in the Yakima Fold Belt in the western part of the Columbia Plateau are long, narrow, east-west to east-southeasterly trending anticlinal ridges with intervening broad synclinal basins that essentially partition the groundwater flow system. "The anticlines function as groundwater flow barriers" (USGS 2009a; Vaccaro 2016).

The folding that created the anticlines and synclines within the Yakima region are the consequence of tectonic compression (McCaffrey et al., 2016), initially of the sedimentary rocks now underlying the Columbia River Basalt Group, from south of the Fold Belt region (the anticline's slopes are steeper on the north side) which probably began during the latter part of the Cenezoic Era during the Pliocene Epoch. The Ellensburg sedimentary material was still accumulating during this time. Earlier explanations suggested that the folding was likely related to the Cascade uplift and subsidence of the center of the lava body approaching from the southeast (Foxworthy 1962). The folding proceeded slowly enough so that the Yakima River could continue to erode its channel (Union Gap) as the Ahtanum Ridge anticline rose (Foxworthy 1962). The Ahtanum Ridge and the Rattlesnake Hills are the same anticline (Alt/Hyndman 2007). The Toppenish Ridge is another anticline, forming the southern boundary of the Toppenish Basin.

As the folding continued, the sedimentary material previously deposited on the parts of the plain that became the anticlinal ridges was eroded off and carried down into the centers of the synclinal basins. This process accounts in part for the great thickness of the Ellensburg formation (USGS 1962).

FIGURE 5 – GEOLOGY



Hydrogeology

The geologic framework and some of its hydrogeologic units of the Columbia Plateau regional aquifer system was described by Drost and others (USGS 1990b). The aquifer system consists of a large thickness of basalt made of numerous flows with minor interbedded sediments (USGS 1990b). The principal water bearing zones in the basalt sequence are those upper parts of certain flows rendered relatively permeable by weathering, jointing, and vesicularity (USGS 1962).

The lithology, or general physical character, of the materials within the hydrogeologic units of the LYVGWMA was described by USGS in its 2009 report (USGS 2009a), see Table 1. The several units described have various consolidated or unconsolidated structure. The unconsolidated units include alluvial, alluvial fan, terrace, glacial, loess, lacustrine, and flood (Touchet Beds) deposits that range from coarse-grained gravels to fine-grained clays, with some cemented gravel (Thorp gravel and similar unnamed gravels). Most of the unconsolidated units consist of coarse-grained deposits. The consolidated units are principally deposits of the Ellensburg Formation, but also include some undifferentiated continental sedimentary deposits. These units include continental sandstone, shale, siltstone, mudstone, claystone, clay, and lenses or layers of uncemented and weakly to strongly cemented gravel and sand (conglomerate). These clastic deposits are one of the most stratigraphically complex parts of the aquifer system (USGS 2009a).

TABLE 1 – HYDROGEOLOGY WITHIN THE ELLENSBURG AND OTHER SEDIMENTARY UNITS

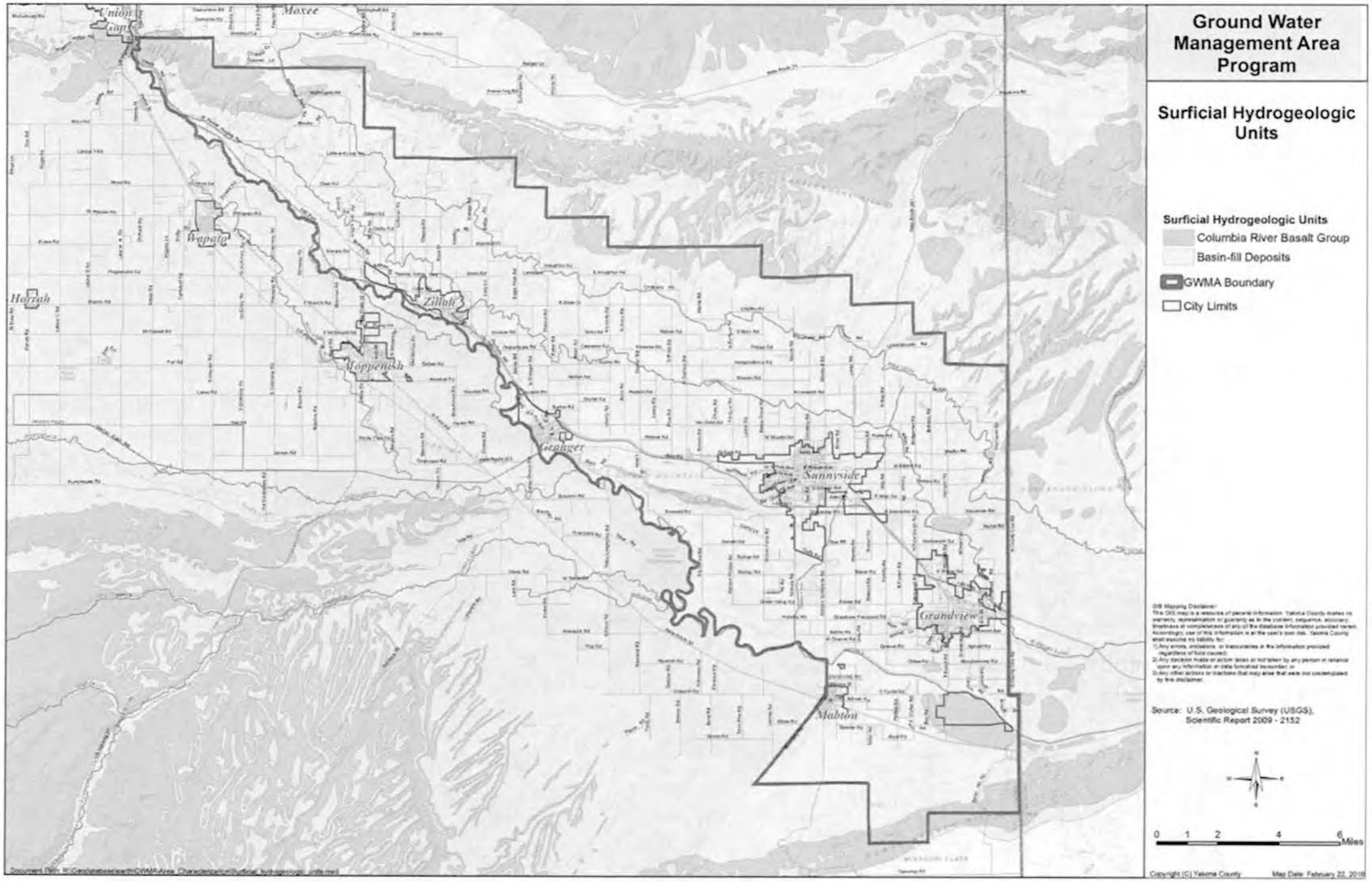
(AFTER USGS 2009A)

Structural Basin Name	Mapped Area	Unit	Lithology	Thickness		
				Range	Average	Median
Toppenish Basin	440	1 (fine grained consolidated)	Touchet Beds, terrace, loess, and some alluvial deposits	0 to 80	10	10
		2 (coarse grained unconsolidated)	Coarse-grained sand and gravel deposits	0 to 270	90	80
		3 (consolidated)	Consolidated deposits of the upper Ellensburg Formation and undefined continental sedimentary deposits	0 to 970	350	320
		4 (fine grained deposits)	Top of Rattlesnake Ridge unit of the Ellensburg Formation or "Blue Clay unit"	0 to 520	170	140
		5 (coarse grained deposits)	Base of Rattlesnake Ridge unit of the Ellensburg Formation	0 to 140	20	20
Benton Basin	Portions of 1020	1 (unconsolidated)	Alluvial, alluvial fan, loess, terrace, dune sand, Touchet beds, Missoula flood, and Ringold Formation deposits	0 to 870	120	70
		2 (consolidated)	Ellensburg Formation and undenfined continental sedimentary deposits	0 to 680	100	60

Bedrock units underlie the hydrogeologic units (USGS 2009a). As bedrock units likely hold little or no groundwater to be taken up by wells for domestic water supply, they are not discussed here. Most domestic wells are in the sediments above basalt. There are several basalt wells providing domestic water supply along the northern fringe of the project area.

Figure 6, derived from the USGS 2009 report, shows the surficial hydrogeologic units within the LYVGWMA.

FIGURE 6 – SURFICIAL HYDROGEOLOCIC UNITS



Aquifers

In 2009, the United States Geological Survey published its study of the geology, hydrology and hydrogeology of aquifers in the Yakima River Basin. The study found that there are two main aquifer types in the LYVGWMA. The first is a surficial unconfined to semi-confined alluvial aquifer. This aquifer is composed of highly layered alluvial material with predominantly silt, sand, and cobbles with a total thickness of up to 500 feet (USGS 2009a).

The second aquifer is an extensive basalt aquifer of great thickness underlying the surficial aquifer. The basalt aquifer is believed by the USGS to be semi-isolated from the surficial aquifer and stream systems. Natural groundwater flow within the shallower, surficial aquifer generally follows topography, but may be locally influenced by irrigation practices, ponds, lagoons, drains, ditches, and canals. Groundwater in this shallower aquifer generally flows toward the Yakima River (USGS 2009a) and is used locally for irrigation and residential water supply.

An aquifer is rock material where the pore space in the material is saturated, or full of water. Ground water occurs in the interstices in the rock material, in the spaces not occupied by solid material. If there is a pressure gradient in that material and the abundance, character, and degree of interconnection of those spaces can create a pathway for water to follow, it will move or be transmitted.

Natural rock materials differ in porosity. Porosity is a measure of the ability of the rock to contain water. It is the ratio of the volume of its interstices to its total volume. The porosity of some consolidated rocks, such as tightly cemented sandstone or massive lava flows, is only a few percent or even a fraction of a percent. The porosity of some clays may exceed 50 percent. In unconsolidated rocks, the well-sorted materials, such as clay or clean even-textured sand or gravel, have very high porosity. Poorly sorted materials, in which the smaller particles fill the openings between the larger grains, have low porosity.

Both "confined" and "unconfined" aquifers are known to exist within the LYVGWMA. A "confined aquifer" is one in which water has become confined between relatively impermeable materials. Water in confined aquifers will rise higher in a well than the bottom of the overlying confining bed. Such wells are called "artesian." The level to which water will theoretically rise in an artesian well is called the potentiometric (or piezometric) surface.

An "unconfined aquifer" (or "water table aquifer") is one where the upper surface of the water in the rock mass is at atmospheric pressure due to direct contact with the atmosphere through the pore space in the overlying soil and rock, and there is not confining pressure imparted by an overlying impermeable material. This surface level is called the "water table." The water table is the upper surface of an unconfined aquifer. The level at which water stands in a well penetrating an unconfined zone of saturation represents the water table at that place.

Aquifer dynamics are generally described in terms of amounts of water entering and exiting the aquifer. "Recharge" is the natural replenishment of an aquifer's water volume by downward seepage from the surface (rainfall, snowmelt, infiltration from lakes, wetlands and streams, irrigation or waste water), or groundwater moving from other underground sources. Water exiting the aquifer (water seeping from the ground (spring), pumped from a well, or departing the aquifer into surface water (wetland, stream, lake, estuary, ocean) or the atmosphere) is "discharge". The water table fluctuates chiefly in response to variations in recharge to, and discharge from, the ground-water body. Natural recharge may occur because of precipitation. Artificial recharge may occur through irrigation. Surface water streams or irrigation canals that cross permeable zones may recharge the aquifers beneath. Surface water streams or rivers that flow at an elevation below the water table discharge water from the aquifer.

Both the potentiometric surface of a confined aquifer and the water table of an unconfined aquifer are usually sloping, irregular, fluctuating surfaces. They are higher in areas of ground-water recharge, lower in areas of discharge, and affected by differences in permeability within the aquifer. The slope of either surface is called the "hydraulic gradient."

Figure 7, derived from USGS' 2009 study (USGS 2009a), shows the location of known springs within the Toppenish Basin. Figure 8, derived from the same study, shows the mean annual recharge of the surficial aquifers within the LYVGWMA.

FIGURE 7 – SPRINGS WITHIN THE TOPPENISH BASIN

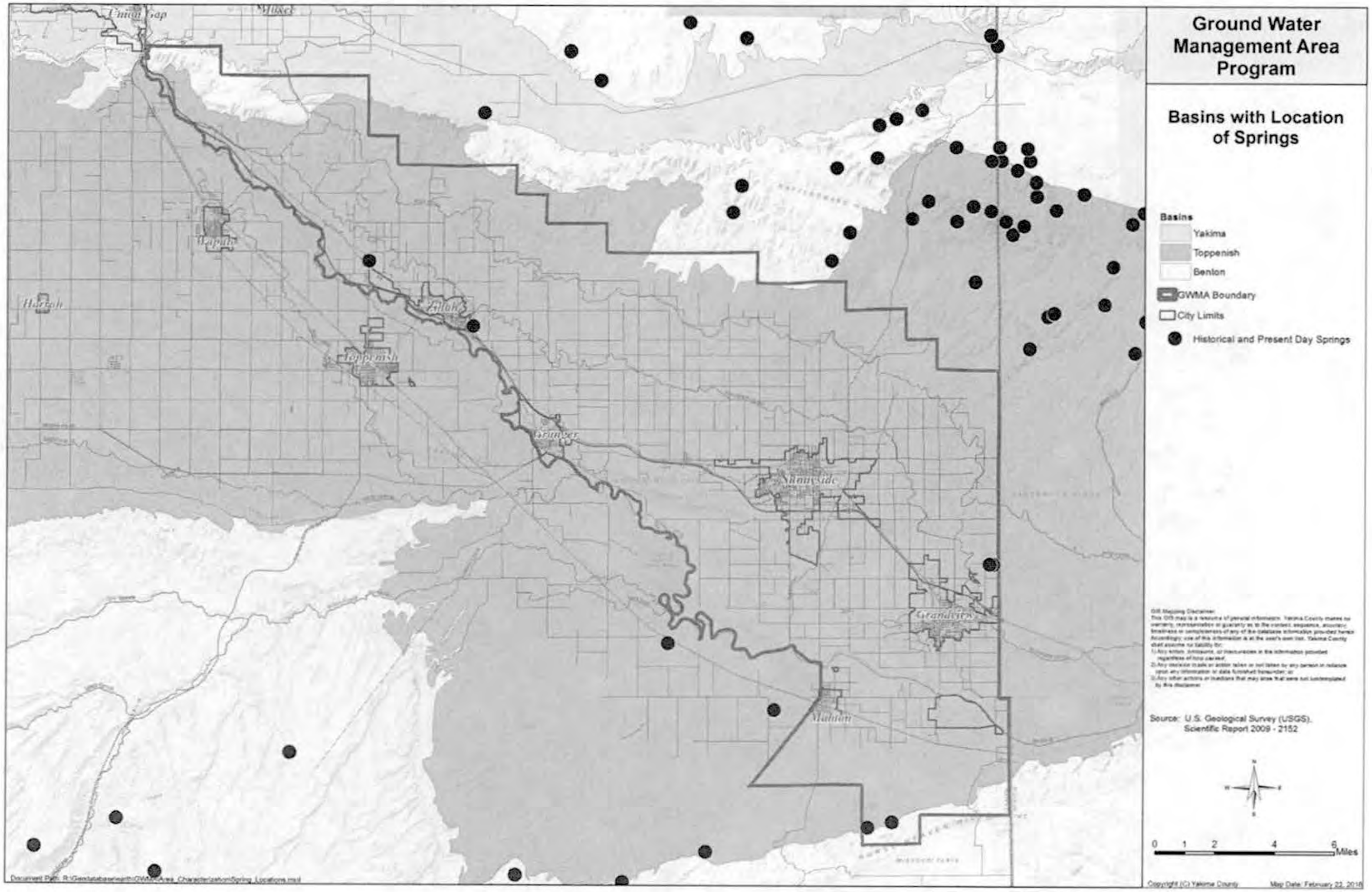
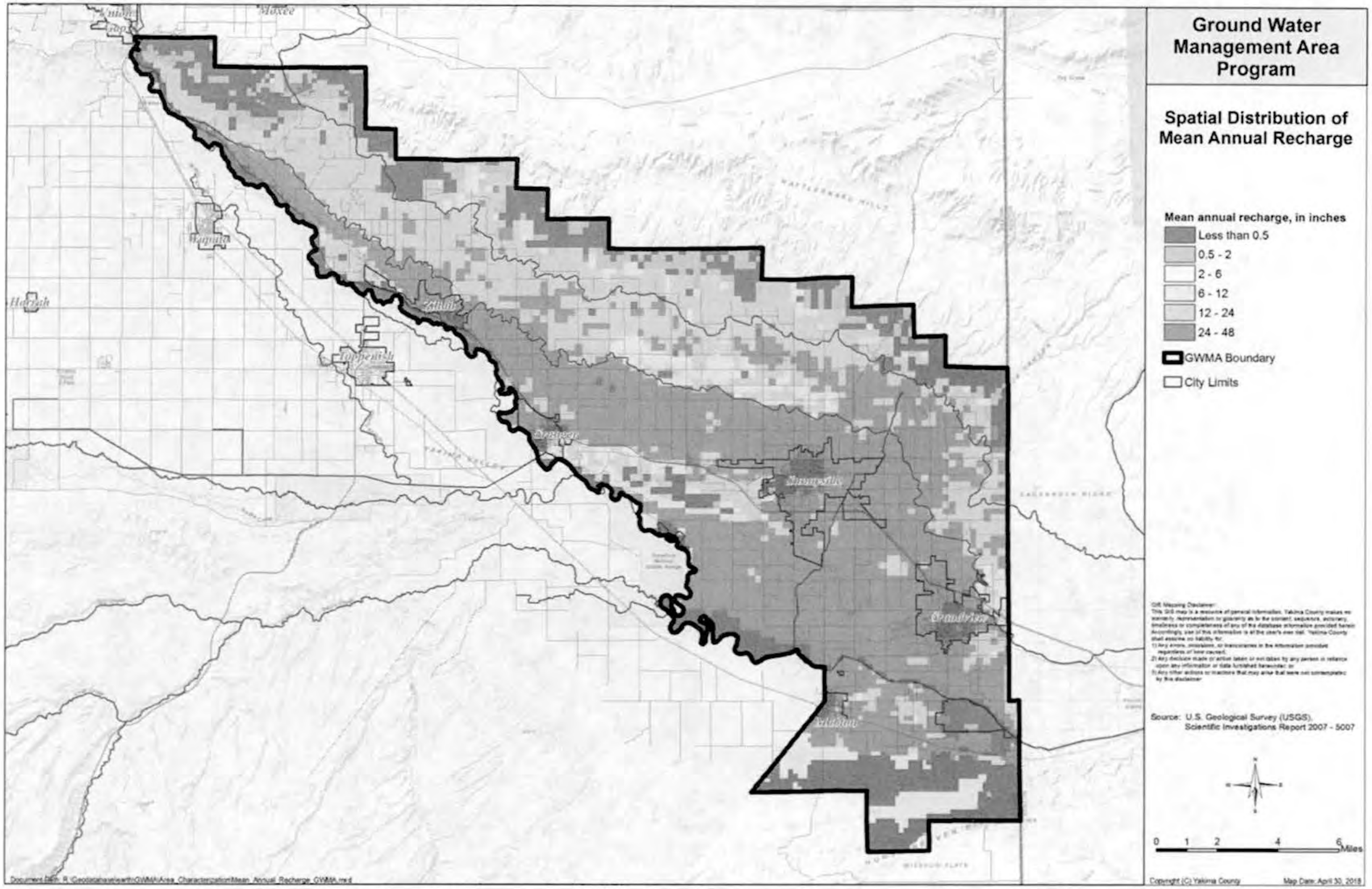


FIGURE 7 – MEAN ANNUAL RECHARGE WITHIN THE LYVGWMA



Mean Annual Groundwater Recharge

"Groundwater recharge" is a combination of all water (surface water, irrigation water, waste water, precipitation, etc.) that infiltrates the ground surface. "The delivery and use of surface water in the irrigation districts provide a source of recharge (more than 10 inches per year and in some areas more than 20 inches per year" (Vaccaro 2016; USGS 2007a). These are "acre-inches," a portion of the area's precipitation and around 3 acre feet of delivery by the irrigation districts. They are typically what would be called the non-consumptive portion of water use, that which actually soaks into the ground past the root zone / plant uptake. From there it goes to drains, surficial aquifers or deeper aquifers, at some eventual time either returning to the river or being pumped and returned to the surface for use. The USGS' conclusion of recharge was established by a one-day time-step model, utilizing the daily inputs from 25 years (1959-2001) of historical records, taking into account droughts, cool years, etc. It takes precipitation, temperature, humidity, evaporation and crop-specific evapotranspiration of plants into account.

Figure 8 reflects the conclusions derived from Figure 10 of the USGS' 2007 report (USGS 2007a). It is possible that the current state of mean annual groundwater recharge differs from that represented by this figure. Members of the LYVGWMA felt intuitively that the conclusions of the report were too high and failed to take into consideration changed conditions relevant to groundwater recharge. Members also believed that the increments of estimated annual recharge, i.e. 12-24 inches, 24-48 inches, were too great to be informative about any particular segment of land within the LYVGWMA. A better estimate might be derived by using a more recent period of climate condition, considering evolved irrigation methods, taking significant conversion of irrigation method into account, considering actual irrigation water application rather than estimated irrigation water application, considering irrigation canal lining, and studying the LYVGWMA more particularly rather than the basin-wide study of the USGS' 2007 report.

Vaccaro studied recharge in the context of water supply available for potential rural residential development (Vaccaro 2016). Two "domains," "Rattlesnake Hills Domain," and the "Mabton Domain," were identified within the LYVGWMA. "The Rattlesnake Hills Domain (246 square miles) includes the relevant lands south of the Moxee Drain and east and north of the Yakima River (left bank). The eastern boundary of the domain is the boundary between Yakima and Benton Counties." The "Mabton Domain" (40.9 square miles) includes the area north of Horse Heaven Hills (defined by the ridge line) east of the Yakama Nation boundary, south of the Yakima River and west of the Yakima-Benton County line. These two domains thus include the same area as that contained within the LYVGWMA. The Rattlesnake Hills Domain was divided into sectors, one below the Roza Irrigation District canal ("Sector 1"), the other above that canal ("Sector 2"), both of which are contained within the LYVGWMA boundaries. The Mabton Domain was not further divided. (Vaccaro 2016).

> "Sector 1 [of the Rattlesnake Hills Domain] (194 square miles) includes the irrigation districts present on Rattlesnake Hills such as Sunnyside Valley [SVID], Roza [RID] and Union Gap [UGID]. The delivery and use of surface water in the irrigation districts provide a source of recharge (more than 10 inches per year and in some areas more than 20 inches per year (USGS 2007a) to the system. The sector includes the cities of Zillah, Sunnyside, Granger, and Grandview. Except for the northern and eastern part of the sector, the area is typified by basin fill deposits generally over 200 feet thick. That is, basin-fill deposits over more than two-thirds of this sector are almost everywhere greater than 200 feet, and over about one-half of the sector they are greater than 400 feet. In the smaller, southeastern part of the sector, the deposits are thinner and future residential wells may need to be finished into the Saddle Mountains unit. Most of the existing wells may need to be finished in the basin-fill deposits and much of the future pumpage in this sector would occur from these deposits except along the peripheral boundary with sector 2 or where the basin-fill deposits thin toward the east. Future wells near the boundary between the two sectors likely would be needed to be drilled deeper than wells downslope. Groundwater-level hydrographs indicate stable water levels in these deposits. The groundwater levels for the units indicate that future withdrawals from the basin-fill deposits would have minimal, if any affect, on the deeper Wanapum and Grande Ronde units."
>
> "Recharge over most of th[e] area [in the Mabton Domain north of the 700 foot water level contour for the Saddle Mountains unit [described by] Vaccaro and others (USGS 2009a)] is more than 10 inches per year because of the influence of surface water irrigation [from the Roza Irrigation District]" (Vaccaro 2016).

Groundwater Levels and Flow

The two main aquifers underlying the area bordered on the north by the Ahtanum Ridge, on the south by the Toppenish Ridge, and bisected by the Wapato Syncline (USGS 2009a). These include a surficial unconfined to semi-confined alluvial aquifer and basalt aquifers underlying the sedimentary deposits (USGS 2009a). The basalt is believed to be semi-isolated from the surficial aquifer and stream systems. Groundwater flow within both aquifers generally follows topography, with natural recharge occurring within the headlands and on the sides of the valley and discharge occurring to the Yakima River. This produces a major flow direction from northwest to southeast, and a minor component flowing northeast to southwest and southwest to northeast. It is likely that the minor components of flow are enhanced by irrigation practices upland from the Yakima River (USGS 2009a; Vacarro 2016).

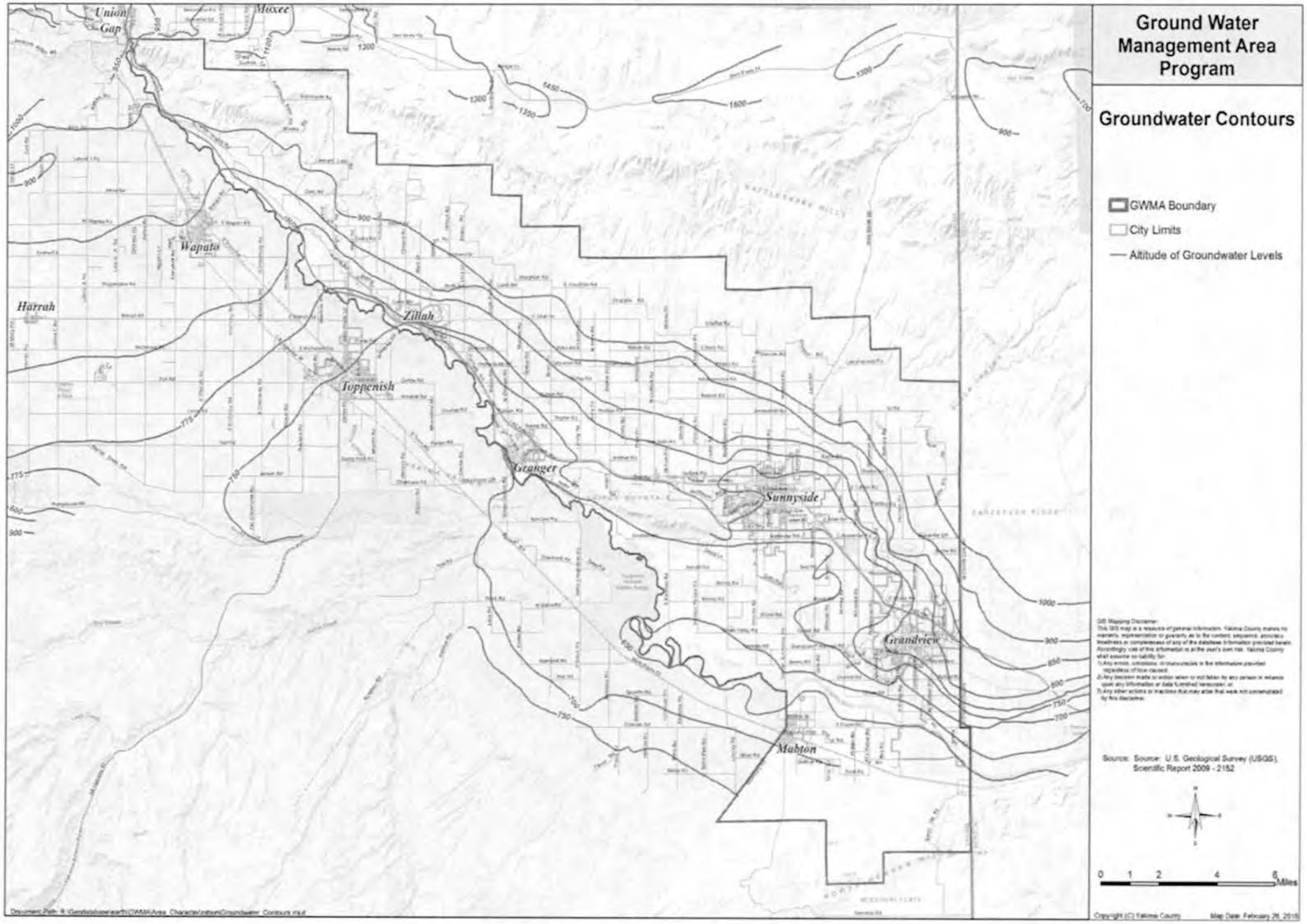
Because the potentiometric surface or water table of confined and unconfined aquifers, respectively, are variable, it is difficult to determine with certainty the depth of either from the ground surface. The USGS has, however, established groundwater level contours that can be used to compare against ground surface contours. Figure 9, derived from USGS' 2009 report (USGS 2009a), shows groundwater level contours (without distinguishing whether that level occurs within the alluvial, basalt, or both parts of the aquifer system). Figure 10 shows ground surface contours (topography) in meters. Figure 11, derived from determining the distance between the two contours, shows calculated depth to groundwater.

The vadose zone is the unsaturated zone between the land surface and the top of the water table. Depth to water is the distance between the ground surface and the water table. Time of travel through the vadose zone is dependent on depth to water, the vadose zone material, the amount of recharge, and other factors. Earthen materials within the vadose zone have different degrees of "permeability." Permeability is a measurement of the rate of infiltration. Permeability is used on both unsaturated and saturated flow. It is a measure of the intrinsic properties of a material that describes the ability of fluids to move through the material. It is independent of moisture content. It is intrinsic to the material (aquifer matrix). Moisture movement through the vadose zone is controlled by both material property and percent saturation or moisture content.

Unconfined (water-table) aquifers flow generally in accordance with the topography towards rivers, streams, lakes, and springs. The direction of groundwater flow in unconfined aquifers is normally perpendicular to groundwater contours premised upon measured or hypothetical water table levels (USGS 2009a). Groundwater flows from the direction of the highest potential energy to the lowest potential energy. The four types of potential energy that influence groundwater flow include gravitational potential, pressure potential, matric potential, and osmotic potential. The USGS has drawn its best judgment of the direction of that groundwater flow within the LYVGWMA. See Figure 16.

The hydraulic conductivity of bedrock units, CRBG basalts, and basin fill units were estimated from specific capacity data reported on drillers' logs by USGS (USGS 2009a). The median lateral K_h of bedrock, basalt, and basin fill units were 3, 3, and 6 ft/day in 9,833 and 882 wells, respectively, throughout the larger study area of the Yakima River Basin (USGS 2009a).

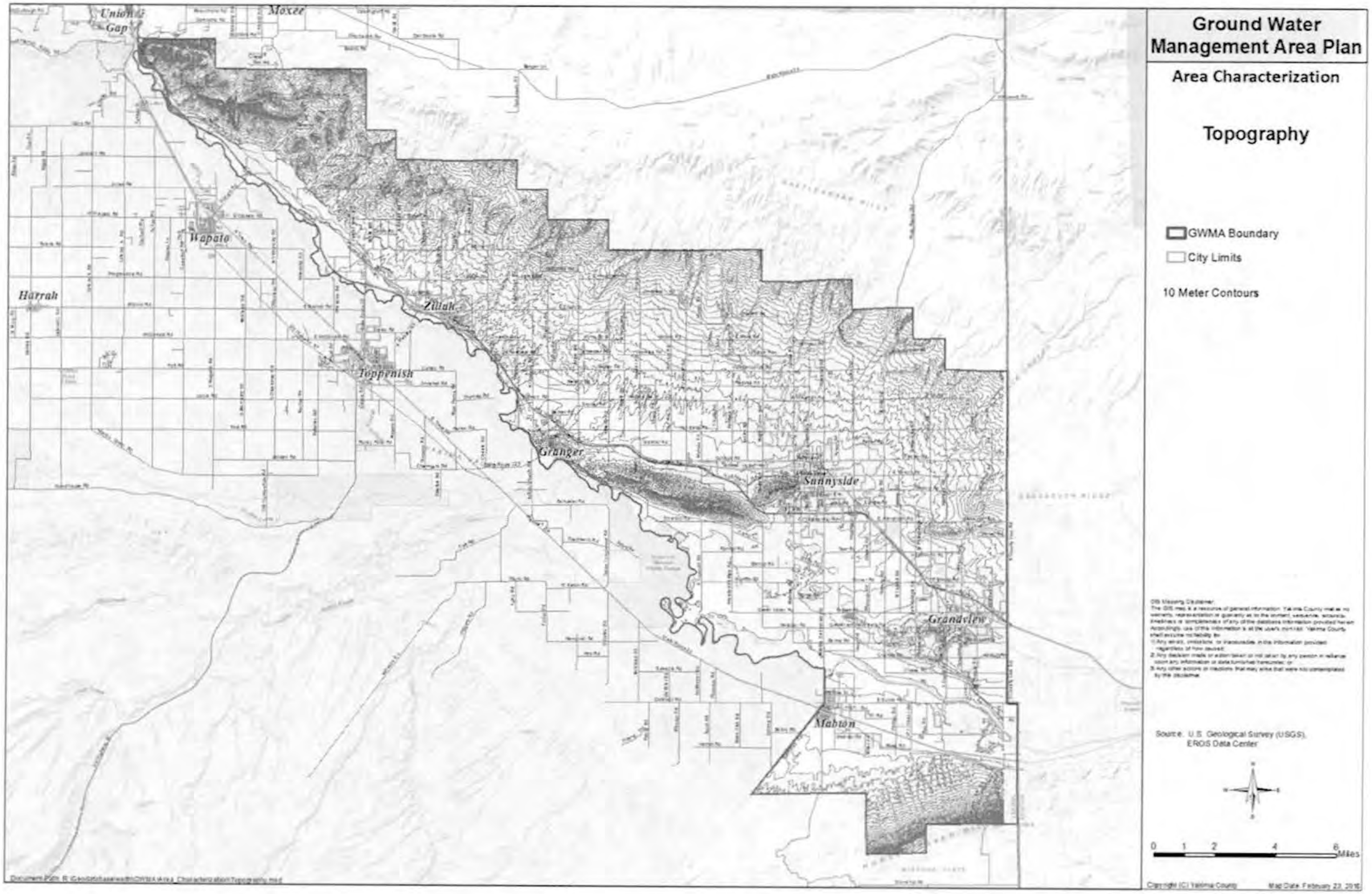
FIGURE 8 - GROUNDWATER LEVEL CONTOURS ESTABLISHED BY USGS WITHIN THE LYVGWMA



Topography

The topographical surface of the groundwater management area is undulating hillside running down (from an elevation of approximately 400 meters or 1312 feet above sea level) to the valley floor and river floodplain (at an elevation of approximately 230 meters or 755 feet above sea level). The topographical map on the next page illustrates essentially parallel elevation contours (denominated in meters)—evidence of a gradual descent from north-northeast along the Rattlesnake Ridge to south-southwest along the Yakima River.

FIGURE 9 - GROUND SURFACE CONTOURS (TOPOGRAPHY) WITHIN THE LYVGWMA



Depth to Groundwater

Groundwater levels are very shallow (0-15 feet) in the valley bottom and in several areas northeast of Granger, north and southeast of Sunnyside, surrounding Grandview and southeast of Mabton. They are marginally deeper (15-25 feet) in adjacent lands running east-southeastward from north of Granger past areas north of Sunnyside to Grandview and in the areas surrounding Mabton. Groundwater levels are deeper (25-100 feet) roughly in the areas between the SVID and RID irrigation canals. They become much deeper (100-1,000 feet) in areas above the RID irrigation canal.

FIGURE 10 - CALCULATED DEPTH TO GROUNDWATER WITHIN THE LYVGWMA

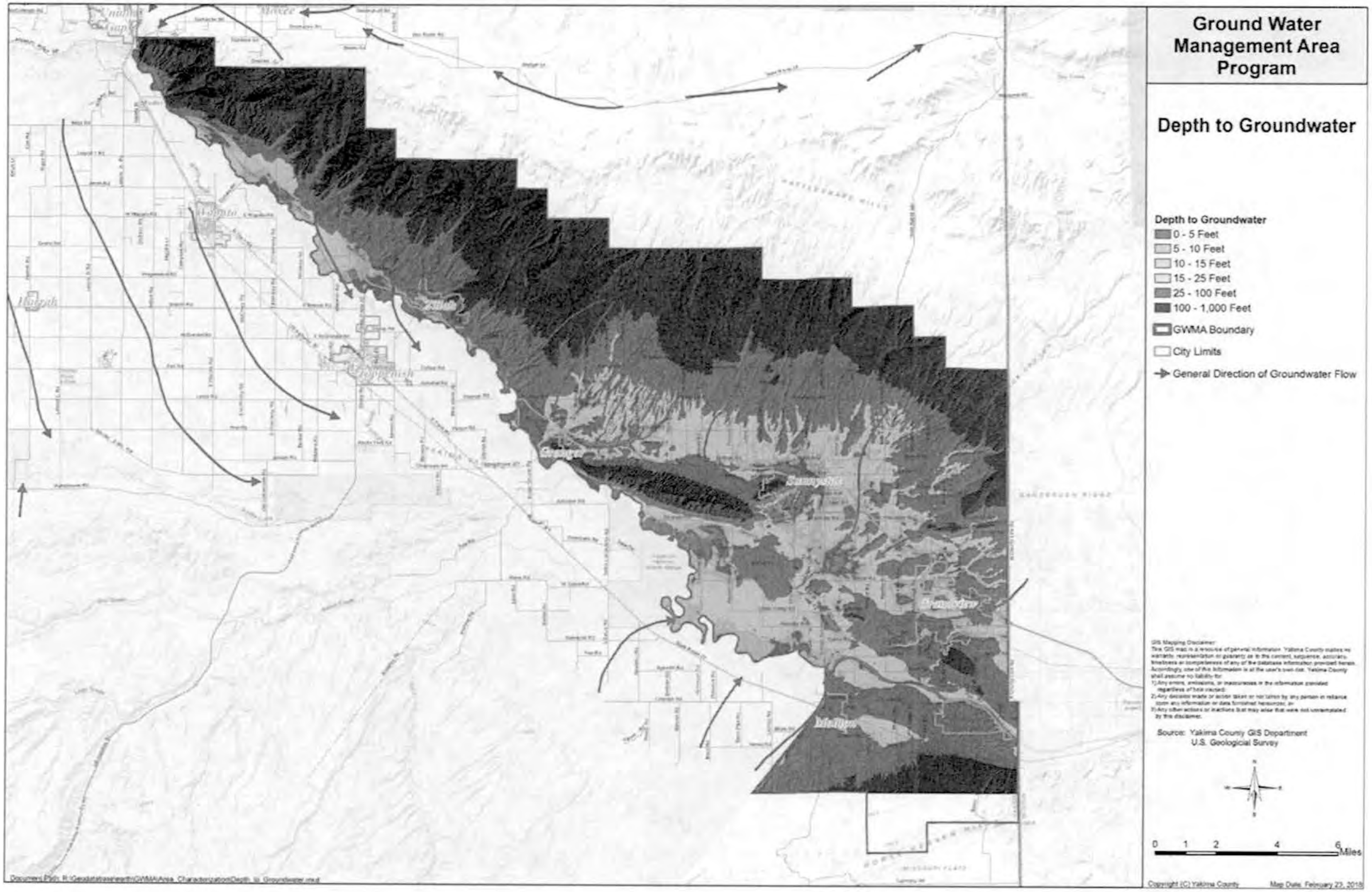
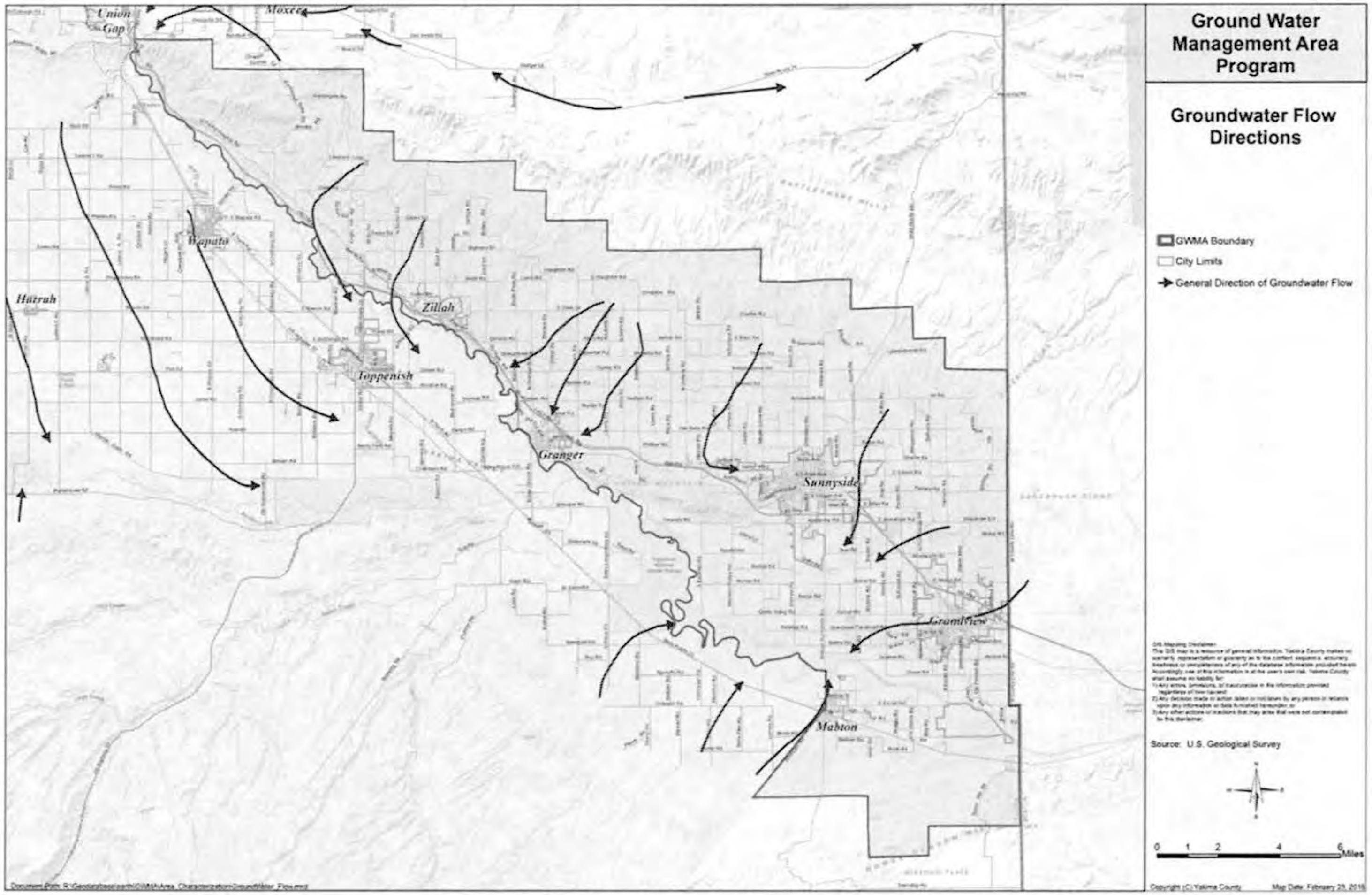


Figure 12 shows direction of groundwater flow within the LYVGWMA, as illustrated by USGS (USGS 2009a).

FIGURE 11 - DIRECTION OF GROUNDWATER FLOW WITHIN THE LYVGWMA



Soil Types

There are 89 soil types within the GWMA (NRCS Soil Survey). They differ based on constituency of materials (coarse to very fine sands, loams, clay), values of porosity, specific yield, hydraulic conductivity and infiltration rate. "Hydraulic conductivity" and "infiltration rate" are calculated presuming complete saturation of the soil material. Both quantify the three-dimensional volume of a liquid through a two-dimensional plane of a matrix.

Predominant soil types within the GWMA are Scoon silt loam and Burke silt loam (ground surface roughly above 300 meters or 1000 feet above sea level), Warden fine sandy loam interlineated generally northeast to southwest with Harwood-Burke-Wiehl very stony silt loams and Esquatzel silt loam (ground surface roughly between 300 meters or 1000 feet and 250 meters or 800 feet above sea level), and Esquatzel silt loam, Quincy loamy fine sand, Wanser loamy find sand, Warden fine sandy loam and Warden silt loam (roughly within the valley bottom between 250 meters or 800 feet and 200 meters or 650 feet above sea level). The hydraulic conductivity of each of these primary soil types is available from NRCS' *Web Soil Survey* at https://websoilsurvey.nrcs.usda.gov/app/ and is presented in Table 2 below. The rates set forth in the table presume full soil saturation. Because soils in the vadose (unsaturated) zone within the LYVGWMA are only intermittently wetted, by irrigation or precipitation, the rates set forth must be variously reduced for those soils.

TABLE 2 - PRIMARY SOIL TYPES HYDRAULIC CONDUCTIVITY (K)
(NRCS SOIL SURVEY)

Primary Soil Types Within LYVGWMA		
Soil Type	cu. In / hr	NRCS rate
Warden silt loam	0.57-1.98	Moderate
Warden fine sandy loam	0.57-1.98	Moderate
Esquatzel silt loam	0.57-1.98	Moderate
Shano silt loam	0.57-1.98	Moderate
Quincy loamy fine sand	5.95-19.98	Rapid
Wanser loamy fine sand	5.95-19.98	Rapid
Harwood Burke-Wiehl silt loam	0.00-0.06	Very slow, impermeable
Burke silt loam	0.00-0.06	Very slow, impermeable
Scoon silt loam	0.00-0.06	Very slow, impermeable

FIGURE 12 - SOIL TYPES

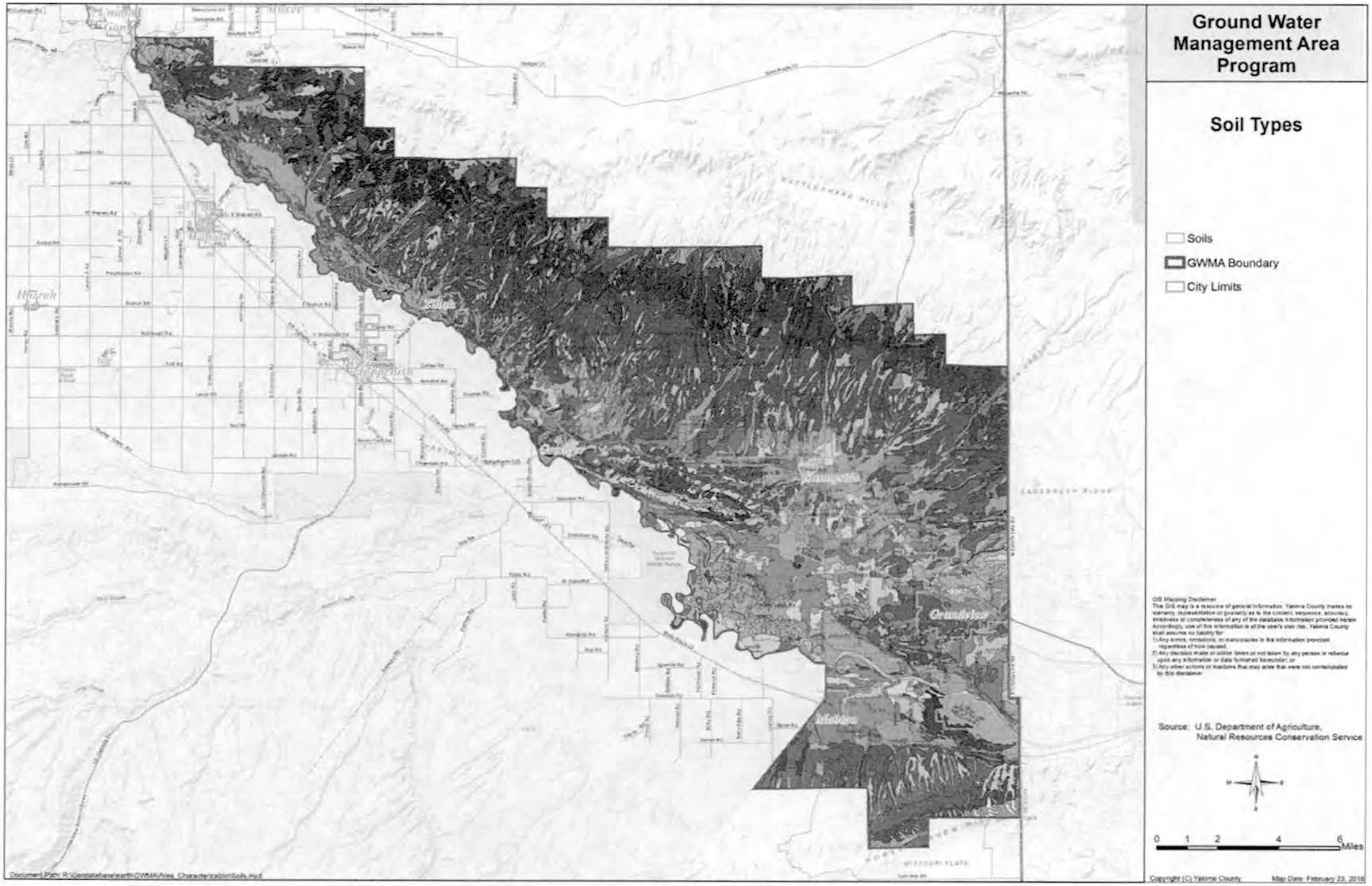


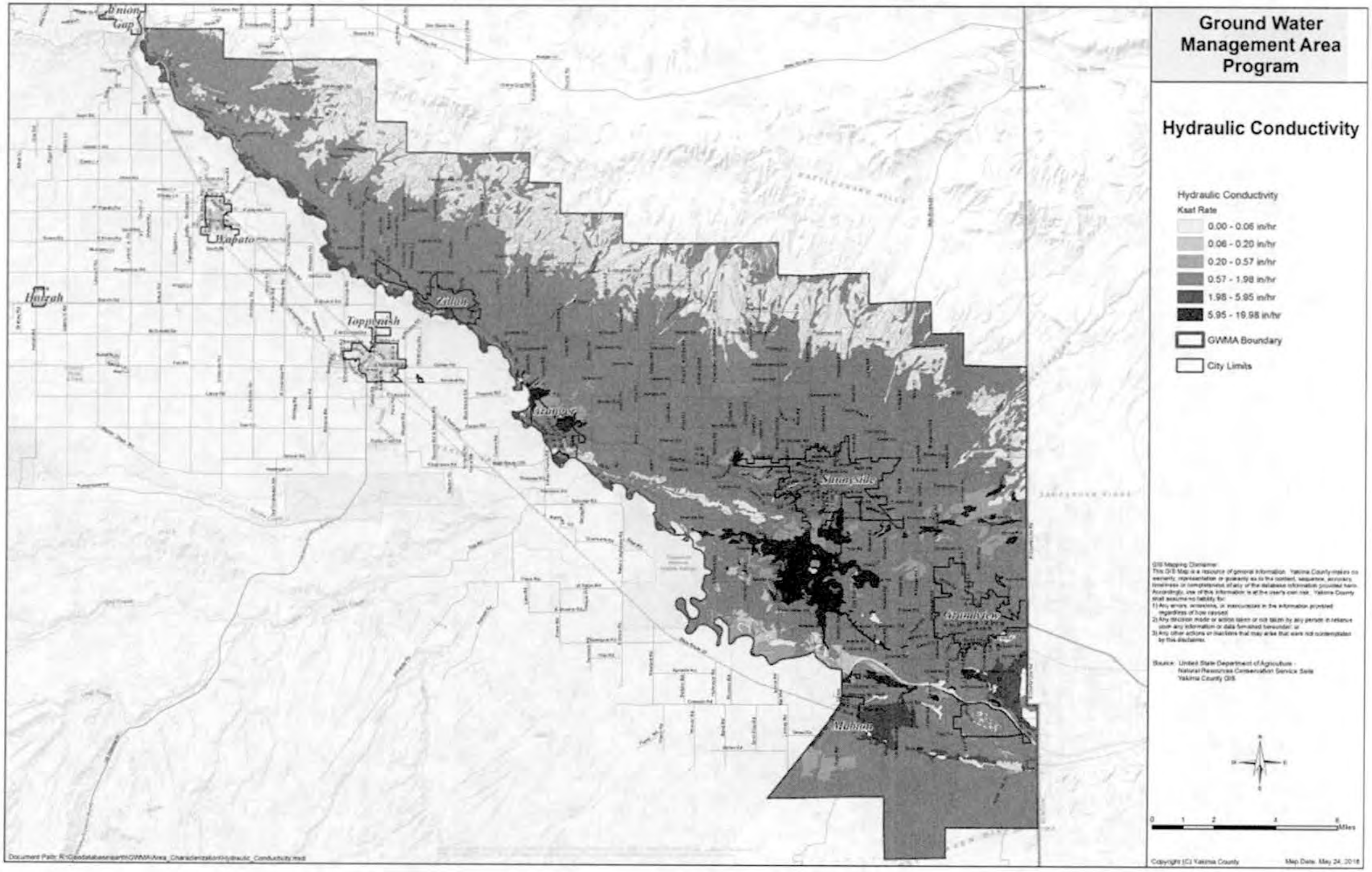
TABLE 3 - LIST OF ALL SOIL TYPES WITHIN THE LYVGWMA

Soils

- Bakeoven very cobbly silt loam, 0 to 30 percent slopes
- Burke silt loam, 2 to 5 percent slopes
- Burke silt loam, 5 to 8 percent slopes
- Burke silt loam, 8 to 15 percent slopes
- Cleman very fine sandy loam, 0 to 2 percent slopes
- Cleman very fine sandy loam, 2 to 5 percent slopes
- Dam
- Esquatzel silt loam, 0 to 2 percent slopes
- Esquatzel silt loam, 2 to 5 percent slopes
- Fiander silt loam
- Finley cobbly fine sandy loam, 0 to 5 percent slopes
- Finley silt loam, 0 to 2 percent slopes
- Finley silt loam, 2 to 5 percent slopes
- Finley silt loam, 5 to 8 percent slopes
- Finley silt loam, 8 to 15 percent slopes
- Gorst loam, 2 to 15 percent slopes
- Harwood-Burke-Wiehl silt loams, 15 to 30 percent slopes
- Harwood-Burke-Wiehl silt loams, 2 to 5 percent slopes
- Harwood-Burke-Wiehl silt loams, 30 to 60 percent slopes
- Harwood-Burke-Wiehl silt loams, 5 to 8 percent slopes
- Harwood-Burke-Wiehl silt loams, 8 to 15 percent slopes
- Harwood-Burke-Wiehl very stony silt loams, 15 to 30 percent slopes
- Hezel loamy fine sand, 0 to 2 percent slopes
- Hezel loamy fine sand, 2 to 15 percent slopes
- Kiona stony silt loam, 15 to 45 percent slopes
- Kittitas silt loam
- Lickskillet very stony silt loam, 5 to 45 percent slopes
- Logy silt loam, 0 to 2 percent slopes
- McDaniel-Rock Creek complex, 5 to 30 percent slopes
- Mikkalo silt loam, 0 to 5 percent slopes
- Mikkalo silt loam, 15 to 30 percent slopes
- Mikkalo silt loam, 5 to 15 percent slopes
- Moxee cobbly silt loam, 0 to 30 percent slopes
- Moxee silt loam, 15 to 30 percent slopes
- Moxee silt loam, 2 to 15 percent slopes
- Outlook fine sandy loam
- Outlook silt loam
- Pits
- Prosser silt loam, 0 to 15 percent slopes
- Quincy loamy fine sand, 0 to 10 percent slopes
- Ritzville silt loam, 15 to 30 percent slopes
- Ritzville silt loam, 2 to 5 percent slopes
- Ritzville silt loam, 30 to 60 percent slopes
- Ritzville silt loam, 5 to 8 percent slopes
- Ritzville silt loam, 8 to 15 percent slopes
- Ritzville silt loam, basalt substratum, 15 to 30 percent slopes
- Ritzville silt loam, basalt substratum, 5 to 15 percent slopes
- Scoon silt loam, 15 to 30 percent slopes
- Scoon silt loam, 2 to 5 percent slopes
- Scoon silt loam, 5 to 8 percent slopes
- Scoon silt loam, 8 to 15 percent slopes
- Scooteney cobbly silt loam, 0 to 5 percent slopes
- Scooteney silt loam, 0 to 2 percent slopes
- Scooteney silt loam, 2 to 5 percent slopes
- Scooteney silt loam, 5 to 15 percent slopes
- Shano silt loam, 15 to 30 percent slopes
- Shano silt loam, 2 to 5 percent slopes
- Shano silt loam, 5 to 8 percent slopes
- Shano silt loam, 8 to 15 percent slopes
- Sinloc fine sandy loam, 0 to 2 percent slopes
- Sinloc silt loam, 0 to 2 percent slopes
- Sinloc silt loam, 2 to 5 percent slopes
- Sinloc silt loam, 5 to 8 percent slopes
- Starbuck silt loam, 2 to 15 percent slopes
- Starbuck-Rock outcrop complex, 0 to 45 percent slopes
- Starbuck-Rock outcrop complex, 45 to 60 percent slopes
- Umapine silt loam, drained, 0 to 2 percent slopes
- Umapine silt loam, drained, 2 to 5 percent slopes
- Wanser loamy fine sand
- Warden fine sandy loam, 0 to 2 percent slopes
- Warden fine sandy loam, 2 to 5 percent slopes
- Warden fine sandy loam, 5 to 8 percent slopes
- Warden fine sandy loam, 8 to 15 percent slopes
- Warden silt loam, 0 to 2 percent slopes
- Warden silt loam, 15 to 30 percent slopes
- Warden silt loam, 2 to 5 percent slopes
- Warden silt loam, 5 to 8 percent slopes
- Warden silt loam, 8 to 15 percent slopes
- Water
- Weirman fine sandy loam
- Weirman gravelly fine sandy loam
- Weirman sandy loam, channeled
- Willis fine sandy loam, 2 to 5 percent slopes
- Willis silt loam, 2 to 5 percent slopes
- Willis silt loam, 8 to 15 percent slopes
- Yakima silt loam
- Zillah sandy loam
- Zillah silt loam
- Zillah silt loam, channeled

All of the 89 soil types within the LYVGWMA illustrated in Figure 13 were sorted by Yakima County GIS into the hydraulic conductivity rate categories utilized by the U.S. Department of Agriculture, Natural Resources Conservation Service. These are illustrated in Figure 14.

FIGURE 13 - SOIL TYPES IN LYVGWMA SIMPLIFIED IN HYDRAULIC CONDUCTIVITY GROUPS



Climate

The Western Regional Climate Center (WRCC) maintains climate data at three stations within the Lower Yakima Valley at Wapato, Sunnyside, and Prosser. Temperatures have historically ranged from 90 to 24 degrees Fahrenheit over the course of a year (WRCC). The data does not anticipate or address climate change.

TABLE 4 – CLIMATE (WRCC)

WAPATO, WASHINGTON (458959)													
Period of Record Monthly Climate Summary, Western Regional Climate Center, wrcc@dri.edu													
Period of Record : 10/01/1915 to 09/05/2013													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	39	47	58	66	75	81	89	88	80	67	50	40	64.8
Average Min. Temperature (F)	23	27	33	39	47	54	59	57	49	38	30	25	40.1
Average Total Precipitation (in.)	1	0.7	0.6	0.5	0.5	0.6	0.2	0.3	0.3	0.5	1	1.2	7.35
Average Total SnowFall (in.)	5.8	2.2	0.7	0	0	0	0	0	0	0	1.9	5.4	15.9
Average Snow Depth (in.)	2	1	0	0	0	0	0	0	0	0	0	1	0

SUNNYSIDE, WASHINGTON (458207)													
Period of Record Monthly Climate Summary, Western Regional Climate Center, wrcc@dri.edu													
Period of Record : 09/14/1894 to 01/05/2014													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	39	47	58	67	75	82	90	89	80	67	51	40	65.3
Average Min. Temperature (F)	23	27	32	38	45	51	54.7	53	46	37	30	25	38.4
Average Total Precipitation (in.)	0.9	0.6	0.5	0.5	0.5	0.5	0.18	0.3	0.4	0.6	0.9	0.9	6.8
Average Total SnowFall (in.)	4.5	1.8	0.2	0	0	0	0	0	0	0	1.8	4	12.4
Average Snow Depth (in.)						No	Data						

PROSSER, WASHINGTON (456768)													
Period of Record Monthly Climate Summary, Western Regional Climate Center, wrcc@dri.edu													
Period of Record : 07/01/1925 to 01/04/2015													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	38	46	56	65	73	80	89	87	78	65	49	40	63.9
Average Min. Temperature (F)	24	28	33	38	45	50	55	53	47	39	31	26	38.9
Average Total Precipitation (in.)	1.1	0.7	0.6	0.6	0.6	0.7	0.2	0.3	0.4	0.7	1	1.2	7.95
Average Total SnowFall (in.)	2.6	1.2	0.1	0	0	0	0	0	0	0	0.9	2.3	7.2
Average Snow Depth (in.)	1	0	0	0	0	0	0	0	0	0	0	0	0

Land Use

Agriculture is the primary economic and land use activity in the area. Approximately 70-80 percent of the area is used for agriculture. Agricultural production on the 464,000 irrigated acres within the Yakima River Basin is estimated to be worth over $2 billion (apples: $1 billion, dairy: $900 million, hops: $500 million) annually.

In 2007, the total market value of Yakima County crops sold was $1,203,806,000, and the average market value per farm was $340,058. In 2012, the total market value of Yakima County crops sold was $1,645,510,000 and the average market value per farm was $523,548 (YCDAa).

In 2007, the value of Yakima County milk production was $325,000,000. In 2012, the value of Yakima County milk production was $439,000,000 (YCDAb).

In 2007, Yakima County's Net Cash Farm Income was $372,055,000 and its Net Cash Farm Income per farm was $105,100. In 2012, its Net Cash Farm Income was $321,705,000 and its Net Cash Farm Income per farm was $102,356 (YCDAc).

In 2007, the 68,087 acres of fruit trees in Yakima County were valued at $749,883,000. In 2012, the 62,415 acres of fruit trees in the County were valued at $935,452,000 (YCDAd).

Most cropland in the area is irrigated. Major commodities grown in the valley include apples, pears, cherries, peaches, vegetables, hay, mint, and hops. In 2002, Yakima County ranked first statewide for apple, milk, hop, and grape production and first nationally for apple and hop production. Dairy operations were greatly expanded starting in the late 1980's, (WSDA 2013) and Yakima County cattle reached nearly 40 percent of Washington State's cattle population by 2018 (YCDAe). Also, animal feeding operations operate at various sizes from very small home lots to large commercial feedlots. The dairies and animal feeding operations are concentrated in the lower parts of the valley in and around the cities of Sunnyside, Grandview, Mabton, and Granger; although some occur in more disperse parts of the valley on the Yakama Indian Reservation.

Viewed from the perspective of American history, problems of nitrate contamination have been identified in locations throughout the United States where community and rural population growth and more intensive agricultural practices have been practiced for extended periods. (USGS 2003c) (Roman et al.) (USGS 1990a) (Foster) (Vermont) (USGS 1993a) (Anderson) (USGS1985) (Beck) (Royte) (USGS 1984) (Lilbra et al.) (Kross et al.). Nitrate contamination has been identified as a public concern in New England, the Ohio Valley, southwest Georgia, the Middle West, and ultimately in the American West; particularly in Montana, Idaho, California, and now Eastern Washington.

Catholic Missionaries arrived in the Yakima River Basin in 1848. They established a mission in 1852 on Atanum (now Ahtanum) Creek, using irrigation on a small scale. Miners and cattlemen immigrated to the basin in the 1850s and 1860s. In 1859, Ben Snipes first drove cattle through the Yakima Valley. Five years later, he returned and established the Snipes and Allen Company; grazing 40,000-50,000 head of cattle in the Lower Yakima Valley. By the 1880s, it is estimated that there were 200,000 cattle; 350,000 sheep; and 125,000 horses grazing in the Yakima Valley. With increasing settlement in the mid-1860s, irrigation of the valley bottoms began. Outlying areas were used extensively for raising stock. Private companies began to deliver water through canal systems built between 1880 and 1904 for the irrigation of large areas. Irrigated agriculture began to be practiced more widely at this time. The Northern Pacific Railway was constructed through the Yakima Valley, reaching Yakima in December 1884 and Seattle in 1896, facilitating the development of irrigated agriculture through transport of agricultural goods to markets. Statehood in 1889 assisted Lower Yakima Valley agricultural growth, Yakima contending for state capital. When the National Reclamation Act was passed in 1902, about 85,000 acres were under irrigation in the Yakima Valley, mostly by surface water (Boening).

By 1901, farming had largely replaced livestock ranching in the easily irrigated acres of the valley. A state survey of that year reported the following crops grown in the Yakima Valley: apples, pears, prunes, plums, cherries, apricots, peaches, and grapes; alfalfa, corn, wheat, barley, oats, rye, flax, broom corn, other grasses including brome, orchard, tall meadow fescue, timothy, red top, and clover; melons, potatoes, garden vegetables, hops and sugar beets (Jensen).

Crops

The Yakima Valley Museum maintains a collection of photographs that indicate significant production of hops in the early period, primarily in

the Moxee and North Yakima area.[5]

Above Union Gap, early crops included hops. In the Lower Valley, early agriculture primarily involved the production of hay (Jensen). Newly planted orchards were planted in the

Sunnyside area by 1908.

Between 1905 and 1912 the Lower Yakima Valley towns of Sunnyside, Mabton, Toppenish, Wapato, Grandview, Granger, and Zillah were all incorporated.

Another survey assembled in 1917 showed the following crops and agricultural products produced in the

[5] Historical photographs courtesy of the Yakima Valley Museum. For further study, see http://www.yakimamemory.org/

Yakima Valley: strawberries, cherries, prunes, apples, peaches, pears, apricots, grapes, cantaloupes, and watermelons; onions, turnips, green corn, carrots, rutabagas, cabbage, asparagus, tomatoes, green peppers, squash, pumpkins, beans, potatoes, hops, and sugar beets; alfalfa hay, wheat, oats and barley (WSDA 2013).

Field crops such as potatoes, onions, and corn; primarily watered by flood irrigation, either through total inundation or rill irrigation, were successful crops by the early 1920s.

Tree fruits had become successful export products by the 1930s.

The Federal Reclamation Act of 1902 and Washington State's Yakima Federal Reclamation Act of 1905 authorized construction of water delivery facilities to irrigate about 500,000 acres of land within the Yakima River Basin, including those within the Lower Yakima Valley. Six dams and five reservoirs were constructed as part of the Yakima Project.

These Federal reservoirs provide storage to meet water requirements of the major irrigation districts during the period of the year, called "storage control," when the natural streamflow from unregulated streams can no longer meet demands.

Farm sizes were relatively small during the first half of the twentieth century. There were 6,351 farms in Yakima County, making up 600,106 acres of farmland, in 1925 (WSDA 2013).

> "Farmers often produced their own livestock feed on farm, and maintained soil fertility through crop rotations and the retention of manure and crop residues on-farm. Weeds, insects, and plant diseases were controlled largely through mechanical practices, crop rotation, and the use of natural predators. During this time the conversion from horse-powered farming to the widespread use of tractors was taking place. . . . This spread of mechanization made it possible for farmers to use agricultural practices like intensive inversion-based tillage that remove all cover from the soil and use large amounts of fuel" (WSDA 2013).

The National Map Company's 1930 map entitled *Latest Official Survey of Washington* shows the route of two railroads then running through the GWMA area, with which to ship agricultural goods to market (Presby Museum; Goldendale, Washington). The density of the railroad's depots indicates the abundance of agricultural commodity available to be sent to market. The Union Pacific route stopped in Grandview, Forsell, Waneta, Midvale, Morris, Emerald, Bain, Noride, Granger, Blaine Acres, Dalton, Boone, Pam, Zillah, Buena, Flint, Sawyer, Dunbro and Parker en route to Union Gap and Yakima. The Northern Pacific route stopped at Grandview, Lichty, Sunnyside, Outlook Nass, Sinto, Granger, Boone, Gilliland, Cenauer, Zillah, Keck, Cutler, Buena, Sawyer, Donald, Mellis, and Parker en route to Union Gap and Yakima.

The number of farms and the area being farmed throughout Yakima County both stabilized during the 1940s. In the 1950s, the total number of farms began to decrease while the total amount of land being farmed increased, due primarily to the growth of land used as pasture. Between the 1960s and early 2000s, the total amount of land being farmed in Yakima County remained relatively static. It is reasonable to presume that the same trends occurred more specifically within the Lower Yakima Valley area.

Information regarding the total number of acres farmed in each crop category throughout Yakima County was collected by the U.S. Department of Commerce (USDOC), Bureau of the Census and published in the United States Census of Agriculture (USDOC Agriculture). The census information does not segregate data into geographic subdivisions of Yakima County. Nevertheless, the information does reflect trends in agricultural practices within the LYVGWMA, as this area constitutes a major portion of the County's agricultural economy.

TABLE 5 - AGRICULTURAL CENSUS DATA - GENERAL CROP TYPES

Summary of Yakima County Acres Farmed--- As Reported in USDOC Agricultural Censuses (numbers rounded) (WSDA 2013)				
	Number of acres farmed (x1000)			
	1935	1959	1982	2007
Apples, cherries, peaches, pears, plums, prunes and grapes	52.0	83.0	89.0	95.0
Corn, wheat, oats, barley, rye and triticale	55.0	94.0	101.0	83.0
Hay, forage, haylage and silage (including small grains cut for hay, wild hay, sorghum cut for silage or greenchop)	71.0	49.0	32.0	52.0
Potatoes, sugar beets, mint, hops, dill and dried herbs	18.0	48.0	36.0	44.0
Vegetables (including snap and string beans, cabbages, sweet corn, tomatoes and watermelons)	6.0	23.0	20.0	10.0
Field seeds and grass seeds	0.0	10.0	0.5	1.0
Legumes (excluding cover crops)	0.1	0.3	3.3	0.5
Berries	0.0	0.1	0.0	0.1

Some County-wide information on specific field crops is also available from the USDOC Agricultural Censuses.

TABLE 6 - AGRICULTURAL CENSUS DATA - FIELD CROPS

USDOC Agricultural Censuses (numbers rounded) (WSDA 2013)				
	Number of acres farmed (x1000)			
	1935	1959	1982	2007
Sweet Corn	1.00	9.00	5.00	2.00
Asparagus	2.00	10.00	10.00	2.50
Hops	4.00	19.00	19.00	19.00
Mint	0.00	10.00	25.00	10.00
Sugar Beets	1.00	19.00	8.00	2.00
Alfalfa	65.00	40.00	30.00	41.00
Alfalfa seed	0.30	10.00	3.00	1.00
Wheat	20.00	31.00	60.00	21.00
Corn for grain and silage	8.00	43.00	21.00	42.00
Barley	7.00	17.00	17.00	0.50

According to the information contained in several years' Agricultural Census, the number of cattle raised in Yakima County (excluding dairy cows) increased from 45,403 animals in 1925 to 212,762 animals in 2007. The number of dairy cows in Yakima County was stable at about 20,000 animals between 1925 and 1950. The number decreased during the 1950s and 1960s, reaching a low of 7,868 animals in 1969. The total number of dairy cows (excluding calves) reached 89,575 by 2007 (WSDA 2013).

TABLE 7 - AGRICULTURAL CENSUS - LIVESTOCK

Yakima County Livestock--As Reported by USDA Census (numbers rounded) (WSDA 2013)				
	Number of Livestock (x1000)			
	1935	1959	1982	2007
Cattle and calves	51	135	152	213
Dairy Cows	20	18	19	90
Chickens	220	240	520	300
Sheep	100	75	25	10

Trends in U.S. farming began shifting after World War II from mixed crop and livestock operations to specialized monocultures. Livestock became commonly raised separately on feedlots. Crop rotation decreased. Livestock manure, commercial fertilizer, and pesticides became more greatly available. Yields of corn, wheat, and rice increased during the latter half of the twentieth century due to large-scale mechanization of tilling, planting and harvesting, improved plant varieties, development of irrigation infrastructure, availability of low cost fertilizers and pesticides, and favorable commodity prices. Economies of scale led farm sizes to increase. By 2007, there were 3,540 farms, making up 1,649,281 acres, in Yakima County (WSDA 2013).

The Washington State Department of Agriculture maintains an annual inventory of crops grown on particular properties. The inventory is maintained in a Geographic Information System (GIS) format. Figure 15 illustrates the variety and location of crops grown within the LYVGWMA in 2015.

A more defined inventory within the LYVGWMA was conducted by the Washington State Department of Agriculture (Figure 15). In 2015, the crops constituting one percent or more of the acreage within the GWMA are shown on Figure 15.

FIGURE 14 - LOCATIONS OF CROPS GROWN WITHIN THE LYVGWMA (2015)

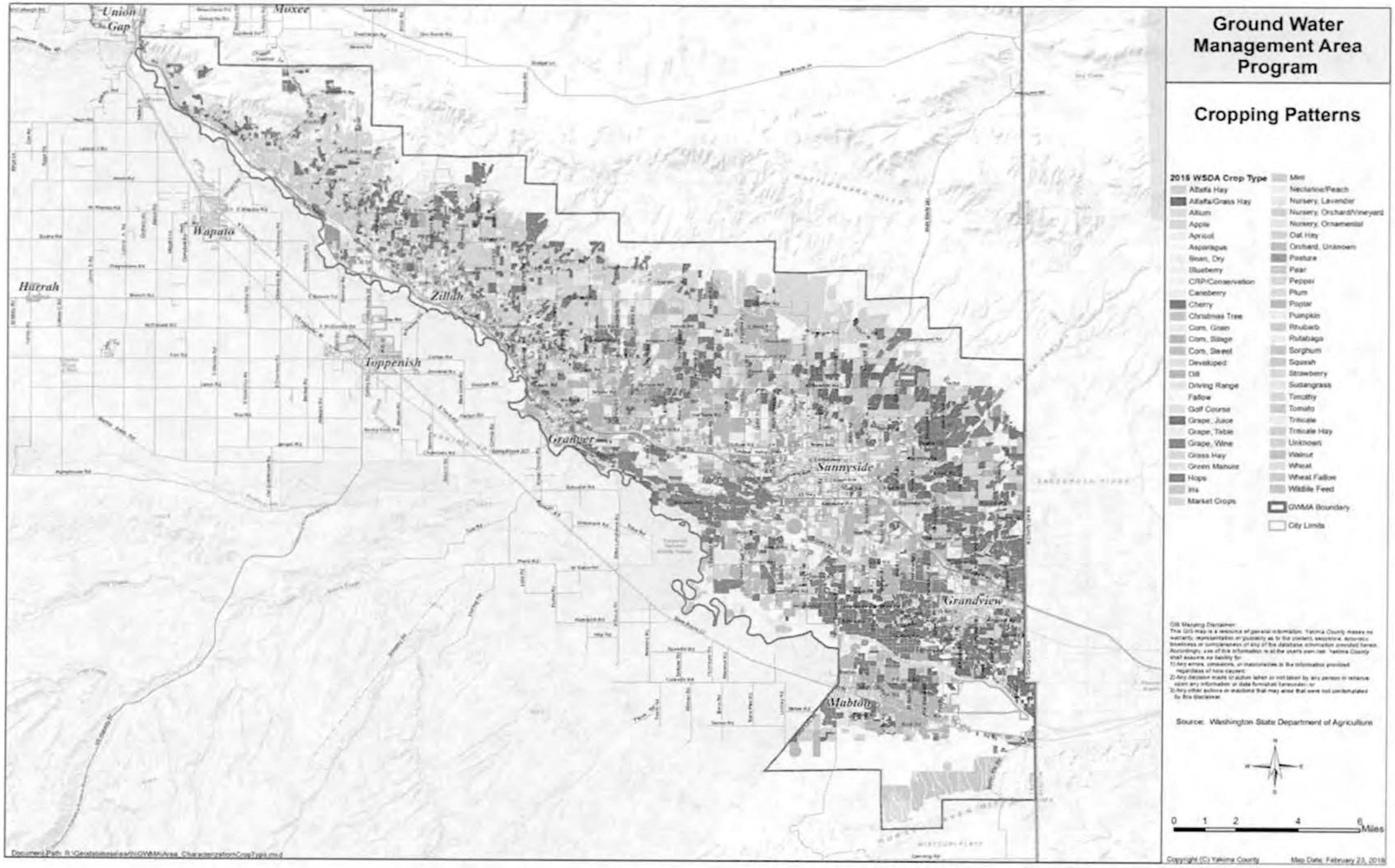


Table 8 - WSDA 2015 Crop Inventory Within LYVGWMA

Top 20 Crop Types	Acres	% of Total Acres
Apple	17,351	18%
Corn Silage	16,826	17%
Grape, Juice	10,269	11%
Alfalfa Hay	7,977	8%
Pasture	6,702	7%
Cherry	6,361	7%
Hops	5,922	6%
Grape, Wine	5,129	5%
Fallow	4,791	5%
Pear	3,335	3%
Wheat Fallow	1,761	2%
Sudangrass	1,623	2%
Mint	1,414	1%
Wheat	1,283	1%
Corn, Grain	1,148	1%
Grass Hay	1,133	1%
Developed	1,019	1%
Asparagus	853	1%
Nectarine/Peach	843	1%
Alfalfa/Grass Hay	648	1%
Total Acreage	96,459	

The acreage totals in Table 8 do not account for multiple cropping of any particular acreage in a single year. According to WSDA, 10,780 acres of triticale were farmed ("double-cropped"), primarily on the same ground as corn silage, after the corn silage had been harvested. Double cropping was taken into account however in the WSDA's Nitrogen availability assessment (WSDA 2018).

Fertilizers

According to the USDOC Agricultural Census, as reported in the Agricultural History of Yakima County (WSDA 2013), 136,553 farmed acres were fertilized in Yakima County in 1954. In 1964, 203,062 farmed acres were fertilized. The number of fertilized acres remained at about that rate through 2007. In 2002, 28,152 acres were fertilized by manure. In 2007; 27,742 acres were fertilized by manure, or approximately 14 percent of total fertilized acres within the county.

The USDOC Agricultural Census also collected information, between 1954 and 1974, about the number of acres within Yakima County that were fertilized with chemical fertilizer. The maximum number of acres fertilized with chemical fertilizer occurred in 1970, when approximately 110,000 acres received chemical fertilizer (WSDA 2013).

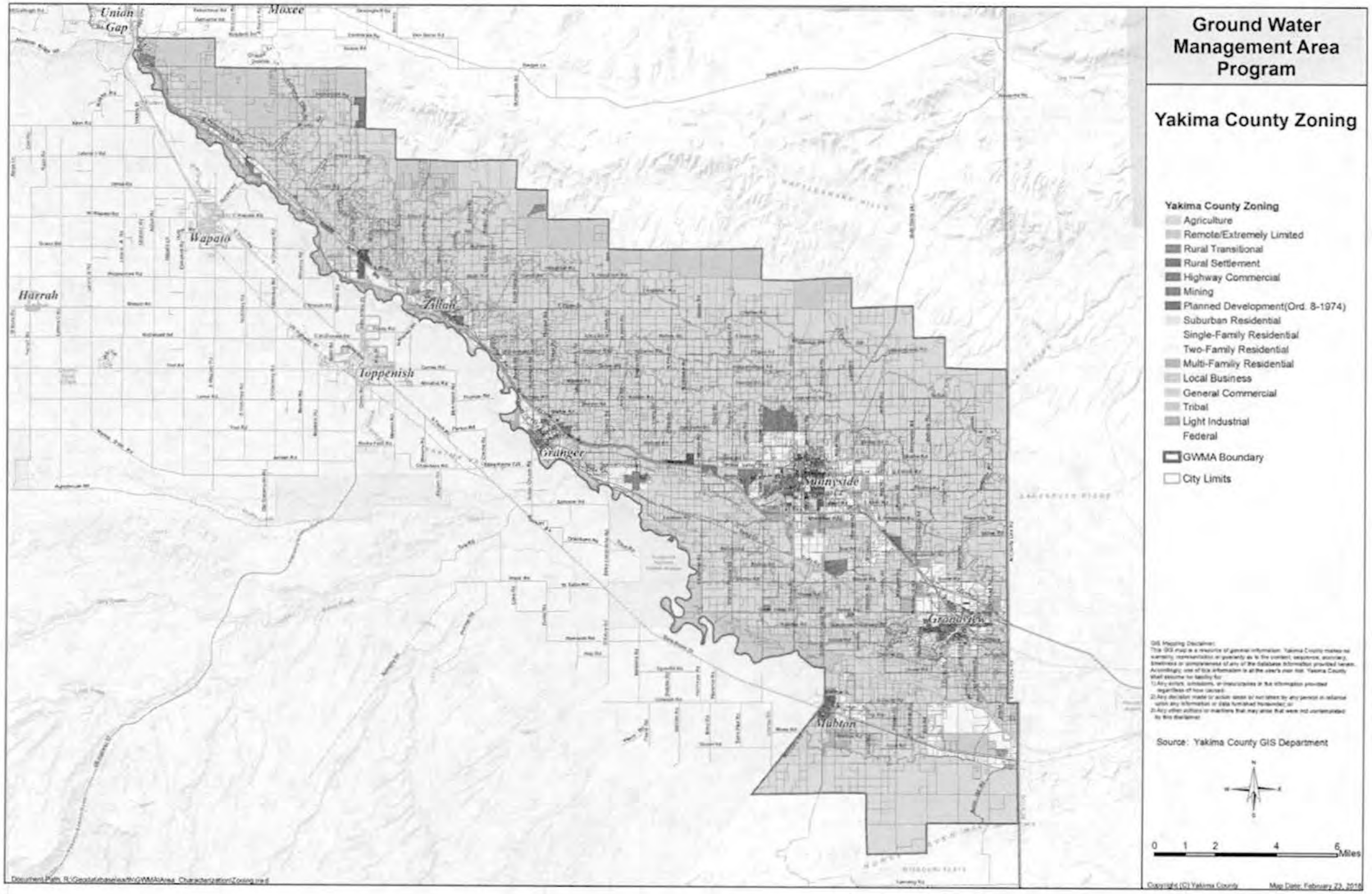
The use of synthetic (commercial) fertilizers began to increase between 1900 and 1944. After WWI, the use of chemical pesticides increased as well. WSDA's 2018 interview of commodity-specific experts to obtain a typical range of use rates for manure, compost, and commercial fertilizer for each of the GWMA's 15 top commodities (WSDA 2018) indicated that 19 percent of total GWMA irrigated acreage was fertilized by manure, 74 percent by commercial fertilizer, and 8 percent by compost.

TABLE 9 - PERCENTAGE DISTRIBUTION OF COMMERCIAL, MANURE, AND COMPOST FERTILIZER (WSDA 2018)

Crop	Area (acres)	Commer-cial N % of load	Acres of Commercial N	Manure N % of load	Acres of Manure N	Compost N % of load	Acres of Compost N
Apple	17333	86.3%	14958	0.0%	0	13.7%	2375
Corn (silage)	16778	49.6%	8322	53.9%	9043	0.0%	0
Triticale	10780	27.2%	2932	74.8%	8063	0.8%	86
Grape (juice)	10257	91.0%	9334	0.0%	0	11.6%	1190
Alfalfa	7989	91.8%	7334	8.2%	655	0.0%	0
Pasture	6731	97.2%	6543	2.8%	188	0.0%	0
Cherry	6336	80.5%	5100	0.0%	0	19.5%	1236
Hops	5961	97.3%	5800	2.7%	161	16.0%	954
Grape (wine)	5126	100.0%	5126	0.0%	0	20.0%	1025
Pear	3331	76.6%	2552	0.0%	0	23.4%	779
Mint	1418	100.0%	1418	0.0%	0	0.0%	0
Wheat	1283	93.9%	1205	22.4%	287	0.0%	0
Corn (grain)	1166	71.3%	831	62.6%	730	0.0%	0
Asparagus	854	100.0%	854	0.0%	0	0.0%	0
Peach/Nectarine	843	81.0%	683	0.0%	0	19.0%	160
Total			72992		19129		7805
Per cent of total			0.73		0.19		0.08

Land use within the LYVGWMA is subject to the Yakima County Code. Most of the land within the GWMA is within the Agricultural Zone. Figure 16 illustrates Yakima County zoning districts within the LYVGWMA.

FIGURE 15 - YAKIMA COUNTY ZONING WITHIN LYVGWMA



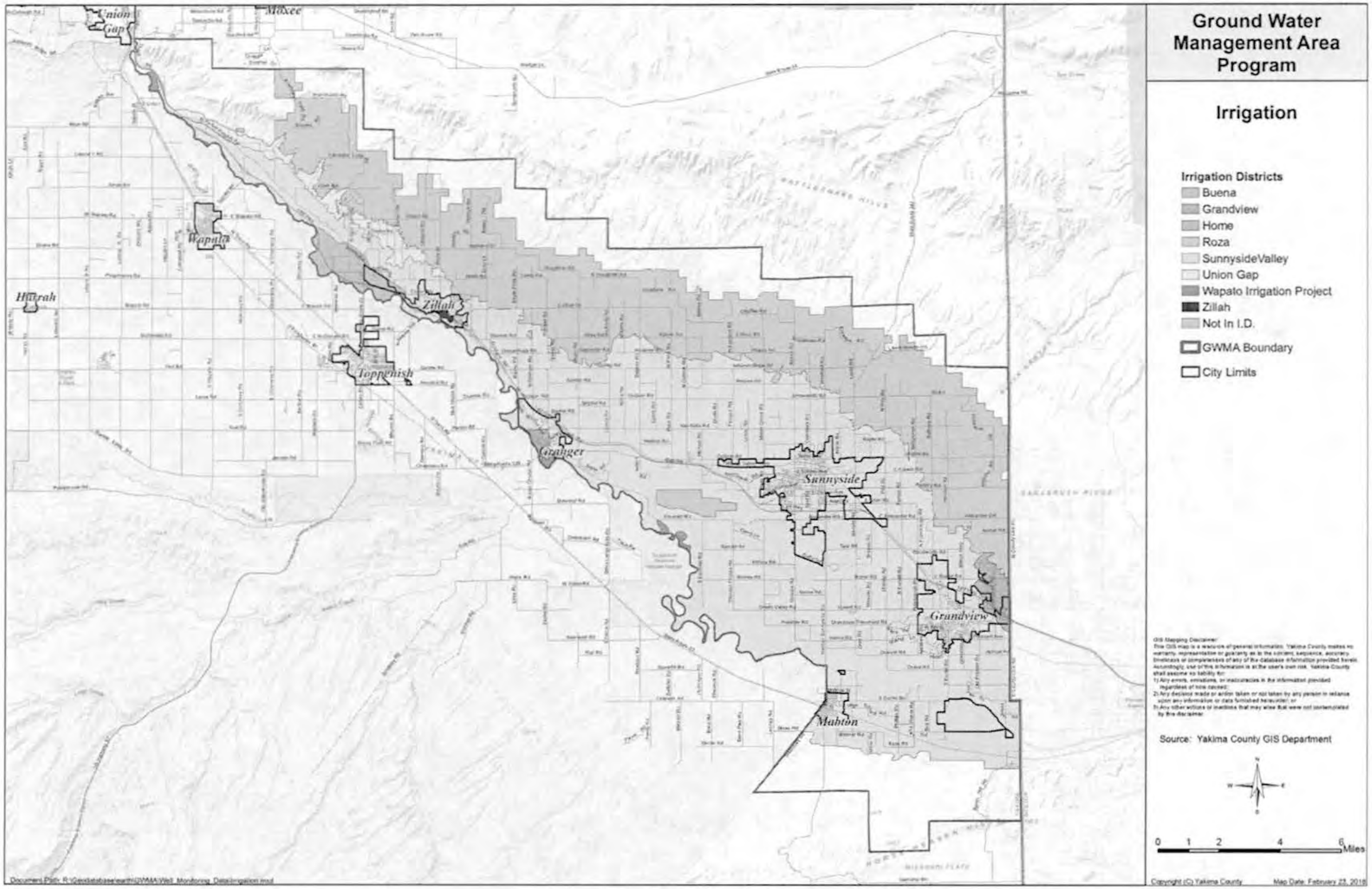
Water Use

The Lower Yakima Valley, south of Union Gap, is semi-arid with a mean annual precipitation of 6.8 inches. Precipitation and snowpack in the Cascade Mountains provide the source water and natural storage capacity for the Yakima River and the primary irrigation supply. Diversions from the river are managed by the U.S. Bureau of Reclamation (USBR). Irrigation water can also be drawn from wells pursuant to individual water rights recognized by the Washington State Department of Ecology. Under the Washington State Groundwater code (RCW 90.44.050), prospective groundwater users must obtain authorization of a water right for irrigation (other than that exempted by the statute). Post-1945 well-drilling technologies, legal rulings, and the onset of a multi-year dry period in 1977 stimulated the drilling of numerous irrigation wells. Population growth in the basin has also resulted in increased drilling of shallow domestic wells in addition to deeper public-supply wells. There are now more than 20,000 wells in the basin, more than 70 percent of which are shallow, 10–250 ft deep, domestic wells. The Department of Ecology's online water-rights database indicates that there are 2,874 active groundwater rights associated with wells in the Yakima basin. They collectively withdraw about 529,231 acre-ft during dry years. The irrigation rights are for the irrigation of about 129,570 acres. There are about 16,600 groundwater claims in the basin, for some 270,000 acre-ft of groundwater (USGS 2011). The more limited numbers of groundwater irrigation rights and acreage watered by groundwater specifically within the LYVGWMA has not been determined.

The three largest irrigation providers in the lower valley are the Wapato Irrigation Project, Sunnyside Valley Irrigation District, and the Roza Irrigation District. Wapato Irrigation Project serves irrigators within the Yakama Indian Reservation and is managed by the U.S. Bureau of Indian Affairs on behalf of the U.S. Bureau of Reclamation. In 2012, the Sunnyside Valley Irrigation District (SVID) served 94,614 acres on the valley floor and lower slopes. SVID diverts its water near Parker into a 60-mile canal running generally northwest to southeast through the GWMA, in essentially the same direction of groundwater flow. The SVID's primary canal and delivery laterals are unlined. The Roza Irrigation District (RID) serves 72,491 acres, some of which are not within the LYVGWMA, at higher elevations. Those within the LYVGWMA are on the north slopes of the valley (WSDA 2013). The RID diverts its water from the Yakima River upstream of the City of Selah into a

94.8-mile canal. Its primary canal is lined and its delivery laterals are for the most part contained. The waste ways in both the SVID's and RID's irrigation systems are unlined. Diverse crops are grown in both the SVID and RID service areas. Generally, forage crops dominate the SVID and tree fruits dominate the RID. Both canals end, returning tail water to the Yakima River, near Benton City. From the canals, water is delivered through 709 miles of laterals to over 5,300 individual deliveries. Diversions usually begin in March to prime the canal system and cease in mid-October. On-farm deliveries typically begin in early April. Figure 17 shows the service areas of the SVID and RID within the LYVGWMA.

FIGURE 16 - SUNNYSIDE VALLEY AND ROZA IRRIGATION DISTRICTS WITHIN THE LYVGWMA



Irrigation Methods

Irrigation in the Yakima River Basin is accomplished using one of three methods: rill, sprinkler, or drip. Rill (or gravity) irrigation is the oldest and simplest form in use. In its simplest form, an open channel (head ditch) delivers water to the high point of a field. Water is siphoned out of the head ditch and into small furrows cut into the field between each crop row. Water exits the furrows at the low point of the field, and is collected in a second open channel (tail ditch). This water may be reused by pumping back to the head ditch, sometimes repeatedly. The tailwater in the tail ditch may then be routed to a drain that feeds into the regional drainage network. On many rill-irrigated fields, the open head ditch has been replaced with PVC pipe. Instead of siphon tubes, manually operated spigots or sliding gates direct irrigation water into the furrows.

A variety of sprinkler systems are used throughout the Yakima River Basin, and each system varies in its efficiency of delivering water. Portable solid set, wheel lines, and big guns are examples of simple systems to operate, but typically do not provide a uniform coverage of water to a field. They also require manual labor to move from place to place in a field. Fixed solid set, center pivots, and liners are more expensive to install and more complex to operate, but they provide a more even coverage and give the farmer greater control over the irrigation process. These systems can be fully automated, enabling the farmer to irrigate a large area with less labor. The most sophisticated systems use feedback from soil-moisture probes to cycle the irrigation system off and on (USGS 2004).

Drip irrigation employs plastic lines with small openings to deliver water directly to the base of the plant. The drip lines may be installed above or below the soil. A properly operating drip-irrigation system enables a farmer to make maximum use of his allotment of water—very little water is lost to evaporation, no tailwater is generated, and virtually no water is lost to the groundwater system. Drip systems also enable the farmer to deliver nutrients and some pesticides through the lines, significantly reducing the amount of chemicals used on the field and reducing the potential for the chemical to leave the field (USGS 2004).

Sprinkler irrigation systems increased in the Roza and Sunnyside Irrigation Districts between 2005 and 2012, the years in which records are available. Rill (gravity) irrigation systems have decreased. Sprinkler irrigation in those districts is somewhat lower than it is statewide. Low-flow drip irrigation had increased to 26.16 percent of the acreage in the Roza District by 2010 (WSDA 2013).

Demographics

Population

Yakima County is the eighth largest county in state by population, with 244,654 people (USDOC 2010). It is the second largest county in State by land mass: 4,311 square miles. The population within the LYVGWMA is 56,210, with 19,952 living in a rural area (USDOC 2010).

There are five of cities in the LYVGWMA —Sunnyside, Grandview, Granger, Zillah, and Mabton. Over half of the GWMA's residents live in those cities (USDOC 2010):

- City of Sunnyside-15,858
- City of Grandview-10,862
- City of Granger-3,246
- City of Zillah-2,964
- City of Mabton-2,286

The remaining population resides in an unincorporated area. Most of that remaining population– approximately 19,952 individuals – reside in a rural area not served by public water or sewer. These residents typically rely on a private or shared well for their drinking water. A nearly equal number rely on an on-site sewage system (OSS, or septic system) to dispose of their waste (derived using ARCGIS, a geographic information system, in combination with the 2010 Decennial Census).

In the GWMA, economics and livelihood play a critical role in the decision to live in a rural area instead of an urban one. Affordable housing is a draw to rural areas, and so is the proximity to agricultural-related employment. Farmers, for example, usually live on or near the acreage they farm.

However, other factors are at play in addition to affordable housing and agriculture. In recent decades in Yakima County, large-tract farmsteads have been parceled off and sold in smaller pieces over time. The smaller parcels were not large enough to make a living at farming, but they did offer part-time farming opportunities for people already employed and seeking a country lifestyle. This is perhaps the chief characteristic of "rural" living in Yakima County and the GWMA (Horizon 2040 5.9.4 Rural Lands-Existing Conditions). The desire for a "country" environment in part accounts for the growing number of rural GWMA households— ranging in property size from .5 to 10 acres— whose distance from urban areas preclude them from receiving municipal water or sewer services.

Income and Poverty

Yakima County's median household income of $43,506 is below Washington State's median income of $59,478. The County's per capita income of $19,433 is also below Washington State's per capita income of $30,742 (USDOC 2013).

22.6 percent of Yakima County's population is living below the poverty level, an increase of 2.4 percent since 1990. In comparison, only 13.4 percent of all persons in Washington State live below the poverty level (USDOC 2013) (Horizon 2040).

The population of the GWMA is generally poorer than the rest of Yakima County, with over a quarter of the GWMA's population living in poverty. There is also a higher percentage of children in the GWMA living in poverty, which is in line with the larger percentages of children living there.

Education

The educational disparity between the State, Yakima County, and the GWMA is even greater than the income disparity. In Washington State, for example, 10 percent of the population did not graduate from high school or receive a high school diploma. In Yakima County that rate is almost 3 times higher at 29 percent. Yet in the GWMA it is almost 4 times higher than the state at 39.6 percent. In some GWMA pockets the span is even greater: in the city of Mabton, which lies in the southeast section of the GWMA, 28.1 percent of the population over the age of 25 has less than a ninth-grade education.

Households and Families

The average household size in the GWMA ranges from 3.36 to 3.98 people per household, larger than the County (3.02 people) and State (2.54 people). Average family size in the GWMA ranges from 3.72 to 4.38 people—again, larger than the average County family size (3.53) or the State (3.11). In the GWMA, 80.2 percent of all households are comprised of families compared to 73.0 percent for the County and 64.5 percent for the State (USDOC 2013).

Race and Ethnicity

The GWMA has a higher concentration of individuals whose ethnicity is Hispanic/Latino compared to Yakima County, Washington State, or the Nation, and a lower concentration of American Indian/Alaska natives and Blacks/African-Americans (USDOC 2013).

Within Yakima County there is a wide gap between communities for both race and ethnicity. For example, the range for individuals who are Hispanic/Latino ranges from 0.4 percent in the City of Naches to 96.1 percent in the City of Mabton. Additionally, the range of individuals who are American Indian/Alaskan Native ranges from 0.0 percent in the city of Selah to 21.7 percent in the town of Harrah, which is located outside of the GWMA on the Yakama Indian Reservation (USDOC 2013).

The racial groups of Asian, Black or African-American, and native Hawaiian or other Pacific Islander represent a very small part of the population in the GWMA as well as Yakima County when compared to the State and the Nation.

Language

In Yakima County, 39.6 percent of the population over age 5 speaks a language other than English at home (predominantly Spanish). Additionally, 18.6 percent speak English less than "very well," indicating that the other 21.0 percent are bilingual. In the GWMA, 60.6 percent of the population over age 5 speaks a language other than English at home – 24 percent speak English less than "very well" indicating that the other 36.4 percent are bilingual (USDOC 2013).

Sources of Nitrate

Irrigated Agriculture

There are 360,906 acres of crops in Yakima County. 96,459 (27 percent) of those acres are located within the GWMA (WSDA 2018). In 2015, irrigated agriculture within the GWMA occupied 55 percent of the total land area within the GWMA boundaries (175,161 acres) (WSDA 2018).

Most crops grown in the GWMA have the potential for positive nitrogen loading under some management practices. WSDA 2015 crop data shows that there is a large and diverse number of crops grown in the GWMA. The top 15 crops by acreage represent 96 percent of the irrigated agricultural land within the GWMA. Each crop has a unique cultivation practice.

Nitrogen from organic matter becomes available for crop uptake as well as losses including leaching below the crop root zone with water.

Crops Supporting Livestock Operations

A significant portion of irrigated agricultural acreage within the GWMA (31,790 acres or 32 percent) is dedicated to crops and land uses (corn, triticale, pasture, and alfalfa) that support dairy or other livestock operations. The majority of manure and compost applications observed by representatives of the WSDA during interviews with farmers and crop consultants were taking place on crops intended for animal feed.

Triticale is normally "double-cropped" (two crops in one growing year (WSDA 2018)). Triticale is planted in the fall (September-October) and harvested in the spring (April-May). Silage corn is seeded immediately afterward and harvested in late summer or fall (August-October).

Alfalfa is also planted. Alfalfa is a complex perennial crop. It removes large quantities of nutrients from the soil (PNW). It can meet most of its nitrogen needs from the atmosphere through nitrogen fixation, but is dependent both on the presence of rhizobia bacteria in the soil and on whether or not supplemental nitrogen is added. Alfalfa is considered a "lazy" plant, using nitrogen from other sources such as manure or commercial fertilizer if given the chance. The practice of nitrogen supplementation on alfalfa does occur within the GWMA. However, agricultural practices used for perennial crops like alfalfa and pasture remove the majority of the plant residue from the field during harvest (hay/silage) or through grazing.

During 1998-2003, 29 percent of the irrigated acres in the Granger drainage and 12 percent in the Sulphur drainage were owned by dairies (Crowe) and there were 20, 24, 2, and 0 dairies in Granger, Sulphur, Spring and Snipes drainages, respectively (RSJB 2009).

Tree Fruit and Vegetable Crops

The primary crops grown in the region are tree fruit, grapes (both juice and wine), hops, wheat, mint, and asparagus. The orchard and vineyard crops, e.g., apples, grapes, cherries, pears, peaches/nectarines are not replanted annually. Rather, they are replanted as appropriate to enhance farming efficiency and anticipate market preference and demand.

Fertilizers

Fertilizers available within the GWMA include commercial fertilizer, green manure (growing plants that are plowed back into the soil) or compost (made from manure). There is no current measured data regarding the distribution of the amounts of these three nitrogen sources within the GWMA. WSDA interviews with farmers and crop consultants indicate that the most commonly used product is commercial fertilizer. The only exceptions were silage corn and triticale, where more acres were fertilized with manure than with commercial fertilizer. The only crops where growers or crop consultants reported use of all three fertilizer products were hops and triticale.

Fertilizer application timing can affect nitrogen availability for plant uptake and resultant leaching of excess nitrogen. For instance, synthetic fertilizers are formulated to release a specific amount of nutrients at a specific rate over a select period of time. Nitrogen from compost or manure would be released over a much longer period of time at a much lower rate. Crop fertilizers (manure, compost, and synthetic fertilizer) also react differently at the point of application. Compost or manure also contain components with soil health improvement properties.

Generally, crop fertilizer application choices are affected by several parameters including fertilizer type, crop nitrogen needs, application recommendations, expected crop pricing, and anticipated yields. They also may be influenced by recommendations from crop consultants and fertilizer guides, historical practices, and practices of other growers in the community. This variability, in combination with effects of fertilizer types used, irrigation type and practices, and nutrient application timing, soil type and organic matter content, soil nutrient content, manure nutrient content, handling, and storage before application, organic carbon cycling and mineralization, and fertilizer fixing in alfalfa will all affect whether or not any fertilizer application represents a nitrogen loading risk. Alfalfa will resort to fixing nitrogen (i.e., create its own nitrogen by pulling it out of the air) only if there is insufficient nitrogen already in the soil. If there is sufficient nitrogen in the soil, it will utilize the soil nitrogen first.

High nutrient applications or application of multiple nutrient sources may be used on permanent tree fruit and vegetable crops to improve soil health and maximize fruit production. Producers of crops intended for human consumption may be reluctant to make manure and compost application because of concerns about pathogen transfer, reducing fertilization options (WSDA 2018).

Annual crops such as silage corn, triticale (for silage), and wheat use both commercial nitrogen and manure throughout the GWMA (WSDA 2018). Generally, the nitrogen application for this corn/triticale cropping system is split - one in the fall and one in the spring. Corn (silage and grain) use fairly even amounts of commercial nitrogen and manure on most of the acreage (WSDA 2018).

Fertilizers of any type should be applied only at an "agronomic rate;" that is, the rate of application of nutrients to supply crop or plant nutrient needs to achieve realistic yields, while at the same time minimizing the movements of nutrients to surface and groundwaters (Cf. WAC 16-611-010). " 'Agronomic rates' means the application rate (dry weight basis) that will provide the amount of nitrogen or other critical nutrient required for optimum growth of vegetation, and that will not result in the violation of applicable standards or requirements for the protection of ground or surface water as established under chapter 90.48 RCW, water pollution control and related rules including chapter 173-200 WAC, water quality standards for groundwaters of the state of Washington, and chapter 173-201A WAC, water quality standards for surface waters of the state of Washington" (WAC 173-350-100). Where the root zone of agricultural crops are within saturated ground, the "agronomic rate" is limited by the groundwater standard.

Organic Fertilizers: Cover Crops, Manure and Compost

Cover crops can fix nitrogen within the soil, if plowed into the soil onsite. The variety of cover crop and number of years of integration of cover crops into the soil can affect overall nitrogen concentrations in the soil.

Manure from dairy and livestock operations within the GWMA is a widely-used source of organic fertilizer for irrigated crops within the GWMA. While total volume of manure production can be calculated, as a function of total animals, no public records are currently maintained from which to analyze whether, in gross (minus exportation of such materials), the application of such volume on available irrigated acreage within the GWMA equates to an agronomic rate in gross. Some pre-application site-specific soil characterization is practiced, so as to accomplish specific site application at an agronomic rate.

Manure contains two primary forms of nitrogen: ammonium and organic nitrogen. Organic nitrogen is nearly immobile. It becomes mobile, and available to crops as fertilizer, through mineralization, the process by which soil microbes decompose organic nitrogen into ammonium. The rate of mineralization varies with soil temperature, soil moisture, and the amount of oxygen in the soil. After mineralization, microorganisms within the soil convert ammonium into nitrate. This process, called nitrification, occurs most rapidly when the soil is warm, moist, and well-aerated.

Livestock wastes contain high concentrations of nitrogen and ammonium, and low concentrations of nitrate relative to inorganic fertilizer. It is difficult to estimate nitrogen loading to soil, air, and water from manure application without sufficient analysis of nitrogen content in these waste streams. These are subject to some nitrogen loss to air and soil under natural conditions.

Synthetic Fertilizers

There is no public record of the total amount of synthetic fertilizers sold or used within the LYVGWMA. Crop consultants or agronomists, either academic or mercantile (G.S. Long, Co., D & M Chemical, Bleyhl's, Wilbur-Ellis, Simplot, Crop Production Services, Husch and Husch), are used by the majority of commercial farms operating within the GWMA. There are only a few companies that do this type of work. These consultants are not usually farmers. They create prescriptions for pesticide and fertilizer applications across multiple crops on many different farms. Mercantile crop consultants have economic incentives to recommend larger applications of fertilizers. Agronomists without such incentives could review and evaluate such recommendations for farmers.

Water Applications

Irrigation practices can affect both amounts and rates of nitrogen leaching and the potential for increased nitrogen concentrations in irrigation return flows (which relocate nitrogen applied through fertilizer).

Irrigation water requirements vary based on crop type. The nitrogen concentration of irrigation water likely resembles that of the Yakima River. The average N concentration of high flow (late spring) and low flow (late summer) conditions of the Yakima River at Kiona during the 2012 irrigation season was 0.809 mg N/L (USGS 2013).

Irrigated agriculture is mapped statewide by WSDA, including the area within the GWMA. There is no current measured data regarding the distribution of the three general irrigation methods (sprinkler, drip, macro/rill) within the GWMA. Interviews with farmers and crop consultants indicate that sprinkler irrigation was used on 61 percent of the total irrigated acreage in the GWMA, drip irrigation (including drip, micro sprinkler, drip/sprinkler, and combinations) was used on 23 percent of the acreage. Macro, or rill, irrigation was used on 15 percent of the acreage (total does not equal 100 percent due to rounding) (WSDA 2018).

Silage corn and triticale cultivation is almost all irrigated with sprinkler or center pivot irrigation systems. Triticale cultivation rarely occurs on rill irrigated fields (Sheehan).

Any improperly decommissioned wells beneath livestock operations, including crop fields onto which waste is applied, could provide a direct conduit for contaminants to reach the groundwater.

Livestock Operations/CAFOs

Dairy Operations

USDA's 2012 estimate of dairy operations was 99,532 milk cows on 97 farms (USDA NASS 2014) in Yakima County (WSDA 2018). The majority, or near total of these, are thought to be located within the GWMA. Dairy farms are increasing in size, while the number of farms is decreasing (WSDA 2018).

Manure and other animal wastes supply nutrients to crops because they contain nitrogen and other elements essential to plant growth, and the recycling of animal nutrients to increase soil fertility and crop yield is a historic practice. Manures are recommended over commercial fertilizers where there is a desire to build the soil profile by increasing and diversifying soil organisms, increasing moisture holding capacity, and reducing the need for inputs.

Livestock operations have the potential to release nitrate, chloride, sulfate, and bacteria to surface or groundwater (Harter et al., 2002; Harter et al., 2012). Whether groundwater contamination occurs depends on contaminant characteristics, management practices, meteorological conditions, soil types, geological conditions, and groundwater characteristics (Viers et al., 2012). Contaminant sources can be animal holding areas, manure storage impoundments (either lagoons or settling ponds/basins), and manure applications to cropland (Harter et al., 2002).

The national statistical average of manure production of milk cows (in 2000) was 15.24 tons per animal unit of manure excreted per year. The national statistical average of nitrogen per ton of manure excreted is 10.69 pounds of nitrogen per ton (Kellog et al., 2000). The formulas used by the EPA to calculate animal manure production, nitrogen production, and losses due to volatilization or denitrification for Holstein cows (EPA 2012, attributable to WSDA) in the Yakima Valley are as follows:

Annual manure production is calculated using the following formula: [((# of milking cows)*1.4 108) + ((# of dry cows)*1.4*51) + 99# of heifers)*0.97*56) = ((# of calves)I0.33*83)] *365/2000 (WSDA 2010)

Nitrogen production is calculated using the following formula: [((# of milking cows)*1.4*.710 = ((# of dry cows)*1.4*.3) + ((# of heifers)* 0.97*.27)+((# of calves)*0.33*.42)]*365/2000 (WSDA 2010)

Losses due to volatilization or denitrification during storage are estimated at 35 percent. This does not include application losses (WSDA 2010; EPA 2012).

Waste Storage Facilities (Lagoons)

Liquid manure stored in lagoons can be a source of nitrate and other contaminants. Contents of lagoons often consist of liquid manure (including urine), rainfall and snowmelt, any other liquid corral runoff, and process water from feeding pens and milking areas. Design, construction and management of lagoons are all very important for the protection of groundwater. In studying dairy, beef, and swine lagoons, researchers found substantial variation in the composition of solids, liquids, and dissolved constituents and leakage rates causing a wide variation in the potential to impact groundwater quality (Ham 2002; Harter et al., 2012a).

The distinction between a lagoon, a settling basin, a settling pond, or a pond is uncertain. Different professionals use different terms for different manure storage impoundments, and different impoundments may be used for different purposes at different times of year. Producers may mix manure and water in additional ponds before land application.

Not all industry experts classify impoundments based on the same criteria and experience. In addition, there are a wide variety of different construction techniques and operational techniques for settling ponds and basins. Some are earthen impoundments that are drained and cleaned as needed. Some ponds are concrete lined, engineered basins.

Lagoon nitrogen concentration depends on farm practices and unit operations on site. Operational differences are often related to whether a dairy uses a flush or scrape system to clean barns, the type of solids separation systems utilized and whether irrigation water is mixed with liquid manure for land application, and potential seasonal effects.

Animal Holding Areas or Corrals

Animal holding areas or corrals at animal feeding operations are typically unvegetated areas that include pens, freestalls, corrals, and resting and feeding areas. Some areas have extensive concrete and other areas are dominated primarily with a flooring or surface of unlined and compacted soil that can be susceptible to leaching or runoff to contaminant areas. If properly constructed and maintained, concrete floor surfaces can contain wastes and minimize leaching. Corral surfaces become compacted with use and become dense enough to slow down the downward movement of water and pollutants. Manure accumulating on the surface mixes with the soil layer and forms a low-permeability interface layer that further reduces the permeability of corral and pen surfaces (Harter et al., 2012a). Nitrogen loading from corrals and pens at dairy and feedlot facilities is governed by engineered sloping, soil type, dairy or feedlot age, unsaturated zone thickness, stocking rate, rainfall, and evapotranspiration rates. In some situations, increased short-term leaching in corrals may occur due to cracking during seasonal weather events.

Pens and Composting Areas

There are 2,632 acres within the GWMA identified by WSDA as pens or composting areas (1,597 acres Dairy CAFO, 499 acres Nondairy CAFO, 536 acres compost) (WSDA 2018). The nitrogen loading rates of pens vary depending upon number and size of stock contained within them and the management of those pens. Nitrogen leaching potential in pens and compost areas is mitigated by low annual precipitation, management of the amount of manures in those pens and compaction of those areas by livestock or equipment. Beef cattle feedlots and dairies have different number of animals per lot. The majority of pens that have been identified as non-dairy CAFOs are most likely dedicated to raising or housing dairy support animals (calves and heifers). However, individual pens may hold calves during one time period and after those animals are moved out, heifers and adult cows may be moved into that same corral or pen.

" 'Composting' means the biological degradation and transformation of organic solid waste under controlled conditions designed to promote aerobic decomposition. Natural decay of organic solid waste under uncontrolled conditions is not composting" (WAC 173-350-100). "Composting" may refer to a category of activities rather than a specific practice or technology, may occur in windrows, composting in bags, spreading material out over a concrete pad or large surface area to dry, turning frequency, potential moisture additions to material that has dried out. Composting reduces the weight of the basic material. Composted waste can be desired by organic growers as a source of additive to soil structure, soil density, nutrient and weed defoliant.

Buildings Housing Animals

Animals may spend time in freestall barns, milking parlors, or loafing sheds. These facilities are built with concrete floors and are cleaned multiple times a day. Potential leaching from these types of buildings, even anticipating cracks in concrete floors that could provide a pathway to leaching, is much smaller than potential from pens and lagoons.

Residential, Commercial, Industrial and Municipal Groundwater

Non-agricultural sources of potential contamination of groundwater within the LYVGWMA boundaries include the following:

Residential Onsite Sewage Systems (ROSS)

Residential Onsite Sewage Systems (OSS) are present throughout the LYVGWMA outside of those areas served by municipal sewage collection and treatment systems. Non-residential OSS are also scattered throughout the project area serving a variety of public and private entities. The OSS comprise one of the several potential sources contributing nitrate to the underlying shallow alluvial groundwater system.

There are 6,044 residential households within the GWMA that discharge wastewater to an onsite sewage system (WSDA 2018). Nitrogen in residential wastewater is mainly generated from human body wastes and food materials from kitchen sinks and dishwashers. The amount of nitrogen present in the wastewater is typically expressed as a concentration in milligrams per liter (mg/L) and/or as a mass loading in grams/person/day.

The highest density of OSS is within and near urban growth areas associated with municipalities. Specifically:

- The highest density of OSS are found on the east and north side of Sunnyside where OSS density ranges from 80 to 100 OSS per section.
- West of Sunnyside near Outlook where OSS density approaches 80 OSS per section.
- In the Zillah to Buena area where density approaches 80 OSS per section.
- Slightly lower OSS density is found south of Grandview, Sunnyside, and Mabton where the OSS range from 50 to 70 per section.

The absence of public water systems in some rural areas where OSS are densely sited, due in part to the date of development of these areas, may cause too-close proximity of septic systems and drinking water wells. Nearby municipalities are constrained in providing new public water service to these denser rural populations by cost and growth limitations imposed by growth management areas established pursuant to the Growth Management Act. Too great a density of ROSS can be a cause of groundwater pollution (EPA 1977) (Swann). In the case of the Buena community within the LYVGWMA, failing septic systems and related contaminated wells caused Yakima County to respond with grant-funded installation of a public water system and a wastewater treatment system utilizing a combined septic/sewer system (Redifer).

The frequency of septic tank pumping in each ROSS in the GWMA is unknown. In a survey conducted by Yakima County, without statistical sampling methodology, 82 percent of 458 surveys collected indicated that they had had their "septic tank pumped recently."

Wastewater discharged to a ROSS is subject to several biological processes including nitrification and denitrification. These processes can take place depending on the environmental conditions and occur most effectively when the soil is unsaturated because the wastewater is forced to percolate over the soil particle surfaces where treatment can take place and air is able to diffuse through the soil. Whether these processes occur and their effectiveness in treatment depends on the physical characteristics of the soil and the environmental conditions of the soil through which the wastewater percolates. Wastewater parameters, such as levels of nitrogen, are removed to varying degrees. Under good conditions (and proper operation and management), organic or ammonia nitrogen is readily and rapidly nitrified biochemically in aerobic soil and some biochemical denitrification can occur in the soil, but without plant uptake, 60 to 90 percent of the nitrate enters the groundwater. Under anaerobic soil conditions, nitrification will not occur, but the positively charged ammonium ion is retained in the soil by absorption onto the soil particles. The ammonium may be held until aerobic soil conditions return allowing nitrification to occur (EPA 2002). Within the GWMA, moderate denitrification occurs about three months a year and poor denitrification occurs about three months (soil saturated and no warmth). These factors determine that the total denitrification average in the GWMA is in the range of 10 to 13 percent.

Conventional ROSS technology relies on primary treatment (settling) for solids and organic reduction prior to dispersion to the ground. Innovative ROSS technologies combine the primary treatment with biological treatment to achieve a higher level of treatment. The biological processes promote the removal of nitrogen from wastewater through the multi-step bacterial conversion of ammonia and organic nitrogen to nitrates (nitrification) and the reduction of nitrates to gaseous nitrogen (denitrification). The optimum nitrogen removal of properly operating conventional ROSS technology is up to 10 to 30 percent (WDOH 2005). Innovative ROSS technology utilizing biological nitrogen removal or introduction of carbon source can increase nitrogen removal (WDOH 2005).

The predominant soil types underlying the ROSS drain fields located within the GWMA are characterized as silt loams that are porous and have a well-developed structure. The estimated depth to groundwater is equal to or greater than 10 feet at approximately 90 percent of the ROSS locations. See Figure 11, Depth to Groundwater. It is reasonable to assume that the environmental conditions underlying the drain fields are conducive to some level of denitrification.

Large Onsite Sewer Systems (LOSS)

A LOSS is a septic system serving multiple residences or nonresidential establishments serving twenty or more people per day or having a design volume over 3,500 gallons. Washington State Department of Health records show that there are two LOSS located within the GWMA. One is located outside of Zillah with a design capacity of 5,000 gallons. The second LOSS site is located outside of Granger with a design capacity of 4,850 gallons. Annual reports for LOSS are submitted to the DOH.

Commercial Onsite Sewer Systems (COSS)

A COSS is a septic system used for employees working at agricultural or other businesses that operate year-round and are not classified as a LOSS by the DOH. The most likely locations of these facilities within the GWMA are wineries, schools, agriculture packing lines, small businesses (stores, fire stations), agricultural business offices and maintenance buildings, churches, and confined animal feeding operations (CAFOs).

Biosolids

Biosolids are a nutrient rich soil amendment derived from public waste treatment plant septage. Septage is a class of biosolids that comes from septic tanks, treatment works, and similar systems receiving domestic wastes (WAC 173-308-050). Biosolids are produced by treating sewage sludge to meet certain quality standards that allow it to be applied to the land for beneficial use.

Biosolid application rates require advanced approval based on pre-plant soil tests, evaluation of crop type and yield estimates, soil types, and use of irrigation. Intermittent post-harvest tests are also conducted. The single site approved for land application of biosolids within the GWMA is Natural Selection Farms located at 6800 Emerald Road in Sunnyside.

FIGURE 18 - BIOSOLIDS APPLICATION SITES

Residential Lawn Fertilizers

Residential lawns exist primarily within towns or urban growth areas within the GWMA. All residents do not fertilize their lawn regularly. Some do not fertilize their lawns at all. Rough estimates are necessary to evaluate how much nitrogen is applied within the GWMA to residential lawns. Nitrate accumulation in the groundwater is not just a matter of nitrogen application rates but also water application rates and removal of "thatch" (grass clippings generated through mowing). While not everyone fertilizes regularly, overwatering and improper thatch management may occur at municipal properties, including residences, schools and businesses, particularly if mowing or watering is frequent. Both can have an effect on the loading of even a small amount of nitrogen. Higher population density areas can have a higher percentage of lawn area and the associated potential for more fertilization and overwatering that could be a factor in N loading.

"Hobby Farms"

The term "hobby farm" is intended to mean a land, which may or may not contain a residence, other than lawns, upon which minimalist agriculture is maintained without the intention of profit. It may contribute nitrogen within the GWMA area. These land uses are on parcels of land less than 10 acres that are not included in the WSDA's crop inventory. Nitrogen contributions on these parcels may come from individual gardens, pastures, pets, and other animals. Co-location of septic drain fields and hobby farming operations, particularly animal farming operations, may cause drain field failure and reduction of denitrification potential.

Underground Injection Wells

Most UIC's in Yakima County are road based and county-owned, put in place to receive surface water runoff from county roads.

Transport (Abandoned Wells)

Abandoned or improperly-constructed wells can be a conduit for nitrogen entering the ground. In Washington State, the construction of groundwater wells was first required to be reported in 1972. Consequently, the Department of Ecology well database includes only those wells constructed after 1972, and those wells identified in information supporting water right claims, permits or certifications predating 1972. A reasonable estimate of wells within Yakima County that are identified in DOE's well database is 45,000. Some portion of that is located within the Groundwater Management Area.

> Groundwater wells typically have a life of about 40 years. This is due to: mechanical failure, deterioration of material (primarily steel well casings), settling of casings within ground materials, change in aquifer conditions (mineralization, scale deposits within casing). In most instances, it is cheaper to drill a new well than to repair an old one (Richardson).
>
> Not all wells have the same risk of failure, or if abandoned the same risk to the public health and welfare. Wells differ in design, construction, diameter of casing, depth of casing, depth to water, water chemistry, etc. Wells constructed pursuant to regulatory standards have less risk of failure, even if "abandoned." "Dug wells," those wells constructed by digging a pit in the ground in order to collect water near ground surface, either with or without a small-diameter casing hammered into the ground from the bottom of the pit have the greatest risk of failure and risk to the public health and welfare. In addition to potential groundwater contamination from dug wells, people and animals can fall into these wells (Richardson).
>
> "Vaulted" wells also present a significant risk of groundwater contamination, whether in use or abandoned. A "vaulted" well is essentially a dug well with a concrete reinforcement of the sides, or bottom, of the pit, creating a "vault". Water can collect in vaults which may migrate down the well casement, or along the annulus (the circular void between the well casing and the ground material through which the well was drilled) of the well casing. Wells with casing top elevations at or near ground level (as opposed to raised above ground level), or cut off below ground level, also present risk of groundwater contamination, due to possible "overtopping" of surface contamination into the well casing. Similar risk occurs where the well casing has no cap. Otherwise properly constructed wells may present risk of groundwater contamination if they have not been "sealed." Sealing is accomplished through the infusion of bentonite clay or cement into the casing annulus for a distance sufficient to prevent surface water intrusion into the subsurface (Richardson).
>
> Deeper wells generally have larger diameters than shallower wells. Industrial, public water system, or irrigation wells are more likely to have larger diameter wells than single-user domestic wells. Unused irrigation wells may be less likely to be discovered because of change of land use or crop choice (Richardson).
>
> Abandoned wells or wells that have not been decommissioned are often located by purchasers of property, parties who may become liable upon foreclosure of real estate financing instruments (banks), and reviewing entities (e.g., county planning officials) when reviewing proposals for change of parcel definitions (short plats, site plans for building permits) (Richardson).

Surface water, streams, and wasteways may also be a means of transportation of nitrogen to the ground.

Atmospheric Deposition

Atmospheric deposition of nitrogen is the process by which aerosol particles collect or deposit themselves on the earth's surfaces. It may be either wet or dry deposition. Nitrogen emissions may come from transportation agriculture, power plants, industrial and natural sources. In agricultural areas emissions from operations involving animals or fertilized cropland. Emissions may travel from very long or very short distances (Viers et al., 2012). Deposition monitoring is conducted by the National Atmospheric Deposition Program. There is one monitoring station in Eastern Washington, in Whitman County (WSDA 2018).

The Regulatory Environment

The water molecules in the ground beneath the LYVGWMA fall within the regulatory structure of the federal Safe Drinking Water Act and Washington Department of Health regulations (as "drinking water") and Washington's Water Pollution Control Act and Water Resources Act (as "groundwater"). Those molecules' potential contribution to surface water quality makes the federal Clean Water Act and surface-water authorities assigned to the Washington State Department of Ecology by the Water Pollution Control Act also apply.

Safe Drinking Water Act

The EPA has broad authority, under Section 1421 of the Safe Drinking Water Act, 42 U.S.C. 300g-1(b)(1)(A), (B), to establish national primary drinking water standards, "if the Administrator determines that . . . the contaminant may have an adverse effect on the health of persons;" "is known to occur . . . in public water systems with a frequency and at levels of public health concern;" or there is "a meaningful opportunity for health risk reduction for persons served by public water systems."

> For each contaminant that the Administrator determines to regulate under subparagraph (B), the Administrator shall publish maximum contaminant level goals and promulgate, by rule, national primary drinking water regulations under this subsection (42 U.S.C. 300g-1(b)(1)(E)).

EPA sets legal limits on over 90 contaminants in drinking water. The legal limit for a contaminant reflects the level that protects human health and that water systems can achieve using the best available technology. EPA rules also set water testing schedules and methods that water systems must follow. The EPA set the maximum contaminant level for nitrate, nitrite and total nitrate, and nitrite in 40 CFR § 141.62:

Contaminant	MCL (mg/l)
(7) Nitrate	10 (as Nitrogen)
(8) Nitrite	1 (as Nitrogen)
(9) Total Nitrate and Nitrite	10 (as Nitrogen)

EPA may approve states to assume primary enforcement authority under the Safe Drinking Water Act. Washington's drinking water quality standard for nitrate is 10 milligrams per liter (mg/L), or 10 parts per million.

When drinking water in private wells contains or is likely to contain a contaminant that may present an imminent and substantial endangerment, such as nitrate, EPA may take an emergency action under the SDWA, Section 1431. EPA must first determine that the state and local authorities have not taken action to protect the health of such persons. An emergency action pursuant to SDWA Section 1431 may include any order that may be necessary to protect the health of persons, including ordering the collection of samples to investigate the sources of the contamination. In addition, where appropriate, EPA may issue orders to require the provision of alternative water supplies. EPA may also judicially enforce its orders, through action seeking civil penalties for each day of such violation. If violation of EPA's orders is "willful," EPA may seek criminal penalties of fines or imprisonment for not more than three years (42 U.S.C. § 300g-2(b)). Citizens may also seek protection of underground sources of drinking water, under 42 USC 300j-8, so as to mandate EPA regulatory or litigative action.

The EPA may also designate sole source drinking water aquifers under Section 1427 of the Safe Drinking Water Act, 42 U.S.C. 300h.

State Department of Health

The Washington State Department of Health is authorized to adopt regulations "to protect public health" (RCW 43.20.050(2)). These may include rules for Group A public water systems, as necessary, to assure safe and reliable public drinking water and to protect the public health. Those rules set requirements regarding: (i) The design and construction of public water system facilities, including proper sizing of pipes and storage for the number and type of customers; (ii) Drinking water quality standards, monitoring requirements, and laboratory certification requirements; (iii) Public water system management and reporting requirements; (iv) Public water system planning and emergency response requirements; (v) Public water system operation and maintenance requirements; (vi) Water quality, reliability, and management of existing but inadequate public water systems; and (vii) Quality standards for the source or supply, or both source and supply, of water for bottled water plants.

The DOH also sets rules for Group B public water systems, as defined in RCW 70.119A.020. These rules establish minimum requirements for the initial design and construction of a public water system and "rules and standards for prevention, control, and abatement of health hazards and nuisances related to the disposal of human and animal excreta and animal remains" (RCW 42.30.050 (2) (b), (c)).

The Department of Health requires that nitrate levels (concentrations) (as N) in Group A public water systems not exceed the maximum contaminant level ("MCL") of 10 mg/L, and that nitrite levels (concentrations) not exceed the MCL of 1 mg/L (WAC 246-290-310(3) (Table 4)). The requirements for Group B public water systems are the same (WAC 246-291-170 (2)(b)). Nitrate and nitrite are "primary inorganic contaminants" and the MCL for nitrate and nitrite are "primary MCLs." When primary MCLs are exceeded by a public water system the water purveyor must "determine the cause of the contamination" and "take action as directed by the Department of Health" (WAC 246-290-320(1)(b)(iii)).

WAC 246-290-300 requires public water systems to sample for many contaminants, including nitrate, on a regular basis. Public water systems with nitrate levels over 10 ppm must notify the people who receive water from them (WAC 246-290-320).

Clean Water Act

Surface water quality in Washington is regulated by the federal Clean Water Act (33 U.S.C. 1342, et seq.) and Washington's Water Quality Standards for Surface Waters (Chapter 173-201A), which are authorized by the State Water Pollution Control Act (Chapter 90.48).

The Clean Water Act makes it unlawful to discharge any pollutant from a point source into waters of the U.S. unless a National Pollutant Discharge Elimination System (NPDES) permit is obtained (33 U.S.C. 1342). The NPDES permitting authority has been delegated to the Department of Ecology (See 33 U.S.C. 1342 (b); RCW 90.48.260). The Department exercises this delegated authority, together with its authority under the Water Pollution Control Act, in issuing NPDES permits and State Waste Discharge Permits (SWDPs) (pursuant to WAC 273-226-030). DOE's water quality standards are used to establish effluent limits in NPDES permits and SWDPs.

DOE's water quality standards and SWDPs apply to both point source activities and nonpoint source activities. Point source activities are activities where a source of pollution can be readily distinguished, such as the industrial discharge of waste onto or into the ground. State law requires point sources to operate under permits that set conditions for discharges. These permits may be issued to a specific entity with conditions designed to protect water quality.

A "point source" is "any discernible, confined, and discrete conveyance, including, but not limited to, any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged. This term does not include return flows from irrigated agriculture." (WAC 273-226-030 (21))

"Nonpoint sources" are more diffuse in nature. They often consist of many small pollutant sources that have a cumulative effect, like highway runoff, on-site septic systems in developed areas, and application of pesticides or nutrients in both agricultural and urban areas. Some nonpoint sources are managed through the development of siting and design standards.

Groundwater contamination may affect surface water quality. Under §303(d) of the Clean Water Act, states are required to develop lists of impaired waters. These are waters for which technology-based regulations and other required controls are not stringent enough to meet the water quality standards set by the state. The law requires that states establish priority rankings for waters on the lists and develop Total Maximum Daily Loads (TMDL) for these waters. A TMDL is a calculation of the maximum amount of a pollutant that a water body can receive and still safely meet water quality standards. A TMDL is generally administered by establishing limits on the discharge of pollutant materials otherwise permitted under the NPDES or state regulatory programs.

Washington's Water Pollution Control Act and Water Resources Act

Groundwater quality in Washington is regulated by the Groundwater Quality Standards (Chapter 173-200 WAC) which are authorized by the state Water Pollution Control Act (Chapter 90.48 RCW) and Water Resources Act (Chapter 90.54 RCW). Discharges to groundwater are regulated through a variety of permitting mechanisms which are authorized by the Water Pollution Control Act (Chapter 90.48. RCW). These permitting regulations include State Waste Discharge Permits, which may be issued as General Permits.

The Water Pollution Control Act, Chapter 90.48 RCW makes it "unlawful for any person to throw, drain, run, or otherwise discharge into any of the waters of this state, or to cause, permit or suffer to be thrown, run, drained, allowed to seep or otherwise discharged into such waters any organic or inorganic matter that shall cause or tend to cause pollution of such waters" (RCW 90.48.080).

The Department of Ecology is the primary agency in Washington State responsible for implementation of this mandate. DOE has adopted Chapter 173-200 WAC, Water Quality Standards for Groundwaters. The standards include "water quality criteria" (numerical limits for specific contaminants that apply to all groundwaters in the state). WAC 173-200-040 (2) (Table 1) establishes that Nitrate concentrations in groundwater may not exceed 10 mg/L.

The standards apply to all groundwaters of the state that occur in a saturated zone (generally at or below the water table) or stratum beneath the surface of land or below a surface water body. The groundwater standards do not apply in the root zone of saturated soils where agricultural pesticides and nutrients have been applied at agronomic rates for agricultural purposes, but only if those contaminants will not cause pollution of groundwaters below the root zone (WAC 173-200-010(3)(a)). In other words (removing the double negative), the standards do apply in saturated root zones if pollution is caused in groundwaters below.

DOE's water quality standards incorporate an "antidegradation policy," an otherwise existing part of state water quality law (WAC 173-200-030). This policy precludes degradation which would harm existing or future beneficial uses of groundwater (drinking water, irrigation and support of wildlife habitat). DOE has antidegradation implementation procedures that explain what needs to be done for an antidegredation analysis. The standards provide numeric values, which must not be exceeded to protect the beneficial use of drinking water.

"General permits" issued by the Department of Ecology (either as a "combined" NPDES and SWDP or as a "state-only" SWDP) may be issued to a group of entities with common discharge characteristics and conditions (WAC 273-226-020). Permits issued under Chapter 273-226 WAC are designed to satisfy the requirements for discharge permits under Sections 307 and 402(b) of the federal Water Pollution Control Act (33 U.S.C. §1251) and the state law governing water pollution control (Ch. 90.48 RCW) (WAC 273-226-020). If eligible, a point source must obtain general permit coverage before discharging to surface or ground waters or the point source may be found to be in violation of state or federal law for discharging without a permit.

General permits establish standards for management. General permits are issued for fixed terms not exceeding five years from the effective date. Point source facility operators must apply to the DOE for coverage under a general permit (WAC 227-226). All permittees covered under a general permit must submit a new application for coverage under a general permit or an application for an individual permit at least 90 days prior to the expiration date of the general permit under which the permittee is covered. When a permittee has made timely and sufficient application for the renewal of coverage under a general permit, an expiring general permit remains in effect and enforceable until the application has been denied, a replacement permit has been issued by the DOE, or the expired general permit has been terminated by the DOE. Coverage under an expired general permit for permittees who fail to submit a timely and sufficient application shall expire on the expiration date of the general permit (WAC 173-226-200).

A general permit may be modified, revoked and reissued, or terminated, during its term if information is obtained by DOE which indicates that cumulative effects on the environment from dischargers covered under the general permit are unacceptable (WAC 173-226-230 (1)(d)). DOE may require any discharger to apply for and obtain an individual permit, or to apply for and obtain coverage under another more specific general permit. Also, any interested person may petition the DOE to require a discharger authorized by a general permit to apply for and obtain an individual permit (WAC 173-226-240 (2), (3)).

DOE may revoke, or "terminate coverage under a general permit," where terms or conditions of the general permit are violated, conditions change such that either temporary or permanent reduction or elimination of permitted discharges is required, or DOE determines that the permitted activity endangers human health, safety, or the environment, or contributes to water or sediment quality standards violations (WAC 173-226-240 (1) (a), (c), and (d)).

Washington's Water Pollution Control Act authorizes DOE to "bring any appropriate action, in law or equity, including action for injunctive relief . . . as may be necessary to carry out the provisions" of that Act (RCW 90.48.037), including its prohibition of the discharge of organic or inorganic matter that may cause pollution of ground or surface water (RCW 90.48.080).

Violations of maximum concentrations may be addressed by enforcement "through all legal, equitable, and other methods available to the department including, but not limited to: issuance of state waste discharge permits, other departmental permits, regulatory orders, court actions, review and approval of plans and specifications, evaluation of compliance with all known, available, and reasonable methods of prevention, control, and treatment of a waste prior to discharge, and pursuit of memoranda of understanding between the department and other regulatory agencies" (WAC 173-200-100 (3)).

If DOE determines that a potential to pollute the groundwater exists, it may request a permit holder or responsible person to prepare and submit a groundwater quality evaluation program for its approval. Each evaluation program must be based on soil and hydrogeologic characteristics and be capable of assessing impacts on groundwater at the "point of compliance." The evaluation program approved by DOE may include (a) groundwater monitoring for a specific activity; (b) groundwater monitoring at selected sites for a group of activities; (c) monitoring of the vadose zone; (d) evaluation and monitoring of effluent quality; (e) evaluation within a treatment process; or (f) evaluation of management practices (WAC 173-200-080 (2)). The "point of compliance" is the location where the "enforcement limit," is "measured and shall not be exceeded" (WAC 173-200-060 (1)). The "enforcement limit" is established in accordance with WAC 173-200-050.

The DOE may also designate a groundwater "special protection area" if it determines that the groundwater in an area requires "special consideration or increased protection because of one or more unique characteristics" (WAC 173-200-090 (1)). These unique characteristics are then to be taken into consideration by DOE when regulating activities, developing regulations, guidelines and policies and when prioritizing department resources for groundwater quality protection programs (WAC 173-200-090 (2)). Characteristics to guide designation of a special protection area are set forth in the rule (WAC 173-200-090 (2)). Designation of special protection areas must be in the public interest (WAC 173-200-090 (5)(b)).

Resource Conservation and Recovery Act

The Resource Conservation and Recovery Act (RCRA) (Pub. L. No. 94-590, 90 Stat 2795, 42 U.S.C. §§6901-6987, 9001-9010) contains both regulatory standards and remedial provisions to achieve goals of conservation, reducing waste disposal, and minimizing the present and future threat to human health and the environment. RCRA provides a comprehensive national regulatory structure for the management of nonhazardous solid wastes (subtitle D, 42 U.S.C. §§ 6941/y-6949a) and hazardous solid wastes (subtitle C, 42 U.S.C. §§ 6921/y-6939b). "Solid waste" is defined as "any garbage, refuse, sludge from a waste treatment plant, water supply treatment plant, or air pollution control facility and other discarded material, including solid, liquid, semisolid, or contained gaseous material resulting from industrial, commercial, mining, and agricultural operations, and from community activities . . . ." 42 U.S.C. §6903(27)

Materials are discarded if they are either abandoned or recycled or are inherently waste-like. 40 C.F.R. § 261.2. Materials are "disposed" if they are discharged, deposited, injected, dumped, spilled, leaked or otherwise placed into or on land or water such that it may enter into the environment or be emitted into the air or discharged into any waters, including groundwaters 42 U.S.C. §6903(3). Agricultural wastes, including manures, crop residues, or commercial chemical fertilizers applied to the soil in amounts greater than can be used as fertilizers or soil conditioners may be the disposal of solid waste.

Washington's Right to Farm Law

Washington State's right to farm law, RCW 7.48.300-320, was first enacted in 1979, with the purpose of protecting agricultural activities conducted on farm and forest lands from nuisance lawsuits. As a consequence, "agricultural activities conducted on farmland and forest practices, if consistent with good agricultural and forest practices and established prior to surrounding nonagricultural and nonforestry activities, are presumed to be reasonable and shall not be found to constitute a nuisance" (RCW 7.48.305 (1)). The defense does not apply however if "the activity or practice has a substantial adverse effect on public health and safety." "Agricultural activities and forest practices undertaken in conformity with all applicable laws and rules are presumed to be good agricultural and forest practices not adversely affecting the public health and safety" (RCW 7.48.305 (2)). The Yakima County Code protects the right to farm in similar terms to the state statute (Ch. 6.22, YCC).

In 2005, Washington's right to farm law was amended to provide for full recovery of costs of litigation in the defense of nuisance suits where the right to farm law was a successful defense (RCW 7.48.315).

Interagency Cooperation

DOE and WSDA signed a Memorandum of Understanding (MOU) in 2003 to guide coordination and cooperation between the two agencies for dairies, CAFOs and other animal feeding operations. A key element of the MOU is that WSDA inspectors must provide field inspections and technical assistance to DOE for CAFO and other AFO related water quality activities. The two agencies continue to coordinate on livestock and manure related complaints and in implementing the CAFO permit. An updated MOU was signed in 2011. The MOU can be found at: http://agr.wa.gov/FP/Pubs/docs/MOUAgricultureEcology2011Final.pdf

Under the MOU, DOE is responsible to EPA for Clean Water Act compliance for AFOs and CAFOs. DOE maintains authority under Ch. 90.48 RCW to take compliance actions on any livestock operations where human health or environmental damage has or may occur due to potential or actual discharges, for pasture or rangeland based operations, for manure spreading operations when it is determined the manure was not applied by a dairy, for non-dairy AFOs, CAFOs and permitted CAFOs, and ultimately for permitted dairies. Where compliance actions are against non-permitted dairies, DOE recognizes WSDA as lead. Where DOE is involved in investigations and compliance actions against non-permitted dairies, DOE will discuss the compliance actions with WSDA to ensure that timely compliance actions are sufficient to protect human health and the environment. DOE is responsible for the approval of best management practices used to show compliance with water quality standards. DOE must provide available monitoring data and trend analysis for livestock related pollutants to WSDA upon request. DOE's TMDL process must involve WSDA as a stakeholder if livestock issues are anticipated.

The DOE/WSDA MOU requires that both agencies provide the other all livestock related records that either may possess as necessary to fulfill state and federal requirements for livestock under the Clean Water Act (MOU ¶ C.2), and that the two agencies will coordinate in response to public disclosure requests for AFOs, CAFOs and dairies (MOU ¶ C.4).

WSDA is responsible for implementing Ch. 90.64 RCW and is required to follow Ch. 43.05 RCW. WSDA is responsible for inspections and may initiate compliance actions on permitted dairies, but must notify DOE if there is a discharge to waters of the state and provide a Recommendation for Enforcement. WSDA is responsible for inspections, complaint response and warning letters for all non-dairy permitted CAFOs. DOE is responsible for complaint response for non-dairy AFOs and CAFOs but WSDA may respond for initial complaint response if resources are available and may write warning letters. WSDA must coordinate, but seldom becomes involved with DOE when compliance actions beyond warning letters are necessary for non-dairy AFOs and CAFOs or permitted CAFOs. WSDA must enter complaint inspections and warning letters on non-permitted AFOs and CAFOs into DOE's PARIS database.

Natural Resources Conservation Service (NRCS) offers voluntary financial and technical assistance programs to eligible landowners and agricultural producers to help them manage natural resources in a sustainable manner. Those under contract with NRCS to participate in voluntary programs must adhere to relevant standards for funded projects. Current financial assistance programs in Washington State include:

- Agricultural Management Assistance (AMA): helps agricultural producers use conservation to manage risk and solve natural resource issues through natural resources conservation.
- Conservation Stewardship Program (CSP): helps agricultural producers maintain and improve their existing conservation systems and adopt additional conservation activities to address priority resources concerns.
- Environmental Quality Incentives Program (EQIP): provides financial and technical assistance to agricultural producers in order to address natural resource concerns and deliver environmental benefits such as improved water and air quality, conserved ground and surface water, reduced soil erosion and sedimentation or improved or created wildlife habitat.

Regulations Pertaining to Particular Sources

Crops Supporting Livestock Operations

WSDA's regulations implementing the Dairy Nutrient Management Act, Ch. 16-611 WAC, require dairy producers to maintain records to demonstrate that applications of nutrients to crop land are within acceptable agronomic rates. Soil analysis should include annual postharvest soil nitrate nitrogen analysis; triennial soil analysis that includes organic matter; pH, ammonium nitrogen; phosphorus, potassium; and electrical conductivity. Nutrient analysis is required for all sources of organic and inorganic nutrients including, but not limited to, manure and commercial fertilizer supplied for crop uptake. Manure and other organic sources of nutrients must be analyzed annually for organic nitrogen, ammonia nitrogen, and phosphorus. WSDA conducts on-site inspections of dairies and reviews their records a minimum of every 18 months. Any significant operational change requires an updated dairy nutrient management plan. Dairies are subject to complaint inspections by

WSDA, DOE, and EPA at all times. There is no equivalent requirement for non-dairy agricultural producers.

Nutrient application records should include field identification and year of application, crop grown in each field where the application occurred, crop nutrient needs based on expected crop yield, nutrient sources available from residual soil nitrogen including contributions from soil organic matter, previous legume crop, and previous organic nutrients applied, date of applications, method of application, nutrient sources, nutrient analysis, amount of nitrogen and phosphorus applied and available for each source, total amount of nitrogen and phosphorus applied to each field each year; and the weather conditions twenty-four hours prior to and at time of application (WAC 16-611-020 (2)).

Tree Fruit and Vegetable Crops

There are no groundwater-specific regulations specifically addressing production of tree fruit and vegetable crops

Fertilizers

Bulk commercial fertilizer distributors are required by RCW 15.54.275 to be licensed. They are also required by RCW 15.54.362 to report the number of net tons of fertilizer distributed within the state during six-month periods (January to June, July to December) (annual report permitted if less than 100 tons). 220,909 tons (200,406,000 kg) of commercial fertilizer was purchased in Washington State in 2011. As the statute does not require that the report be subdivided by county, region or groundwater management area, there is no specific information with which to evaluate the amount of commercial fertilizer sold within the GWMA. "Bulk fertilizer" is commercial fertilizer distributed in a nonpackage form such as tote bags, tanks, trailers, spreader trucks, and railcars. Fertilizers are required to meet the nutrient value guaranteed by the fertilizer manufacturer. There is no requirement that agricultural producers be licensed to apply commercial or any other fertilizer. Unmanipulated animal and vegetable manures, organic waste-derived materials and biosolids are not commercial fertilizer (WAC 16-200-701).

Regulations pertaining to "chemigation" (Ch. 16-202 WAC) do not pertain to "fertigation," the application of chemical fertilizer through irrigation water delivery systems. "Chemigation" is the application of any substance a pesticide, plant or crop protectant, or system maintenance compound applied with irrigation water (WAC 16-202-1002 (17)). All pesticide laws apply to chemigation. Pesticides cannot be applied with an open surface, gravity irrigation system unless allowed by the product label.

The Director of the Department of Agriculture may adopt regulations for the appropriate use and disposal of commercial fertilizers for the protection of groundwater (RCW 15.54.800). Although "deep percolation" ("the movement of water downward through the soil profile below a plant's effective rooting zone") is defined by WSDA regulations, WAC 16-202-1002 (23), the regulations do not specifically prohibit deep percolation.

There are no federal, state, or local regulations specifically pertaining to the application of nitrogen-based fertilizer to agricultural crops, so long as they are applied at an agronomic rate so long as it does not pollute groundwaters below the root zone (WAC 173-200 100-(3)). Manure applied as fertilizer is a "dairy nutrient" under Washington State's Dairy Nutrient Management Act (Ch. 90.64 RCW) "'Dairy nutrient' means any organic waste produced by dairy cows or a dairy farm operation" (RCW 90.64.010 (11)). The 2017 CAFO general permit specifically requires that application of nitrogen-based fertilizers not pollute the groundwater.

Livestock Operations

Washington's Dairy Nutrient Management Act (DNMA) (Ch. 90.64 RCW) authorizes WSDA to "determine if a dairy-related water quality problem requires immediate corrective action under the Washington state water pollution control laws, chapter 90.48 RCW, or the Washington state water quality standards adopted under chapter 90.48 RCW" (RCW 90.64.050 (1)(d)). Dairies that are licensed to sell Grade A milk and who generate large quantities of animal waste that can pollute surface water and ground water must have an "approved" Nutrient Management Plan (NMP) on site within six months of licensing. NMP's must be implemented within two years after licensing (RCW 90.64.026 (7)). The purpose of such plan is to prevent the discharge of livestock nutrients to surface and ground waters of the state.

The DNMA authorizes local conservation districts to "provide technical assistance to dairy producers in developing and implementing a dairy nutrient management plan;" and to "review, approve, and certify dairy nutrient management plans that meet the minimum standards" (RCW 90.64.070 (1)(d),(e)). An employee of the South Yakima Conservation District often writes the NMP. "Approved" means the local conservation district has determined that the facility's plan to manage nutrients meets all the elements identified on a checklist established by the Washington Conservation Commission. "Certified" means the local conservation district has determined all plan elements are in place and implemented as described in the plan. To be certified, both the dairy operator and an authorized representative of the local conservation district must sign the plan. Dairies whose NPDES permits require dairy nutrient management plans need not be otherwise "certified." "Farm Plans," developed and approved by local conservation districts for farmers, must include "livestock nutrient management measures" (RCW 89.08.560). Local conservation districts also provide dairies with technical assistance and planning services with which to implement nutrient management plans.

Local Conservation Districts are authorized to provide dairies and other farms with technical assistance and planning services (RCW 89.08.560) and are required to approve and certify all NMPs. "Farm Plans" developed by conservation districts for farmers must include "livestock nutrient management measures" (RCW 89.08.560). The South Yakima Conservation District (SYCD) often writes the NMPs for dairy farms and later certifies them.

The primary goal of an NMP is to protect water quality from dairy nutrient discharges. The required elements of an NMP specified by the State Conservation Commission include the collection, storage, transfer and application of manure, waste feed and litter, and any potentially contaminated runoff at the site. Plans should focus on management of nitrogen, and phosphorus as well as preventing bacteria and other pollutants, such as sediment, from reaching surface or ground water. Excess nutrients must be exported off site.

The elements of a dairy nutrient management plan may include methods and technologies of the nature prescribed by the Natural Resources Conservation Service, a department of the U.S. Department of Agriculture (RCW 90.64.026(3)).

Nutrient management plans are required to be maintained on the farm for review by WSDA inspectors. The DNMA requires that all dairies be inspected for implementation of their nutrient management plans and to ensure protection of waters of the state. Most dairies keep their NMP and associated sampling data on location.

WSDA's regulations implementing the DNMA are published at chapter 16-611 WAC. WAC 16-611-010 defines "agronomic rate" as "the application of nutrients to supply crop or plant nutrient needs to achieve realistic yields and minimize the movements of nutrients to surface and ground waters." The same section defines "Nutrient" as "any product or combination of products used to supply crops with plant nutrients including, but not limited to, manure or commercial fertilizer." The phrase "transfer of manure" is defined as "the transfer of manure, litter or process waste water to other persons when the receiving facility is in direct control of application acreage, rate or time, and transfer rate and time.

Dairy producers must maintain records to demonstrate that applications of nutrients to crop land are within acceptable agronomic rates. Those records should demonstrate that applications of nutrients to the land were within acceptable agronomic rates. Soil analysis should include annual postharvest soil nitrate nitrogen analysis; triennial soil analysis that includes organic matter; pH, ammonium nitrogen; phosphorus, potassium; and electrical conductivity. Nutrient analysis is required for all sources of organic and inorganic nutrients including, but not limited to, manure and commercial fertilizer supplied for crop uptake. Manure and other organic sources of nutrients must be analyzed annually for organic nitrogen, ammonia nitrogen, and phosphorus.

The Dairy Nutrient Management Act requires that manure application and transfer records, including imports or exports, be maintained by dairies that transfer ownership of manure to others. Nutrient application records should include field identification and year of application, crop grown in each field where the application occurred, crop nutrient needs based on expected crop yield, nutrient sources available from residual soil nitrogen including contributions from soil organic matter, previous legume crop, and previous organic nutrients applied, date of applications, method of application, nutrient sources, nutrient analysis, amount of nitrogen and phosphorus applied and available for each source, total amount of nitrogen and phosphorus applied to each field each year; and the weather conditions twenty-four hours prior to and at time of application. Manure transfer records, including imports or exports should include date of manure transfer, amount of nutrients transferred, the name of the person supplying and receiving the nutrients, and a nutrient analysis of manure transferred. Irrigation water management records should include field identification and the total amount of irrigation water applied to each field each year.

The elements of an NMP must include methods and technologies of the nature prescribed by the Natural Resources Conservation Service (NRCS), a department of the U.S. Department of Agriculture RCW 90.64.026(3)). NRCS provides technical assistance to farmers and other private landowners and managers. NRCS has six mission goals: high quality, productive soils, clean and abundant water, healthy plant and animal communities, clean air, an adequate energy supply, and working farms and ranchlands.

NRCS helps landowners develop conservation plans and provides advice on the design, layout, construction, management, operation, maintenance, and evaluation of recommended, voluntary conservation practices. NRCS activities include farmland protection, upstream flood prevention, emergency watershed protection, urban conservation, and local community projects designed to improve social, economic, and environmental conditions. NRCS conducts soil surveys, conservation needs assessments, and the National Resources Inventory to provide a basis for resource conservation planning activities.

NRCS conservation practice standards contain information on why and where the practice is applied, and sets forth the minimum quality criteria that must be met during the use of that practice. State conservation practice standards are available through the Field Office Technical Guide (FOTG). NRCS believes that nutrient management for the protection of groundwater, although different on each farm, is best accomplished through best management practices beginning with those stated in Standards 590, 449 and 313.

Ch. 90.64 RCW does not require that the best management practices recommended by the NRCS be followed, but allows the use of "alternative methods and standards and specifications" of the NRCS (RCW 90.64.016 (3)). Nutrient Management Plans are required to be maintained on the farm for review by inspectors. The DNMA requires that all dairies be inspected for implementation of their Nutrient Management Plans and to ensure protection of waters of the state. Most dairies keep their NMP and associated sampling data on location.

The DNMA does not authorize the WSDA to compel nutrient management consistent with NMPs. Representatives of the WSDA state that most "enforcement" is accomplished through the "soft enforcement" efforts that the Department accomplishes through its administrative activities (visitation and advice) under its Dairy Nutrient Management Program (Prest).

Although "farm plans" are not subject to disclosure under Washington's public records law, (RCW 42.56.270 (17)), plans, records, and reports obtained by state and local agencies from dairies, animal feeding operations, and concentrated animal feeding operations not required to apply for a NPDES permit are disclosable under Washington's public records law (Ch. 42.56 RCW), but only in ranges that provide meaningful information to the public while ensuring confidentiality of business information regarding: (1) number of animals; (2) volume of livestock nutrients generated; (3) number of acres covered by the plan or used for land application of livestock nutrients; (4) livestock nutrients transferred to other persons; and (5) crop yields. The ranges of the information required to be disclosed by the public disclosure law (Ch. 42.56 RCW) are set forth in the WSDA's rules implementing that law and Ch. 90.64 RCW, WAC 16-06-210 (29).

The WSDA's mission under the DNMA is to "protect water quality from livestock nutrient discharges" and to "help maintain a healthy agricultural business climate." The WSDA encourages compliance by providing technical assistance as a first step as required by RCW 43.05, but when that is not successful the WSDA has authority under both RCW 90.64 and RCW 90.48 and has informal (warning letters and notices of correction) and formal (civil penalties and orders) enforcement tools available.

In 2013-2014, WSDA issued 17 notices of correction, one order, and 11 notices of penalty for discharges of pollutants to surface waters, statewide, as well as 122 warning letters and 27 notices of correction for potential to pollute (including failures in record-keeping). WSDA usually begins with informal enforcement, using warning letters and notices of correction, then proceeding to formal enforcement through civil penalty or administrative order. Most penalties include a settlement process including reduction in penalty, requirements to adopt specific management practices, to abstain from discharge and collection of entire penalty in the event of non-performance.

Concentrated Animal Feeding Operations

The Clean Water Act's regulations (40 CFR, Part 122) define dairies with 700 or more animals and feedlots with 1,000 or more animals as Large Concentrated Animal Feeding Operations (CAFO). Large CAFOs are defined as point sources of water pollution if they can or do discharge to surface waters, becoming subject to the National Pollutant Discharge Elimination System (NPDES) requirement for permit. However, unlike other point sources that have continuous or regular discharges to surface waters, CAFOs are not considered to automatically have a surface water discharge. Consequently, they may be required to obtain an NPDES CAFO permit only if they have a discharge or potential to discharge. The DOE administers the CAFO permit, decides when a facility is required to apply for a permit and is responsible for enforcing the permit.

The Washington Department of Ecology issued two CAFO permits under its general permitting authority (Chapter 173-226 WAC) in January 2017 (effective March 3, 2017) (Ecology 2017). (A National Pollutant Discharge Elimination System and State Waste Discharge General Permit for Concentrated Animal Feeding Operations (combined permit) and a State Waste Discharge General Permit (state only)). The state and combined permits regulate the discharge of pollutants such as manure, litter, or process wastewater from CAFOs into waters of the state.

The permits conditionally authorize the permittees to discharge, but only in a manner that does not cause or contribute to a violation of water quality standards. The permittees are prohibited from discharging manure, litter, feed, process wastewater, other organic by-products, or water that has come into contact with manure, litter, feed process wastewater, or other organic by-products, to surface waters of the state from the production area with a few exceptions.

The permittees must implement measures to address the pollution prevention performance objectives listed in special conditions of the permit. Livestock may not be allowed to come into contact with surface waters or conduits to surface waters. Each calendar year, the permittees must develop a field-specific nutrient budget for each land application field they will control to which they plan to apply manure, litter, process wastewater, or other organic by-products (Ecology 2017).

The permittees must have all sources of manure, litter, process wastewater, and other organic by-products sampled and analyzed prior to land application and at least twice more, spaced evenly throughout the land application season, to account for seasonal variation in nutrient concentration (e.g., dilution due to rainfall or concentration from evaporation) (Ecology 2017).

The permittees must land-apply manure, litter, process wastewater, or other organic byproducts in accordance with their yearly field nutrient budgets and at the appropriate rates and times to comply with permit conditions. If the permittees generate more manure, litter, process wastewater, or other organic by-products than the land application fields available to the permittees can appropriately utilize according to their yearly field nutrient budgets, the permittees must find other avenues of appropriately utilizing the excess manure, litter, process wastewater, or other organic by-products (e.g., export, composting) (Ecology 2017).

Lands to which manure, litter, process wastewater, and other organic byproducts have been applied must be sampled in spring and fall. The permittees must manage the application irrigation water so that the amount of water applied from precipitation and irrigation does not exceed the water holding capacity in the top two feet of soil, thereby preventing the downward movement of nitrate.

The permittees must use field discharge management practices on their land-application fields to limit discharge of manure, litter, process wastewater, and other organic by-products to down-gradient surface waters or to conduits to surface or ground water.

The permittees are permitted to "export" manure, i.e., to relinquish control of how the manure is used. When exporting manure, the permittees must provide the most recent manure, litter, process wastewater, or other organic by-product nutrient analysis to the recipient as part of export. The permittees must keep records of its manure exports.

Waste Storage Facilities (Lagoons)

Under the 2017 CAFO permit, the permittee must have adequate storage space for the manure, litter, process wastewater, feed, and any other sources of pollutants on-site during the storage period for the area where the CAFO is located. Lagoons and other liquid storage structures built, expanded, or having major refurbishment e.g., complete emptying and re-compaction to restore the earthen liner done after the issuance of this permit must achieve a permeability of $1x10^{-6}$ cm/s without consideration for manure sealing and there must be a minimum of two feet of vertical separation between the bottom of the lagoon (measured from the outside of the earthen liner) and the water table, including seasonal high water table. Lagoons must be inspected, maintained as to structure and volume, and permanently decommissioned when closed. Existing lagoons are required to be assessed.

Pens and Composting Areas

Management practices are advisable on the site of dairy CAFO pens, such as maintaining an intact layer between the cattle and the underlying ground to inhibit leaching through the surface of the pen, changes in precipitation and evapotranspiration from season to season, and animal density rates. Particulate matter practices require that the pens maintain a certain percentage of moisture to reduce dust emissions.

Water Applications

There are no federal, state or local regulations specifically pertaining to the application of irrigation water to agricultural crops. State water law generally precludes wasting water (RCW 90.03.005). Water may only be used for "beneficial use," the opposite of which is "waste."

Residential Onsite Sewage Systems (ROSS)

"Septage" is "the mixture of solid wastes, scum, sludge and liquids pumped from within septic tanks, pump chambers, holding tanks and other OSS components" (WAC 246-271A-0010). The total nitrogen content of septage generated in the GWMA varies under individual circumstances. An area-wide average is not available.

WAC 246-272A-0270 provides that the owner of an OSS is responsible for its operation, monitoring, maintaining, repairing, altering or expanding an OSS. The owner must also assure that an evaluation of a simple gravity septic system's components happens at least once every three years and that an evaluation of all other systems occurs every year. The solids and scum must be pumped from the septic system by an approved pumper generally every three to five years or whenever necessary (EPA 2002). The septic system must not be covered by structures or impervious material. Surface drainage must be trained away from the septic system. The soil above the drain field should not be compacted by vehicles or livestock. It is advisable to inform prospective buyers about the septic system. Most septic systems are now pumped prior to transfer of title to the property.

The location, design, installation, operation, maintenance, and monitoring of OSS is regulated by Chapter 246-272A WAC. The chapter is intended to coordinate with other statutes and rules for the design of OSS under Chapter 18.210 RCW and Chapter 196-33 WAC.

A local board of health must apply to the state DOH to approve local regulations. They must be at least as stringent as the regulations of the state department WAC 246-272A-0015 (9), (10). Yakima County does not have additional regulations.

Permitting for septic systems is done by the Yakima Health District. That agency is also authorized by WAC 246-272A-0015 (5) to "develop a written plan that will provide guidance to the local jurisdiction regarding development and management activities for all OSS within the jurisdiction." The elements of the plan are listed in the WAC.

The amount of land necessary for the installation of an onsite sewage (septic) tank varies depending upon soil type. Table X in WAC 246-272A-0320 establishes the minimums. Table V in WAC 246- 272A-0220 describes the soil types. A site is required to meet certain ground absorption parameters, pass a percolation test, in order to qualify for a permit to install a septic system. If the ground does not have a certain absorption rate, it does not qualify for a septic system.

TABLE 10 - (WAC 246-272A-0320)

MINIMUM LAND AREA REQUIREMENT

SINGLE FAMILY RESIDENCE OR UNIT VOLUME OF SEWAGE

Type of Water Supply	Soil Type (defined by WAC 246-272A-0220)					
	1	2	3	4	5	6
Public	0.5 acre 2.5 acres	12,500 sq. ft.	15,000 sq. ft.	18,000 sq. ft.	20,000 sq. ft.	22,000 sq. ft.
Individual, on each lot	1.0 acre 2.5 acres	1 acre	1 acre	1 acre	2 acres	2 acres

TABLE 11 - (WAC 246-272A-220)

Soil Type	Soil Textural Classifications
1	Gravelly and very gravelly coarse sands, all extremely gravelly soils excluding soil types 5 and 6, all soil types with greater than or equal to 90 percent rock fragments.
2	Coarse sands.
3	Medium sands, loamy coarse sands, loamy medium sands.
4	Fine sands, loamy fine sands, sandy loams, loams.
5	Very fine sands, loamy very fine sands; or silt loams, sandy clay loams, clay loams and silty clay loams with a moderate or strong structure (excluding platy structure).
6	Other silt loams, sandy clay loams, clay loams, silty clay loams.
7 **Unsuitable for treatment or dispersal**	Sandy clay, clay, silty clay, strongly cemented or firm soils, soil with a moderate or strong platy structure, any soil with a massive structure, any soil with appreciable amounts of expanding clays.

The minimum liquid volume for a septic tank serving a single-family residence containing three or fewer bedrooms is 900 gallons. A septic tank serving a single-family residence containing four bedrooms may be 1,000 gallons. Each bedroom after that requires an additional 250 gallons of septic capacity. The actual size of each ROSS within the GWMA is unknown.

The local health officer may require the owner of a failing OSS located within 200 feet of a public sewer service to hook up to that system WAC 246-272A-0025. Design specifications for OSS tanks are located at WAC 246-272C.

Large Onsite Sewer Systems (LOSS)

Regulations for large on-site sewage (septic) systems (LOSS) are found at WAC 264-272B. LOSS are inventoried with the Department of Ecology as UIC wells (WAC 173-218-040) under a memorandum agreement between DOE and DOH.

Biosolids

The DOE's biosolid program is administered independently of other agencies, but coordinated with health districts. Land application of biosolids requires pre-approval of application rates that are based upon agronomic crop requirements. Permittees receive coverage under a statewide general permit. Permit coverage is mandated for those who produce and/or land apply biosolids. The DOE's regulatory program incorporates site specific approvals with specific testing and analysis procedures, development of land application plans that prescribe specific practices and prohibitions, and a review and approval process for land application of the wastewater solids. Land application may only occur on permitted sites with pre-established buffers and setbacks.

"Regarding the statistics, the fields in the GWMA are almost all irrigated, high value crops: corn, hops, and alfalfa. As an example, the appropriate yield table for silage corn (attached) shows a requirement of 270 lbs/acre for a 30-ton yield—the median yield value. I make the pre-plant calculation so you look on the top line and ignore the soil-test-value column. So my average approval rate of 248 lbs/acre of plant available N (pre-plant soil N + biosolids N) is a very defensible value" (Sievertson).

Residential Lawn Fertilizers

There are no known laws or regulations regarding homeowner maintenance of residential lawns. There are also no known laws or regulations regarding municipal maintenance of parks or grounds.

"Hobby Farms"

There are no known laws or regulations regarding maintenance of animals or herbaceous material on "hobby farms."

Underground Injection Wells

Part C of the Federal Safe Drinking Water Act (SDWA), 42 U.S.C. §300h-3, regulates underground injection wells (UIC). Washington's UIC program is administered by the Department of Ecology. Its UIC regulations are found at WAC 173-218. The program is approved by the EPA pursuant to SDWA §1422, 40 CFR

147.2400. The program regulates the injection of fluids underground for storage, enhanced recovery, in the context of Class II, and disposal to prevent the contamination of underground sources of drinking water. Injection activities may be authorized by rule or permit. The regulations establish a non-endangerment standard designed to ensure that injected fluids do not cause or contribute to the movement of a contaminant into an underground source of drinking water if the presence of that contaminant may cause or contribute to the exceedance of a drinking water standard ("MCL") or otherwise adversely affect the health of persons (40 CFR 144.12, WAC 173-18-080).

Abandoned Wells

An "abandoned well" is one "that is unmaintained or is in such disrepair that it is unusable or is a risk to public health and welfare" (RCW 18.104.020 (1)).

Wells no longer in use are required by law to be "decommissioned" (RCW 18.104.020 (3)). WAC 173-160-381 describes the processes that must be used to decommission wells. A permit must be obtained before decommissioning may occur (RCW 18.104.030).

Environmental Effects

Nitrate

Nitrate is an acute contaminant. It is colorless and odorless. It is found in many fertilizers, manure, liquid waste from septic tanks, and food processing waste. Precipitation or irrigation water can carry nitrate down through the soil into groundwater. Drinking water wells may contain nitrate if they draw from this groundwater (Ecology 2010).

The Nitrogen Cycle

The Nitrogen Cycle was adequately described in the EPA's 2012 Report, "Relation Between Nitrate in Water Wells and Potential Sources in the Lower Yakima Valley":

Nitrogen is present in many chemical forms in the environment. Nitrogen gas (N2) composes about 78 percent of the atmosphere. Nitrite (NO2-), nitrate (NO3-) and organic nitrogen, ammonium (NH4) are also present.

Nitrogen is critical to plant growth. It aids in the formation and function of cellular tissue, proteins, and reproductive structures. Nitrogen can be supplied to plants through the application of synthetic fertilizers or animal waste products or by the organic decomposition of other plants. Atmospheric nitrogen must be processed, or fixed, to be used by plants. The majority of fixation occurs by bacteria. Small quantities of nitrate may wash out of the atmosphere from aerosol salt particles from the ocean or dusts from arid regions, or from fossil fuel combustion (EPA 2012).

Important processes in the nitrogen cycle include nitrogen fixation, mineralization, nitrification, and denitrification. The mobility of nitrogen is highly dependent on its form and the matrix through which it moves. Organic nitrogen is nearly immobile. Mineralization occurs when organic nitrogen in the soil is converted by bacteria into ammonium (NH4). Nitrification occurs as ammonium is biologically oxidized to become nitrite. Nitrite is then biologically oxidized to become nitrate as it moves through the vadose zone.

Nitrate is the most mobile form of nitrogen in both the vadose and saturated zones. Nitrate moves quickly in the saturated zone, together with migrating groundwater. Its mobility is enhanced by the action of negatively charged soil particles, which repel the negatively charged nitrate ion (USGS 2000b). In the absence of denitrification, nitrate moves with the groundwater until the groundwater is discharged to surface water, or extracted from a well. Denitrification is the conversion of nitrate back into nitrogen gas (N2) by bacteria. It can occur in anoxic conditions (where oxygen is depleted in the root zone) (EPA 2012).

Nitrate Leaching

"Leaching" is the process of the removal of soluble material from a substance through the percolation of water. Nitrate can "leach" from the agricultural soils to the elevation of the groundwater aquifer. "The increase in groundwater nitrate concentration measured in domestic wells, irrigation wells, and public supply wells lags significantly behind the actual time of nitrate discharge from the land surface. The lag is due, first, to travel time between the land surface, which ranges from less than one year in areas with shallow water table to several years or even decades where the water table is deep. High water recharge rates shorten travel time to a deep water table, but in irrigated areas with high irrigation efficiency and low recharge rates, the transfer to a deep water table may take many decades" (Harter 2012).

Health Effects to People

Exposure to excessive nitrate concentrations can reduce the ability of red blood cells to carry oxygen (WDOH 2007c, WDOH 2016, Harter 2012, Appendix J). In most adults and children these red blood cells rapidly return to normal. However, in infants it can take much longer. 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."

> "Infants younger than 6 months may develop acquired methemoglobinemia from contaminated well water that has excess nitrates. Bacteria in a baby's digestive system mixes with the nitrates and leads to methemoglobinemia. Fully developed digestive systems keep children older than 6 months and adults from developing this nitrate poisoning" (McDowell/Biggers 2017).

While the problem is relatively well understood, there are no accurate statistics on the causal relationship between high nitrate concentrations in drinking water and the occurrence of methemoglobinemia. Acute cases do occur. There have been no deaths reported by medical professionals within the GWMA.

Bottled water is recommended for use in babies' foods and drinks. Although boiling water kills bacteria, it will not remove chemicals such as nitrate. In fact, boiling may actually increase the nitrate level. "Some studies have shown a positive association between long term exposure to nitrate in drinking water and risk of cancer and certain reproductive outcomes" (EPA 2012; Ward 2005). Other studies have shown no association (Ward 2005; Avery 1999). As nitrates rise in water supplies, the potential for increasing the health risk rises.

An infant with moderate to serious "blue baby syndrome" may have a brownish-blue skin tone due to lack of oxygen. This condition may be hard to detect in infants with dark skin. Infant decolorization is not required to be reported by physicians as health effects data. An infant with mild to moderate "blue baby syndrome" may have symptoms similar to a cold or other infection (fussy, tired, diarrhea or vomiting). While there is a simple 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.

The best way to prevent "blue baby syndrome," is to avoid giving babies water that may be contaminated with nitrate or foods that are high in nitrate. Infants less than one year old should not be given drinking water with nitrate levels more than 10 ppm. High-nitrate vegetables such as beets, broccoli, carrots, cauliflower, green beans, spinach, and turnips should not be offered until after six months of age. If a baby has a brownish-blue skin tone, he or she should be taken to a hospital immediately. A medication called "methylene blue" will quickly return the baby's blood to normal.

Red blood cells in older children and adults quickly return to normal. However, some health conditions make people susceptible to health problems from nitrate. They include individuals who don't have enough stomach acids and individuals with an inherited lack of the enzyme that converts affected red blood cells back to normal (methemoglobin reductase).

The *Preliminary Assessment* concluded that over 2,000 people in the area are exposed to nitrate over the maximum contaminant level (MCL) through their drinking water (EPA

2010). It also found that not all water supplies in the area have been affected, particularly including public water system supply. Public water systems are regularly monitored for suspected contaminants. They must meet national and state drinking water standards, and public systems that use contaminated water are required by law to treat the water, thus maintaining a safe supply of drinking water to their customers. Until treatment has been installed, or if the treatment isn't working, public water systems must notify their users if nitrate levels exceed the standard.

The *Preliminary Assessment* found that many families of the Lower Yakima Valley are served by private wells and do not have access to public water systems. Regular testing of drinking water is not required for private water wells. The *Preliminary Assessment* concluded that "There is sufficient data to suggest that many of these well water supplies are at risk, even if they do not currently exceed a drinking water standard" (EPA 2012). The Valley Institute for Research and Education collected data from the wells of low income households in 2001 and 2002. In some areas, up to 40 percent of the wells sampled were above 5 mg/L nitrate, a level below the 10 mg/L Drinking Water Standard, but nevertheless recognized in the *Preliminary Assessment* as a concern. The LYVGWMA has caused testing of private groundwater wells to occur since it was organized. The data collected from that testing is set forth below under the section entitled "Initiatives Completed by the GWAC."

Owners of private wells who are unsure about their water quality may have their water tested for coliform bacteria and nitrate. The Yakima Health District (YHD) can advise where to get water tested and has specific recommendations for testing. Many certified labs in Washington charge $20 to $40 per test. If nitrate test results are over 8 mg/L, annual testing is recommended. If results are less than 8 mg/L, testing every three years is recommended.

The *Preliminary Assessment* expressed the concern that those who rely on private well water may not know the quality of the drinking water within their homes. They may not use tested wells, and if so, they may not know how to interpret the test results. Many residents are renters and are not the property or well owners. The well owner of record may not be the current property owner. Current property owners may not live on the property. Property owners may fear or question the implications of owning a contaminated well (in terms of liability, responsibility, property values, and access to safe and affordable housing) (EPA 2012).

Nitrates in groundwater may impact both domestic animals and wildlife. This can be either directly by ingestion, or indirectly through impacts to habitats, where groundwater discharging to surface water contributes to nutrient loading of streams, lakes, and wetlands.

The *Preliminary Assessment* found that nitrate-nitrogen concentrations are greatest in shallow groundwater. Shallow wells, poorly sealed or 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. Nitrate levels in well water can vary throughout the year. A significant decrease in nitrate-nitrogen concentrations was found in groundwater samples collected from depths below 300 feet. The highest percentage of samples exceeding State Drinking Water Standards (10 mg/l nitrate-nitrogen) was obtained from shallow wells (less than 300 feet deep), a well depth typical of most private domestic drinking water wells (EPA 2012).

Yakima River Surface Water Quality

The USGS' Hydrogeologic Framework of the Yakima River Basin Aquifer System (USGS 2009a) posited a hydrologic connection between the surface water within the Yakima River and the groundwater beneath lands adjacent to the river. The USGS report did not establish any direct correlation between nitrogen in groundwater and nitrogen in the Yakima River. Water quality testing of agricultural surface-drains (which deliver water directly to the River) in 2017 found that 12.8 percent of drain samples had nitrate concentrations that exceeded the maximum contaminant level (MCL) of 10 milligrams per liter.

Section 303(d) of the CWA, 33 U.S.C., § 1313(d), requires states to identify waters where current pollution control technologies alone cannot meet the water quality standards set for that waterbody. Every two years, states are required to submit a list of impaired waters plus any that may soon become impaired to EPA for approval. The impaired waters are prioritized based on the severity of the pollution and the designated use of the waterbody (e.g., fish propagation or human recreation). States must establish the "total maximum daily load(s)" of the pollutant(s) in the waterbody for impaired waters on their list.

A "total maximum daily load" or "TMDL" is the amount of a specific pollutant that a waterbody can receive and still meet water quality standards. A TMDL is made up of the sum of all the point source loads ("wasteload allocation") and load associated with nonpoint sources and background sources ("load allocation"). TMDLs must include a margin of safety (explicit or implicit) and consider seasonal variations. Potential wasteload allocations include background, groundwater inflow, diffuse runoff, irrigated agriculture return flow, agricultural stormwater, atmospheric deposition, nonpoint sources, stormwater point sources, and non-stormwater point sources.

Numerous water quality assessments of the Yakima River are contained within Washington State's 303(d) list. Primary Yakima River surface water quality problems of concern are temperature, dissolved oxygen (DO) and acidity (pH). Nitrogen is an aquatic nutrient in surface water, which contributes to algae growth, but not included in the Yakima River's surface water quality problems.

EPA has approved two Ecology-proposed TMDL projects within the Lower Yakima River area. They are: Lower Yakima River Suspended Sediment and DDT TMDL—project approved for DDT and TSS parameters. See: http://www.ecy.wa.gov/programs/wq/tmdl/yakima_wq/LowerYakTMDL.html; https://fortress.wa.gov/ecy/publications/documents/97321.pdf; Granger Drain Bacteria TMDL—project approved for fecal coliform bacteria parameter. See: http://www.ecy.wa.gov/programs/wq/tmdl/GrangerTMDL.html.

Water Quantity and Quality Goals and Objectives

The LYVGMA goals and objectives for water quantity are set forth in the Yakima River Basin Water Enhancement Project (YRBWEP 2012).

The LYVGWMA goals for water quality published in the LYVGWAC Work Plan (9/30/2013) were as follows. **Some, but not all, of the Goals and Objectives have been realized.**

Lower Yakima Valley Groundwater Management Area

GOALS AND OBJECTIVES

The GWMA will be a multi-agency, citizen-based, coordinated effort to reduce groundwater nitrate contamination in the Lower Yakima Valley. It will receive input from people affected or interested in the problems and solutions and will coordinate their energies toward action. It will work to achieve credibility with the general public and the farming community.

GWMA GOAL

The primary long-term goal of the GWMA is to reduce concentrations of nitrate in groundwater to below Washington State drinking water standards.

PROPOSED OBJECTIVES

Objectives have been divided into six categories: Data and Monitoring. Problem Identification, Measures to Reduce Groundwater Contamination, Education, Drinking Water Systems, and General objectives.

Input from the GWAC and citizen input will be used to refine and prioritize objectives. In general, refinement of objectives in each category will begin with an updated assessment of the current status of work.

DATA AND MONITORING

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

- Establish a monitoring program to identify sources of nitrate contamination and their relative importance.
- Establish and conduct long-term groundwater quality monitoring program and evaluate progress.

PROBLEM IDENTIFICATION

- Characterize the nature and extent of nitrate concentrations in Lower Yakima Valley groundwater.
- Identify and rank the sources of elevated nitrate in groundwater, with site-specific characteristics developed for 'hot spots" as appropriate.
- Identify and describe activities contributing to groundwater contamination based on scientific data and evaluation. Scientific and other data will be shared among the partners to facilitate development of effective programs and strategies.

MEASURES TO REDUCE GROUNDWATER CONTAMINATION

- Develop effective and coordinated best management practices (BMPs) to address specific nitrate sources.
- Develop strategies for implementing best management practices such as technical assistance, education, ordinances and coordination with other regulatory and nonregulatory programs.
- Support enforcement of new and existing laws and ordinances.

EDUCATION

- Establish educational programs to promote the protection of groundwater quality and provide a forum for stakeholders to discuss nitrate reduction methods and improvement of groundwater quality. This will include culturally-appropriate education and outreach.
- Establish a clearinghouse for pertinent public health, environmental, and business information.
- Educate private well owners on water quality testing methods, frequencies, interpretation of results, and funding sources.

DRINKING WATER SYSTEMS

- Provide water quality and hydrogeologic data to assess needs and methods of expanding public water supplies, and provide a forum for initiation of these plans.
- Consider options to encourage appropriate expansion of public water supplies to areas that are currently dealing with contaminated private supplies.
- Assist residents whose supplies have been contaminated to access safe and reliable water supplies, using culturally-appropriate communications.

GENERAL

- Pollution prevention will be a guiding principle for all work done by the GWMA.
- Participation by the Yakama Nation will be requested and encouraged in a way that is consistent with their sovereignty.
- Participating agencies will maintain their regulatory authority using their own discretion as appropriate. They will also seek opportunities to coordinate actions and address regulatory gaps.
- The GWMA will seek sustainable funding sources to carry out its mission.

GWAC Initiatives

Interim Education and Outreach

The education and public outreach (EPO) objectives identified in the GWMA Work Plan recognized the role that public health, time, evolving investigations, and the final GWMA Program would play in an outreach strategy. Accordingly, multiple objectives were identified for the Education Program component, from early Program development, to post-GWMA Program implementation and future Program reviews.

The first objective: to develop a strategy to guide the GWAC's education and public outreach during Program development. The plan identified four central components for the GWAC to follow. The first three were:

> *"... establish educational programs to promote the protection of groundwater quality and provide a forum for stakeholders to discuss nitrate reduction methods and improvement of groundwater quality. This will include culturally-appropriate education and outreach. Establish a clearinghouse for pertinent public health, environmental, and business information" (GWAC Work Plan, Adopted February 6, 2013).*

A fourth component—to educate private well owners on water quality testing methods, frequencies, interpretation of results, and funding sources—completed the educational expectations set forth in the GWAC Work Plan.

The role of education, however, did not stop at the GWMA Program adoption. The work plan suggested that the outreach conducted during Program development would inform—and be an integral part of—the final GWMA Program's sections on water quality goals and objectives, the regulatory environment, and investigation and analysis of Program alternatives.

A successful GWMA Program would require an informed and field-tested educational strategy, which could not be defined without the groundwork laid during Program development. Success of educational efforts made during Program development would define how to better engage the public in the GWMA Program, to implement proposed educational alternatives, and to measure the success of multiple milestones over time within the GWMA Program.

2011 Nitrate Treatment Pilot Program

In 2010-11, Yakima County partnered with the Departments of Health, Ecology, EPA, the Yakima Health District, the Yakama Nation and others to provide free water treatment systems, public education, and technical assistance to households with individuals at high public health risk from nitrate contaminated wells in the lower Yakima basin. (Lower Yakima Basin Nitrate Treatment Pilot Program Final Report June 2011). The Program boundaries followed what would become the LYVGWMA, as well as encompassing the Yakama Nation.

An intensive bilingual outreach effort was implemented (7641 English/Spanish packets either mailed or hand-delivered to every household on a private well in the target area; bilingual public meetings were held; bilingual radio and TV spots aired; door-to-door intensive Spanish-language outreach conducted, a toll-free bilingual hot line established) to provide education, technical assistance, and free water treatment systems to households that exceeded the 10 mg/L standard.

While it was estimated that between 700 and 1,000 homes in the Program area were supplied by water wells with nitrates in excess of the drinking water standard, only 177 households requested (and qualified for, based on certified lab results) the water treatment system. The lessons learned that would inform future outreach included:

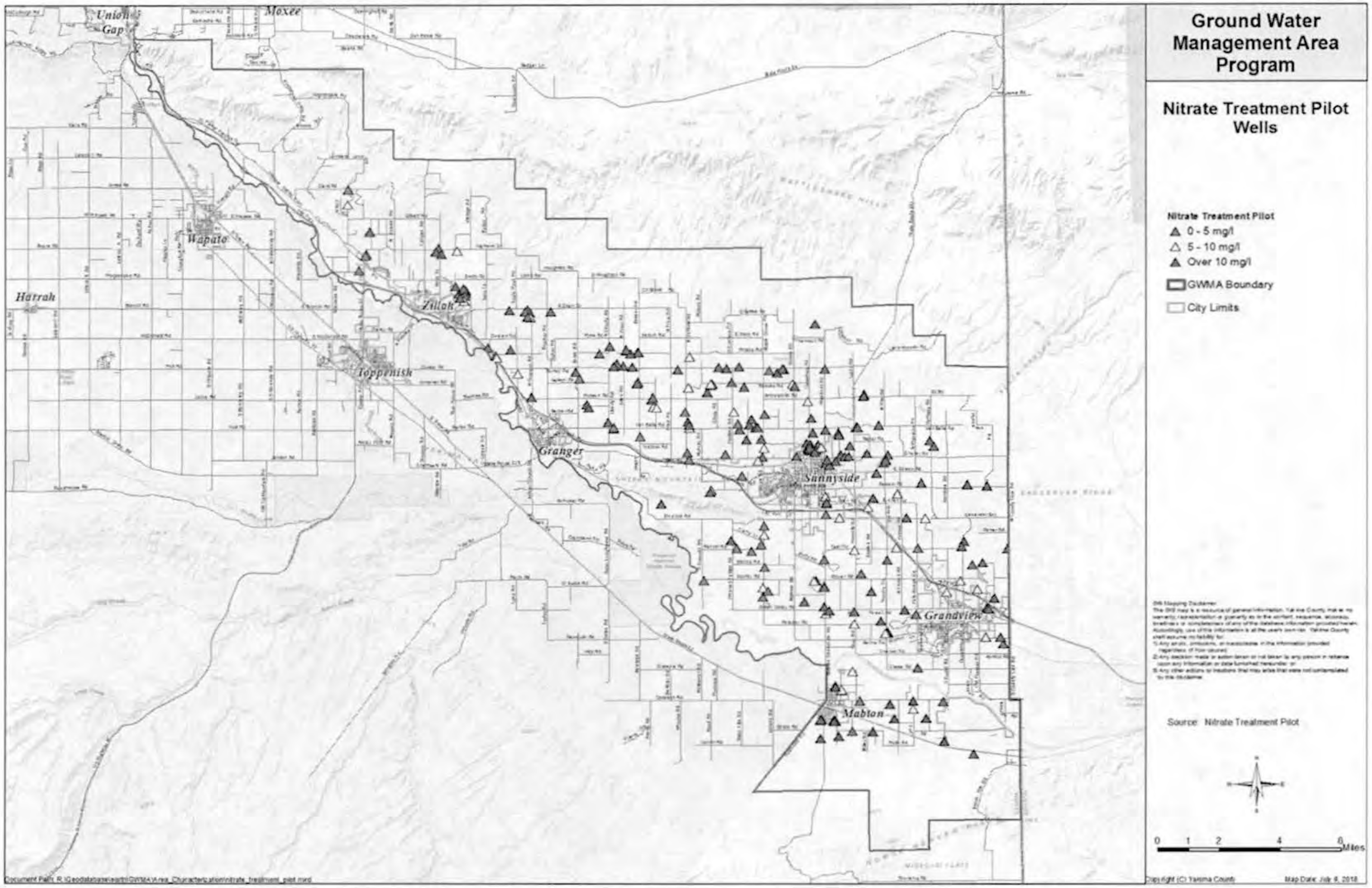
- Health effects of nitrate are difficult to convey, not visible, not easily understood related to contamination threshold and risk factors.
- A lack of interest from the public. With no local reports of nitrate-related health problems, the public's concern was not high.
- Due to the large size of the project area and its rural character, there is little "community" presence and community leadership to draw upon for outreach.

- Illiteracy and low reading comprehension skills in some households required one-on-one site assistance to verify Program eligibility and to complete applications.

The Nitrate Treatment Program illustrated the challenge of communicating complex messages to a discrete, hard-to-reach audience. But it did introduce the nitrate issue to residents within the target area. Therefore, residents who participated in the Treatment Program were familiar with the nitrate issue when the GWMA Outreach Program was launched.

Water quality samples were also taken. See Appendix K for data collected.

FIGURE 18 - NITRATE PILOT PROJECT WATER TEST LOCATIONS



GWMA Program Development, Early Products

With immediate contractual obligations to create both an outreach program and a web-based information application (IAA No. C1200235, the Department of Ecology and Yakima County), the Education and Public Outreach (EPO) working group was organized and began regular meetings in the fall of 2012.

The outcome of those early meetings was the *Public Education and Outreach Plan* (adopted December 12, 2012), and the creation of the first GWMA website. The website would be redesigned twice and undergo numerous revisions as GWAC activities, outreach, and the evolving GWMA Program took shape.

The outreach work of the next four years – 2013-2017 – was guided by the *Public Education and Outreach Plan* objectives: 1) educating at-risk audiences about the risks of elevated nitrate to human health and how to protect themselves from that risk; 2) informing audiences about the GWAC planning process, and 3) inviting participation in the development of the GWMA Program.

The work: message development, audience targeting, evaluating and responding to outreach requests from the GWAC and working groups. The products: "boots on the ground" bilingual campaigns that included door-to-door surveys, "New Mom" hospital brochures, presentations to Sunnyside WorkSource clients, free private well testing, direct mail, billboards, participation at health fairs, and radio and TV outreach. Partnership: A new partnership was developed with the University of Washington's Pediatric Health Specialty Unit (PEHSU) to train healthcare providers to be aware of the nitrate issue and address it with their at-risk patients. These campaigns would be the field tests for the final GWMA Program outreach strategy [Full list – Appendix I].

Three outreach campaigns that would help inform the Program are highlighted below.

2013 Door-To-Door Public Opinion Survey

A 2013 bilingual door-to-door survey was developed to measure what residents in the GWMA served by private wells knew – or didn't know –about their private wells, about nitrates in drinking water, and about the formation of the GWMA. The eight targeted areas encompassed 300 households in the LYVGWMA ranging from Konnowac Pass in the northeast to County Line Road to the southeast. The areas chosen were known to either have high nitrate in groundwater or were in areas where little data on nitrate levels existed.

136 households responded to the survey, administered by Heritage University students. The results indicated that 69 percent (94 households) surveyed were aware of the potential health risks associated with drinking water with high levels of nitrate. Over half of those surveys had their private well tested for nitrate. Four percent (six households) believed someone in their home had become ill from drinking their well water. None, however, indicated that high levels of nitrate were the source of the illness.

Out of the 136 households, only one reported having an infant. Only one household had a pregnant woman. Seven households reported having a chronically ill individual; however, the survey did not ask for the specific illness.

Less than half (42 percent) had heard of the Lower Yakima Valley Groundwater Management Area (see Appendix I for survey results). Participants were also asked if they were interested in participating in a more in-depth private well testing. The participants responding "yes" would be invited to a second, more in-depth study of private wells in the Lower Yakima Valley.

High Risk Well Assessment Surveys Phases I & II (2014 and 2016, respectively).

This campaign took a closer look at the water quality of private wells in the GWMA, and measured households' understanding of their well maintenance responsibilities, how their own actions might influence groundwater quality, and also measured households' awareness of how to protect the quality of their drinking water. 466 sampling surveys were conducted. See survey instrument in Appendix I.

Although the sample size was too small to assess data patterns, the lessons learned included:

1) Residents on private wells need to test their wells;

2) Well owners should become more familiar with their wells (e.g., location of their well log, depth of

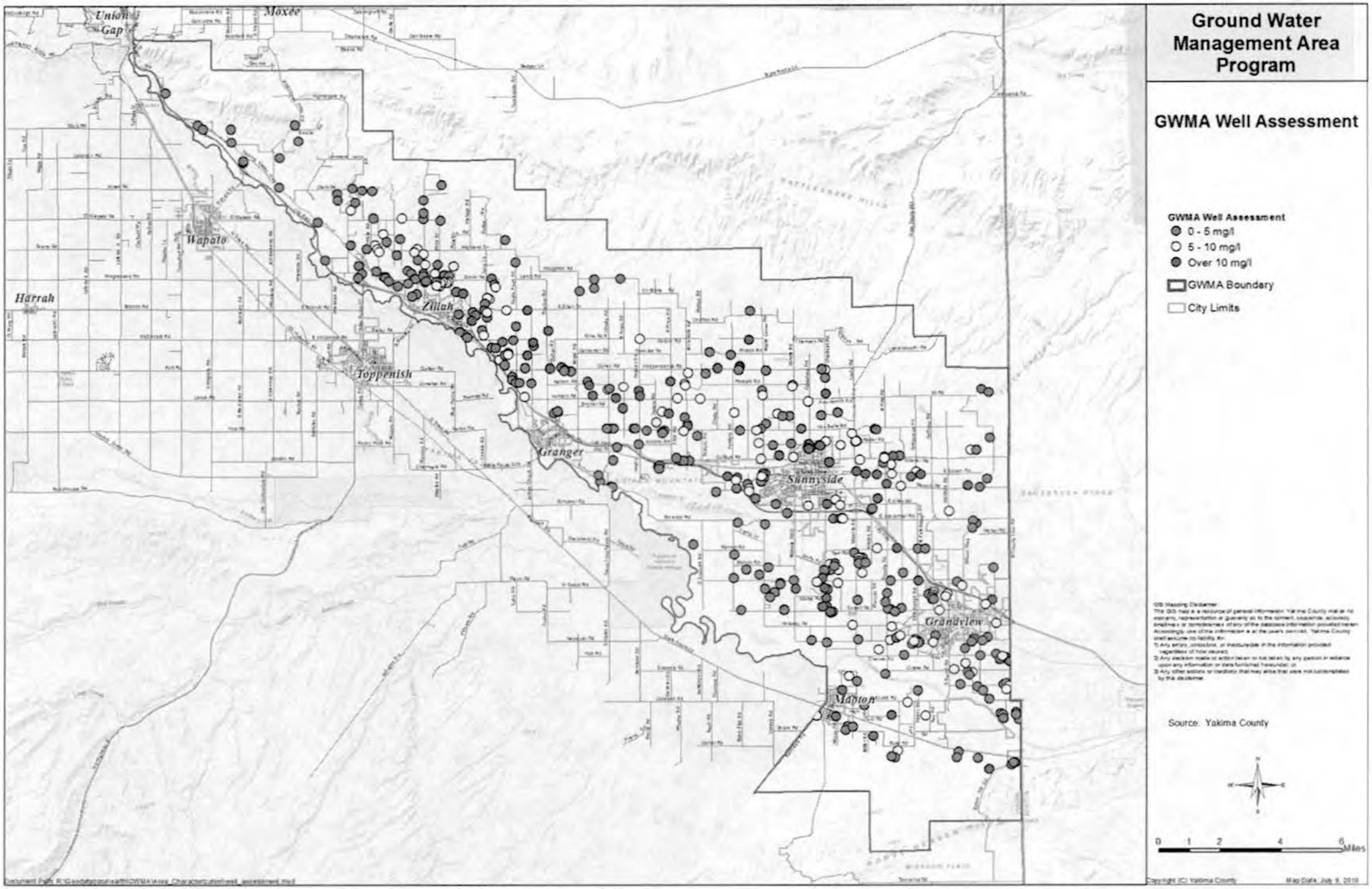
well, condition of well);

3) The need to explore the possible connection between not testing a well and its likelihood of testing

high for nitrate.

Water quality samples were also taken. See Appendix L for collected data.

FIGURE 19 - HIGH RISK WELL ASSESSMENT TEST LOCATIONS



GWMA Website

The GWMA Website (http://www.yakimacounty.us/541/Groundwater-Management-Area) served as the information clearinghouse required under the Work Plan. It provided a central source of information about the GWAC, the working groups and their products, and links to technical assistance. It was also intended to inform the public about the GWMA Program development.

Although the website link was advertised on nearly every English/Spanish document, presentation and billboard the EPO produced, the hits the website received and the specific pages that were viewed (resource materials) suggested that the primary users were GWAC members and researchers from outside the Program area (some access to Spanish language pages requires navigation first through English language pages). The EPO working group speculated that the web's most practical use was for agencies and individuals seeking academic information about the GWMA. While efforts were made to make it more inviting to the public (bilingual content, graphics, surveys), there was no evidence (e.g., increased page hits) that the effort was successful.

The results of the EPO's outreach campaigns and the products it produced are set forth in Appendix I of this Program.

Best Management Practices

The LYVGWMA initially contracted with HDR to produce a complete list of all the potential best management practices that may be applicable to agricultural, industrial, urban and domestic activity within the LYVGWMA. The Irrigated Agriculture Work Group of the Groundwater Advisory Committee reviewed the HDR produced list and selected those best management practices they felt particularly relevant to their respective operations. Those best management practices are set forth in Appendix D of this Program. The Livestock/CAFO Work Group of the Committee elected to review the best management practices listed by the Natural Resource Conservation Service (NRCS) to determine those particularly relevant to livestock/CAFO operations. Those best management practices are set forth in Appendix E of this Program.

Groundwater Monitoring Plan

The GWAC developed an Interim Final Groundwater Monitoring Plan (PGG 2014) in order to establish a network of wells and field procedures with which to evaluate current and future nitrate concentrations in the Area's groundwater. The objectives of this Plan were to establish procedures for the collection and analysis of representative groundwater samples for nitrate and nitrate-related analyses. Data collected pursuant to the Plan is intended to be used to: evaluate BMP effectiveness, evaluate groundwater trends, identify nitrate hotspots, and calculate basin-wide average nitrate concentrations. Analytic results from the same data was intended to be used by the GWAC to make administrative decisions and policy recommendations. The Plan, prepared in accordance with hydrogeologic practices generally accepted at this time in the relevant area, addressed sampling procedures, sampling schedule (developed following identification of the sampling network), establishment of a sampling network, quality assurance/quality control, reporting frequency and schedule.

The sampling program described in the Plan involved collecting groundwater samples from a network of wells for analyses of nitrate, nitrite, ammonia, and the sum of organic nitrogen + ammonia + ammonium (Total Kjeldahl Nitrogen). The network could include wells that already have pumps (private, public, and irrigation supply wells) and monitoring wells that require use of sampling pumps. Groundwater samples would be analyzed by labs accredited by the Washington State Department of Ecology (Ecology). "A Groundwater Monitoring Quality Assurance/Quality Control Plan (PGG 2013d) was prepared in anticipation of the Groundwater Monitoring Plan, and a revised version (PGG 2014e) published as an attachment with the Interim Final Groundwater Monitoring Plan." Yakima County has begun to contract for the installation of monitoring wells. The network is formative but not complete at this time. No private, public or irrigation supply wells are included in the anticipated monitoring well network. No plan for data gathering or analysis has yet been established to determine whether there is a reduction of the number of incidents of measured exceedance of water quality standards.

Statistical methods for analyzing existing and new groundwater quality are described in a GWAC document titled "Potential Groundwater Monitoring Stations, Yakima

Groundwater Management Area", (PGG, 2013). This document also describes six different groundwater monitoring programs including the two that the GWAC approved to conduct 1) basin-wide monitoring (ambient groundwater monitoring) and 2) common water supply aquifers (drinking water monitoring).

PGG (2013) recommends basic summary statistics for all data sets considering: the number of samples, the number of locations, the number and percentage of non-detects, minimum, maximum, mean, median, variance and standard deviation. The following statistical procedures are recommended:

- Data distribution determination
- Comparison to natural background
- Comparison to Groundwater Quality Criterion
- Variability with Depth

PGG (2013) cautions not to use existing data in the database for trend analysis if QA/QC data are not available. The purpose built wells for the ambient groundwater monitoring network provide the basis for future trend analysis. Mann-Kendall Trend Test is recommended, which requires a minimum of 10 data points per well, adjustments for outliers and seasonality.

The statistical methods for analyzing groundwater data are corroborated by other publications: Ecology, 1996; Visser et al., 2009; Hirsch et al., 1991.

USGS Drinking Water Quality Testing

Yakima County contracted with the USGS to test and evaluate the quality of drinking water supplies within the LYVGWMA. USGS identified 160 water wells common to USGS' water testing database and Yakima County's water testing database, all of which had existing drilling records from which to determine water levels, well construction details and some prior testing history. USGS then tested these wells six times each during calendar year 2017, with the objective of determining whether measurements vary based on the seasons of the year or agricultural cropping schedules.

USGS, in cooperation with the LYVGWMA group, conducted an intensive groundwater sampling collection effort of collecting nitrate concentration data in drinking water to provide a baseline for future nitrate assessments within the LYVGWMA. About every 6 weeks from April through December 2017, a total of 1,059 samples were collected from 156 wells and 24 surface-water drains. See Appendix M for collected data. The domestic wells were selected based on known location, completion depth, ability to collect a sample prior to treatment or filtration, and distribution across the LYVGWMA. The drains were pre-selected by the GWAC, and further assessed based on ability to access sites and obtain a representative sample. More than 20 percent of samples from the domestic wells and 12.8 percent of drain samples had nitrate concentrations that exceeded the maximum contaminant level (MCL) of 10 milligrams per liter established by the U.S. Environmental Protection Agency. At least one nitrate concentration above the MCL was detected in 26 percent of wells and 33 percent of drains sampled. Nitrate was not detected in 13 percent of all samples collected (USGS 2018).

FIGURE 20 - USGS 2017 GROUNDWATER WELL TEST LOCATIONS

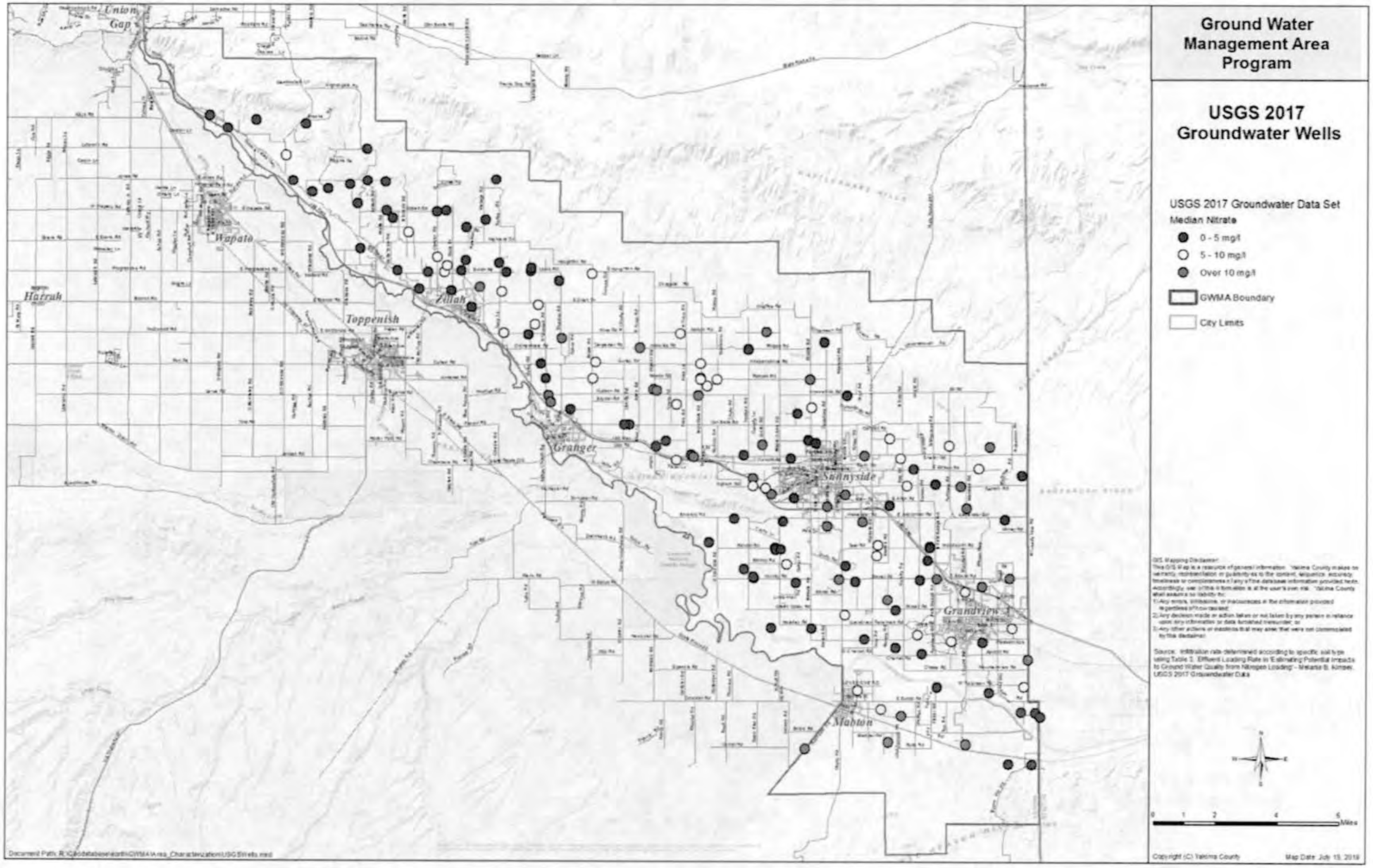
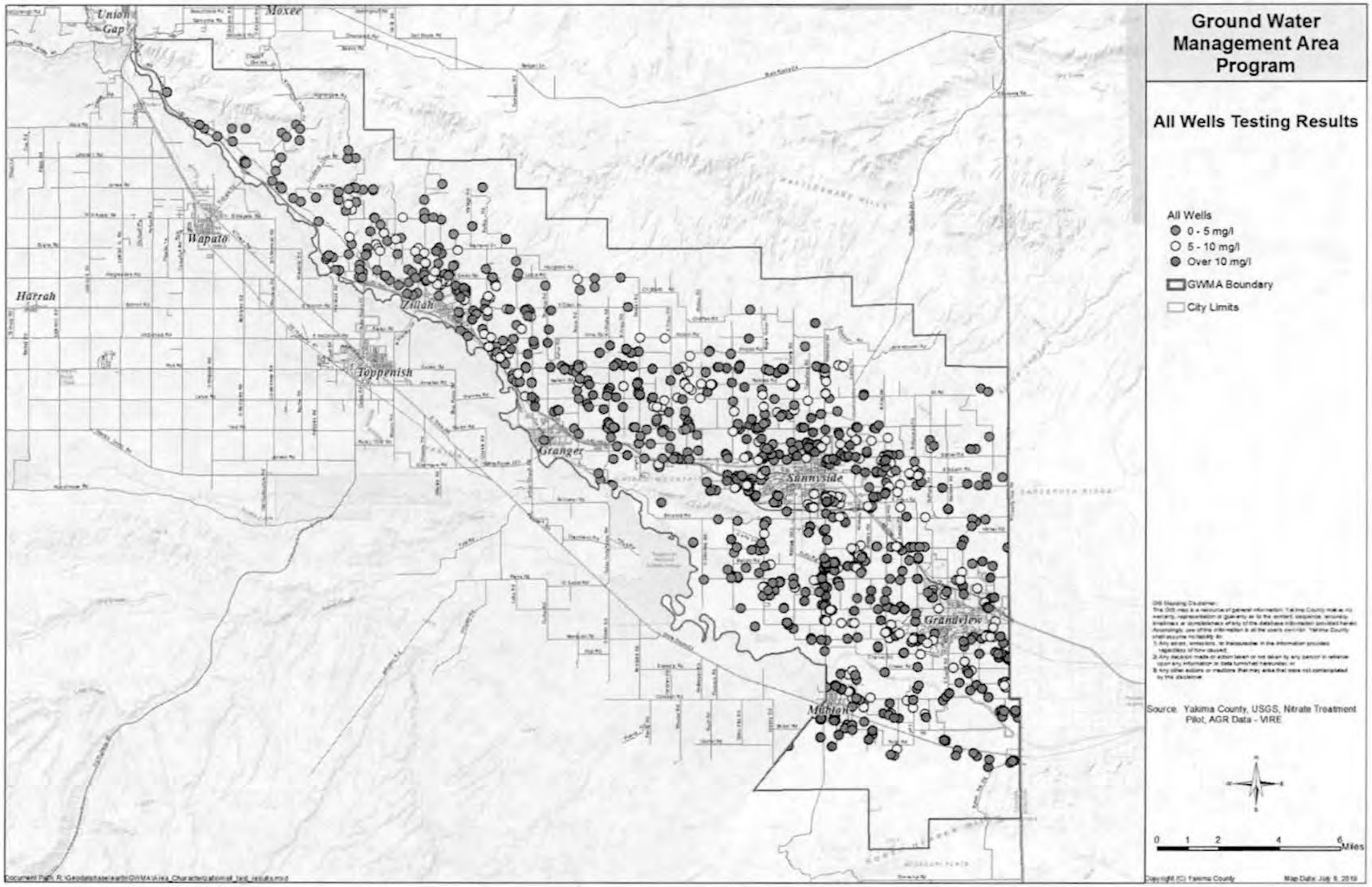


FIGURE 21 - ALL WATER QUALITY SAMPLING LOCATIONS (3 TESTING PROGRAMS)



Deep Soil Sampling Program

Between the fall of 2014 and the spring of 2016, Yakima County contracted with the South Yakima Conservation District and Landau Associates to perform four rounds of deep soil sampling (DSS) on agricultural land in the GWMA target area. All participants volunteered to participate in the Program, subject to the condition that the physical location of sampling was anonymous and undisclosed.

The purposes of the DSS as stated in the Sampling Plan were to 1) provide baseline data regarding the nitrogen content (nitrate, ammonium, and organic matter) of soils underlying a variety of soil, crop, and irrigation systems that represent a cross-section of agricultural activities; 2) provide an initial assessment of current nitrogen and water management practices in place today and in the past; 3) provide information regarding availability of soil nitrogen to crops; 4) provide the foundation for a technically based education program; and 5) provide information about project design, practical realities, time requirements and costs that can be used in developing subsequent project scopes.

Due to the fact that the physical location of sampling was not disclosed, all of the project's purposes were not realized. Nitrate concentrations were measured at 6 ft below ground surface at 175 sites. Members of the GWAC who are actively farming stated that they believe property owners who volunteered to participate in the project gathered helpful information to improve their management practices related to nitrogen application and movement of nitrates within the soil of their agricultural property. Analysis of the practical realities, time requirements and costs of the project indicate that, without possible identification of particular locations tested, the project would be too expensive to continue or repeat.

Identification and Ranking of Sources of Elevated Nitrate in Groundwater

The LYVGWAC identified sources of elevated nitrate generically (presented above). No ranking was made of these sources.

Development of Specific Characteristics of "Hot Spots"

The LYVGWAC did not develop specific characteristics of hot spots nor locate them. The Groundwater Monitoring Program does not include an approach for identifying hot spots.

Nitrogen Loading Assessment

Yakima County contracted with the Washington State Department of Agriculture to study the amount of nitrogen "loaded" to groundwater within the LYVGWMA. WSDA produced a final report in June 2018 incorporating analysis provided by Yakima County regarding nitrogen contributions from residential, commercial, industrial, and municipal sources (WSDA 2018). That report estimated and analyzed the amount of nitrogen "available" for potential loading, but did not take into account soil processes between the point of availability and the groundwater surface.

The report estimated potential nitrogen availability in the landscape in four categories: Concentrated Animal Feeding Operations (CAFOs and dairies), including livestock pens and manure lagoons, irrigated agriculture activities including 15 types of irrigated crops that constitute 96 percent of irrigated acreage within the LYVGWMA, residential, commercial and municipal sources and atmospheric deposition. Both locally-derived information (particularly from mass-balance calculations of irrigated agriculture within the area) and data from scientific literature (particularly related to CAFOs and dairies) was used. The report based its conclusions on low, medium, and high estimates of nitrogen available within the four categories. No measurement or analysis was done regarding biosolids. Atmospheric deposition of nitrogen was assumed within the calculations performed with respect to irrigated crops, animal pens and lagoons, and otherwise estimated for other acreage (WSDA 2018).

The report estimated the nitrogen available within the GWMA from irrigated agriculture, CAFO/dairies, on-site septic/sewer systems, residential lawn fertilizers and small scale (hobby) farms, and atmospheric deposition. The final report listed the low, medium, and high estimate for irrigated agriculture in ranges, each beginning with zero.

TABLE 12 - AVAILABLE N OF IRRIGATED AGRICULTURE

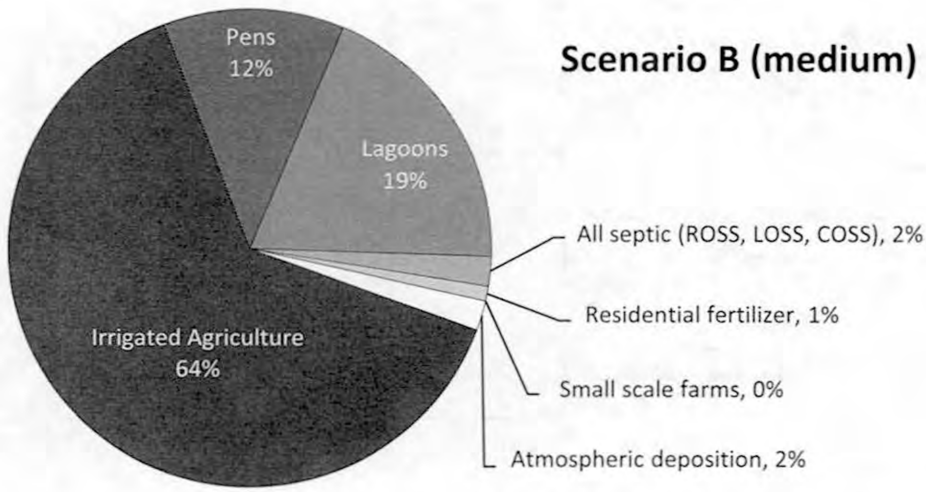
Commodity	Acreage	Sum of inputs and outputs for one year (lb N/ac-yr)		
		Low	Medium	High
Apple	17,333.0	-	64.0	165.0
Corn (silage)	16,778.0	-	47.0	242.0
Triticale	10,780.0	-	13.0	250.0
Grape (juice)	10,257.0	15.0	105.0	142.0
Alfalfa	7,989.0	-	-	-
Pasture	6,731.0	-	-	62.0
Cherry	6,336.0	27.0	78.0	156.0
Hops	5,961.0	-	99.0	113.0
Grape (wine)	5,126.0	40.0	67.0	102.0
Pear	3,331.0	-	65.0	119.0
Mint	1,418.0	-	46.0	102.0
Wheat	1,283.0	-	44.0	113.0
Corn (grain)	1,166.0	-	148.0	284.0
Asparagus	854.0	58.0	130.0	156.0
Peach/Nectarine	843.0	12.0	54.0	104.0
Total	96,186.0	152.0	960.0	2,110.0

TABLE 13 – AVAILABLE N OF CAFO / DAIRY, ON-SITE SEPTIC/SEWAGE, RCIM WASTE AND ATMOSPHERIC DEPOSITION

	Acres	Low (lbs/ac/yr)	Medium (lbs/ac/yr)	High (lbs/ac/yr)
Pens	2,096.0	67.0	480.0	892.0
Lagoons	210.0	1,354.0	7,448.0	13,542.0
ROSS	398.0	223.0	403.0	662.0
LOSS	3.0	195.0	209.0	225.0
COSS	30.0	163.0	173.0	183.0
Res Fert	4,381.0	4.7	11.7	18.6
Small Scale Farm	2,096.0	4.3	10.7	17.1
Atmospheric Deposition	73,976.0	1.5	2.1	6.2

WSDA's final study concluded that approximately 64 percent of the available N was attributable to irrigated agriculture, 12 percent to dairy and cattle pens, 19 percent to liquid manure lagoons, two percent to all septic systems, two percent to atmospheric deposition (that portion attributable to irrigated agricultural acreage) one percent to residential fertilizers and less than one percent to small scale farms.

FIGURE 22 - PERCENT OF TOTAL N AVAILABLE BY SOURCE (WSDA)



Selecting the WSDA's "medium" estimate of the "sum of inputs and outputs" (otherwise the "available" nitrogen) of the 15 crops with the greatest acreage within the GWMA, and the medium estimate of the of pens, lagoons, on-site septic/sewage, RCIM waste and atmospheric deposition, then multiplying the acreage of each times the amount of N available, the total contribution of all sources can be estimated.

The "medium" nitrogen availability has been chosen as the preferred analytic measure because of the numerous assumptions and subjective estimates contained in the mass balance analysis done for irrigated agriculture and the potential variance of location, climate, latitude, soils, or other conditions in the cases cited in the scientific literature relied upon for CAFO/dairy facilities.

Table 14 - Total Available N From All Sources Studied In WSDA 2018

Source of Available N	Acres	Medium (lbs N/ac-yr)	Total (lbs N/yr)	Total (Tons N/yr)	% of Total N Available
Apple	17,333.0	64.0	1,109,312.0	554.66	13.83%
Corn (silage)	16,778.0	47.0	788,566.0	394.28	9.83%
Triticale	10,780.0	13.0	140,140.0	70.07	1.75%
Grape (juice)	10,257.0	105.0	1,076,985.0	538.49	13.43%
Alfalfa	7,989.0	-	-	-	0.00%
Pasture	6,731.0	-	-	-	0.00%
Cherry	6,336.0	78.0	494,208.0	247.10	6.16%
Hops	5,961.0	99.0	590,139.0	295.07	7.36%
Grape (wine)	5,126.0	67.0	343,442.0	171.72	4.28%
Pear	3,331.0	65.0	216,515.0	108.26	2.70%
Mint	1,418.0	46.0	65,228.0	32.61	0.81%
Wheat	1,283.0	44.0	56,452.0	28.23	0.70%
Corn (grain)	1,166.0	148.0	172,568.0	86.28	2.15%
Asparagus	854.0	130.0	111,020.0	55.51	1.38%
Peach/Nectarine	843.0	54.0	45,522.0	22.76	0.57%
Pens	2,096.0	480.0	1,006,080.0	503.0	12.54%
Lagoons	210.0	7,448.0	1,564,080.0	782.0	19.50%
ROSS	398.0	403.0	160,394.0	80.2	2.00%
LOSS	3.0	209.0	627.0	0.3	0.01%
COSS	30.0	173.0	5,190.0	2.6	0.06%
Res Fert	4,381.0	11.7	51,257.7	25.6	0.64%
Small Scale Farm	2,096.0	10.7	22,427.2	11.2	0.28%
Total	105,400.0	9,695.4	8,020,152.9	4,010.1	100.00%

When the acreages utilized by WSDA are summed, the total is greater than the acreage within the GWMA.

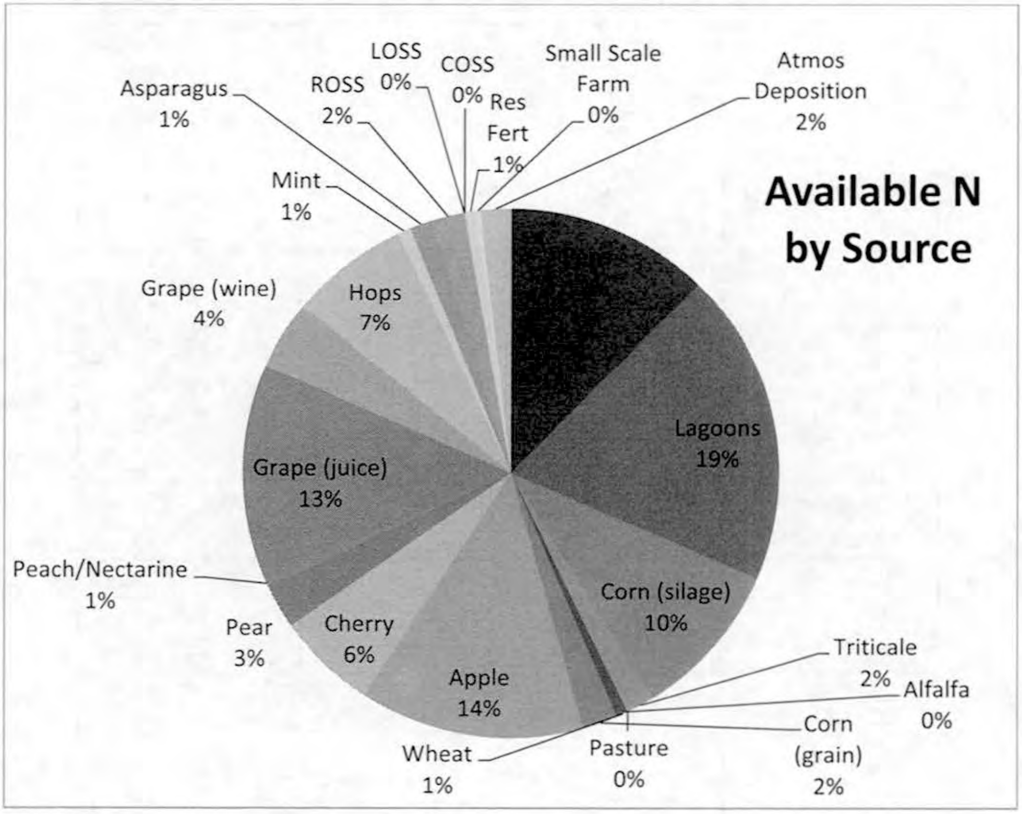
Table 15 - Total Acreage For N Availability Computations

	Acres
Total Irrigated Agriculture	96,186.0
Total Other	9,214.0
Total Acreage	105,400.0

This is a result of double-counting of acreage which is "double cropped" (corn (silage), triticale, alfalfa), or "double used" (farming, septic). The double counting of acreage is necessary to obtain total nitrogen availability.

It is thus possible to see the contribution of total nitrogen available from all studied sources.

FIGURE 23 - NITROGEN AVAILABLE BY SPECIFIC SOURCE



The information provided by WSDA (WSDA 2018) can also be assembled by more general industry groups:

Table 16 - Nitrogen Availability Assembled By Industry Group

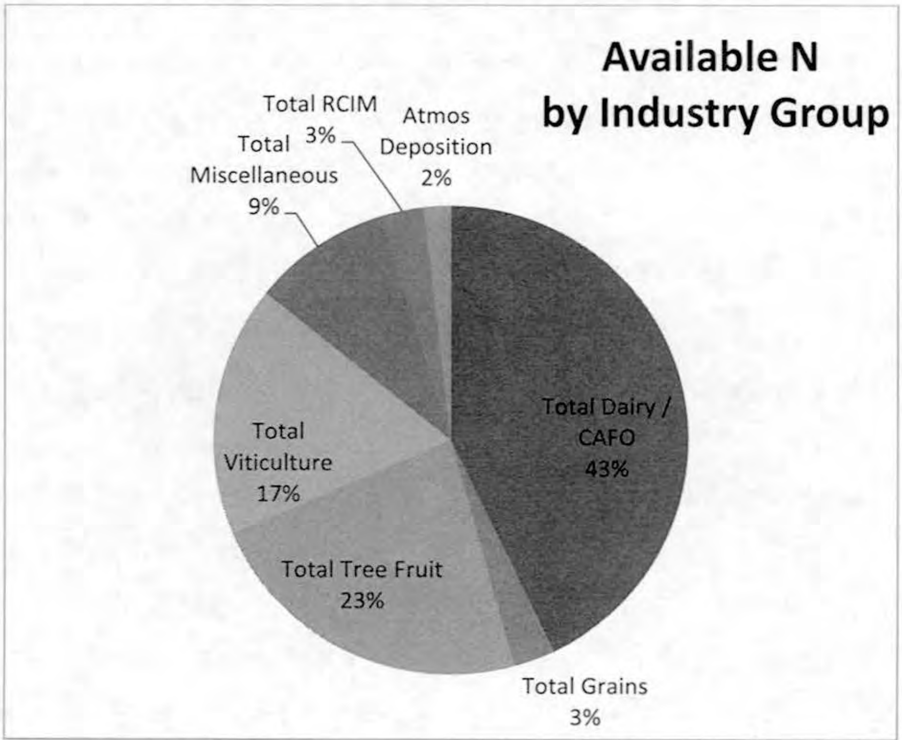
Nitrogen Availability by Industry Group				
	Acres	Medium N (lbs/ac/yr)	Total N Medium (lbs/yr)	Total N Medium (tons/yr)
Pens	2,096.0	480.0	1,006,080.0	503.04
Lagoons	210.0	7,448.0	1,564,080.0	782.04
Corn (silage)	16,778.0	47.0	788,566.0	394.28
Triticale	10,780.0	13.0	140,140.0	70.07
Alfalfa	7,989.0	-	-	-
Pasture	6,731.0	-	-	-
Wheat	1,283.0	44.0	56,452.0	28.23
Corn (grain)	1,166.0	148.0	172,568.0	86.28
Apple	17,333.0	64.0	1,109,312.0	554.66
Cherry	6,336.0	78.0	494,208.0	247.10
Pear	3,331.0	65.0	216,515.0	108.26
Peach/Nectarine	843.0	54.0	45,522.0	22.76
Grape (juice)	10,257.0	105.0	1,076,985.0	538.49
Grape (wine)	5,126.0	67.0	343,442.0	171.72
Hops	5,961.0	99.0	590,139.0	295.07
Mint	1,418.0	46.0	65,228.0	32.61
Asparagus	854.0	130.0	111,020.0	55.51
ROSS	398.0	403.0	160,394.0	80.20
LOSS	3.0	209.0	627.0	0.31
COSS	30.0	173.0	5,190.0	2.60
Res Fert	4,381.0	11.7	51,257.7	25.63
Small Scale Farm	2,096.0	10.7	22,427.2	11.21
Atmos Depositior	73,976.0	2.1	151,650.8	75.83

When the components of industry groups are totaled, a somewhat different view of nitrogen availability is possible:

TABLE 17 - INDUSTRY GROUP TOTAL N AVAILABILITY

Industry Group	Total N Medium (tons/yr)
Total Dairy / CAFO	1,749.43
Total Grains	114.51
Total Tree Fruit	932.78
Total Viticulture	710.21
Total Miscellaneous	383.19
Total RCIM	119.95
Atmos Deposition	75.83

FIGURE 24 - NITROGEN AVAILABLE BY INDUSTRY



Mean Annual Groundwater Recharge Model

The LYVGWMA did not remodel estimates of mean annual groundwater recharge as modeled by USGS (USGS 2007a). Remodeling could consider more recent data inputs including a more recent period of climate condition, evolved irrigation methods, actual irrigation water application rather than estimated irrigation water application, and more particularized study of the LYVGWMA, rather than the basin-wide study of the USGS' 2007 report. The increments of estimated annual recharge could also be refined to be more informative about any particular segment of land within the LYVGWMA

Geographic Information System Study

Yakima County maintains a geographic information system (GIS) data bank of numerous categories of information delivered to or through the county's various governmental processes. Data requests were made to the Washington State Departments of Agriculture, Ecology, Health, and Natural Resources, U.S. Departments of Agriculture (NRCS), Geological Survey (USGS), Census Bureau, Environmental Protection Agency and National Atmospheric Deposition Program for additional relevant information maintained or organized by geographic coordinates capable of inclusion in Yakima County's GIS system. Information from WSDA's nitrogen availability study (WSDA 2018) was fully integrated into the GIS system, as was the data from several water well testing programs administered by Yakima County and the Department of Health. All that information relevant to the LYVGWMA was structured into layers of GIS-mapped information.

The WSDA's Nitrogen Availability Assessment (WSDA 2018) contained information about a number of sources of nitrogen that may be available to the groundwater in such a way as to contribute to a contaminated well. The nitrogen available from all those sources within gridded section were totaled and mapped (Figure 26). The USGS 2017 well test data was then mapped and laid atop the map of total nitrogen availability (Figure 27). Similar overlaid maps created include USGS well data over soil types, soil infiltration rates, irrigation canals and drains, cropping patterns, point sources, and septic system locations (Figures 27-32).

FIGURE 25 - TOTAL NITROGEN AVAILABILITY

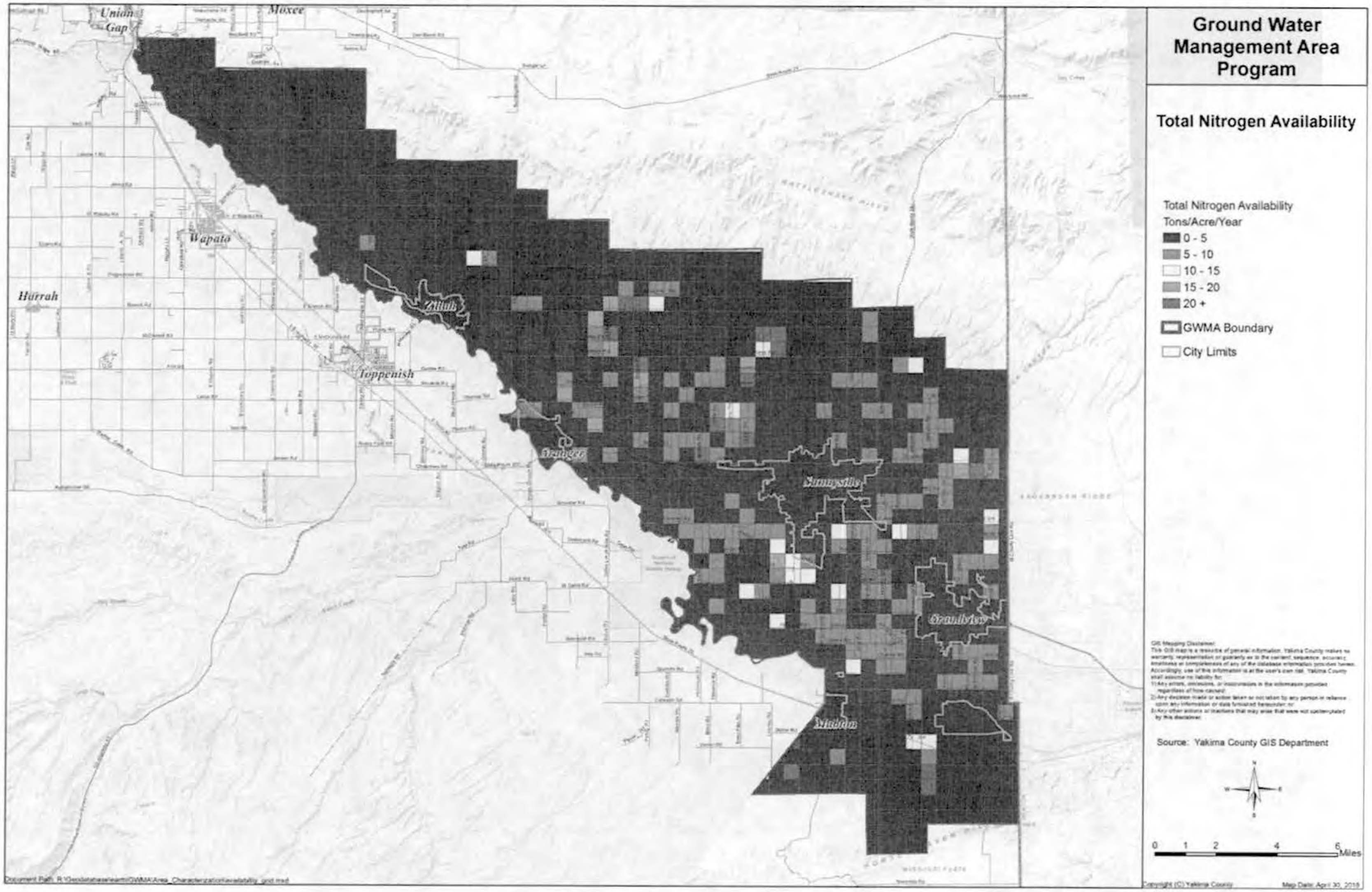


FIGURE 26 - NITROGEN AVAILABILITY AND USGS WELLS

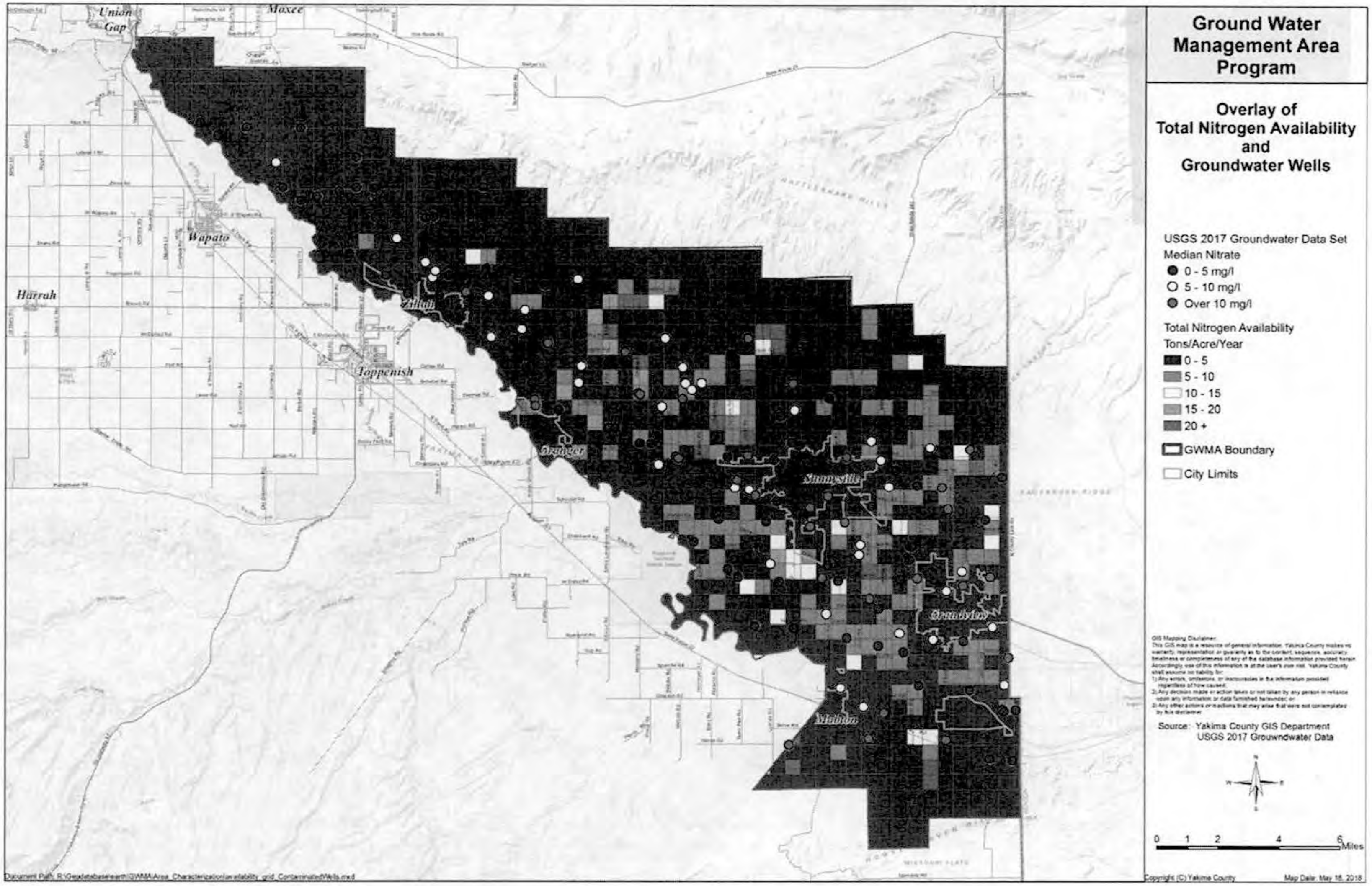


FIGURE 27 - USGS WELL DATA OVERLAID ON SOIL TYPES SIMPLIFIED BY HYDRAULIC CONDUCTIVITY GROUPS

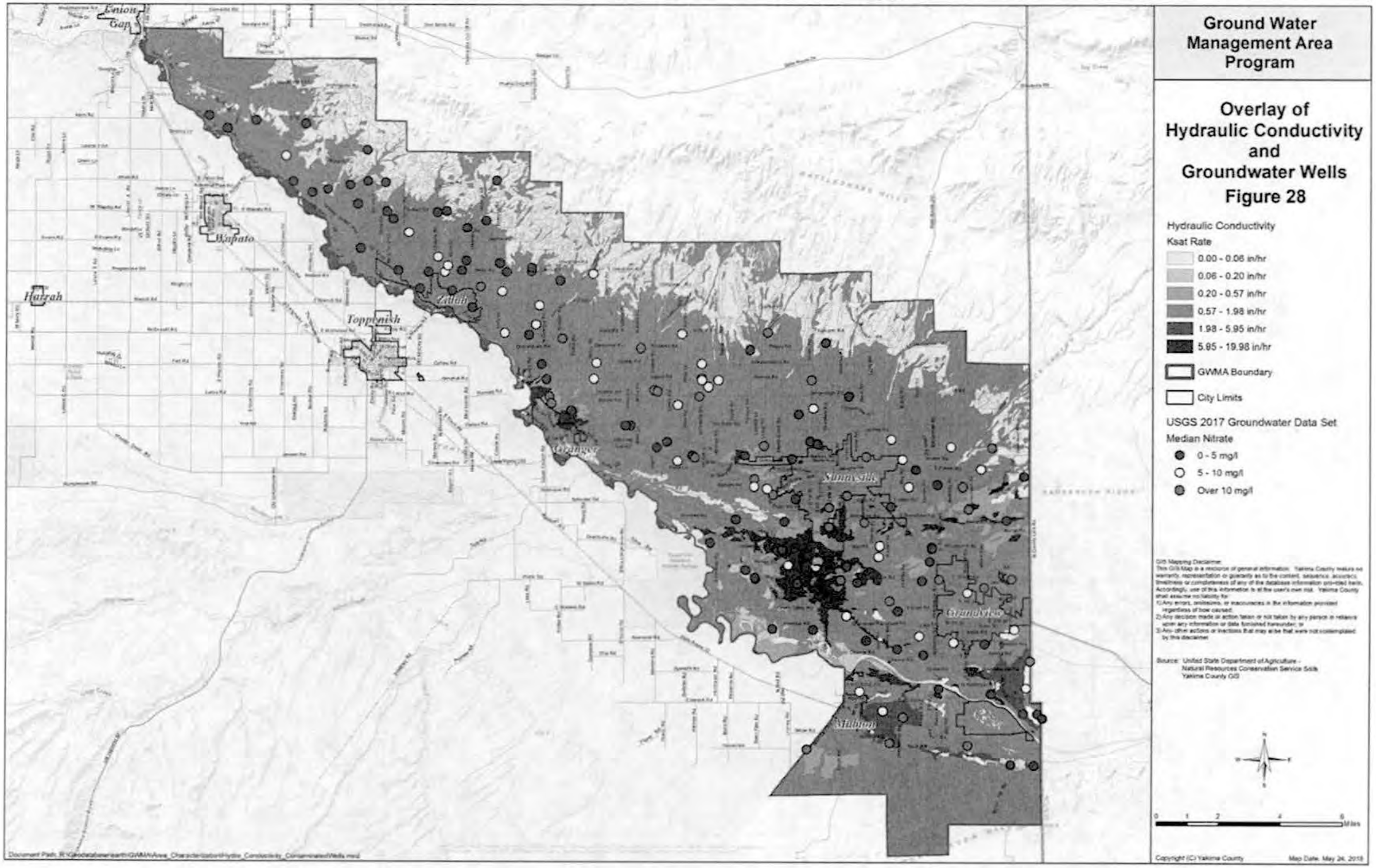


FIGURE 28 - USGS WELL DATA OVERLAID ON IRRIGATION CANAL AND DRAIN INFORMATION

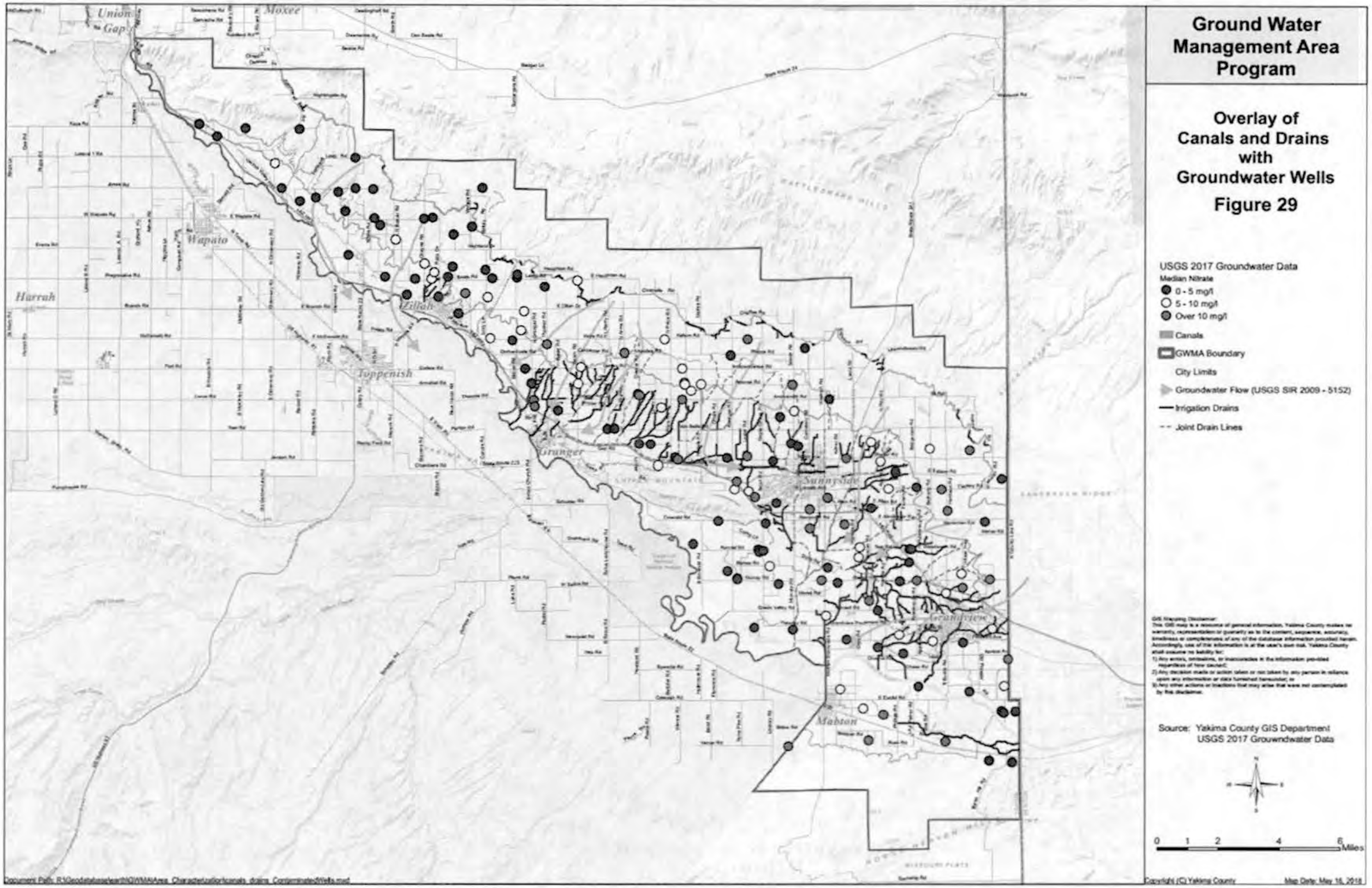


FIGURE 29 - USGS WELL DATA OVERLAID ON CROPPING PATTERNS

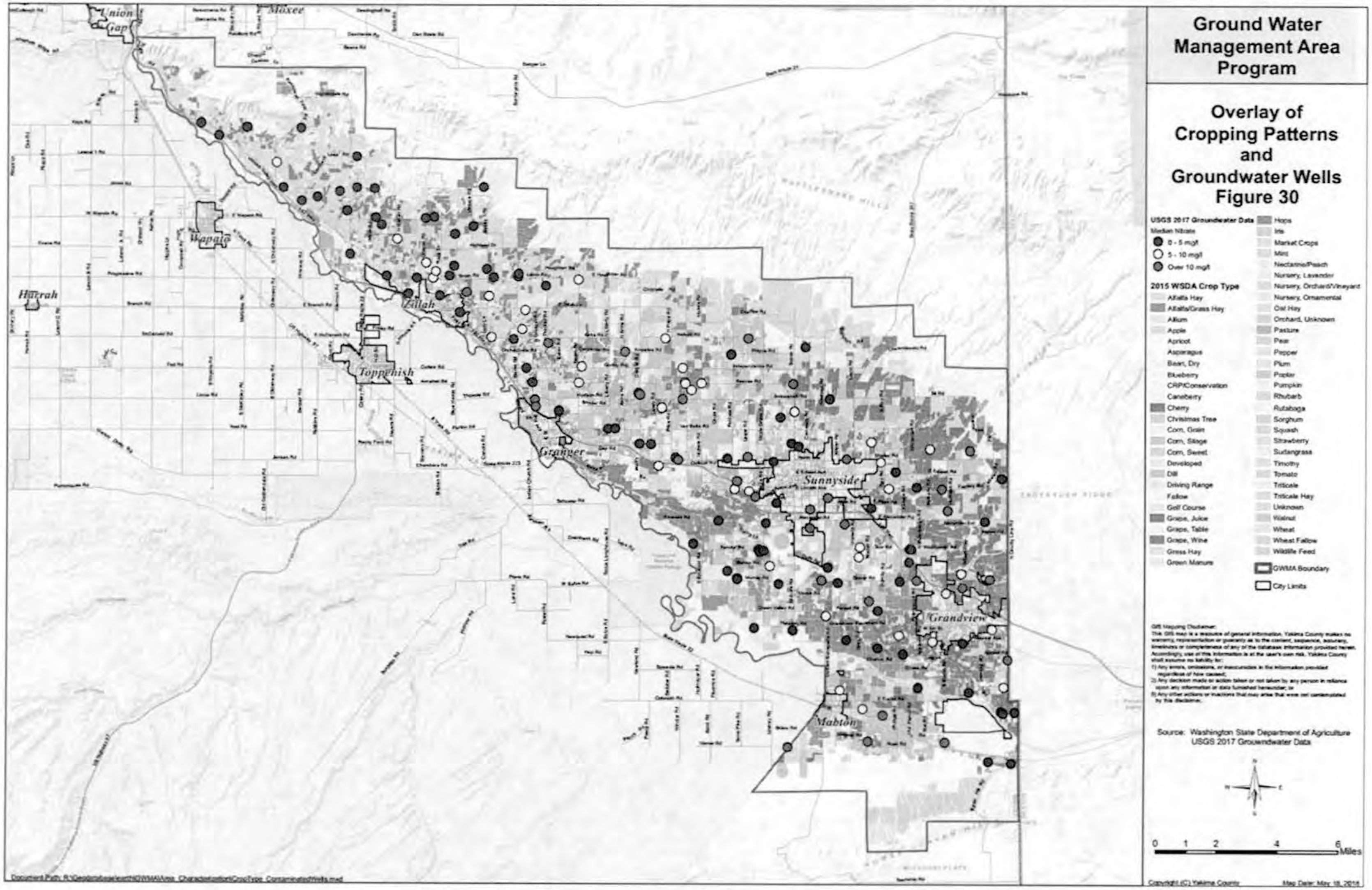


FIGURE 30 - USGS WELL DATA OVERLAID ON MAP OF POINT SOURCES

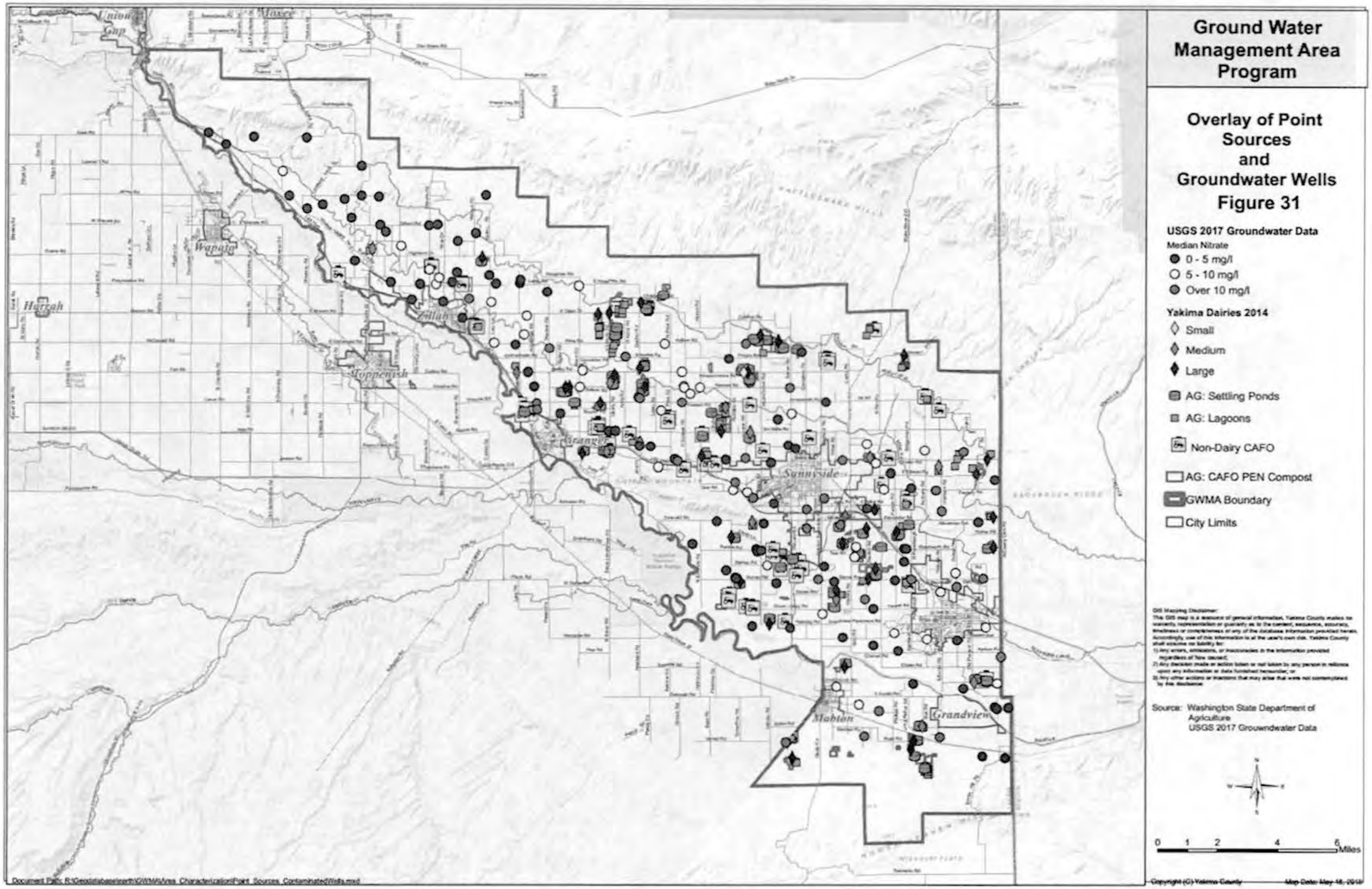
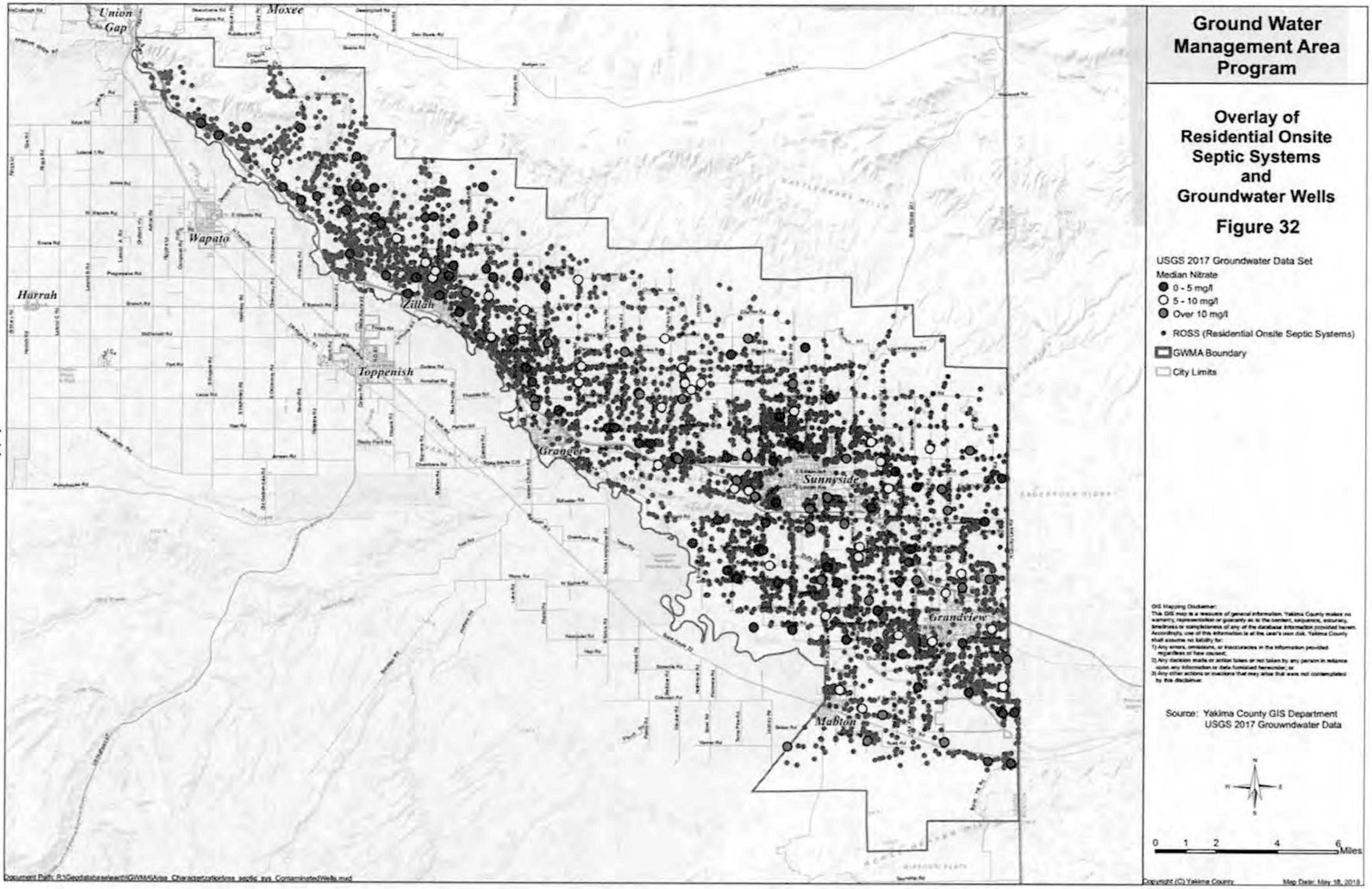


FIGURE 31 - USGS WELL DATA OVERLAID ON MAP OF SEPTIC SYSTEMS



Caution should be taken to distinguish between few source locations (as with other point sources, Figure 31) and many source locations (as with septic systems, Figure 32). The ratio of actual combined gross settling pond and lagoon capacity to actual gross septic system capacity, for example, is 132/1. There are 6022 septic tanks, 105 settling ponds, and 172 lagoons, respectively, within the GWMA. The gross settling pond capacity (8,596,140 gallons) is equivalent to the capacity of 8,596 individual septic tanks. The gross lagoon capacity (784,650,928 gallons) is equivalent to the capacity of 784,651 individual septic tanks.

The average capacity of a septic tank when full is 133 cu. ft. (1,000 gallons); the average capacity of a settling pond when full is 81,868 cu. ft. (612,418 gallons); the average capacity of a lagoon when full is 609,840 cu. ft. (4,561,924 gallons). Not all of the relevant capacity is in use at any given time. These comparisons do not lead to reliable conclusions of relative contribution to ambient groundwater conditions.

While the broad distribution of septic systems throughout the GWMA suggest that they are a factor contributing to the ambient condition, and that some specific well contamination events may occur because of proximity to a specific septic system, caution should be taken when considering their relative total contribution of nitrogen available to the ambient groundwater system. See Figure 22, Percentage of Total N Available by Source (WSDA) and Figure 23, Nitrogen Available by Specific Source.

It is difficult to compare particular sources directly, as they have different design and performance objectives. For example, septic systems are best sited in soils with high porosity (perc test required), settling ponds and lagoon systems are best sited in soils with low porosity (clays as impediment to flow).

All of the maps overlaid with USGS well data may suggest some correlation between source and effect. It is not suggested, however, that any is the sole cause of a given effect, nor that a particular combination of mapped data suggests any causative relationship. The distance between all potential sources inside a given radius of each of the USGS wells with greater than 10 mg/L nitrate has not been measured, nor has the geology, hydrogeology or water quality condition between them been analyzed.

Description of Alternative Actions to Address the Problem

WAC 173-100-100 (4) requires that this Program include:

> (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. .... 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....

WAC 173-100-100 (4) suggests that the Program may include, "if necessary, alternative data collection and analysis programs" with which to "enable better characterization of the groundwater and potential quality and quantity problems."

> "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."

In Yakima County, including the area within the LYVGMA, these subjects are being addressed through the Yakima River Basin Integrated Water Resource Plan (WBIWRP 2012).

The Groundwater Management Committee first made a list of some 300 potential alternatives, incorporating working group recommendations, ideas raised in working group conversations and reviews of scientific and environmental literature [See Appendix G]. The GWAC first applied a "consensus" screen in order to reduce the large list of alternatives to those potential recommendations with which no one would disagree. This produced a shorter list of 83 potential recommendations to be evaluated by the criteria established by WAC 173-100-100 (4) [See Appendix H].

Discussion of Pros and Cons of Alternative Actions

The GWAC first considered a lengthy list of ideas and thoughts that had surfaced throughout the several years of work group and GWAC meetings, particular recommendations made by working groups, or ideas derived from technical literature reviewed in preparation of this Program. The GWAC first removed from this list all those ideas where it was clear, through open meeting discussion, that consensus could not be reached. A spreadsheet was prepared listing all the remaining ideas. With respect to each, the feasibility, effectiveness, cost, proposed funding, timing, difficulty of implementation and consistency with Yakima County's Comprehensive Plan was estimated and set forth (See Appendix H). This information was made available to all GWAC members prior to their final evaluation of the then-draft recommendations. Seventeen of the twenty-two primary GWAC members responded to a request to evaluate the draft recommendations, placing a value of -3 to +3 on each draft recommendation. The results were totaled. A unanimous consensus could not be obtained that the outcome of this method represented the consensus of the GWAC regarding its recommendations. The GWAC membership took a recorded vote at its May 17, 2018 meeting whether to recommend all draft recommendations which had received a total score greater than zero. The GWAC voted 17 - 1, 1 not voting, to recommend those draft recommendations. They appear below as "Recommended Actions." Those draft recommendations obtaining a total value of zero or less appear further below.

Environmental Justice

An additional criterion with which to evaluate alternatives, other than those suggested by WAC 173-100-100, is "environmental justice." Environmental justice is the "fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations and policies" (Ex. Ord. 1994). Federal and state agencies seek to implement this policy. Because abatement of nitrogen contamination in drinking water should have a positive effect for poorer, minority communities without alternative drinking water supply, alternatives that abate contamination should be considered favorably.

Discussion of environmental justice in LYVGWAC work group meetings led to argument about the applicability of the concept of environmental justice to the LYVGWMA groundwater problem.

The *Preliminary Assessment* (EPA 2010) found that the demographics of the Lower Yakima Valley require that final implementation of any or all the recommendations "takes into account, cultural, economic, and geographic factors." English is not the primary language (written or spoken) in many households in the Lower Yakima Valley. Prior outreach materials in Spanish and other languages were limited and focused for specific audiences and purposes (coliform boil water notices, nitrate advisories for high risk populations). When new materials are developed under any of the recommendations to address the specific needs of the Lower Valley residents, they should be written and delivered in a manner that is most likely to reach all residents of the LYVGWMA (see Interim Education and Outreach).

Recommended Actions

The GWAC refined that list of alternatives (Appendix H) to the recommended actions set forth below. The parenthesized number following the recommendation represents the total of all values provided by GWAC members.

Administration

Yakima County should:

ADM 1: Establish a Lead Agency responsible for implementation and oversight of the LYVGWMA Groundwater Management Plan and acquisition of stable funding to support their activities. (41)

Subject to state funding: Administer the Groundwater Quality Program. Administer funds and distribute to other entities by subcontract. Host the LYVGWMA website. Maintain a GIS data base on the GWMA.

Environmental Protection Agency and WA Department of Ecology should collaboratively:

ADM 2: Identify and support opportunities, including educational research institutions, for private, public, and industry investment in technology specific to addressing nitrate contamination in groundwater. (20)

Public Health and Safety

WA Department of Health, Yakima Health District, Yakima County should collaboratively:

PHS 1: Develop a bilingual, health-risk education and outreach campaign. (28)

Establish a public education program regarding nitrate pollution and health risk over a 5-10-year period. 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).

Residential, Commercial, Industrial, and Municipal

<u>Yakima County</u> should:

RCIM 1: 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. (26)

RCIM 2: Perform an engineering study of water supply alternatives. (14)

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).

RCIM 3: Develop an urban and hobby agriculturalist education and outreach campaign. (10)

Provide information targeted to small farm/hobby farm/ranchettes about manure management. Publish and distribute homeowner guides on proper septic system construction, operation, and maintenance. Educate the public, particularly in towns, about lawn and garden nitrogen applications' contribution to nitrate concentrations. Recommend against farming around a water well.

<u>Yakima Health District</u> should:

RCIM 4: Publish and distribute homeowner guide on how to maintain septic systems. (40)

RCIM 5: Study potential nitrate contamination attributable to improperly operated septic systems. (32)

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.

Municipalities should:

RCIM 6: Provide funding for municipalities to replace aging sewer system infrastructure and ensure proper system maintenance to reduce nitrate leaching. (11)

Municipalities need to estimate costs and system integration.

WA Department of Ecology should:

RCIM 7: Develop a plan for finding and decommissioning abandoned wells in the next 12 months, using the LYVGWMA as a pilot project. (23)

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 decommissioning. Provide some form of protection for self-reporting of abandoned or improperly decommissioned wells.

WA Department of Health should:

RCIM 8: Determine, prior to issuing or reissuing LOSS permits, that all employee counts are regularly reported. (19)

So that the LOSS will continue to operate as designed.

Irrigated Agriculture

Washington State University should:

IA 1: Operate a mobile irrigation lab to assess the efficiency of current or advised irrigation practices, either through a singular lab or component parts. (25)

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 regarding corn and triticale water practices.

WA Department of Agriculture should:

IA 2: Design and implement pilot studies focusing on innovative farm techniques which reduce nitrogen loading to crops and monitor results. (34)

South Yakima Conservation District, WA Department of Agriculture, and WSU Extension Service should collaboratively:

IA 3: Create Irrigation Management Plans (similar to Nutrient Management Plans) for farms over a minimum size and provide financial assistance for implemented plans. (23)

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.

IA 4: Encourage advanced irrigation management. Integrate management of synthetic /organic fertilizers and application of water. (31)

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.

Natural Resources Conservation Service and Department of Ecology should collaboratively:

IA 5: Provide financial assistance for implementation of Irrigation Management Plans. (32)

Details include: 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.

Department of Ecology and WA Department of Agriculture should collaboratively:

IA 6: Make grants and allocate cost share funding or other funding assistance to people implementing environmental protection measures affecting groundwater quality. (17)

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.

Livestock/CAFO

WA Department of Agriculture should:

LC 1: Complete NRCS Technical Note 23 inspections on all waste storage ponds (lagoons) within the GWMA boundaries. (23)

LC 2: Identify and support opportunities, including education research institutions for private, public and industry investment in technology and management of fertilizers and manures, including separation of solid and liquid wastes. (17)

WSDA construct LYVGWMA administrative program.

LC 3: Develop strategies for marketing the economic, fertilizer value, and soil enhancing properties of appropriate application of manure and other livestock wastes. (18)

Producers should:

LC 4: Make capital improvements. (2)

Install liners in liquid waste storage lagoons. Install impervious surfaces beneath silage storage.

Washington State University should:

LC 5: Continue research of water management with application of agricultural nutrients. (25)

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.

Washington State University and Producers should collaboratively:

LC 6: Integrate use of animal waste and synthetic fertilizer. (23)

Research chemical integration of animal waste and synthetic fertilizers with objective of balancing nutrient application amounts in order to maximize crop production and full nitrogen uptake.

US Department of Energy and US Department of Agriculture should collaboratively:

LC 7: Explore investment in animal and agricultural waste to energy technology. (22)

Explore state of technology, economic viability, return on investment (national corporate research & development/ governmental incentives).

WA Department of Agriculture and Washington State University should collaboratively:

LC 8: 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. (19)

Washington Conservation Commission should:

LC 9: 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. (26)

South Yakima Conservation District, WA Department of Agriculture, Washington State University, Private Industry and Producers should collaboratively:

LC 10: Educate producers regarding application of nutrients at Agronomic Rate. (30)

Develop technologies and provide information about improvements made in nutrient management and agronomic rate application of fertilizer by specific developing technologies.

Recommendations for Irrigated Agriculture and Livestock CAFO Together

Washington Conservation Commission, WSU Extension Service, WA Department of Agriculture, Department of Ecology, Yakima County, South Yakima Conservation District and Ag Industry Associations should collaboratively:

IALC 1: Develop a post-GWAC agricultural producer education and outreach campaign. (36)

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.

Washington Conservation Commission should:

IALC 2: Fund SYCD, through State Conservation Commission budget, for projected educational, administrative, nutrient management planning, engineering, cost share, and lending activities. (39)

South Yakima Conservation District and Washington Conservation Commission should collaboratively:

IALC 3: Establish a local forum for disseminating information and facilitating technical exchange regarding best management practices (BMPs) for irrigated agriculture and livestock management and groundwater protection. (36)

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.

WA Department of Agriculture and South Yakima Conservation District should collaboratively:

IALC 4: Inform farmers of those BMPs prioritized by Livestock/CAFO and Irrigated Agriculture Work Groups to reflect greatest effectiveness in nitrate reduction. (25)

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 regulations listing 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.

IALC 5: Encourage appropriate use of surface banding ("dribbling," "stripping" of liquid fertilizer, "broadcasting" or prompt incorporation of manures and fertilizers after application to cropland. (18)

Broadcast is effective for corn, alfalfa, triticale. Incorporation should occur within 24 hours.

IALC 6: Continue to provide underlying soils information to individual livestock operations, provide same for all irrigated agriculture. (25)

So that individual property owners can evaluate contamination potential, already in DNMP process.

Data Collections, Characterization, Monitoring

Department of Ecology, Yakima County and Yakima Health District should collaboratively:

DATA 1: Establish or maintain ongoing, extended funding necessary for the Yakima County Department of Public Services and the Yakima Health District to actively participate in water quality improvement, testing, monitoring, scientific data analysis, and infrastructure development. (35)

Collect data to track water quality improvement progress and nutrients generated, applied, or exported within the LYVGWMA. 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 LYVGWMA.

South Yakima Conservation District and WA Department of Agriculture should collaboratively:

DATA 2: Monitor changes occurring in agricultural operations. Evaluate whether those changes positively affect improvement in groundwater quality. (25)

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.

Yakima County should:

DATA 3: Adopt and Implement an Adaptive Management Plan. (22)

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 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.

<u>South Yakima Conservation District</u> should:

DATA 4: 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. (25)

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.

<u>Department of Ecology</u> should:

DATA 5: Analyze the trends of nitrate data contained within reports required by NPDES and SWD permits. (23)

<u>Department of Ecology</u> and <u>WA Department of Health</u> should collaboratively:

DATA 6: Establish time-based performance objectives against which well-monitoring data can be compared. (16)

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.

Yakima County should:

DATA 7: Install Ambient Groundwater Monitoring Wells. (42)

Monitoring well construction: Monitoring well data collection:

Yakima Health District should:

DATA 8: Collect data from Ambient Groundwater Monitoring Wells. (42)

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.

Roza-SVID Joint Board of Control should:

DATA 9: Monitor nitrate concentrations of irrigation water at headgates. (35)

Report nitrate concentrations annually to Department of Ecology.

Yakima County should:

DATA 10: Contract with USGS to collect data from water well system per 2017. (28)

DATA 11: Contract with USGS to do particle tracking model study to indicate where groundwater moves faster (permeability). (9)

USGS Particle Tracking Model Overview--potentially combined with MT3D MODFLOW application to the vadose Zone.

WA Department of Agriculture, Department of Ecology and Yakima County should collaboratively:

DATA 12: Assess Nitrogen 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. (5)

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 (NO_x), 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 database and refine estimates of atmospheric deposition.

Regulatory Framework

Environmental Protection Agency, WA Department of Agriculture and Department of Ecology should collaboratively:

REG 1: Streamline current regulatory enforcement activities. (25)

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.

Department of Ecology should:

REG 2: Inspect, monitor, and regulate stockpiled manures. (1)

Coordinate with WSDA. Currently being done; currently required as part of dairy nutrient management plans.

REG 3: 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 regulations. (12)

REG 4: Provide assistance to local departments of health regarding the regulation of agricultural composting operations. (7)

WA Department of Agriculture should:

REG 5: Document and publish regulatory compliance for dairies within the GWMA that are completing and implementing Dairy Nutrient Management Plans (DNMP). (7)

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.

Yakima Health District should:

REG 6: Issue permits for agricultural composting operations, to appropriately inspect composting operations and to enforce regulations that protect public health and the environment, per WAC 173.350.040. (4)

REG 7: Require new developments outside towns to address potential impacts on groundwater quality. (19)

Work with Yakima County Planning and Building Divisions' permit program to identify methods of permitting while reducing impacts to groundwater.

Yakima County should:

REG 8: 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. (15)

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.

South Yakima Conservation District and Ag Producers should collaboratively:

REG 9: Develop and implement Nutrient Management Plans for all farmers. (19)

Mandatory or Voluntary. Farming operations currently are not required to hold permits or a prepare a Nutrient Management Plan.

WA Department of Agriculture should:

REG 10: 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. (8)

Draft Recommendations Obtaining a Total Value of Zero or Less

The Washington Legislature should:

Make shallow (1, 2, 3 foot) soil testing reports prerequisites for funding, lending or building permits. (0)

In the nature of Phase I Environmental Audits. Make nitrate-related information / data available for water quality management.

WA Department of Health should:

Revise WAC 246-203-130 (keeping of animals) (-1)

So that it includes specific and enforceable requirements designed to protect health.

WA Department of Ecology should:

Require facility process improvements in waste treatment and food processing plants to reduce nitrogen and total discharge volume. (-3)

Addressed by Department of Ecology General Permit for Food Processing, specific problems can be addressed through "special protection areas," WAC 173-200-090.

WA Department of Ecology and WA Department of Agriculture should:

Improve composting regulations (statutory) (-4)

Unclear as to particular regulations proposed.

WA Department of Agriculture should:

Establish a monitoring system for compliance with NRCS Standard 317 on new composting facilities at Washington dairies (phased in for existing facilities). (-4)

WA Superintendent of Public Instruction and Educational Service District 105 should:

Develop educational materials that could be elected by instructors at 8-12 levels about aquifer protection, groundwater and best management practices. (-6)

The Washington Legislature should:

Require commodity commissions to dedicate "check off" money for research and development in water quality technology and practices. (-7)

WA Department of Ecology, Yakima Regional Clean Air Agency and WA Department of Agriculture should:

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. (-33)

Use this to inform the nitrogen balance data base for the GWMA area and refine estimates of atmospheric deposition.

WA Department of Ecology and U.S. Environmental Protection Agency should:

Study the relationship between nitrogen emissions and atmospheric deposition of reactive nitrogen. (-37)

Develop a model that predicts what percentage of emissions return to the GWMA area as atmospheric deposition.

Implementation Work Plans

Parties Responsible for Implementation of the Recommended Actions

The parties responsible for implementation of the recommended actions include:

- Yakima County
- Washington State Department of Ecology
- Washington State Department of Agriculture
- Washington State Department of Health
- Washington State Conservation Commission
- South Yakima Conservation District
- Washington State University Extension Service
- Agricultural Producers

The LYVGWMA did not develop a "detailed work plan for implementing each aspect of the groundwater management strategies as presented in the recommendations section" as recommended by the general framework guidelines listed in WAC 173-100-100.

Yakima County as "Lead Agency"

The LYVGWAC recommended by a vote of 14-1, 1 abstention, 1 not voting, at the May 17, 2018 meeting that Yakima County act as "lead agency" in future Lower Yakima Valley groundwater management programs. The County's activity as lead agency would be subject to available funding from the State of Washington.

As the Lower Yakima Groundwater Management Area's Lead Agency, Yakima County may perform any of the following functions, subject to available funding:

- Seek and administer funding for the accomplishment of recommendations made by the final GWMA Program.
- Encourage the Washington State Departments of Ecology, Agriculture and Health, the Yakima Health District, the South Yakima Conservation District, and Washington State University to perform those activities recommended by the final GWMA Program.
- Host the GWMA website. Maintain a GIS database on the GWMA.

- Participate in educational activities in partnership with the South Yakima Conservation District, Departments of Ecology, Agriculture or Health in a manner consistent with GWMA recommendations.
- Install ambient groundwater monitoring wells and arrange for data collection from those wells.
- Collect data to track water quality improvement progress and nutrients generated, applied, or exported within the GWMA.
- Describe the characteristics or volume of groundwater.
- Analyze nitrogen availability periodically, at least equivalent to WSDA 2018, in order to compare and contrast changes over time.
- When appropriate, call upon citizen involvement in decision making.
- Report at least triennially on the status of groundwater quality within the LYVGWMA.
- Recommend strategies to the Yakima County Commission, Ecology, Agriculture consistent with the GWMA Program, by which to mitigate adverse effects to groundwater quality within the GWMA.
- Develop and implement an Adaptive Management Plan within the GWMA.

Schedule For Implementation Of The Recommended Actions

Those recommendations based upon the implementation of best management practices by agricultural producers should begin immediately.

Those recommended actions that depend upon the availability of public funding will likely require one to two years lead time to secure that funding prior to their implementation.

Those recommended actions that collect data over time, including the proposed Ambient Water Quality Monitoring Well Program, or voluntary Deep Soil Sampling Program, will be implemented over a multi-decade time span.

Monitoring System For Evaluation Of Effectiveness Of Recommended Action

The Ambient Water Quality Monitoring System is intended to be comprised of at least 30 randomly placed, water-table elevation groundwater quality monitoring wells. Data from these wells will be collected sufficiently often to track seasonal variation and general water quality over time.

Lower Yakima Valley Groundwater Management Program

Volume II

August 9, 2018

LOWER YAKIMA VALLEY
GROUNDWATER
ADVISORY
COMMITTEE

Volume II

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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

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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 Agency[6] 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

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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 comprehensiv e 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 administratively, 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)							
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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.							

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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							

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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							

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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							

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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							

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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)						
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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; $200K (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	USPI, 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 list 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 ("dribbling," "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, III-4, 6.1, 6.5, 7.7, 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 food 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 disproportionate to benefit		2019-2122	Possible	Consistent with NG-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 NG-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 leading 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 NG-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 subsidized = $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	Permit 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	$30K Agency Memo only, $500 + K for 5-year study	Legislature	2019 Session	Easy	
7	WSDA, DOE, Lead Agency	Assess Nitrogen 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 (NH3), nitrous oxide (N2O), the anion nitrate, NO3, 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	WCE $200K / yr; SYCD $200 K / yr	WCE, 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, WCE	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 @ $4 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

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		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)	

Appendix I—Documents Produced by LYVGWMA for Education and Public Outreach

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, newborn 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

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What You Can Do_Small Farms Manure Finalpng_Page1.docx

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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

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

LOWER YAKIMA VALLEY
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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

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LOWER YAKIMA VALLEY
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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 divulgación al publico
- Financiacion
- Agricultura de riego
- Ganado/CAFO
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LOWER YAKIMA VALLEY
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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.

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LOWER YAKIMA VALLEY
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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
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Seguridad en pozos: Lo que usted puede hacer

Área de Manejo de Aguas Subterráneas (GWMA):
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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.

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lad de sistemas sépticos: Lo que usted puede hacer

Área de Manejo de Aguas Subterráneas (GWMA):

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- 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

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

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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

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2 Accomplishments_Outreach 2012-17_0814_2017 (ECY).docx

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:

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

Amy D. Person, M.D.,

Yakima County Health District
Health District

Benton-Franklin

attachments: Methemoglobinemia in infants

YVGWMA Vicinity Map

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

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

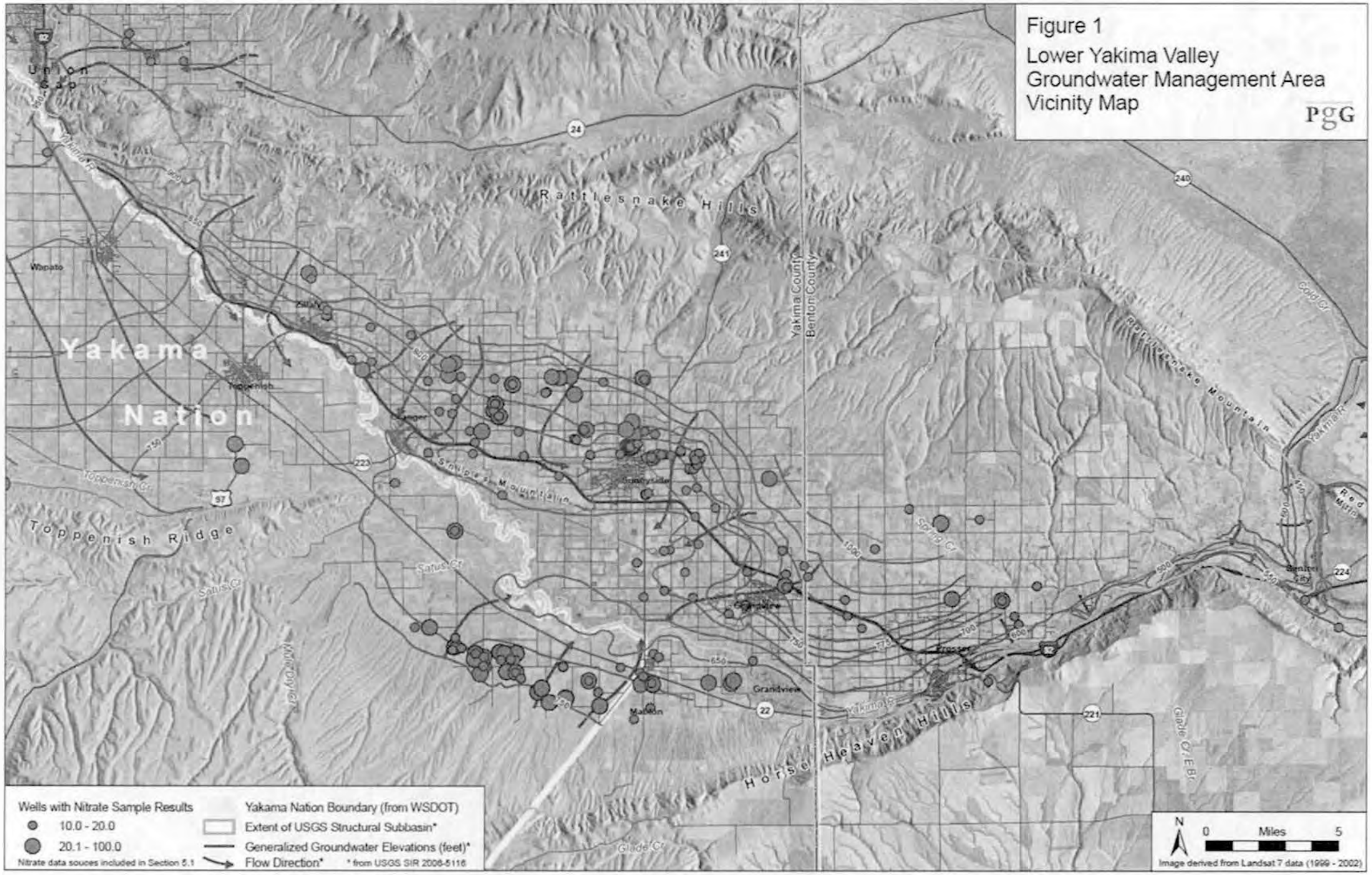


Figure 1
Lower Yakima Valley
Groundwater Management Area
Vicinity Map
PgG
Rattlesnake Hills
Yakama Nation
Toppenish Ridge
Snipes Mountain
Horse Heaven Hills
Rattlesnake Mountain
Union Gap
Wapato
Toppenish
Zillah
Granger
Sunnyside
Grandview
Mabton
Prosser
Benton City
Yakima County
Benton County
Toppenish Cr
Satus Cr
Spring Cr
Yakima R
Glade Cr
Cold Cr
Red Mtn
24
240
241
223
97
22
221
224
82
Wells with Nitrate Sample Results
10.0 - 20.0
20.1 - 100.0
Nitrate data souces included in Section 5.1
Yakama Nation Boundary (from WSDOT)
Extent of USGS Structural Subbasin*
Generalized Groundwater Elevations (feet)*
Flow Direction*
* from USGS SIR 2006-5116
N
0 Miles 5
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.

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

Forma # GWMA0001 A
Refrito 7/25/13

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.

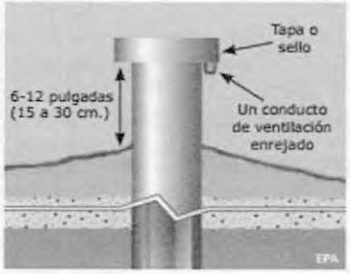
¿Qué son las unidades domésticas de tratamiento de agua? He escuchado que son útiles.

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?



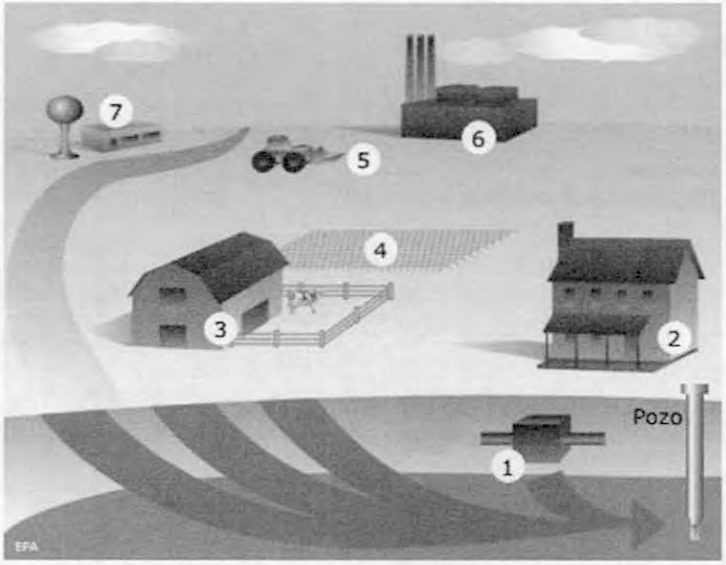
Asegúrese que la boca del pozo se extienda entre 6 a 12 pulgadas (15 a 30 cm.) por encima de la superficie del suelo y que esté tapado para que no entren los contaminantes. Selle el suelo alrededor de la boca del pozo y hágalo en declive para que el agua no se acumule y filtre dentro del pozo.

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.

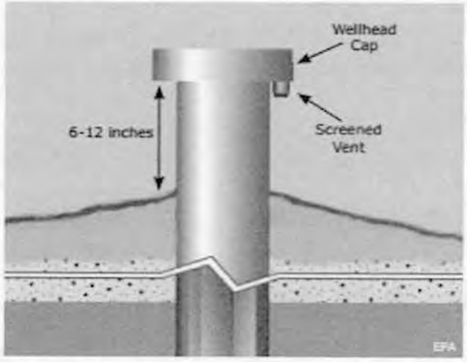
How can I protect my well water from contamination?

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.

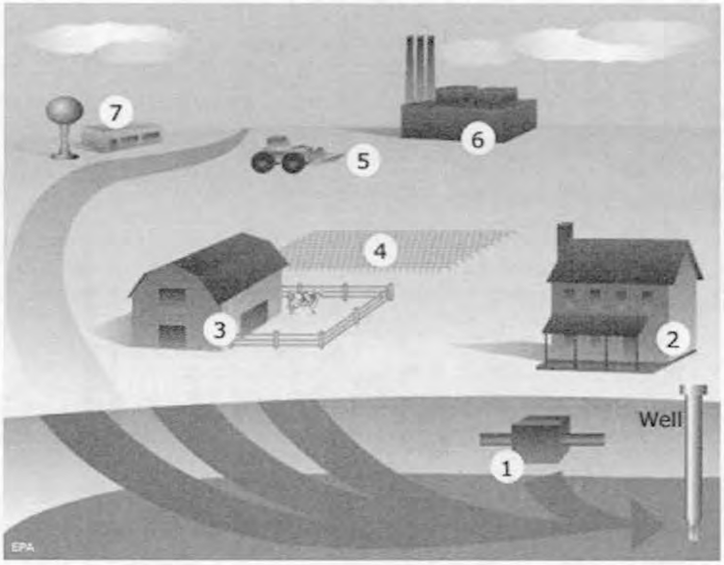
Experts suggest your well should be at least:

- 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).

5f_Handout (Sp) DOH Nitrate In Drinking Water Pub 331-214

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.

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¿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.

5g_Handout DOH Nitrate In Drinking Water Pub 331-214

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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.

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.

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.

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.

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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
HEALTHIER WASHINGTON

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

7 PEHSU nitrates_Clinician Fact Sheet New Mom Companion_2014_1013.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 pO_2, 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
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- Yakima Health District Drinking Water WEB site last accessed March 31, 2014. http://yakimacounty.us/yakimahealthdistrict/drinking_water.php

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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.

9 GWAC Presentation_Basic Talking Points_UPDATED_2017_01 GWAC APPROVED_2013_1219

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)

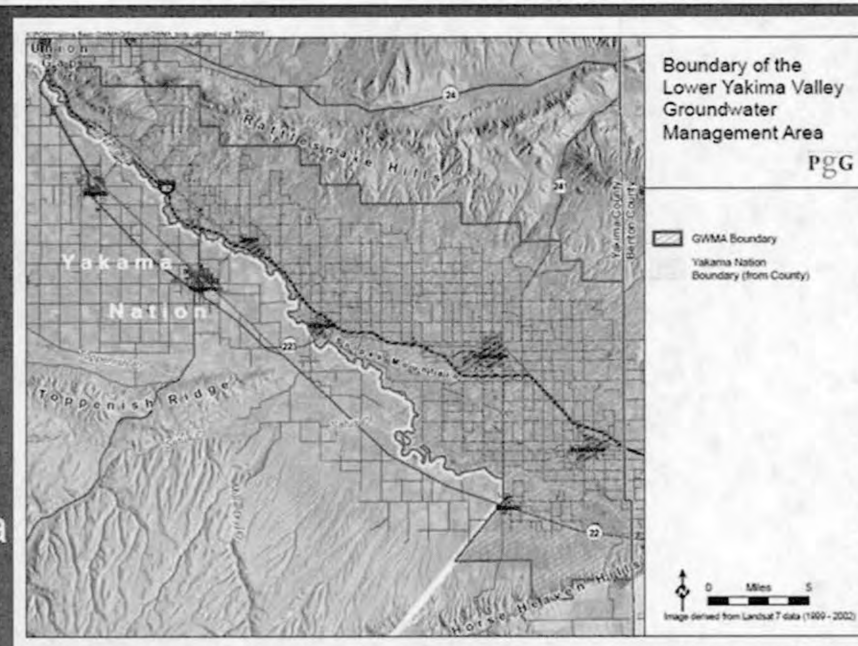
Background

- 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

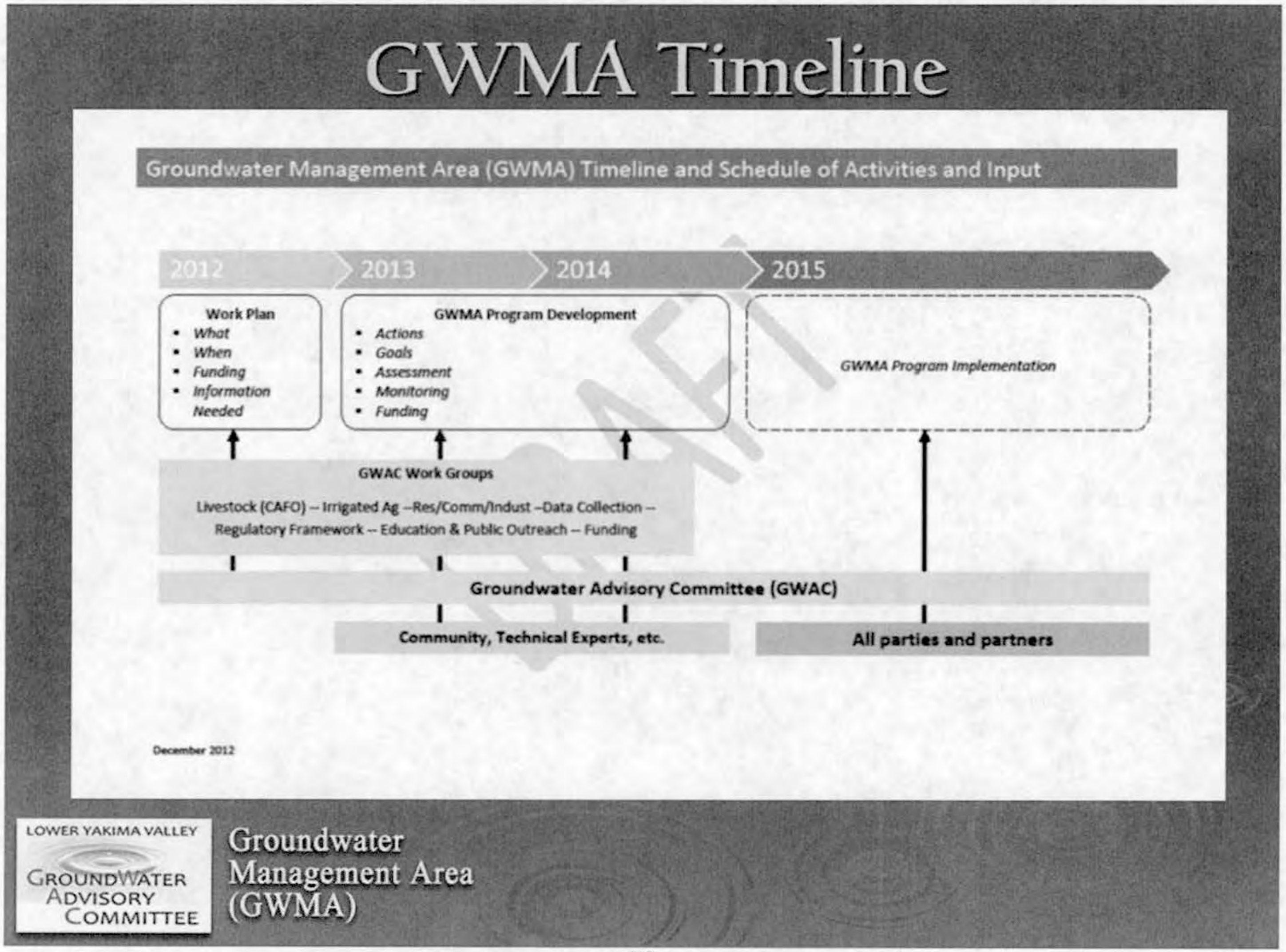
Working groups were convened to provide focused information and plans for the objectives identified in the request.

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
2012
2013
2014
2015
Work Plan
What
When
Funding
Information Needed
GWMA Program Development
Actions
Goals
Assessment
Monitoring
Funding
GWMA Program Implementation
GWAC Work Groups
Livestock (CAFO) – Irrigated Ag – Res/Comm/Indust – Data Collection – Regulatory Framework – Education & Public Outreach – Funding
Groundwater Advisory Committee (GWAC)
Community, Technical Experts, etc.
All parties and partners
December 2012
DRAFT
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)

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

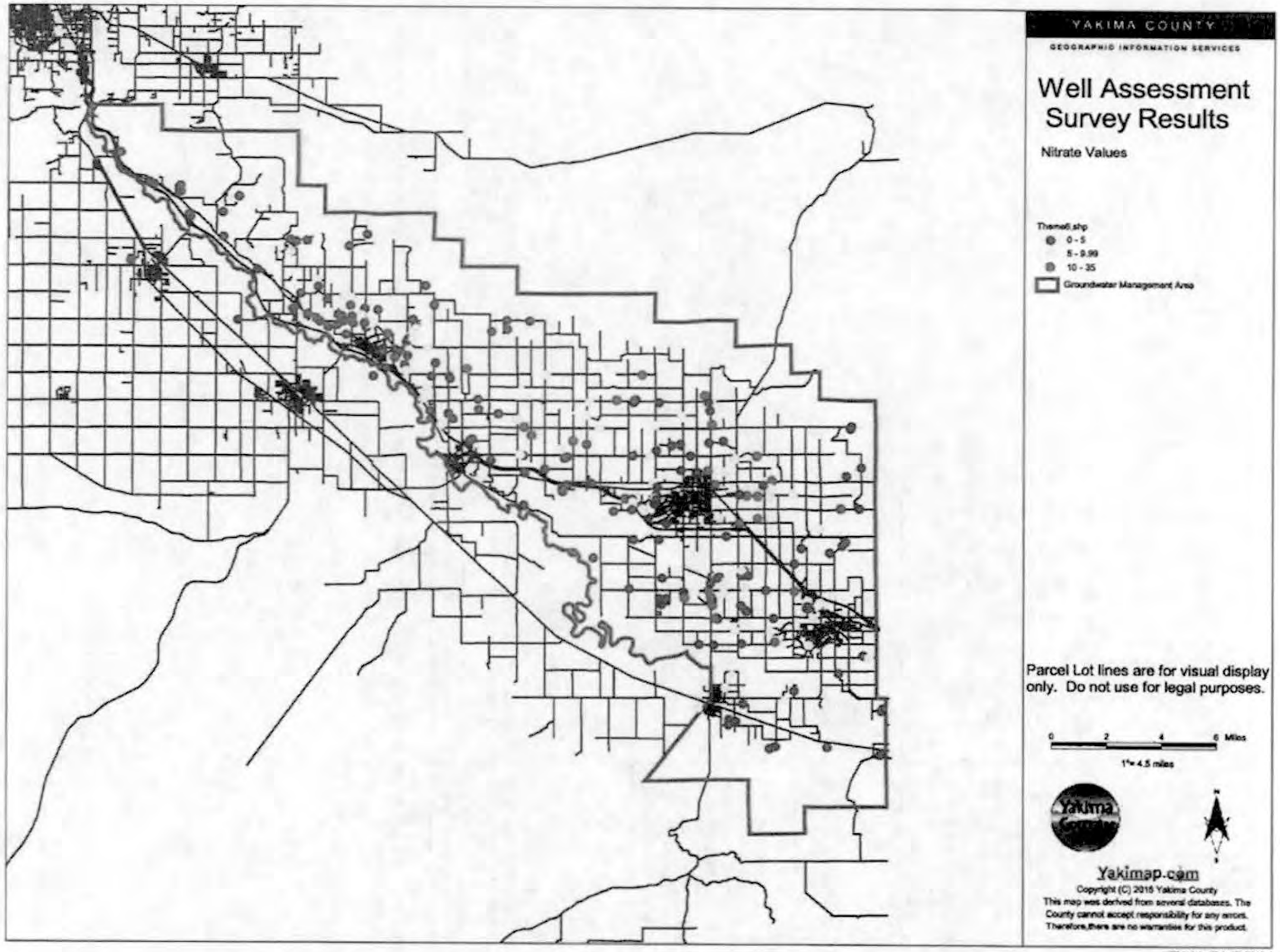
Nitrate Range	Number of Wells	Percent
0 to 5.0	172	60%
5.01 to 9.99	76	26%
10.0 to 35	40	14%
Grand Total	288	100%

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
Yakima
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;

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

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Lower Yakima Valley Groundwater Advisory Committee (GWAC)

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LOWER YAKIMA VALLEY
GROUNDWATER
ADVISORY
COMMITTEE

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parcel #
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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

LOWER YAKIMA VALLEY

GROUNDWATER
ADVISORY
COMMITTEE

Groundwater Management Area (GWMA):
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May 2015

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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
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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,

JRElliott

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

Enclosures

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LOWER YAKIMA VALLEY
GROUNDWATER
ADVISORY
COMMITTEE

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Mayo, 2015

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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

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¿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

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

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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?
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Sincerely,

J. Rand Elliott

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

enclosure: copy of lab results
Fact Sheets

LOWER YAKIMA VALLEY

GROUNDWATER
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Mayo, 2015

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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
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¿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
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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:

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Adjuntos

6bv ltr 5 well survey _unsatisfactor coliform_E-Coli and what they mean1a.docx

LOWER YAKIMA VALLEY

GROUNDWATER
ADVISORY
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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.

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

enclosure: copy of lab results
Fact Sheets

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 estado 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

7 PEHSU nitrates_Clinician Fact Sheet New Mom Companion_2014_1013.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. <u>All private wells should be tested before use and once per year for nitrates.</u> 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
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- 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/

LOWER YAKIMA VALLEY
GROUNDWATER
ADVISORY
COMMITTEE

Yakima Health District

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

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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	23092434007	4.02	1/22/2016
23091333018	9.50	3/1/2016	23092513401	1.56	9/24/2015
23091421404	4.70	1/7/2014	23092522009	2.30	2/10/2016
23091421407	5.40	5/13/2014	23092532002	4.98	1/22/2016
23091513004	5.60	5/22/2014	23092541002	13.60	2/11/2016
23091514019	5.48	6/6/2014	23092541402	8.50	1/15/2016
23091522011	13.30	6/3/2014	23092541403	11.70	1/15/2016
23091524008	2.44	3/21/2014	23092541406	10.30	1/8/2016
23091524014	5.80	5/21/2014	23092542004	12.20	1/15/2016
23091531003	1.24	5/21/2014	23092542405	8.10	10/9/2015
23091531005	3.78	5/21/2014	23092612025	1.50	3/8/2016
23091541416	9.00	3/15/2016	23092613401	3.84	3/15/2016
23091541416	9.10	6/3/2014	23092633003	8.50	1/15/2016
23091542401	4.08	5/22/2014	23092643401	7.70	2/11/2016
23091622002	5.00	10/16/2015	23092712404	6.00	1/15/2014
23091623002	4.18	2/9/2016	23092712404	6.00	3/30/2016
23091633411	1.56	3/9/2016	23092722416	8.00	2/9/2016
23091633412	2.30	3/8/2016	23092722417	9.10	2/9/2016
23091634005	2.20	3/29/2016	23092722418	0.70	1/8/2016
23091732408	0.86	2/27/2014	23092811417	2.67	1/8/2016
23091741002	1.64	3/9/2016	23092811419	5.79	1/29/2016
23091821408	5.60	9/24/2015	23092813407	3.40	3/30/2016
23091823006	0.34	10/9/2015	23092913007	5.70	1/7/2014
23091832401	19.70	12/16/2015	23093022401	0.00	12/29/2015
23091833002	18.20	3/9/2016	23093111401	8.85	1/28/2014
23091914004	5.56	5/23/2014	23093142421	10.00	5/1/2014
23091922001	0.94	9/18/2015	23093144416	7.70	2/18/2016
23091922003	2.76	1/17/2014	23093211004	0.00	1/22/2016
23091922018	18.80	1/17/2014	23093223005	0.00	1/19/2016
23092033011	0.00	9/24/2015	23093341005	0.00	11/24/2015
23092121401	0.61	1/31/2014	23093511004	5.80	1/27/2016
23092132414	6.60	5/15/2014	23093512018	2.46	6/12/2014
23092133414	9.70	3/1/2016	23093512020	3.76	1/27/2016
23092134407	12.20	5/22/2014	23093524401	0.00	1/27/2016
23092134411	7.20	10/9/2015	23093541014	4.30	3/1/2016
23092144410	7.46	1/8/2016	23093614004	4.52	3/7/2016
23092212001	8.60	5/13/2014	23093614005	4.10	2/18/2016
23092243471	1.76	8/3/2014	23093632009	0.00	2/25/2016
23092344007	2.50	3/9/2016	23093634404	0.00	1/22/2015
23092413404	9.40	3/31/2016	23093641404	6.24	1/15/2016

23093641408	5.48	1/24/2014	23103022024	10.00	1/23/2014
23100722003	9.80	9/29/2015	23103123433	15.30	5/9/2014
23100722404	0.00	2/21/2014	23103124404	8.50	5/13/2014
23100733410	15.30	5/28/2014	23103131005	7.10	4/7/2016
23101232001	0.72	10/2/2015	23103133011	2.40	3/9/2016
23101234001	3.12	10/2/2015	23103134403	4.52	3/1/2016
23101824003	4.52	4/4/2014	23103143011	3.90	6/3/2014
23101911009	5.59	1/28/2014	23103143015	6.80	3/8/2016
23101923404	5.24	3/17/2016	23103213004	11.30	3/14/2014
23101942403	8.40	10/2/2015	23103234400	12.00	3/15/2016
23102012402	22.20	3/8/2016	23103242405	4.00	3/15/2016
23102012403	16.50	1/28/2014	23103532401	5.84	11/21/2013
23102012403	19.60	1/29/2016	19110122412	0.44	10/2/2015
23102023003	5.24	3/17/2016	19110122420	0.38	2/21/2014
23102023407	6.00	3/8/2016	19110944463	1.40	2/21/2014
23102023408	5.60	3/8/2019	19122134013	2.34	10/20/2015
23102044002	9.44	11/21/2013	19122743004	0.00	2/14/2014
23102134405	4.70	1/31/2014	19123214401	0.88	3/7/2016
23102134407	10.10	9/17/2015	19123412400	0.98	12/2/2015
23102134407	13.80	1/31/2014	19123512008	2.13	10/7/2015
23102344402	5.60	10/29/2015	19123513401	0.84	12/27/2015
23102344405	2.40	10/29/2015	20110143402	4.18	12/17/2015
23102424402	1.55	2/13/2014	20110443004	0.66	2/27/2014
23102531408	2.43	3/9/2016	20110634402	3.89	11/4/2015
23102533003	2.90	1/7/2014	20110911408	1.31	2/21/2014
23102643001	25.50	9/18/2015	20110914408	2.73	11/4/2015
23102723402	6.90	1/28/2014	20110922412	2.49	3/1/2016
23102723402	7.32	3/1/2016	20110923403	0.36	2/11/2016
23102732001	18.00	2/12/2016	20110942411	5.40	11/4/2015
23102822406	6.80	12/11/2013	20111021006	1.90	2/27/2014
23102832011	6.60	9/17/2015	20111034402	2.08	2/23/2016
23102833002	11.10	2/12/2016	20111114401	2.89	5/28/2014
23102841001	10.80	2/12/2016	20111134003	6.20	3/16/2016
23102843403	8.50	4/4/2016	20111144001	2.55	2/11/2016
23102911401	2.50	1/31/2014	20111144400	4.08	3/8/2016
23102911413	7.28	11/21/2013	20111312400	2.14	3/1/2016
23102922403	7.02	1/31/2014	20111432405	2.41	3/1/2016
23102923401	15.50	1/31/2014	20111444002	9.00	10/29/2015
23102931002	10.40	12/29/2015	20111513416	6.70	10/15/2015
23102942401	16.00	2/13/2014	20111533401	2.31	11/18/2015

20111534006	6.60	4/6/2015	20112521405	2.09	11/4/2015
20111534401	5.90	4/6/2016	20112521408	8.50	10/21/2015
20111541416	1.98	9/29/2015	20112522403	0.64	10/2/2015
20111643003	2.16	3/23/2016	20112522404	0.38	1/17/2014
20111712003	2.66	4/16/2014	20112522404	0.36	10/23/2015
20112014405	0.98	3/16/2016	20112614401	2.97	9/23/2015
20112141031	0.86	2/7/2014	20112621014	2.38	9/23/2015
20112144091	2.04	3/24/2016	20112622405	0.91	11/9/2015
20112144098	1.50	2/13/2014	20112642006	2.28	3/3/2016
20112212006	5.60	4/6/2016	20112711012	3.90	9/23/2015
20112231005	3.40	11/17/2015	20123044003	2.21	1/23/2014
20112243403	0.00	2/26/2014	20123114402	2.12	10/20/2015
20112243404	1.32	2/27/2014	20123134004	4.10	10/16/2015
20112243405	1.08	2/27/2014	21100333008	11.20	3/22/2016
20112311404	8.44	2/21/2014	21100334401	1.27	4/10/2014
20112312005	6.50	10/29/2015	21100412400	0.54	1/17/2014
20112313002	4.04	6/12/2014	21100412406	16.00	1/31/2014
20112322403	4.00	11/17/2015	21100431004	11.20	2/23/2016
20112331404	3.47	11/17/2015	21100434405	3.02	2/2/2016
20112343402	0.97	2/14/2014	21100511407	3.68	1/10/2014
20112343411	2.60	10/21/2015	21100512408	2.10	3/22/2016
20112343415	1.45	10/21/2015	21100513413	4.50	3/1/2016
20112344001	0.48	10/2/2015	21100522407	3.20	2/23/2016
20112344003	3.35	9/30/2015	21100524404	0.35	2/9/2016
20112423003	6.60	9/18/2015	21100531012	6.90	1/29/2014
20112431007	4.30	1/22/2014	21100542403	3.96	3/15/2016
20112433401	5.40	11/12/2015	21100542407	7.40	1/17/2014
20112434406	10.00	9/30/2015	21100543401	2.50	3/2/2016
20112434406	9.24	2/20/2014	21100811407	0.25	3/1/2016
20112434411	5.21	1/22/2014	21100814009	4.72	1/17/2014
20112441400	4.96	5/29/2014	21100814401	4.28	3/8/2016
20112441400	5.20	4/6/2016	21100923003	1.78	2/2/2016
20112443401	2.77	2/11/2016	21100924402	1.68	11/21/2013
20112444407	2.83	1/10/2014	21100933007	9.56	11/21/2013
20112511014	7.70	11/24/2015	21101011004	2.60	10/27/2015
20112512004	6.30	4/6/2016	21101012402	1.92	12/9/2015
20112512007	2.85	12/1/2015	21101012404	2.40	3/1/2016
20112512008	5.30	10/16/2015	21101124002	4.62	4/1/2014
20112512402	5.08	9/23/2015	21101131404	12.80	2/2/2016
20112512404	5.16	5/29/2014	21101134405	12.90	3/1/2016

21101141402	8.88	12/4/2015	21113113403	23.40	9/23/2015
21101231405	5.43	2/2/2016	21113122421	2.81	12/9/2015
21101232004	0.78	3/16/2016	21113132006	1.14	12/29/2015
21101233003	10.50	2/27/2014	21113134016	1.84	2/9/2016
21101241401	19.60	4/5/2016	21113141002	0.84	5/29/2014
21101324401	10.90	3/7/2014	21113144407	7.48	11/24/2015
21101333401	5.79	5/29/2014	21113144407	5.48	3/12/2014
21101333404	0.00	11/24/2015	21113212014	5.76	9/30/2015
21101344401	0.00	3/10/2016	21113222401	0.33	9/25/2015
21101344404	3.50	3/10/2016	21113222402	6.34	9/25/2015
21101444005	2.68	2/25/2016	21113241009	4.36	10/15/2015
21101523400	3.40	5/22/2014	21113321401	12.00	3/1/2016
21101524402	2.90	6/3/2014	21113432003	22.60	11/18/2015
21101524403	4.98	5/22/2014	22080114416	10.10	1/8/2016
21102431009	0.00	10/28/2015	22080131419	9.00	3/7/2016
21102441001	0.00	10/16/2015	22090222402	2.12	10/21/2015
21102441001	0.00	1/24/2014	22090322004	4.20	10/2/2015
21102522001	1.84	3/10/2016	22090543402	0.00	9/30/2015
21102534004	0.00	2/13/2014	22091022403	0.09	3/1/2016
21102534403	0.05	2/13/2014	22091031001	0.00	3/9/2016
21102641003	2.79	3/14/2016	22091031001	0.00	3/7/2016
21102642002	3.48	6/5/2014	22091033402	0.00	10/2/2015
21111741005	0.00	9/24/2015	22091044407	0.00	9/24/2015
21112014405	4.05	5/6/2014	22091132402	4.56	4/10/2014
21112032402	2.25	1/17/2014	22091144402	3.65	1/17/2014
21112521003	0.74	10/15/2015	22091241400	1.79	6/20/2014
21112612401	0.00	10/14/2015	22091241402	2.75	5/13/2014
21112613404	4.03	2/21/2014	22091244415	11.50	4/4/2014
21112623402	3.55	10/20/2015	22091311003	11.30	2/14/2014
21112921402	3.80	10/27/2015	22091312001	7.40	3/2/2016
21112924002	8.55	9/24/2015	22091323003	11.90	6/25/2014
21112932402	10.70	9/23/2015	22091344401	19.20	3/9/2016
21112932403	8.60	11/4/2015	22091412410	0.00	3/16/2016
21112932405	7.60	9/25/2015	22091412414	0.00	3/16/2016
21113023402	4.80	4/7/2016	22091423402	0.00	2/27/2014
21113024404	18.60	2/14/2014	22091424407	0.00	2/27/2014
21113044403	4.22	9/24/2015	22091432406	0.00	6/10/2014
21113111003	12.70	10/16/2015	22091442401	0.00	2/18/2016
21113112406	1.07	10/26/2015	22091443400	0.00	2/18/2016
21113112407	2.21	10/26/2015	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

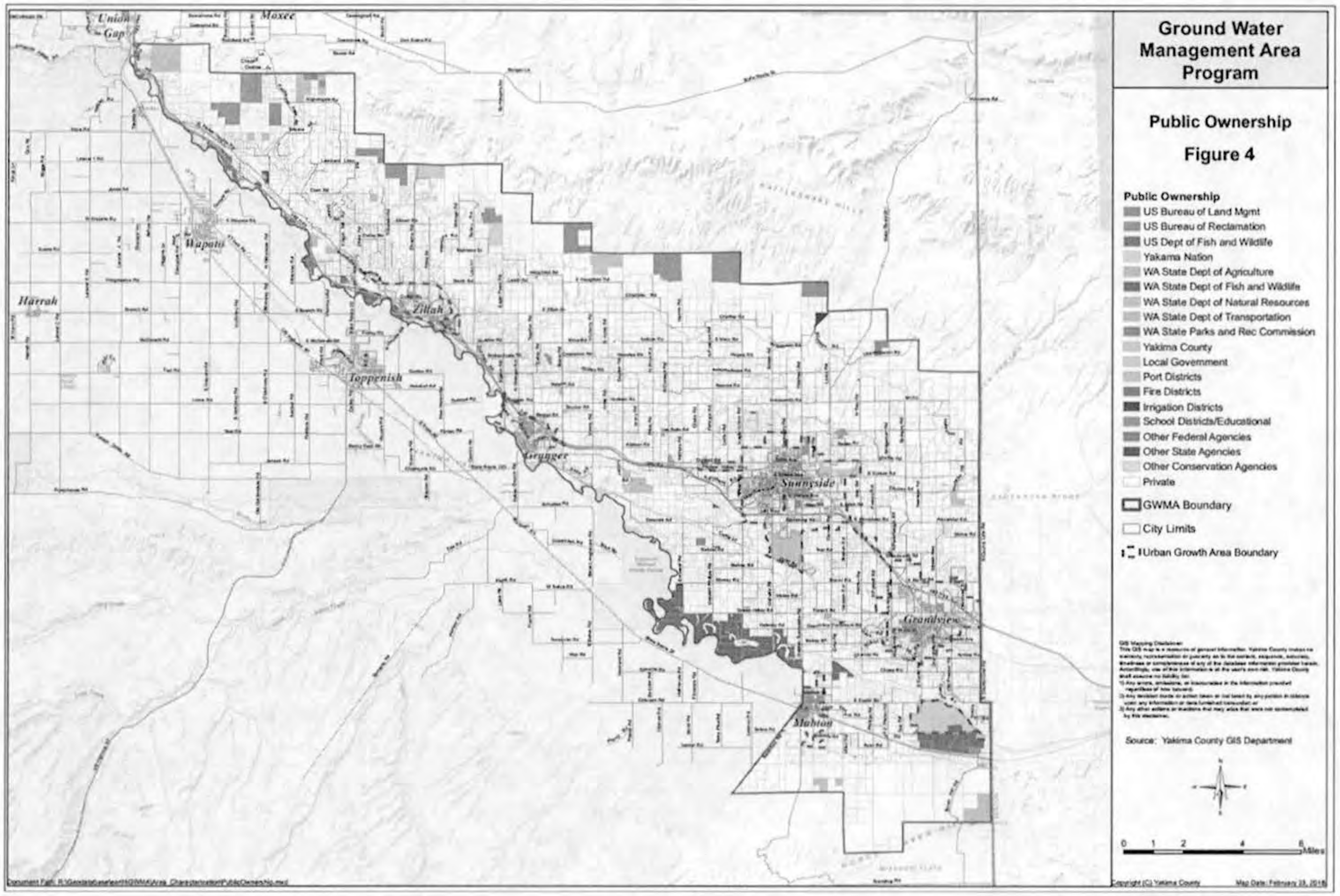


Figure 5 - Geology

Figure 6 - Surficial Hydrogeolgic Units

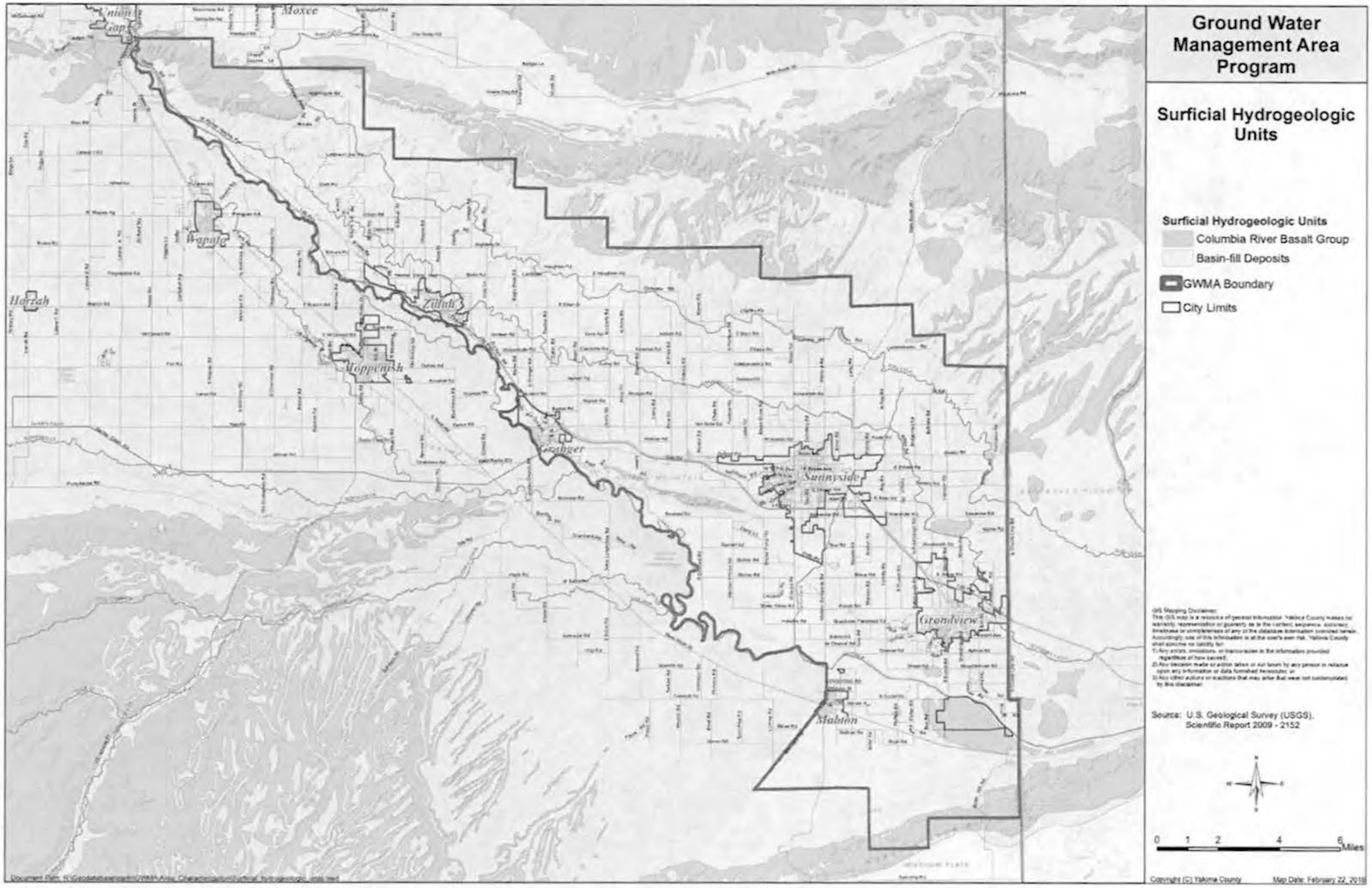


Figure 7 - Basins with Location of Springs

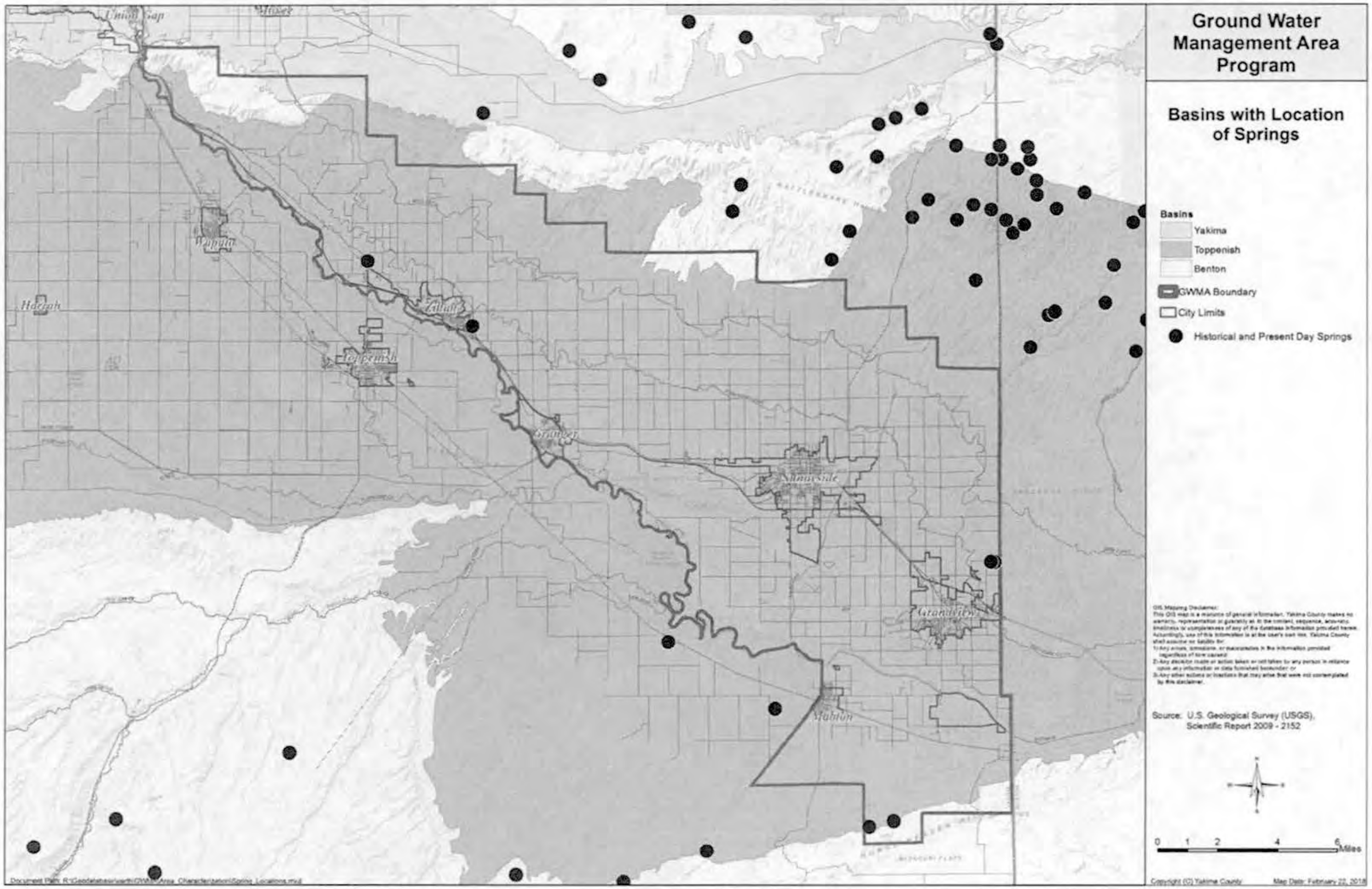


Figure 8 - Spatial Distribution of Mean Annual Recharge

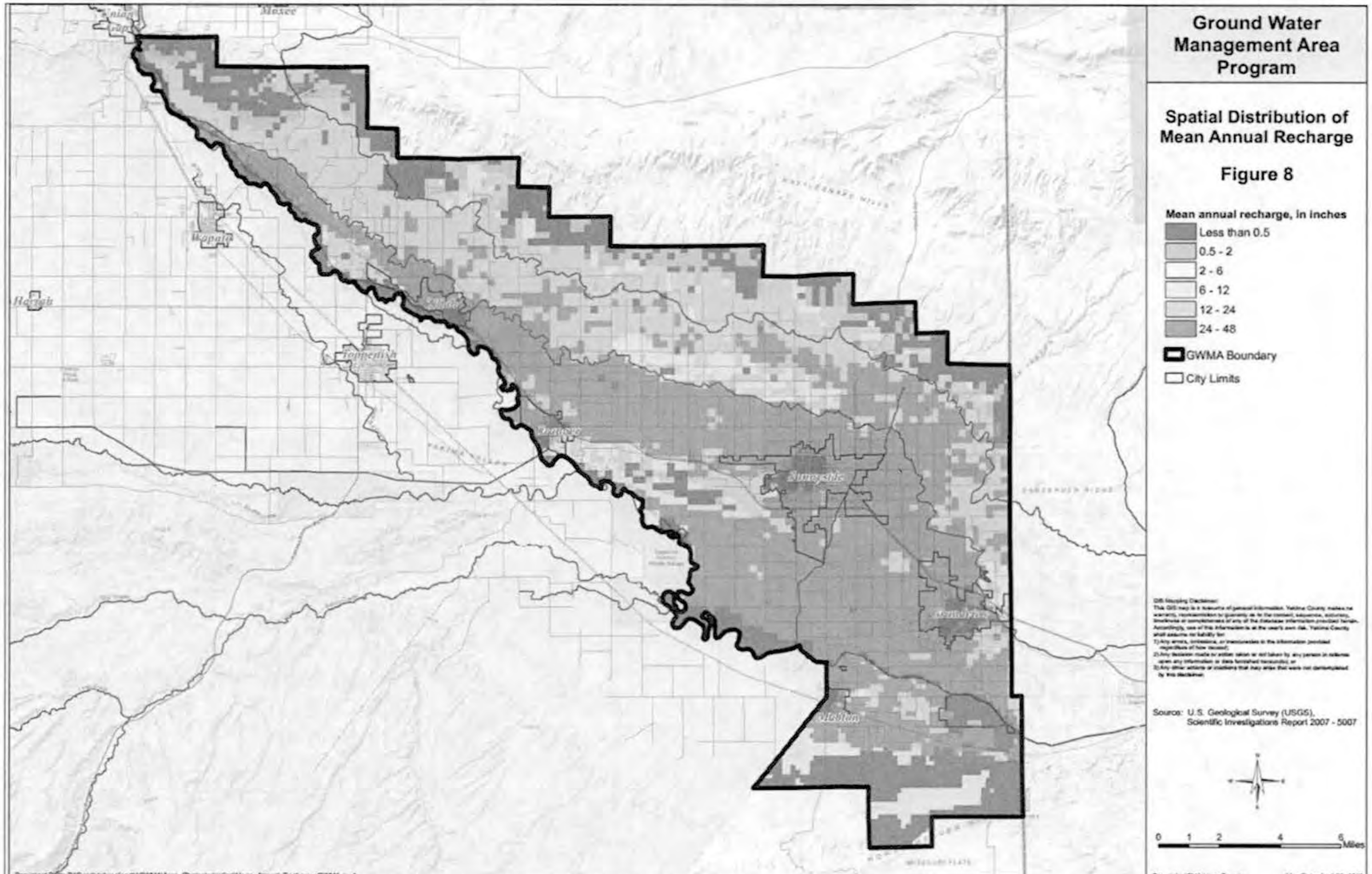


Figure 9 - Groundwater Contours

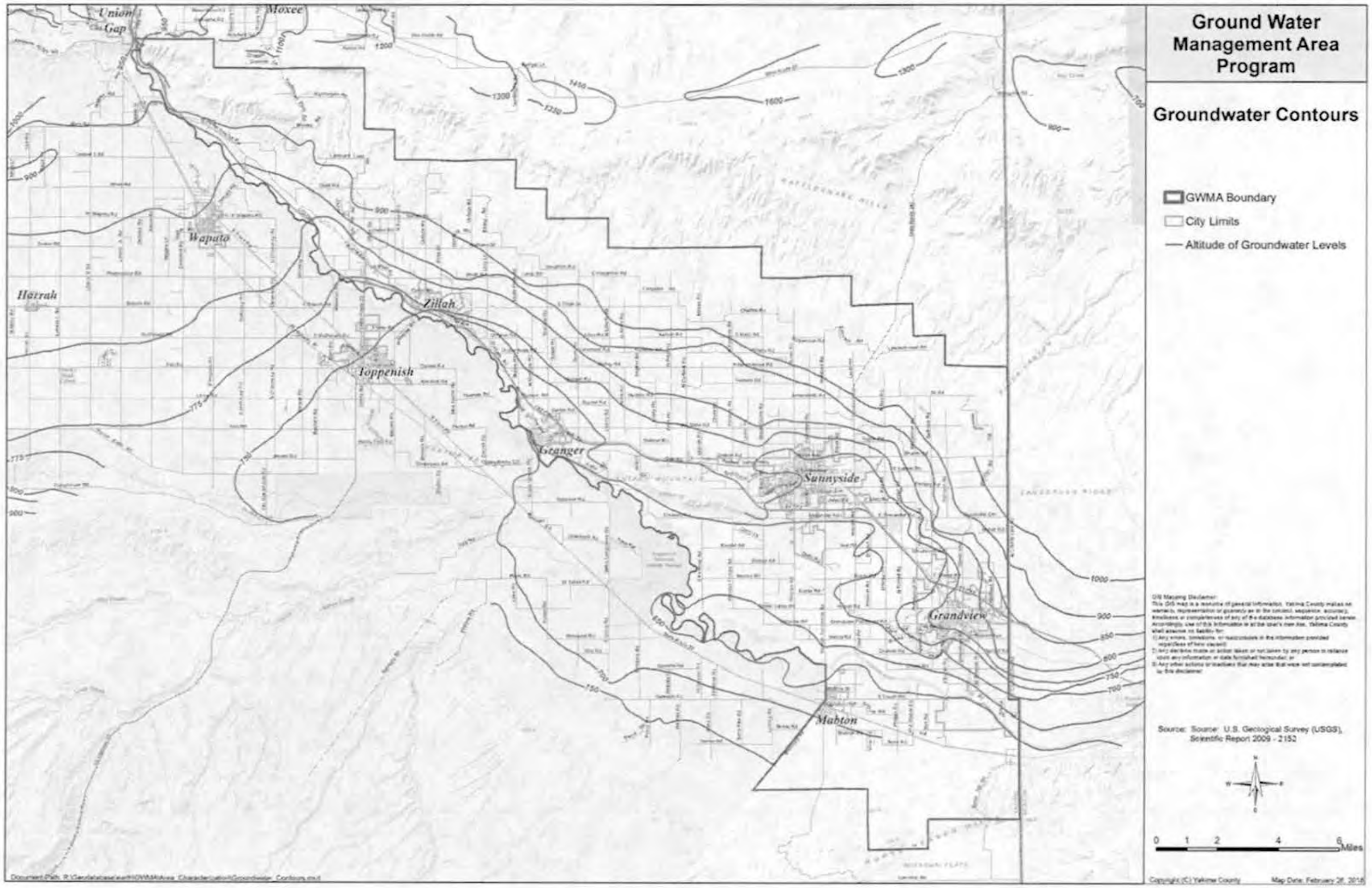
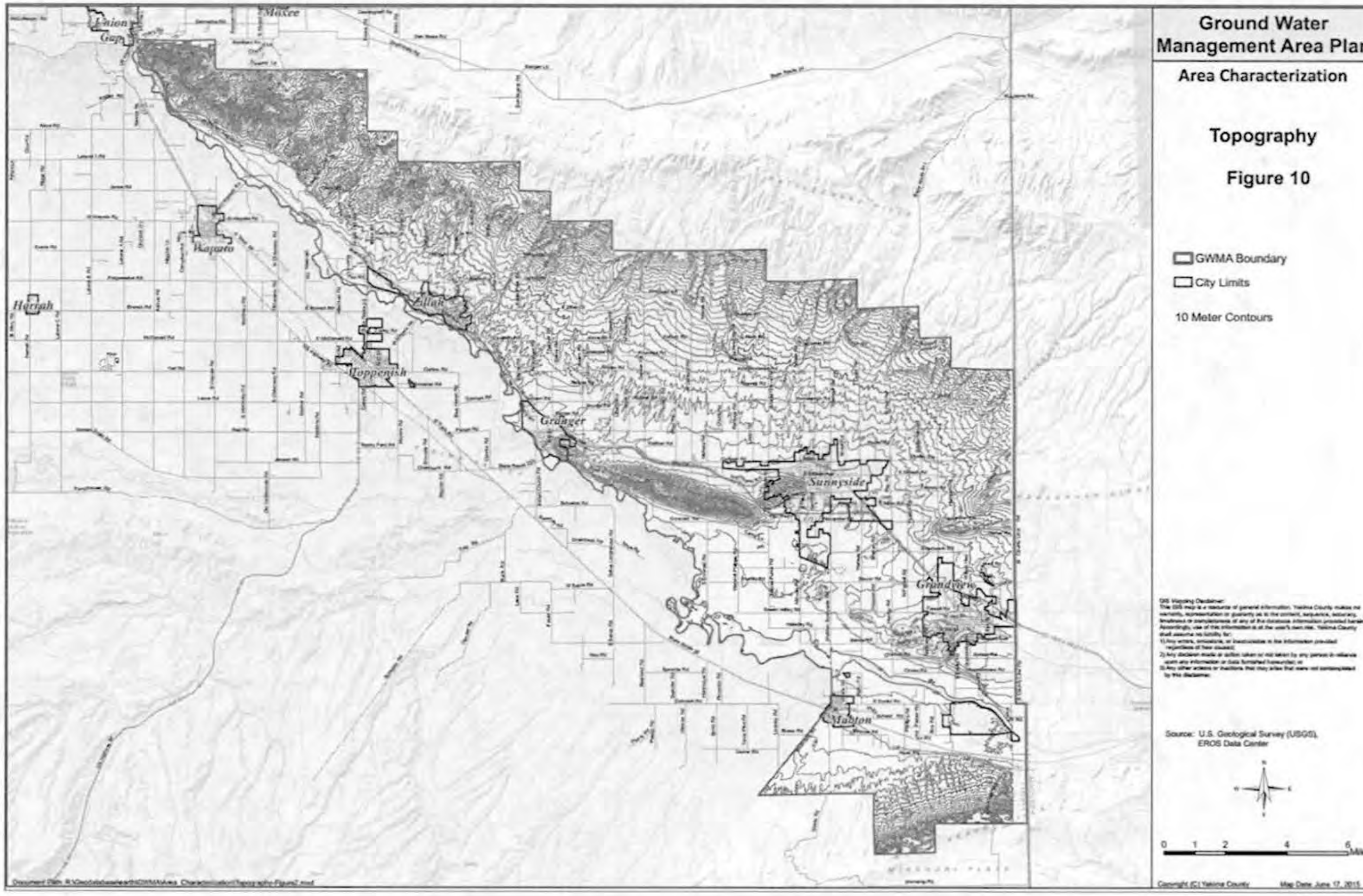


Figure 10 - Topography



[redacted]

Figure 11 - Depth to Groundwater

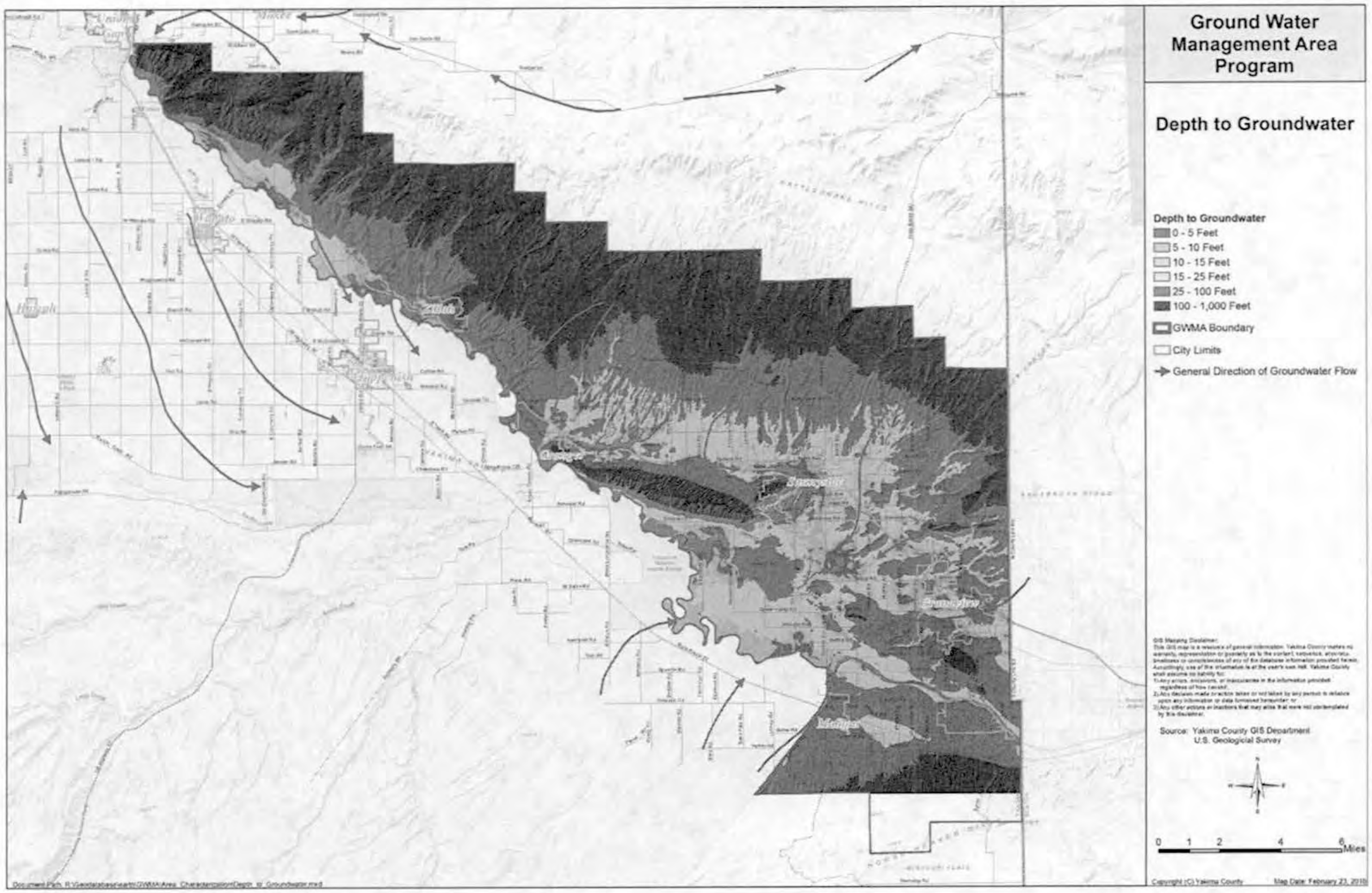


Figure 12 - Groundwater Flow Directions

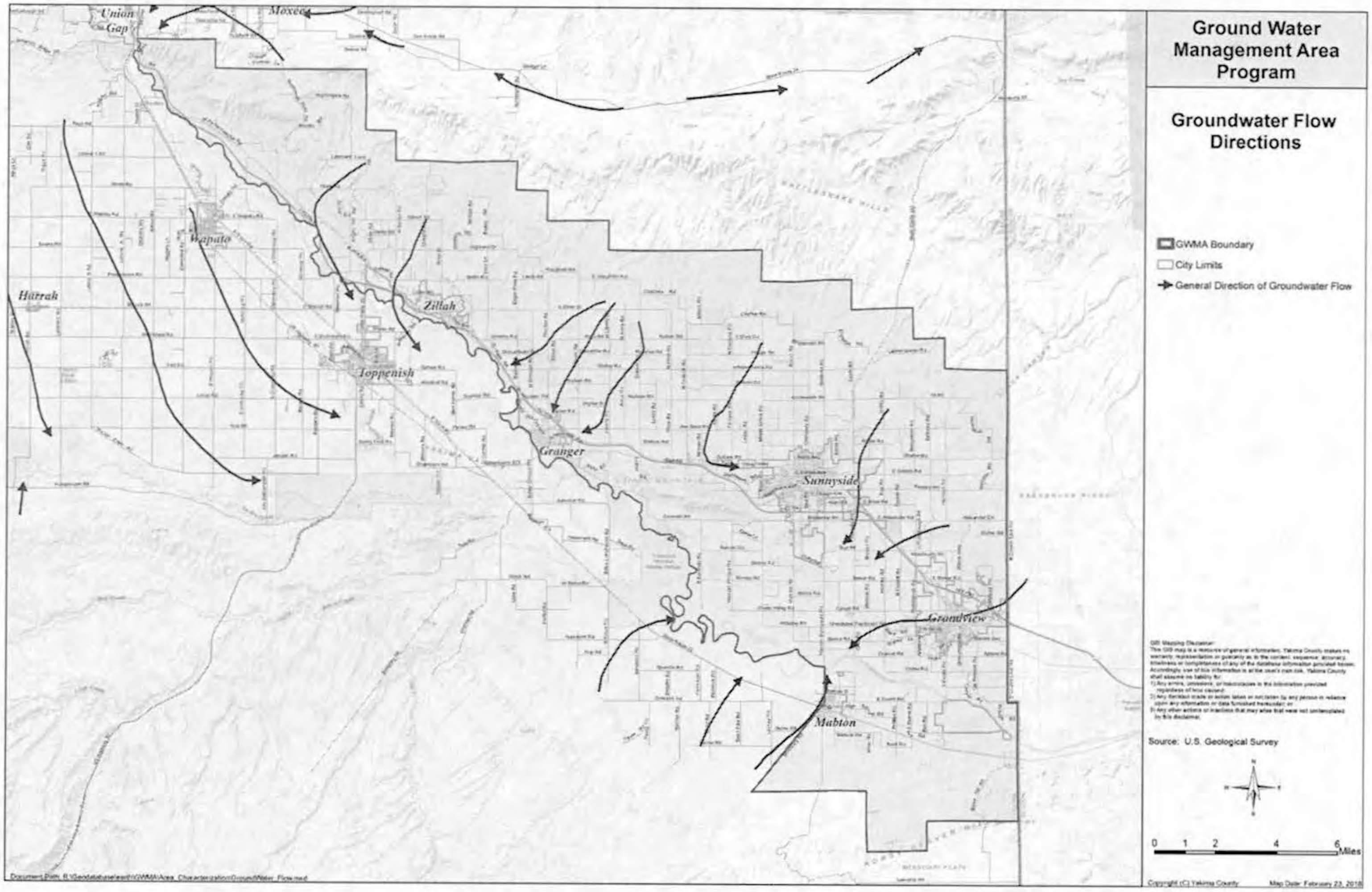


Figure 13 - Soils Key

Soils

- Bakeoven very cobbly silt loam, 0 to 30 percent slopes
- Burke silt loam, 2 to 5 percent slopes
- Burke silt loam, 5 to 8 percent slopes
- Burke silt loam, 8 to 15 percent slopes
- Cleman very fine sandy loam, 0 to 2 percent slopes
- Cleman very fine sandy loam, 2 to 5 percent slopes
- Dam
- Esquatzel silt loam, 0 to 2 percent slopes
- Esquatzel silt loam, 2 to 5 percent slopes
- Flander silt loam
- Finley cobbly fine sandy loam, 0 to 5 percent slopes
- Finley silt loam, 0 to 2 percent slopes
- Finley silt loam, 2 to 5 percent slopes
- Finley silt loam, 5 to 8 percent slopes
- Finley silt loam, 8 to 15 percent slopes
- Gorst loam, 2 to 15 percent slopes
- Harwood-Burke-Wiehl silt loams, 15 to 30 percent slopes
- Harwood-Burke-Wiehl silt loams, 2 to 5 percent slopes
- Harwood-Burke-Wiehl silt loams, 30 to 60 percent slopes
- Harwood-Burke-Wiehl silt loams, 5 to 8 percent slopes
- Harwood-Burke-Wiehl silt loams, 8 to 15 percent slopes
- Harwood-Burke-Wiehl very stony silt loams, 15 to 30 percent slopes
- Hezel loamy fine sand, 0 to 2 percent slopes
- Hezel loamy fine sand, 2 to 15 percent slopes
- Kiona stony silt loam, 15 to 45 percent slopes
- Kittitas silt loam
- Lickskillet very stony silt loam, 5 to 45 percent slopes
- Logy silt loam, 0 to 2 percent slopes
- McDaniel-Rock Creek complex, 5 to 30 percent slopes
- Mikkalo silt loam, 0 to 5 percent slopes
- Mikkalo silt loam, 15 to 30 percent slopes
- Mikkalo silt loam, 5 to 15 percent slopes
- Moxee cobbly silt loam, 0 to 30 percent slopes
- Moxee silt loam, 15 to 30 percent slopes
- Moxee silt loam, 2 to 15 percent slopes
- Outlook fine sandy loam
- Outlook silt loam
- Pits
- Prosser silt loam, 0 to 15 percent slopes
- Quincy loamy fine sand, 0 to 10 percent slopes
- Ritzville silt loam, 15 to 30 percent slopes
- Ritzville silt loam, 2 to 5 percent slopes
- Ritzville silt loam, 30 to 60 percent slopes
- Ritzville silt loam, 5 to 8 percent slopes
- Ritzville silt loam, 8 to 15 percent slopes
- Ritzville silt loam, basalt substratum, 15 to 30 percent slop
- Ritzville silt loam, basalt substratum, 5 to 15 percent slope
- Scoon silt loam, 15 to 30 percent slopes
- Scoon silt loam, 2 to 5 percent slopes
- Scoon silt loam, 5 to 8 percent slopes
- Scoon silt loam, 8 to 15 percent slopes
- Scooteney cobbly silt loam, 0 to 5 percent slopes
- Scooteney silt loam, 0 to 2 percent slopes
- Scooteney silt loam, 2 to 5 percent slopes
- Scooteney silt loam, 5 to 15 percent slopes
- Shano silt loam, 15 to 30 percent slopes
- Shano silt loam, 2 to 5 percent slopes
- Shano silt loam, 5 to 8 percent slopes
- Shano silt loam, 8 to 15 percent slopes
- Sinloc fine sandy loam, 0 to 2 percent slopes
- Sinloc silt loam, 0 to 2 percent slopes
- Sinloc silt loam, 2 to 5 percent slopes
- Sinloc silt loam, 5 to 8 percent slopes
- Starbuck silt loam, 2 to 15 percent slopes
- Starbuck-Rock outcrop complex, 0 to 45 percent slopes
- Starbuck-Rock outcrop complex, 45 to 60 percent slopes
- Umapine silt loam, drained, 0 to 2 percent slopes
- Umapine silt loam, drained, 2 to 5 percent slopes
- Wanser loamy fine sand
- Warden fine sandy loam, 0 to 2 percent slopes
- Warden fine sandy loam, 2 to 5 percent slopes
- Warden fine sandy loam, 5 to 8 percent slopes
- Warden fine sandy loam, 8 to 15 percent slopes
- Warden silt loam, 0 to 2 percent slopes
- Warden silt loam, 15 to 30 percent slopes
- Warden silt loam, 2 to 5 percent slopes
- Warden silt loam, 5 to 8 percent slopes
- Warden silt loam, 8 to 15 percent slopes
- Water
- Weirman fine sandy loam
- Weirman gravelly fine sandy loam
- Weirman sandy loam, channeled
- Willis fine sandy loam, 2 to 5 percent slopes
- Willis silt loam, 2 to 5 percent slopes
- Willis silt loam, 8 to 15 percent slopes
- Yakima silt loam
- Zillah sandy loam
- Zillah silt loam
- Zillah silt loam, channeled

Figure 13 - Soil Types

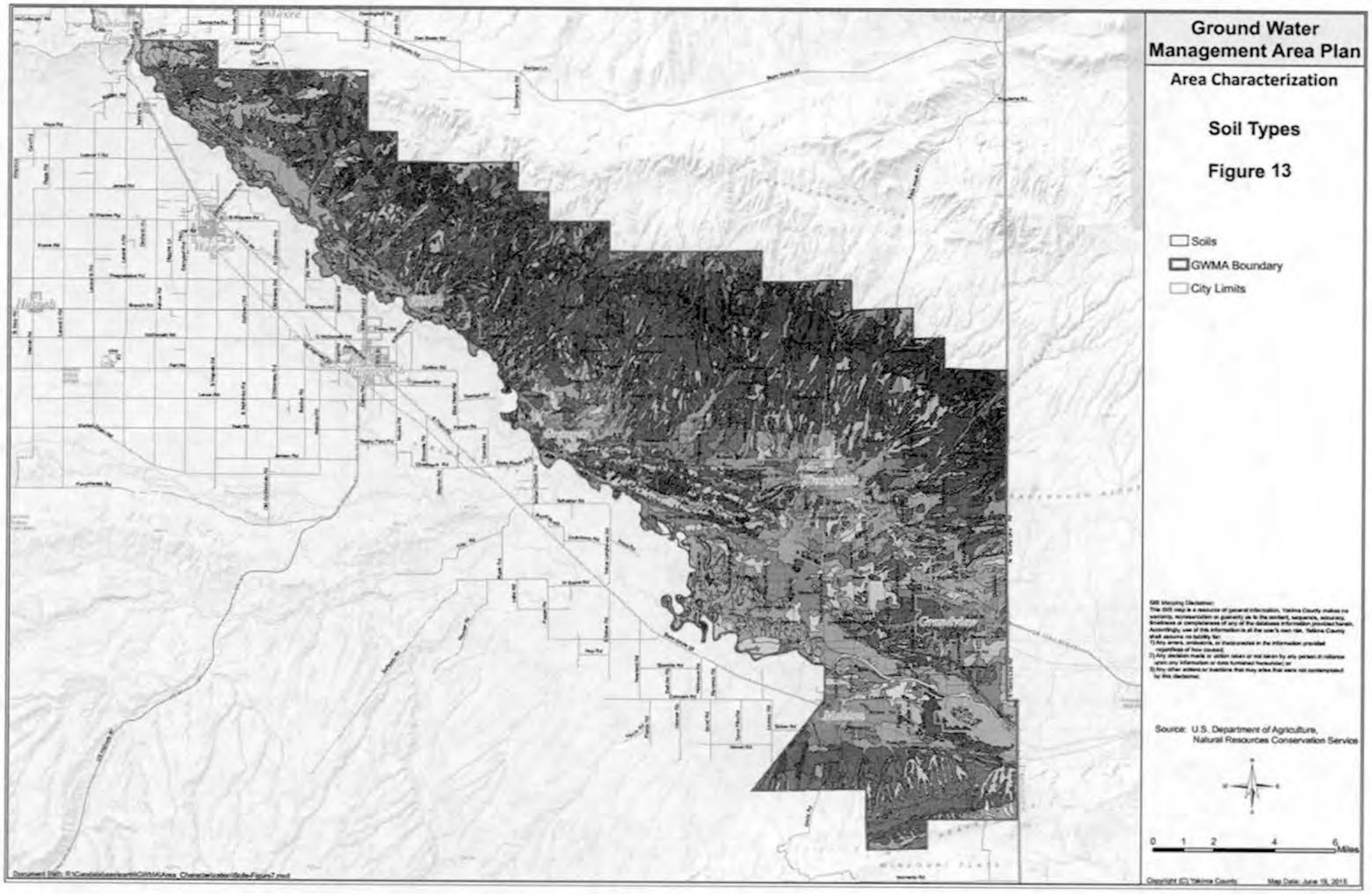


Figure 14 - Hydraulic Conductivity

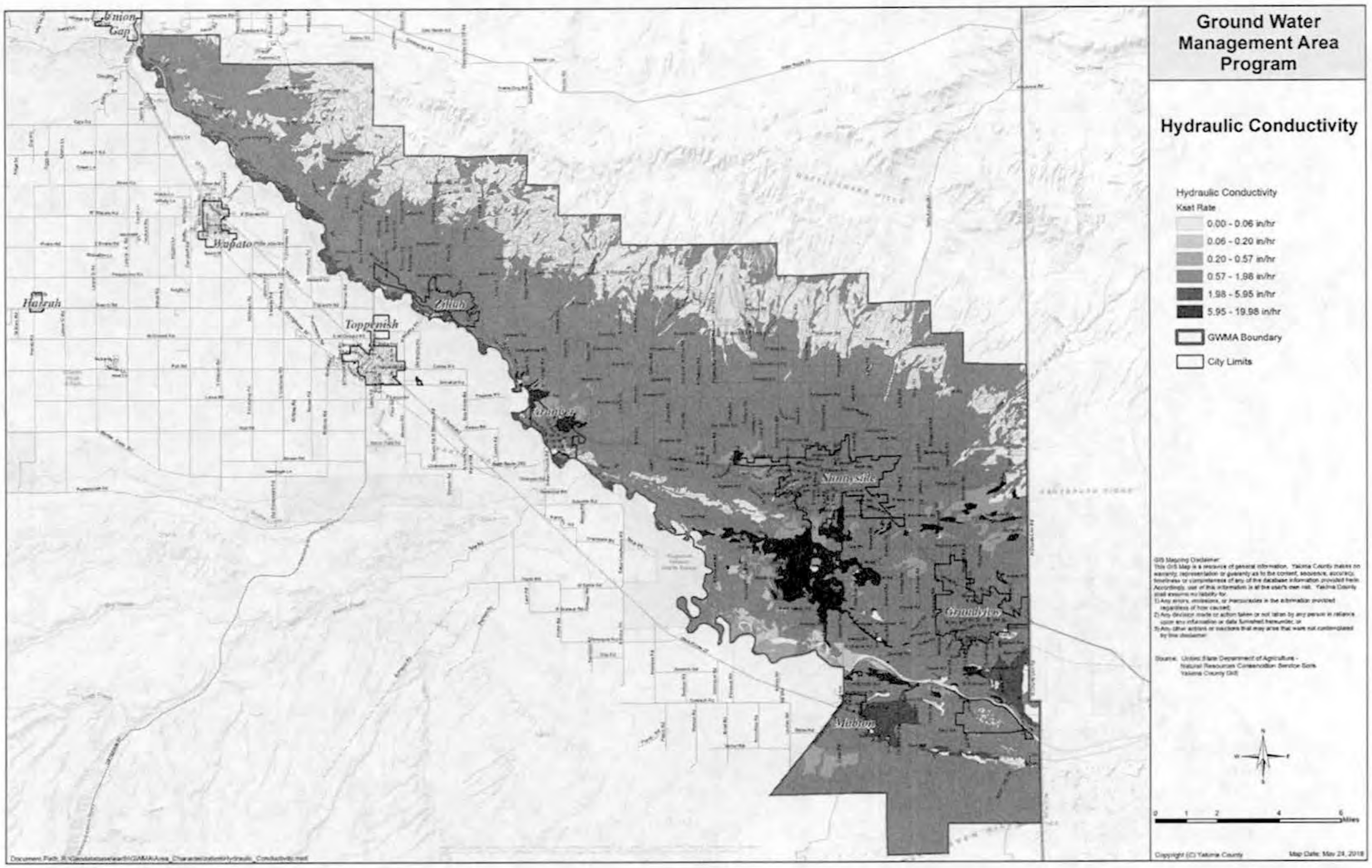


Figure 15 - Cropping Patterns

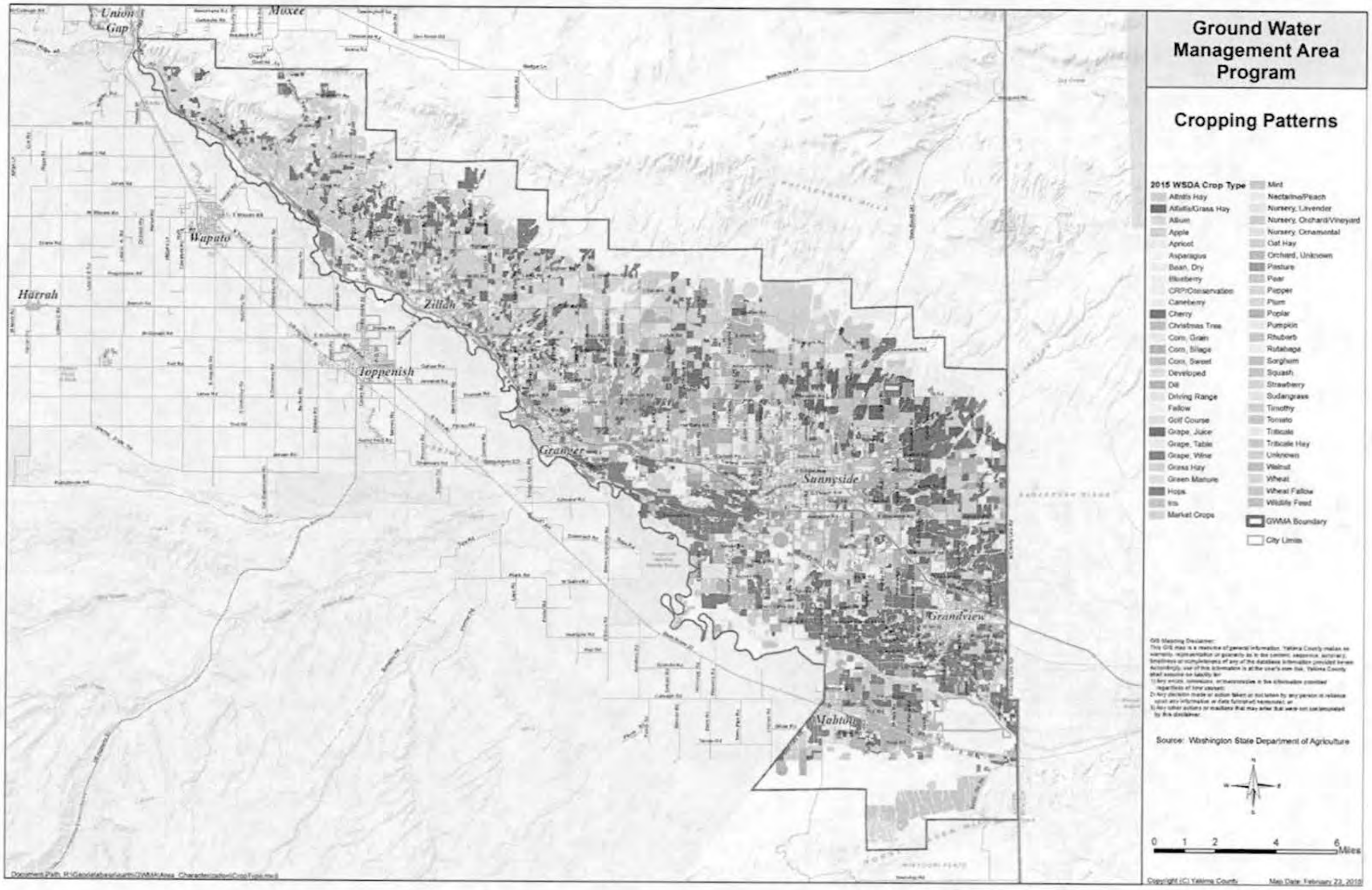


Figure 16 - Yakima County Zoning

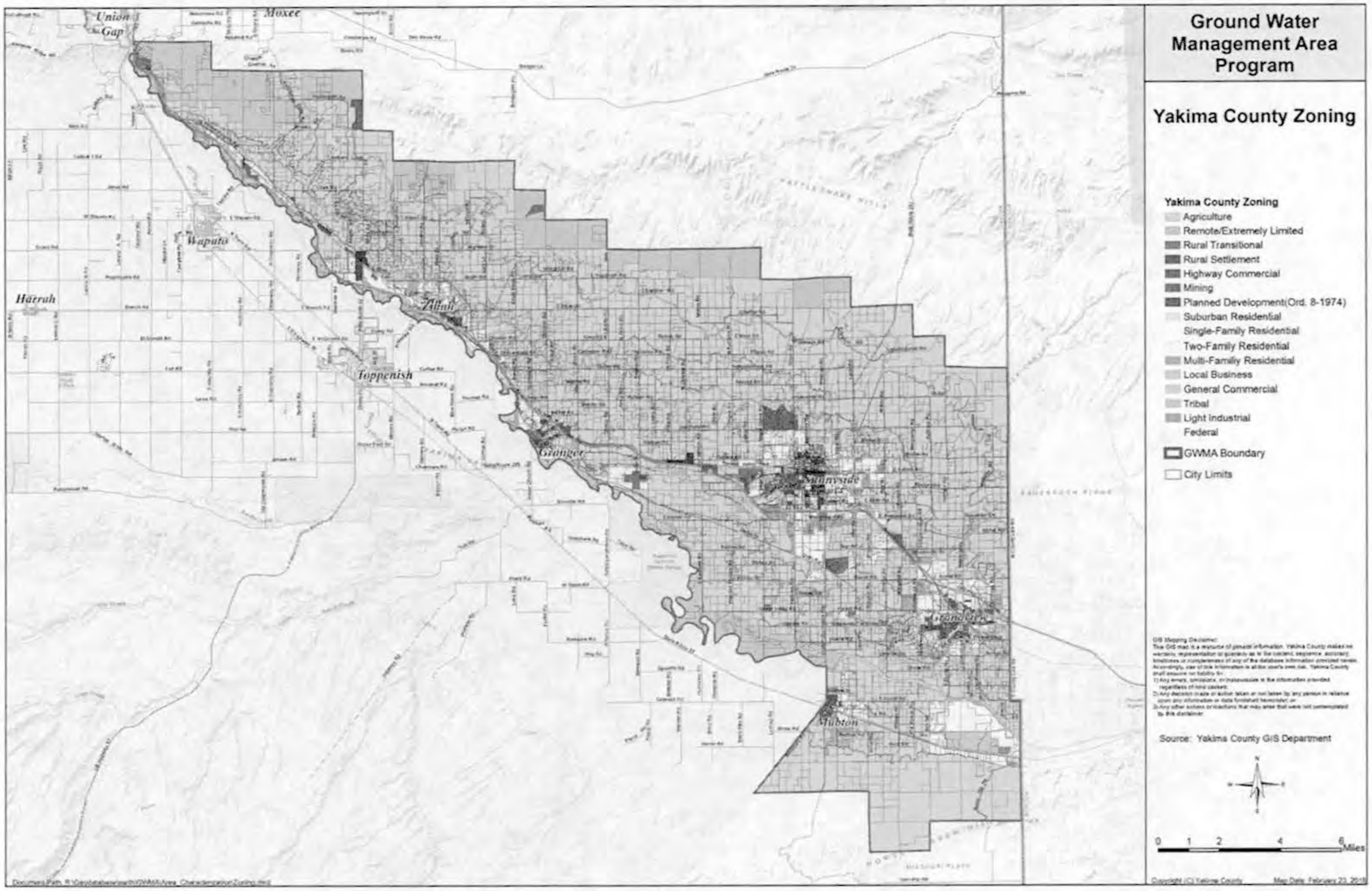


Figure 17 - Irrigation

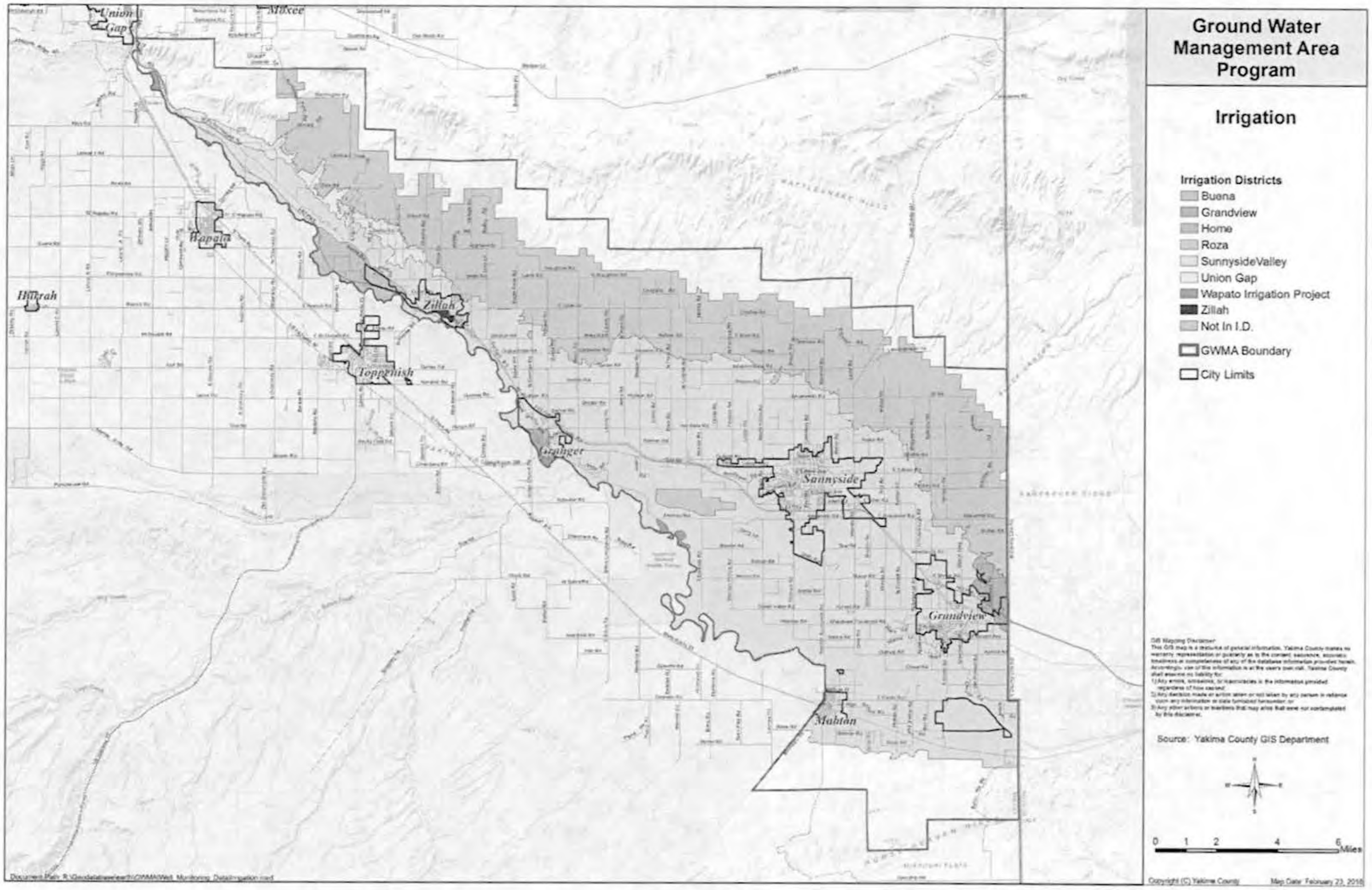


Figure 18 - Biosolids Application Sites

Figure 19 - Nitrate Pilot Project Water Test Locations

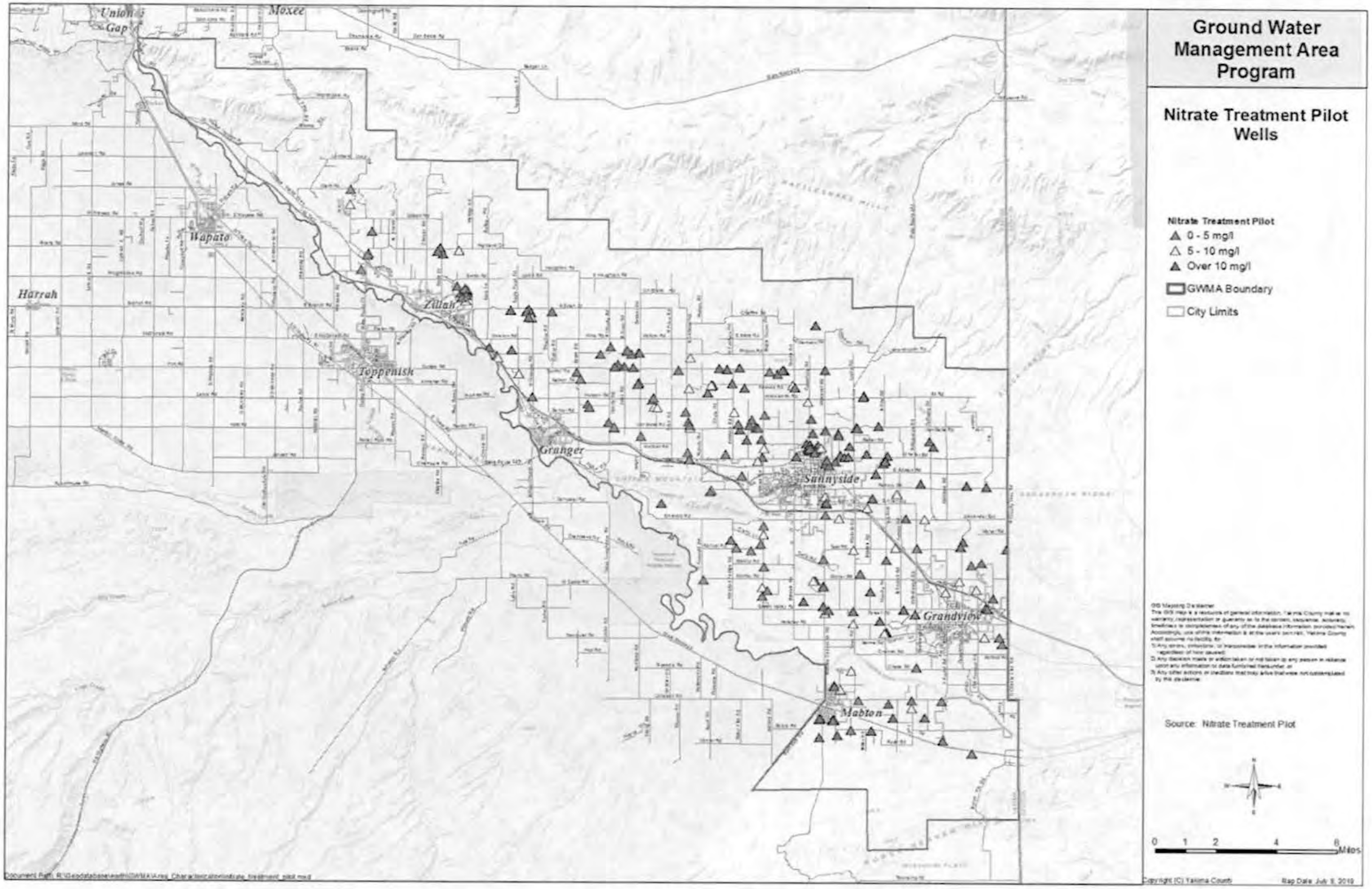


Figure 20 - High Risk Well Assessment test locations

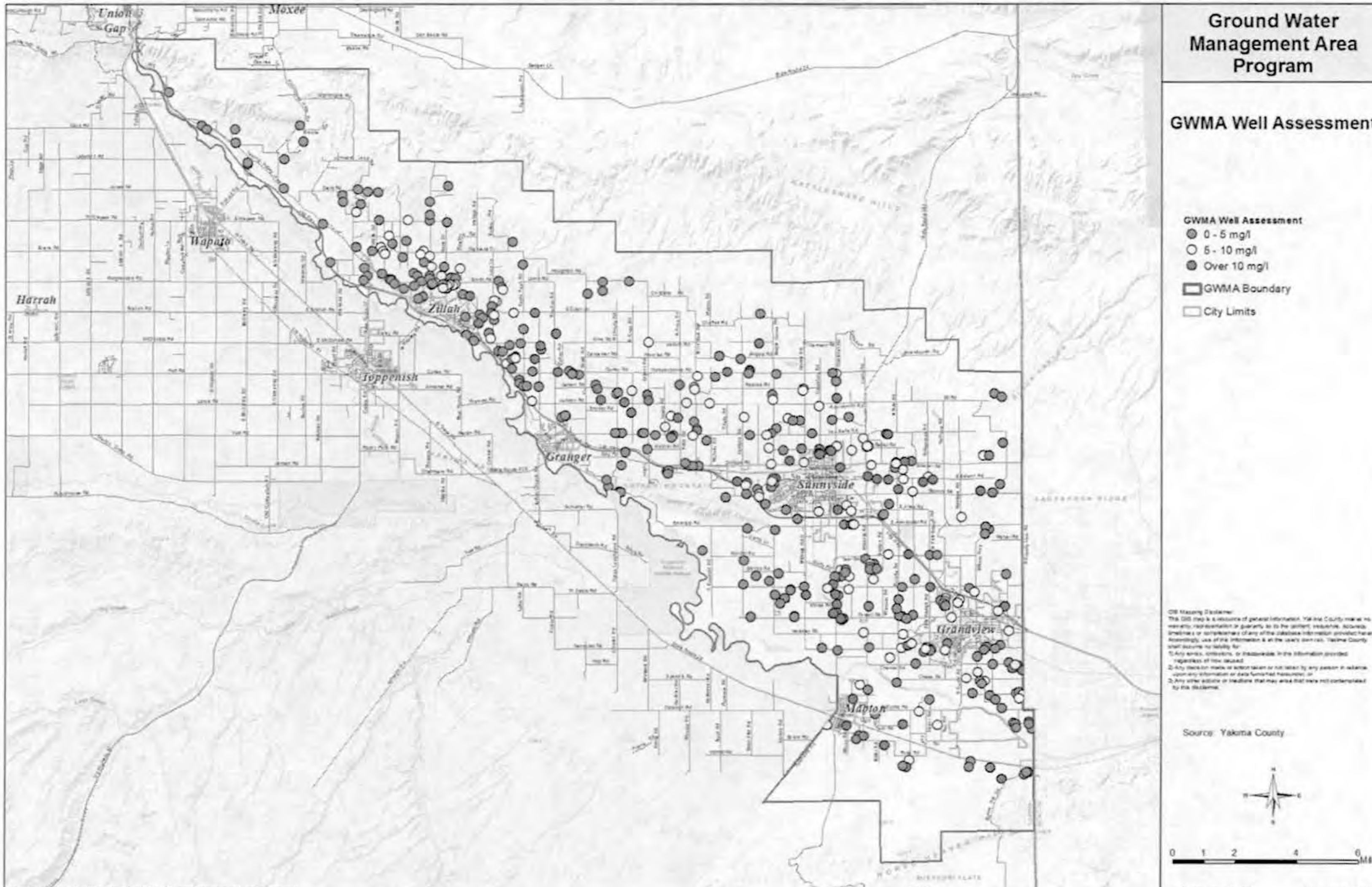


Figure 21 - USGS 2017 Groundwater Well Test Locations

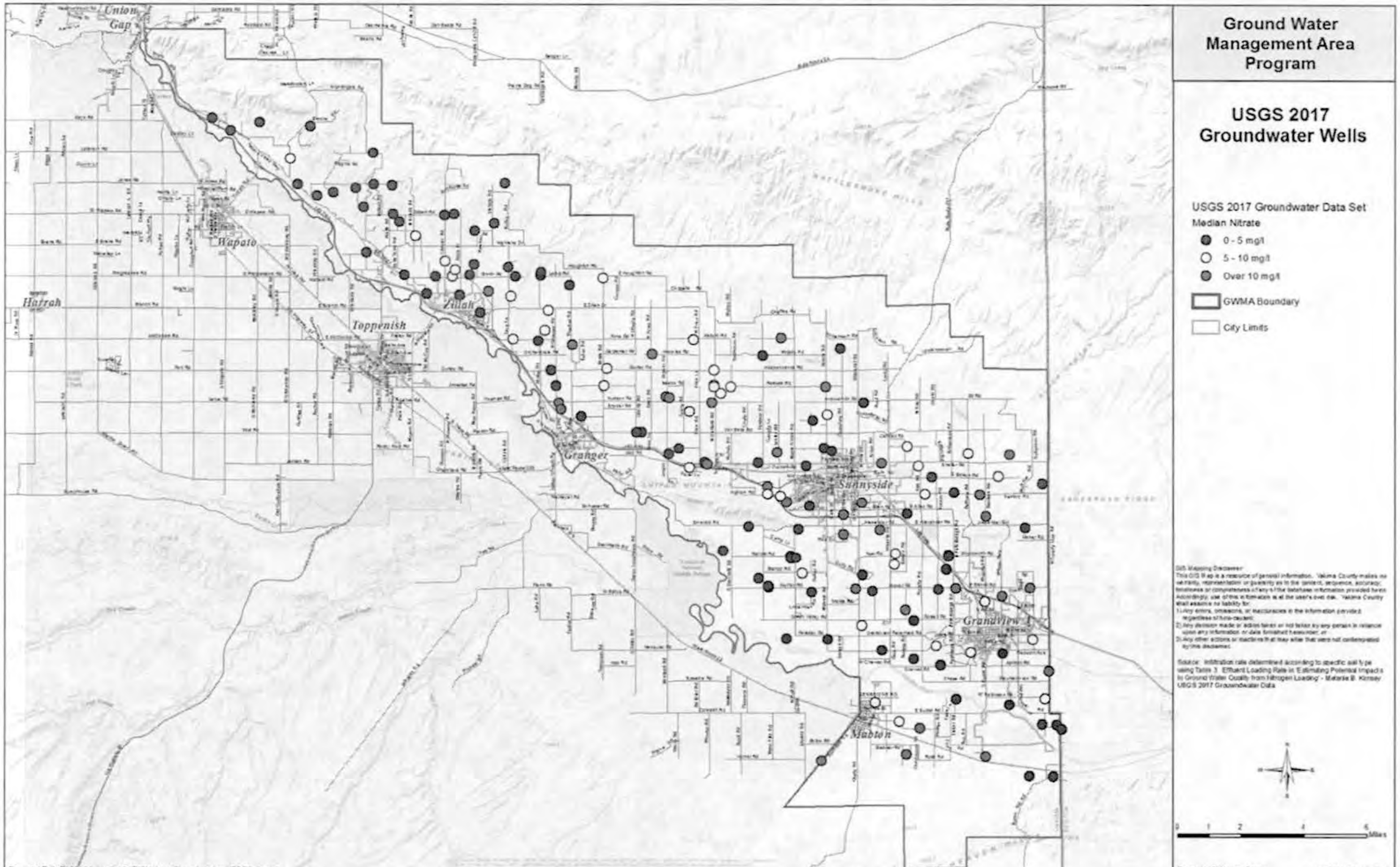


Figure 22 - All Water Quality Sampling Locations (3 Testing Programs)

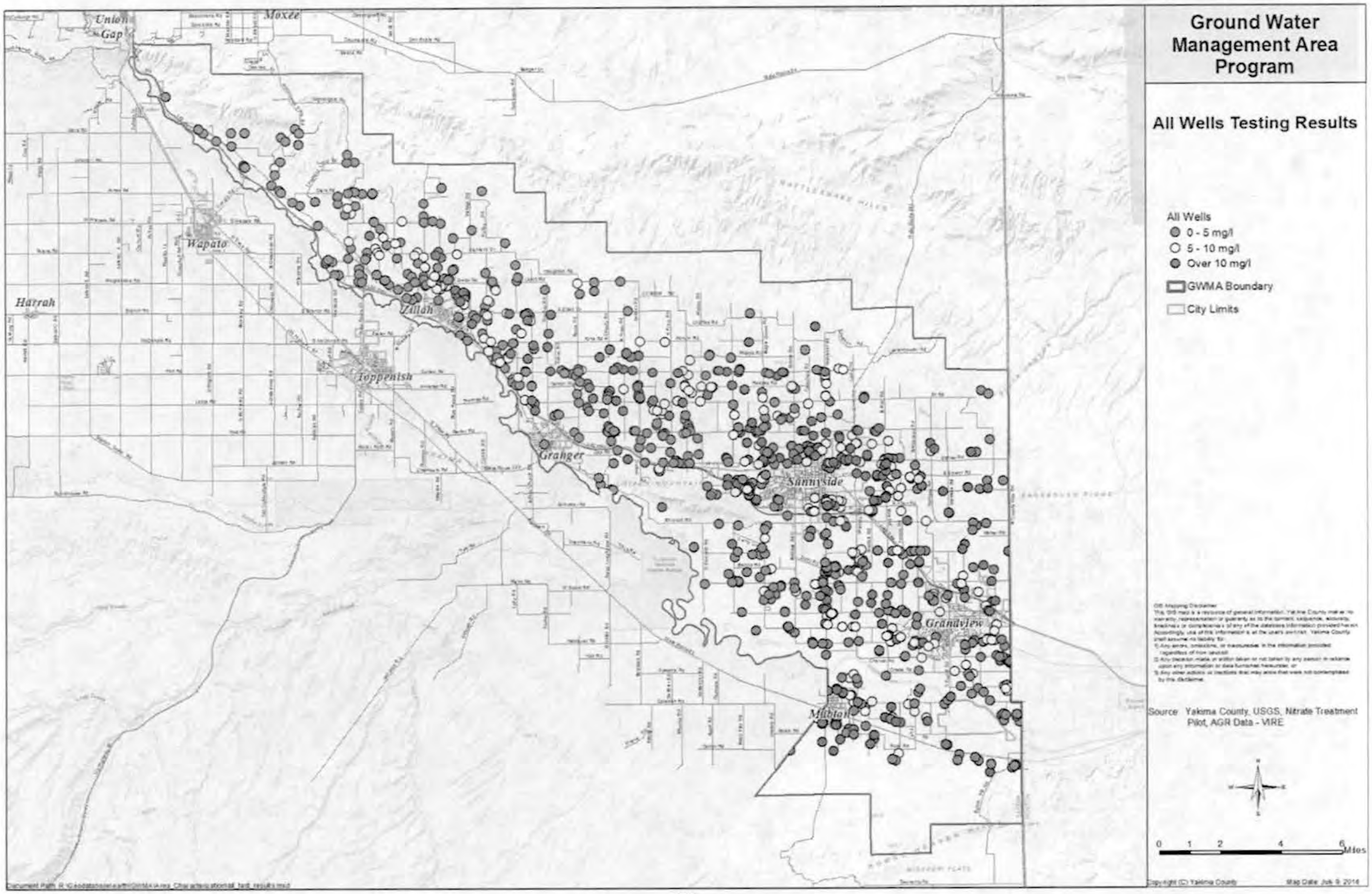


Figure 25 – Total Nitrogen Availability

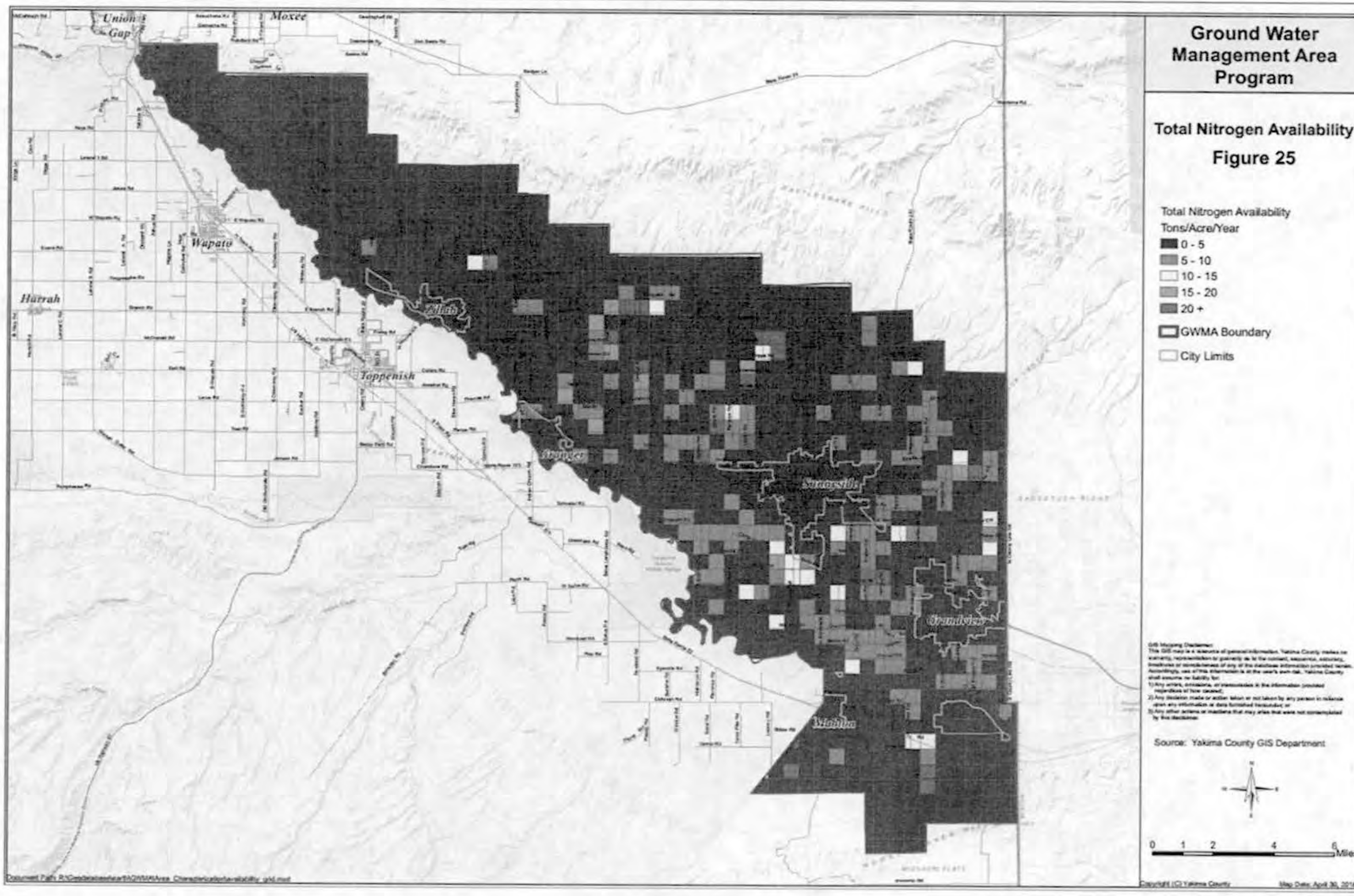


Figure 26 – Overlay of Total Nitrogen Availability and Groundwater Wells

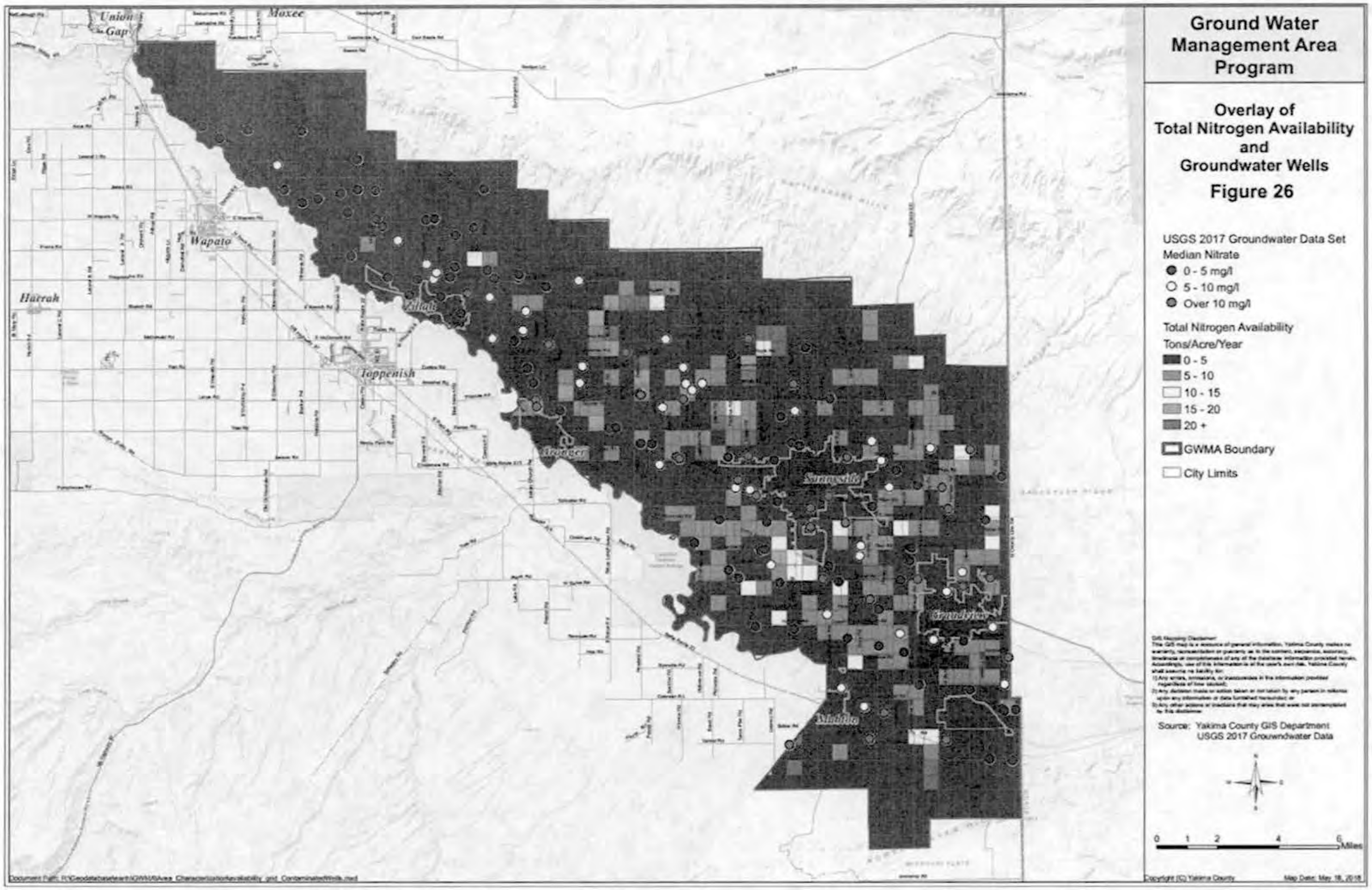


Figure 27 – Overlay of Soil Types and Groundwater Wells

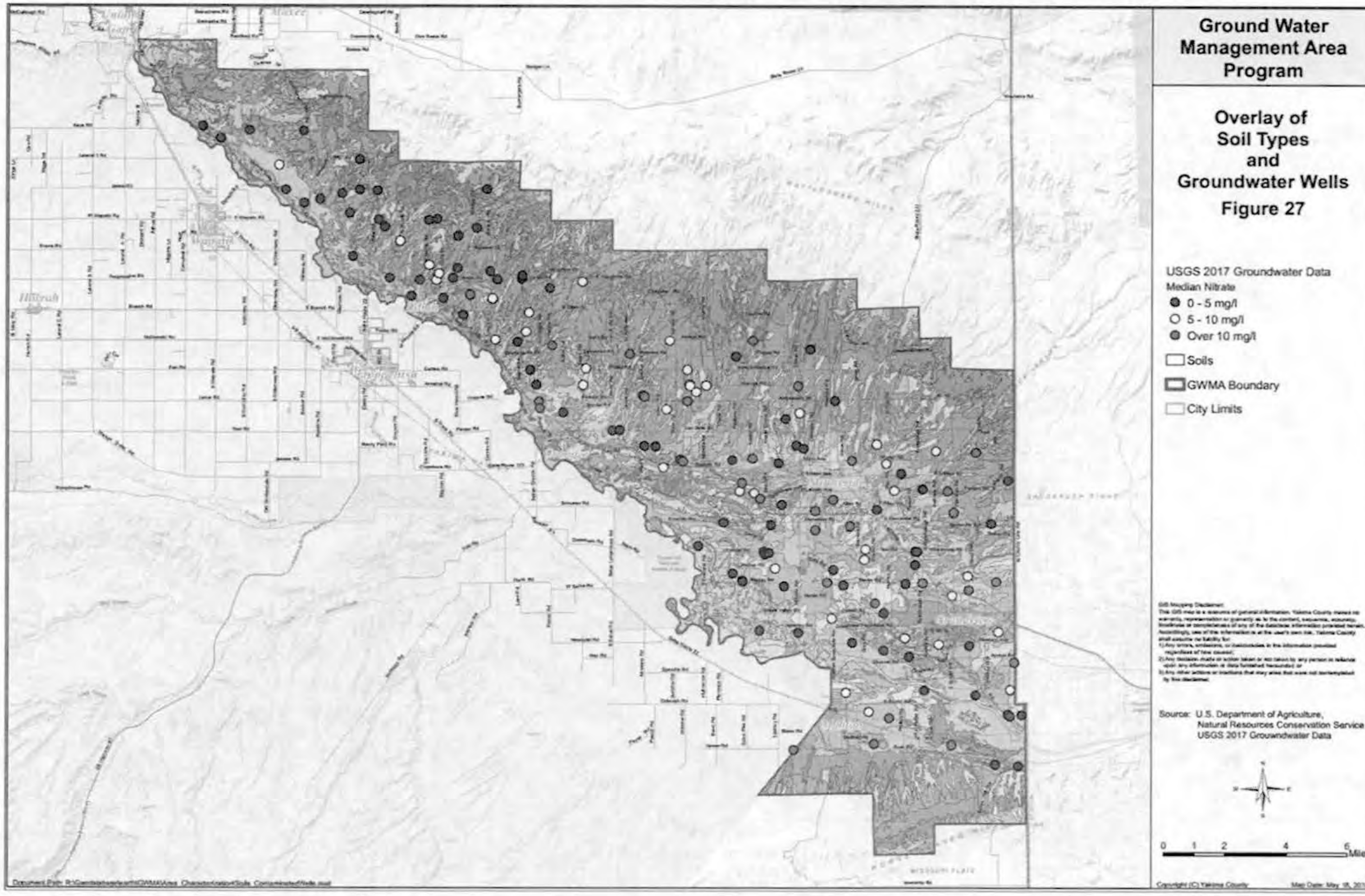


Figure 28 – Overlay of Hydraulic Conductivity and Groundwater Wells

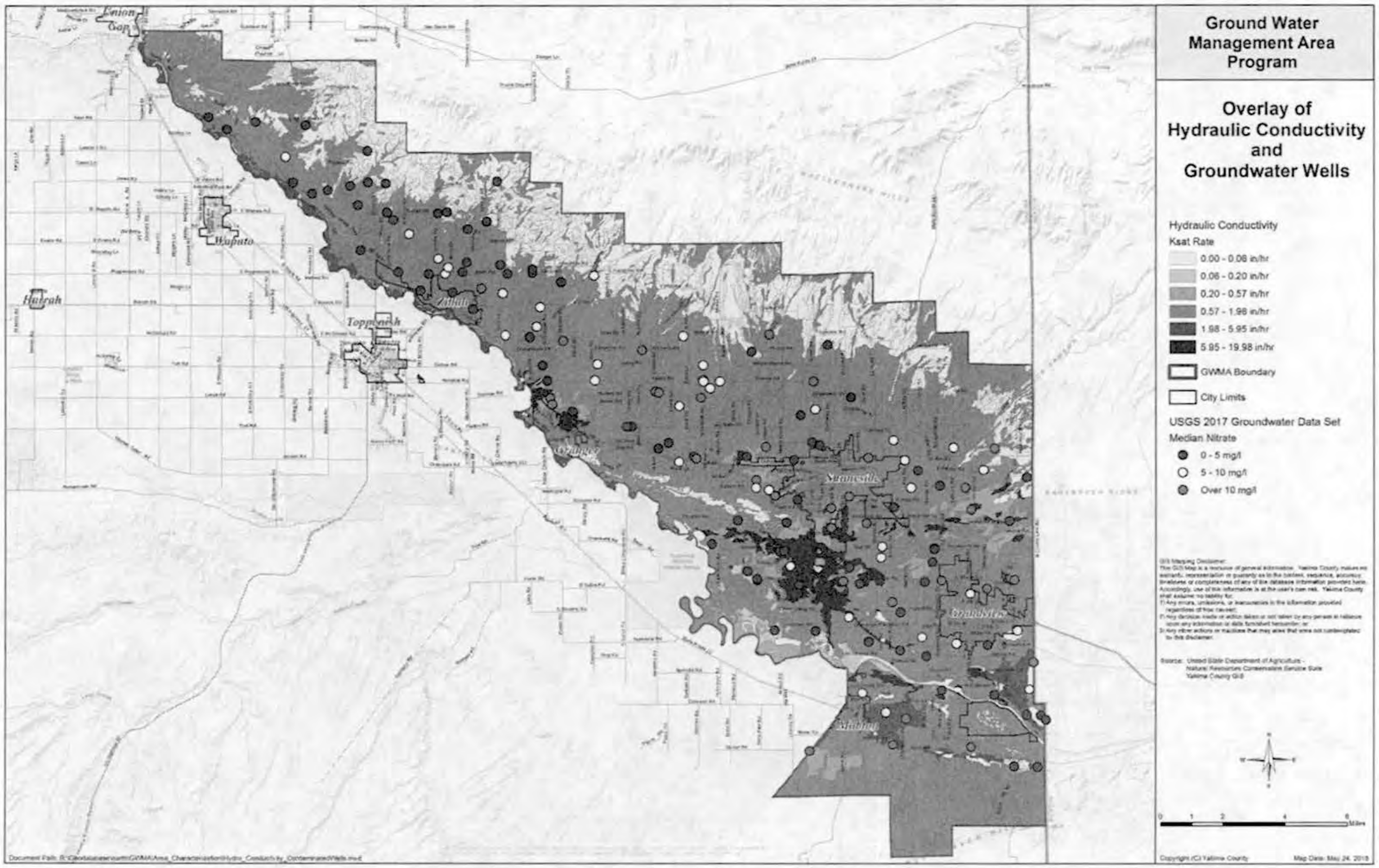


Figure 29 – Overlay of Canals and Drains with Groundwater Wells

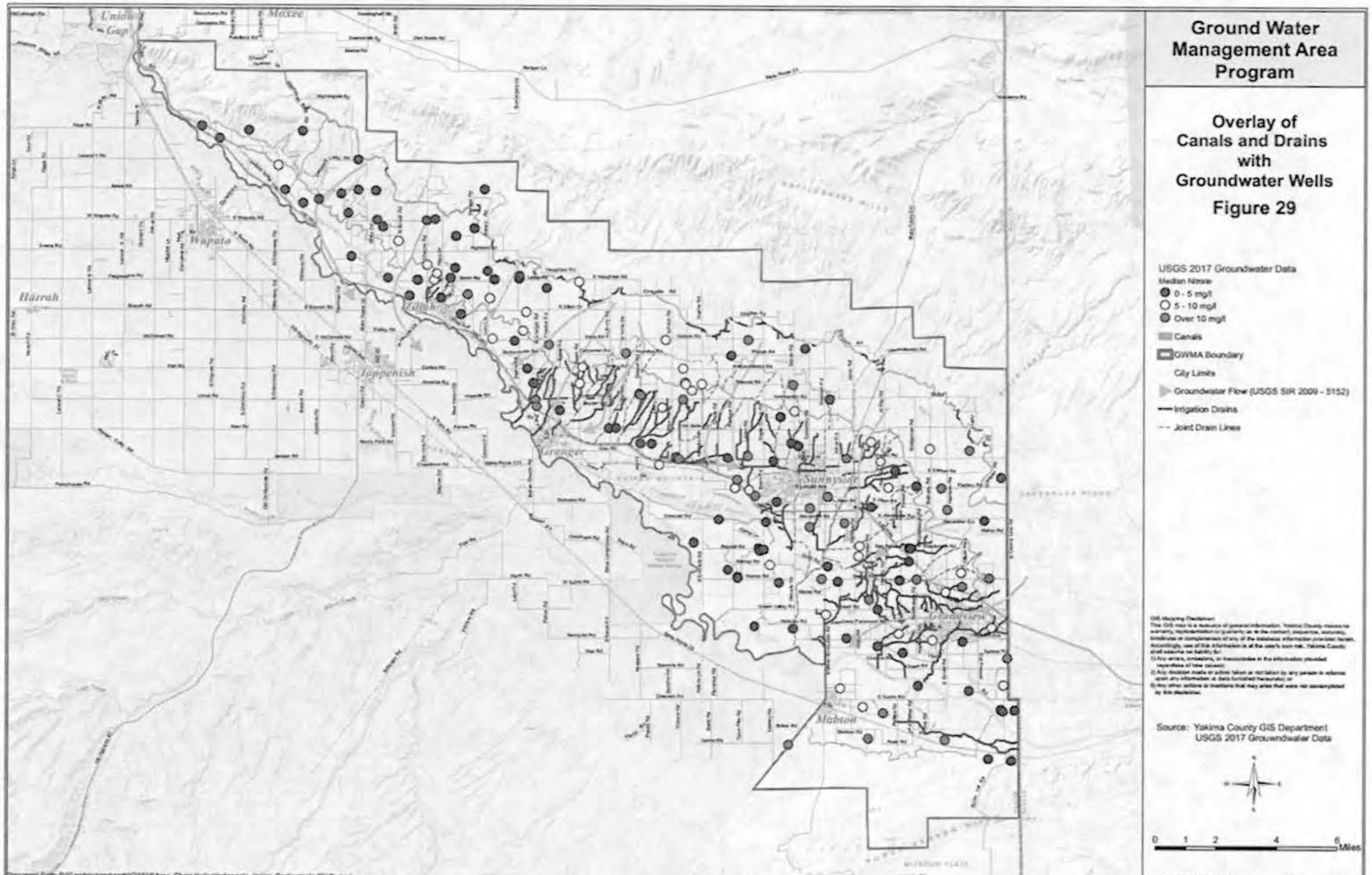


Figure 30 – Overlay of Cropping Patterns and Groundwater Wells

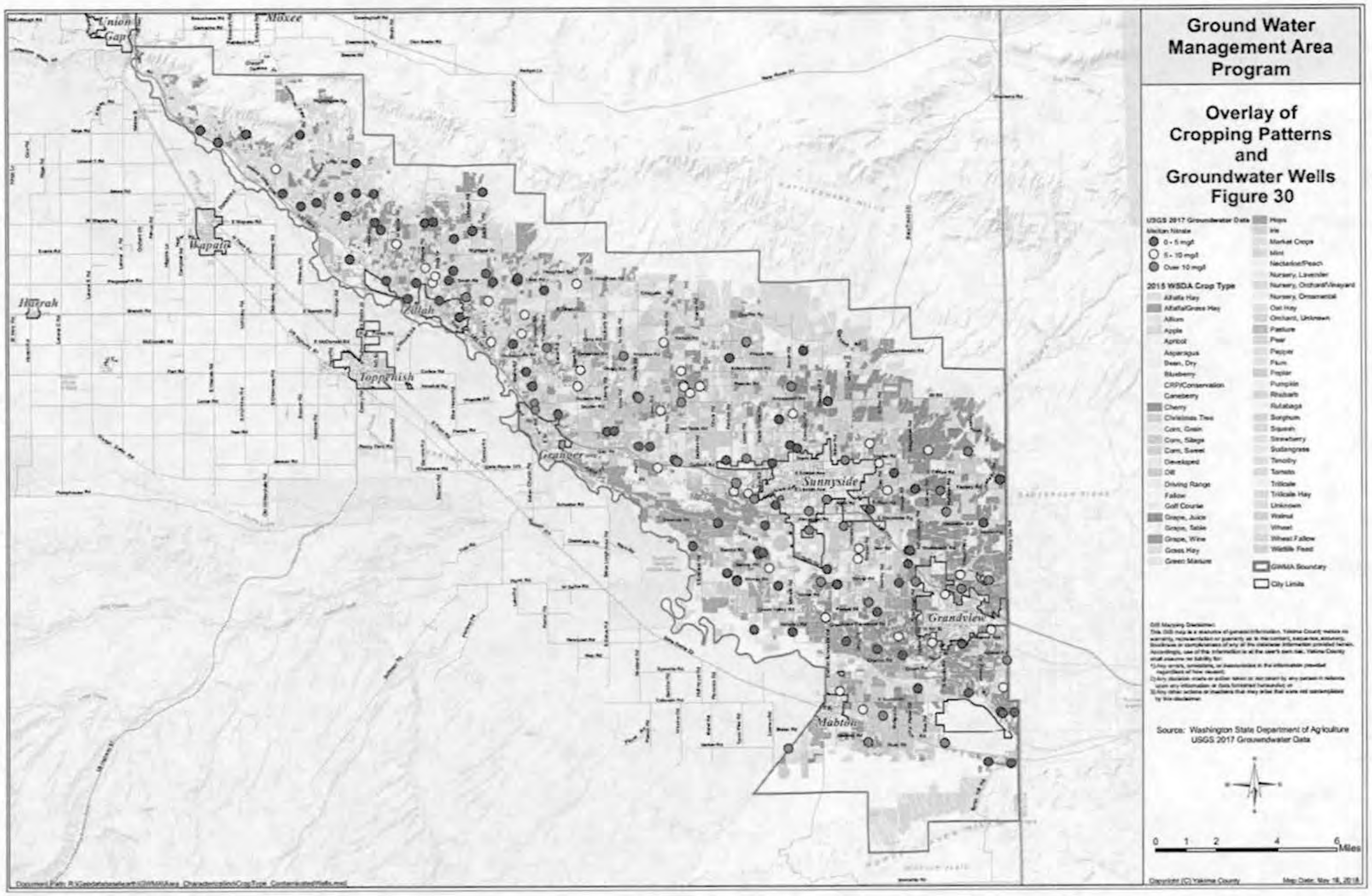


Figure 31 – Overlay of Point Sources and Groundwater Wells

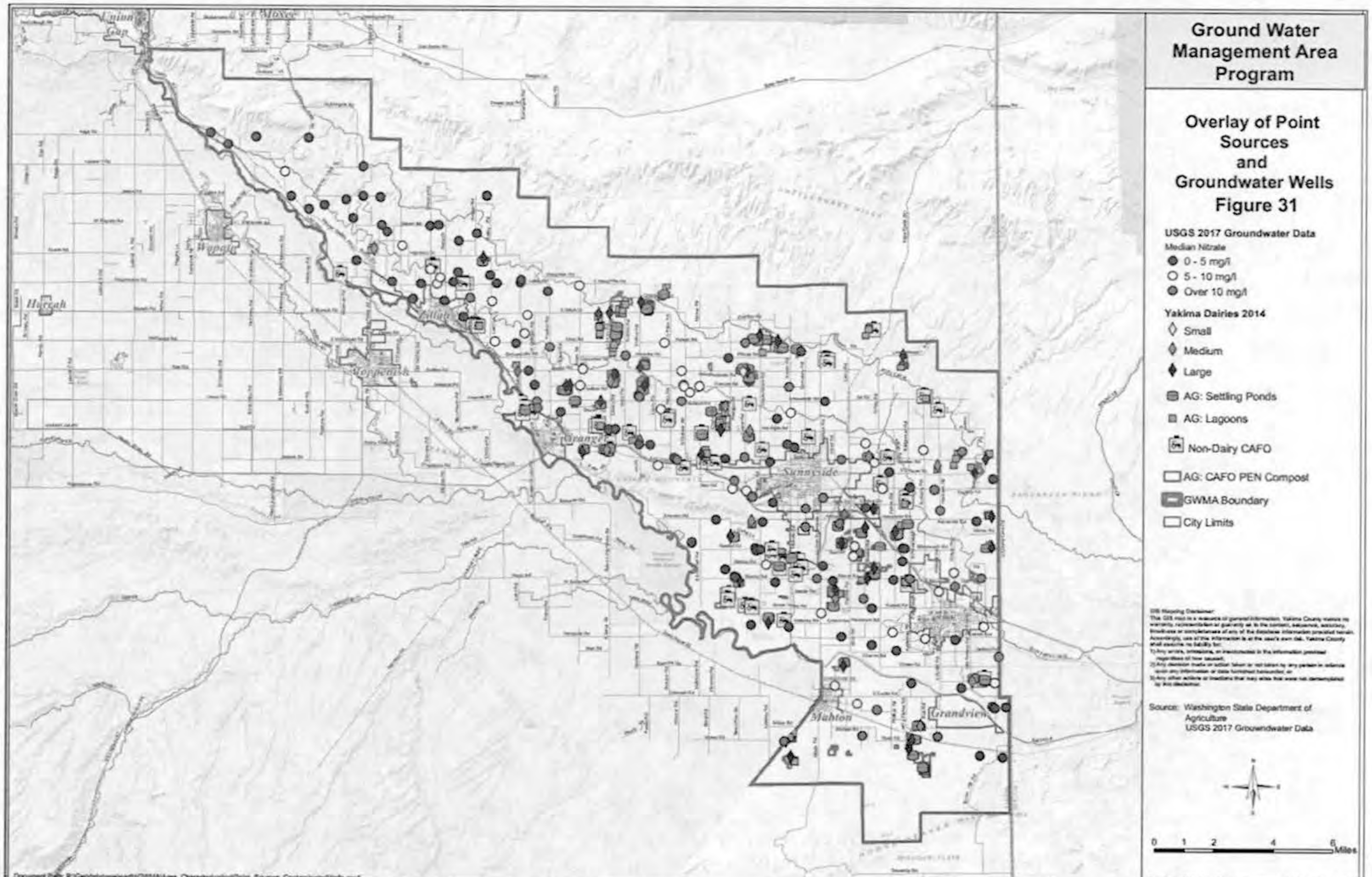
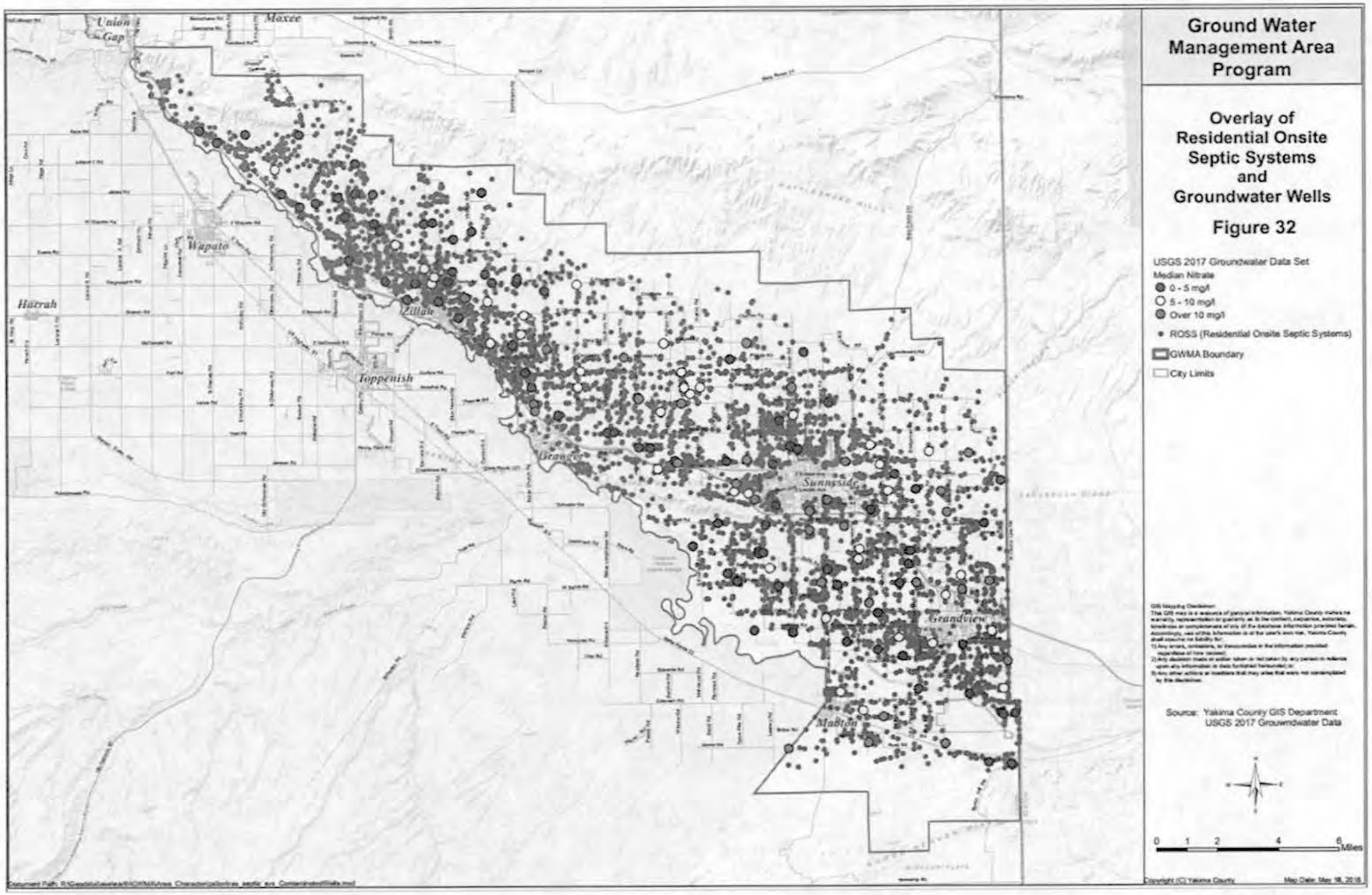


Figure 32 – Overlay of Residential Onsite Septic Systems and Groundwater Wells



Attachment C

- Resolution 308-2018: Awarding the Bid for Lower Yakima Valley GWMA Monitoring Wells Project

BOARD OF YAKIMA COUNTY COMMISSIONERS

IN THE MATTER OF AWARDING THE BID FOR LOWER YAKIMA VALLEY GWMA MONITORING WELLS PROJECT	)	**RESOLUTION 308-2018**

FC 3463

WHEREAS, pursuant to Resolution No. 269-2018, authorizing advertisements for bids a bid date was set for Wednesday, August 29, 2018, at 2:00 p.m., or as soon thereafter as possible, in the Public Services 4th Floor Conference Room, Yakima County Courthouse, Yakima, Washington 98901; and,

WHEREAS, the Clerk of the Board of County Commissioners posted and published "Notice to Bidders" that plans and specifications for said bid were available from the office of the County Engineer; and,

WHEREAS, the following corrected bids were received, opened, and publicly read:

1. Yellow Jacket Drilling Services..$177,862.36
   PO Box 801
   Gilbert, AZ 85299

2. Holt Services, Inc..$183,214.20
   PO Box 1659
   Milton, WA 98354

3. Environmental West Exploration, Inc...................................$191,738.30
   1015 N. Yardley
   Spokane, WA 99212

4. Budinger & Associates, Inc..$213,652.79
   1101 N. Fancher Road
   Spokane, WA 99212

5. Anderson Environmental Contracting, LLC.............................$232,664.77
   705 Colorado Street
   Kelso, WA 98626

6. Cascade Drilling, LP...$321,110.40
   19404 Woodinville Snohomish Rd. NE
   Woodinville, WA 98072

ENGINEER'S ESTIMATE..$168,529.01

WHEREAS, the Environmental Services Director recommends that the award of bid be made to the low bidder, Yellow Jacket Drilling Services, for the low bid of $177,862.36, including Washington State Sales Tax at 7.9%, now, therefore,

BE IT HEREBY RESOLVED by the Board of County Commissioners of Yakima County, Washington, that the bid for the Lower Yakima Valley GWMA Monitoring Wells Project, is acceptable, according to the specifications, and is awarded to Yellow Jacket Drilling Services, PO Box 801, Gilbert, AZ 85299, for the bid amount of $177,862.36 including Washington State Sales Tax at 7.9%.

DONE this 11th day of September 2018.

Excused

Ron Anderson, Chairman

Michael D. Leita, Commissioner

J. Rand Elliott, Commissioner

Constituting the Board of County Commissioners for Yakima County, Washington

Attest: Linda Kay O'Hara
Deputy Clerk of the Board

THE BOARD OF YAKIMA COUNTY COMMISSIONERS
STATE OF WASHINGTON

Attachment D

- BOCC214-2018: Amendment Number 2 to Agreement C1600074
- BOCC232-2018: Agreement with Yellow Jacket Drilling Services, LLC

DEPARTMENT OF ECOLOGY
State of Washington

AMENDMENT NO. 02

TO

CONTRACT NO. C1600074

BETWEEN THE

STATE OF WASHINGTON DEPARTMENT OF ECOLOGY

AND

YAKIMA COUNTY

PURPOSE: To amend the Agreement between the state of Washington, Department of Ecology, hereinafter referred to as "ECOLOGY," and Yakima County, hereinafter referred to as "CONTRACTOR."

WHEREAS, the following corrections are required:

- Budget adjustment(s) between tasks are needed to complete the program development.

IT IS MUTUALLY AGREED that the Agreement is amended as follows:

1) The Lower Yakima Valley Ground Water Management Area (LYV-GWMA) Contract Budget be revised to the Amendment Amount breakdown below. The total grant amount remains the same at $1,614,000.

	Original Amount	Amended Amount
Task 1 – Administrative Functions	$221,000	$300,000
Task 2 – Program Functions	$288,500	$50,000
Task 3 – Technical Functions	$1,104,500	$1,264,000
TOTAL	**$1,614,000**	**$1,614,000**

2) Yakima County is also authorized to move funds between Tasks 1, 2 and 3, up to $20,000.

All other terms and conditions of the original Agreement including any other Amendments remain in full force and effect, except as expressly provided by this Amendment.

This Amendment is signed by persons who represent that they have the authority to execute this Amendment and bind their respective organizations to this Amendment.

This Amendment is effective upon the signature date of ECOLOGY.

IN WITNESS WHEREOF: the parties below, having read this Amendment in its entirety, including all attachments, do agree in each and every particular and have thus set their hands hereunto.

State of Washington
Department of Ecology

Polly Zehm
By: by Kaimi Davies 10/4/18
Signature Date

Polly Zehm

Deputy Director

Attest: Rachel Michael
Clerk of the Board

SEAL OF THE BOARD OF YAKIMA COUNTY COMMISSIONERS STATE OF WASHINGTON

Board of Yakima County Commissioners

By: 9/18/18
Signature Date

Ron Anderson

Chairman

By: 9/18/18
Signature Date

Michael. D. Leita

Commissioner

Approved as to form:

Don L. Anderson
Deputy Prosecuting Attorney

By: Excused
Signature Date

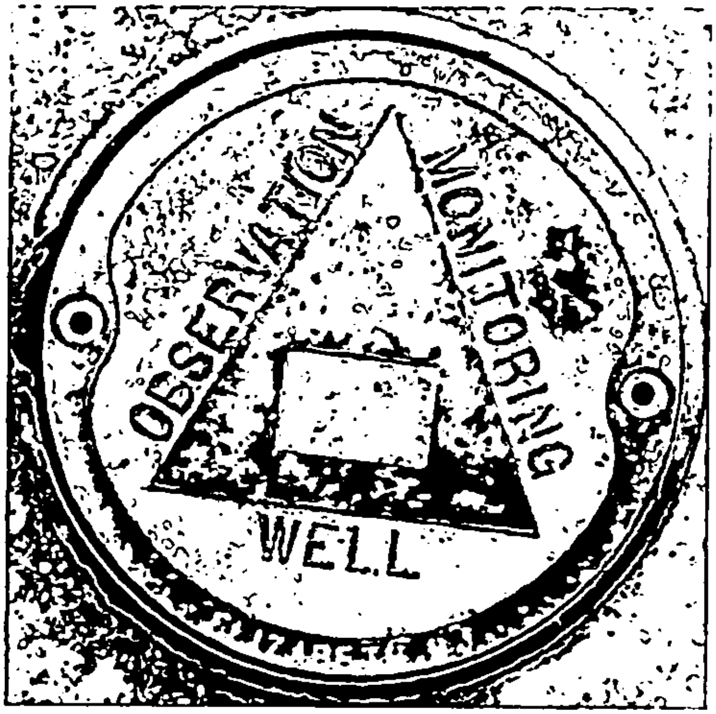
J. Rand Elliott

Commissioner
Constituting the Board of County
Commissioners for Yakima County

Approved as to form only.
Assistant Attorney General

BOCC214-2018
September 18, 2018

CONTRACT SPECIFICATIONS



For The Construction Of:

LOWER YAKIMA VALLEY GWMA MONITORING WELLS

Yakima County Public Services Project FC 3463

CERTIFICATE

I HEREBY CERTIFY THAT THE ATTACHED DOCUMENTS, PLANS, AND SPECIFICATIONS CONFORM TO ORIGINALS WHICH ARE ON FILE IN THE OFFICE OF THE COUNTY ENGINEER OF YAKIMA COUNTY, WASHINGTON.

MATTHEW J. PIETRUSIEWICZ
STATE OF WASHINGTON
35207
REGISTERED
PROFESSIONAL ENGINEER

COUNTY ENGINEER

DATE: 8/7/18

PROPOSAL

This certifies that the undersigned has examined the location of the noted projects:

FC 3463 – LOWER YAKIMA VALLEY GWMA MONITORING WELLS

And that the Plans, Specifications and Contract governing the work embraced in these improvements, and the method by which payment will be made for said work, is understood. The undersigned hereby proposes to undertake and complete the work embraced in these improvements, or as much as can be completed with the money available, in accordance with the said Plans, Specifications, and Contract, and the following schedule of rates and prices:

NOTE: Unit Prices for all items, all extensions, and total amount of bid shall be shown. No oral, telephonic, facsimile, or telegraphic Bids or modifications shall be considered or accepted.

Item No.	Description	Approx. Quantity	Unit	Unit Price	Total Item Amount
1a	HOLLOW STEM AUGER GENERAL MOBILIZATION/DEMOBILIZATION	1	L.S.	$ 0.00	$ 0.00
1b	SONIC GENERAL MOBILIZATION/DEMOBILIZATION	1	L.S.	$ 5,000.00	$ 5,000.00
2	SITE PREP AND SETUP	20	EACH	$ 975.00	$ 19,500.00
3a	DRILL HOLLOW STEM AUGER BORINGS	200	L.F.	$ 25.00	$ 5,000.00
3b	DRILL SONIC BORINGS	1,400	L.F.	$ 42.00	$ 58,800.00
4	MONITORING WELL CASING AND SCREEN	1,600	L.F.	$ 5.40	$ 8,640.00
5	SAND PACK	200	L.F.	$ 20.00	$ 4,000.00
6	WELL SEAL	1,400	L.F.	$ 15.00	$ 21,000.00
7	SURFACE COMPLETION	20	EACH	$ 460.00	$ 9,200.00
8	SUPPLY 55-GALLON DRUM AND DISPOSE OF DRILL CUTTINGS	10	EACH	$ 200.00	$ 2,000.00
9	WELL DEVELOPMENT	20	HOUR	$ 225.00	$ 4,500.00
10a	PROJECT TEMPORARY TRAFFIC CONTROL – NO FLAGGERS	16	EACH	$ 600.00	$ 9,600.00
10b	PROJECT TEMPORARY TRAFFIC CONTROL – FLAGGERS	4	EACH	$ 1,900.00	$ 7,600.00
11	MINOR CHANGES	EST.	F.A.	$ 10,000.00	$ 10,000.00

Subtotal $ 164,840.00

Washington State Sales Tax @ 7.9% $ 13,022.36

BID TOTAL $ 177,862.36

PROPOSAL – Continued

The bidder is hereby advised that by signature of this proposal he/she is deemed to have acknowledged all requirements and signed all certificates contained herein.

A proposal guaranty in an amount of five percent (5%) of the total bid, based upon the approximate estimate of quantities at the above prices and in the form as indicated below, is attached hereto:

CASH	[ ]	IN THE AMOUNT OF ____________
CASHIER'S CHECK	[ ]	____________ DOLLARS
CERTIFIED CHECK	[ ]	($__________) PAYABLE TO THE COUNTY TREASURER
PROPOSAL BOND	[x]	IN THE AMOUNT OF 5 PERCENT (5%) OF THE BID

Bidder acknowledges receipt of the following Addendum's:

No.	Date
N/A	N/A

The undersigned has telephoned the Office of the Yakima County Engineer for verification of the number of Addendum's issued.

SIGNATURE OF AUTHORIZED OFFICIAL(S)

R. LeBlanc   Richard LeBlanc

Title: Operations Manager

Firm Name: Yellow Jacket Drilling Services, LLC

Address: P O Box 801

Gilbert, AZ 85299

Phone No.: 602-453-3252

Washington Registration No.: CC-YELLOJD833NJ

Federal ID Tax No.: 38-3727439

UBI No.: 604059403

E-Mail Address: don@yjdrilling.com

Signed and sworn (or affirmed) before me on 08-28-18

Date

Jo Anne Sites

NOTARY PUBLIC

My appointment expires 03-23-21

(Seal and Stamp)

JO ANNE SITES
Notary Public - State of Arizona
PINAL COUNTY
My Commission Expires
March 23, 2021

NOTE: (1) This proposal is not transferable and any alteration of the firm's name entered hereon without prior permission from the County Engineer shall be cause for considering the proposal irregular and subsequent rejection of the bid.

(2) Please refer to Section 1-02.6 of the Standard Specifications, re: "Preparation of Proposal".

(3) Should it be necessary to modify this proposal either in writing or by electronic means, please make reference to the following proposal number in your communications FC 3463.

LETTER OF RESPONSIBILITY

Date: 08-28-18
County Road Project No.: FC 3463

TO:
BOARD OF COUNTY COMMISSIONERS OF YAKIMA COUNTY, WASHINGTON
(Party awarding principal contract)

Dear Sirs:

I hereby maintain that I am a responsible bidder as contemplated by the policies of the State of Washington (Chapter 157, Laws of Washington of 1937).

a. My permanent place of business is Phoenix, AZ, which I have maintained for 20 years years.

b. I have adequate plant equipment to do expeditiously and properly the work contemplated for Yakima County, Washington.

DESCRIPTION OF WORK:

FC 3463 – Lower Yakima Valley GWMA Monitoring Wells

I have the following equipment available for this work:

One truck-mounted sonic drill rig - a Terra Sonic TSi 150T model year 2017

c. I have adequate funds to promptly meet obligations incident to this work.
Bank reference: Wells Fargo Bank, Daniel Rodriguez, 480-377-1568

d. I have had experience in this class of work, having constructed the following improvements.

I hereby certify that the above is a true and accurate statement.

Very truly yours,

Contractor Richard LeBlanc, Operations Manager
Yellow Jacket Drilling Services, LLC

NOTE: This sheet need not be submitted, unless so requested by the Engineer subsequent to opening of bid. This "letter of responsibility" shall not be construed to be a request for prequalification of bidder.

DEFINITION OF TERMS

In interpreting these specifications, the following definitions shall prevail:

STATE: The State of Washington.

SECRETARY OF TRANSPORTATION: Secretary of Transportation of the State of Washington.

BOARD: The Board of County Commissioners of Yakima County.

ENGINEER: County, or construction engineer, or his duly authorized assistants by whom all explanations and directions necessary for the satisfactory prosecution and completion of the work described in these specifications will be given.

CONTRACTOR AND/OR SUPPLIER: The person, firm, co-partnership, or corporation, or any lawful agent of such person, firm, partnership or corporation constituting one of the principals to the contract and undertaking to perform the work herein specified.

CONTRACT: The Agreement between the Contractor and the County of Yakima acting through the Board of County Commissioners. The contract shall include the accepted "Proposal", "Plans", "Specifications" and "Contract Bond", also any and all supplemental agreements which reasonably could be required to complete the construction of the work in a substantial and acceptable manner.

PROPOSAL: The written offer, or copy thereof of the bidder to perform the work proposed.

PLANS: The officially approved drawings, or reproductions thereof attached to this contract.

SPECIFICATIONS: The directions, provisions and requirements contained herein, together with all written agreements made, or to be made pertaining to the method and manner of performing the work, or to the quantities and qualities of materials to be furnished under the contract.

CONTRACT BOND: The approved form of security furnished by the Contractor and his surety as a guarantee of good faith on the part of the Contractor to execute the work in accordance with the terms of the contract.

LABORATORY: The laboratories of the Department of Transportation, or other laboratories designated by the engineer.

AMOUNT OF THE CONTRACT: For the purpose of awarding the contract and determining the amount of the bond, the lump sum bid, or the summation of the products of the approximate quantities shown on the plans or otherwise stated by the unit prices will be considered the total amount of the bid and the full amount of the contract price.

Failure to return this Declaration as part of the bid proposal package will make the bid nonresponsive and ineligible for award.

NON-COLLUSION DECLARATION

I, by signing the proposal, hereby declare, under penalty of perjury under the laws of the United States that the following statements are true and correct:

1. That the undersigned person(s), firm, association or corporation has (have) not, either directly or indirectly, entered into any agreement, participated in any collusion, or otherwise taken any action in restraint of free competitive bidding in connection with the project for which this proposal is submitted.

2. That by signing the signature page of this proposal, I am deemed to have signed and have agreed to the provisions of this declaration.

NOTICE TO ALL BIDDERS

To report bid rigging activities call:

1-800-424-9071

The U. S. Department of Transportation (USDOT) operates the above toll-free "hotline" Monday through Friday, 8:00 a.m. to 5:00 p.m., eastern time. Anyone with knowledge of possible bid rigging, bidder collusion, or other fraudulent activities should use the "hotline" to report such activities.

The "hotline" is part of USDOT's continuing effort to identify and investigate highway construction contract fraud and abuse and is operated under the direction of the USDOT Inspector General. All information will be treated confidentially and caller anonymity will be respected.

Certification Regarding
Debarment, Suspension, Ineligibility and Voluntary Exclusion
Lower Tier Covered Transactions

This certification is required by the regulations implementing Executive Order 12549, Debarment and Suspension, 29 CFR Part 98, Section 98.510, Participant's responsibilities. The regulations were published as Part VII of the May 26, 1998 Federal Register (pages 19160-19211).

(BEFORE COMPLETING CERTIFICATION, READ ATTACHED INSTRUCTIONS WHICH ARE AN INTEGRAL PART OF THE CERTIFICATION)

(1) The prospective recipient of federal assistance funds certifies, by submission of this proposal, that neither it nor its principals are presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participation in this transaction by any federal department or agency.

(2) Where the prospective recipient of federal assistance funds is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

This certification is also applicable to violations to prevailing wage law (chapter 39.12 RCW), registration law (chapter 18.27 RCW), or industrial insurance law (chapter 51.48 RCW).

Richard LeBlanc, Operations Manager

Name and Title of Authorized Representative

Signature

06-28-18

Date

Yakima County Public Services

Certification of Compliance with Wage Payment Statutes

The bidder hereby certifies that, within the three-year period immediately preceding the bid solicitation date (08-29-18), that the bidder is not a "willful" violator, as defined in RCW 49.48.082, of any provision of chapters 49.46, 49.48, or 49.52 RCW, as determined by a final and binding citation and notice of assessment issued by the Department of Labor and Industries or through a civil judgement entered by a court of limited or general jurisdiction.

I certify under penalty of perjury under the laws of the State of Washington that the foregoing is true and correct.

Yellow Jacket Drilling Services, LLC
Bidder

Signature of Authorized Official*

Richard LeBlanc
Printed Name

Operations Manager
Title

08-29-18 Date   Phoenix City   AZ State

Check One:
_____ Individual   LLC _____ Partnership   _____ Joint Venture   _____ Corporation

State of Incorporation, or if not a Corporation, State where business entity was formed:

AZ

If a co-partnership, give firm name under which business is transacted:

N/A

*If a corporation, proposal must be executed in the corporate name by the president or vice-president (or any other corporate officer accompanied by evidence of authority to sign). If a co-partnership, proposal must be executed by a partner.

BID BOND

The makers of this bond are, Yellow Jacket Drilling Services, LLC, as Principal, and Nationwide Mutual Insurance Company, as Surety and are held and firmly bound unto the Yakima County Public Services, hereinafter called the District, in the penal sum of TEN PERCENT (10%) OF THE TOTAL BID PRICE of the Principal submitted to DISTRICT for the work described below, for the payment of which sum in lawful money of the United States, well and truly to be made, we bind ourselves, our heirs, executors, administrators, successors and assigns, jointly and severally, firmly by these presents.

THE CONDITION OF THIS OBLIGATION IS SUCH that whereas the Principal has submitted the accompanying bid dated August 29th, 2018, for the Project FC 3463 Lower Yakima Valley GWMA Monitoring Wells.

If the Principal does not withdraw its bid within the time specified in the Contract Documents; and if the Principal is awarded the Contract and provides all documents to the District as required by the Contract Documents; then this obligation shall be null and void. Otherwise, this bond will remain in full force and effect.

Surety, for value received, hereby stipulates and agrees that no change, extension of time, alteration or addition to the terms of the Contract Documents shall in affect its obligation under this bond, and Surety does hereby waive notice of any such changes.

In the event a lawsuit is brought upon this bond by the District and judgment is recovered, the Surety shall pay all litigation expenses incurred by the District in such suit, including reasonable attorneys' fees, court costs, expert witness fees and expenses.

IN WITNESS WHEREOF, the above-bound parties have executed this instrument under their several seals this 27th day of August, 2018, the name and corporate seal of each corporation.

(Corporate Seal)

Yellow Jacket Drilling Services, LLC
Principal
R. LeBlanc
By Richard LeBlanc
Title Principal Managing Member

(Corporate Seal)

Nationwide Mutual Insurance Company
Surety
Richard B Usher
By Richard B. Usher

(Attach Attorney-in-Fact Certificate)

Title Attorney-In-Fact

STATE OF ARIZONA)
) ss.
COUNTY OF MARICOPA)

On this 27th day of August, in the year 2018, before me, Brian Baker, a Notary Public in and for said state, personally appeared Richard B. Usher, known to me to be the person whose name is subscribed to the within instrument as the Attorney-In-Fact of the (Surety) acknowledged to me that he subscribed the name of the Nationwide Mutual Insurance Company (Surety) thereto and his own name as Attorney-In-Fact.

Notary Public in and for said State

(SEAL)

BRIAN BAKER
NOTARY PUBLIC, ARIZONA
MARICOPA COUNTY
My Commission Expires
September 17, 2018

Commission expires: 09/17/2018

NOTE: A copy of the Power-of-Attorney to local representatives of the bonding company must be attached hereto.

Power of Attorney

KNOW ALL MEN BY THESE PRESENTS THAT:

Nationwide Mutual Insurance Company, an Ohio corporation
National Casualty Company, an Ohio corporation
AMCO Insurance Company, an Iowa corporation
Allied Property and Casualty Insurance Company, an Iowa corporation

hereinafter referred to severally as the "Company" and collectively as "the Companies" does hereby make, constitute and appoint:

RICHARD B. USHER　　TAYLOR B. USHER　　DEBORAH STREETER

PHOENIX AZ

each in their individual capacity, its true and lawful attorney-in-fact, with full power and authority to sign, seal, and execute on its behalf any and all bonds and undertakings, and other obligatory instruments of similar nature, in penalties not exceeding the sum of

ONE MILLION FIVE HUNDRED THOUSAND AND NO/100 DOLLARS　　$ 1,500,000.00

and to bind the Company thereby, as fully and to the same extent as if such instruments were signed by the duly authorized officers of the Company; and all acts of said Attorney pursuant to the authority given are hereby ratified and confirmed.

This power of attorney is made and executed pursuant to and by authority of the following resolution duly adopted by the board of directors of the Company:

"RESOLVED, that the president, or any vice president be, and each hereby is, authorized and empowered to appoint attorneys-in-fact of the Company, and to authorize them to execute and deliver on behalf of the Company any and all bonds, forms, applications, memorandums, undertakings, recognizances, transfers, contracts of indemnity, policies, contracts guaranteeing the fidelity of persons holding positions of public or private trust, and other writings obligatory in nature that the business of the Company may require; and to modify or revoke, with or without cause, any such appointment or authority; provided, however, that the authority granted hereby shall in no way limit the authority of other duly authorized agents to sign and countersign any of said documents on behalf of the Company."

"RESOLVED FURTHER, that such attorneys-in-fact shall have full power and authority to execute and deliver any and all such documents and to bind the Company subject to the terms and limitations of the power of attorney issued to them, and to affix the seal of the Company thereto; provided, however, that said seal shall not be necessary for the validity of any such documents."

This power of attorney is signed and sealed under and by the following bylaws duly adopted by the board of directors of the Company.

Execution of Instruments. Any vice president, any assistant secretary or any assistant treasurer shall have the power and authority to sign or attest all approved documents, instruments, contracts, or other papers in connection with the operation of the business of the company in addition to the chairman of the board, the chief executive officer, president, treasurer or secretary; provided, however, the signature of any of them may be printed, engraved, or stamped on any approved document, contract, instrument, or other papers of the Company.

IN WITNESS WHEREOF, the Company has caused this instrument to be sealed and duly attested by the signature of its officer the 1st day of May, 2017.

SEAL　SEAL

National Casualty Company CORPORATE 1904 SEAL　SEAL

Antonio C. Albanese, Vice President of Nationwide Mutual Insurance Company, National Casualty Company, AMCO Insurance Company, Allied Property and Casualty Insurance Company

ACKNOWLEDGMENT

STATE OF NEW YORK, COUNTY OF NEW YORK: ss

On this 1st day of May, 2017, before me came the above-named officer for the Company aforesaid, to me personally known to be the officer described in and who executed the preceding instrument, and he acknowledged the execution of the same, and being by me duly sworn, deposes and says, that he is the officer of the Company aforesaid, that the seal affixed hereto is the corporate seal of said Company, and the said corporate seal and his signature were duly affixed and subscribed to said instrument by the authority and direction of said Company

BARRY T. BASSIS
Notary Public, State of New York
No. 02BA4656400
Qualified in New York County
Commission Expires April 30, 2019

Barry T. Bassis
Notary Public
My Commission Expires
April 30, 2019

CERTIFICATE

I, Laura B. Guy, Assistant Secretary of the Company, do hereby certify that the foregoing is a full, true and correct copy of the original power of attorney issued by the Company; that the resolution included therein is a true and correct transcript from the minutes of the meetings of the boards of directors and the same has not been revoked or amended in any manner; that said Antonio C. Albanese was on the date of the execution of the foregoing power of attorney the duly elected officer of the Company, and the corporate seal and his signature as officer were duly affixed and subscribed to the said instrument by the authority of said board of directors; and the foregoing power of attorney is still in full force and effect.

IN WITNESS WHEREOF, I have hereunto subscribed my name as Assistant Secretary, and affixed the corporate seal of said Company this 27th day of August, 2018.

Laura a Guy
Assistant Secretary

This power of attorney expires April 30, 2019

BDJ 1(05-17)00

22330

CONTRACT

THIS AGREEMENT is made and entered into between Yakima County, acting under and by virtue of Titles 36 and 39 RCW, hereinafter called the "COUNTY" and YELLOW JACKET DRILLING SERVICES, hereinafter called the "CONTRACTOR".

That in consideration of the terms and conditions contained herein and attached and made a part of this agreement, the parties hereto covenant and agree as follows:

I. The CONTRACTOR shall do all work and furnish all tools and equipment for **FC 3463 – Lower Yakima Valley GWMA Monitoring Wells**, and shall perform any changes in the work in accordance with the Contract Documents, which include the Contract Form, Bidder's completed Proposal Form, Scope of Work, Contract Plans, Contract Provisions, WSDOT 2018 Standard Specifications, Standard Specifications, Standard Plans, Addenda, various certifications and affidavits, supplemental agreements, and any change orders—all of which are incorporated by reference and made a part of this agreement. In the event of any conflict between terms or provisions contained in the following with those provided in the incorporated documents, the explicit provisions contained here shall control over those provided in incorporated documents.

II. The CONTRACTOR shall provide and bear the expense of all equipment, material and labor of any sort whatsoever that may be required for the transfer of materials and for constructing and completing the work provided for in the Contract Documents except those items mentioned therein to be furnished by Yakima County.

III. The COUNTY hereby promises and agrees to pay the CONTRACTOR according to the conditions stated in the Contract Documents.

IV. The CONTRACTOR for itself, and for its heirs, executors, administrators, successors and assigns does hereby agree to the full performance of all the covenants herein contained upon the part of the CONTRACTOR.

V. It is further provided that no liability shall attach to the COUNTY by reason of entering into this Contract, except as expressly provided herein.

VI. The parties agree that, for the purpose of this agreement, the CONTRACTOR is an independent contractor and neither the CONTRACTOR nor any employee of the CONTRACTOR is an employee of the COUNTY. Neither the CONTRACTOR nor any employee of the CONTRACTOR is entitled to any benefits that the COUNTY provides its employees. The CONTRACTOR is solely responsible for payment of any statutory workers compensation or employer's liability insurance as required by state law.

VII. If any provision of this Agreement or any provision of any document incorporated by reference shall be held invalid, such invalidity shall not affect the other provisions of this Agreement, which can be given effect without the invalid provision if such remainder conforms to the requirements of applicable law and the fundamental purpose of this agreement, and to this end the provisions of this Agreement are declared to be severable.

VIII. In the event that either party shall be required to bring any action to enforce any of the provisions of this Agreement, or shall be required to defend any action brought by the other party with respect to this Agreement, and in the further event that one party shall prevail in such action, the losing party shall, in addition to all other payments required therein, pay all of the prevailing party's actual costs in connection with such action, including such sums as the court or courts may adjudge reasonable as attorneys' fees in the trial court and in any appellate courts.

IN WITNESS WHEREOF, the CONTRACTOR has executed this instrument, on the date indicated below and Yakima County has caused this instrument to be executed in the name of said COUNTY by and through the Board of Yakima County Commissioners on the date indicated below.

CONTRACTOR:

Signed: September 13, 2018

Signature for CONTRACTOR

Richard LeBlanc
Print or Type Name of Person Signing

Operations Manager
Title

Foregoing Contract approved and ratified

__________, 2018

Surety

Attorney in fact

BOARD OF YAKIMA COUNTY COMMISSIONERS

Signed: October 2, 2018

Excused

Ron Anderson, Chairman

Michael D. Leita, Commissioner

J. Rand Elliott, Commissioner
Constituting the Board of County Commissioners for Yakima County, Washington

SEAL OF THE BOARD OF YAKIMA COUNTY COMMISSIONERS STATE OF WASHINGTON

ATTEST: Clerk of the Board

Rachel Michael

Approved as to form:

Deputy Prosecuting Attorney

BOCC232-2018
October 2, 2018

PERFORMANCE BOND
(RCW 39.08)

KNOW ALL MEN BY THESE PRESENTS, That Yellow Jacket Drilling Services, as "PRINCIPAL", and Nationwide Mutual Insurance Company, a corporation authorized to do business in the State of Washington, as "SURETY", are jointly and severally held and bound unto Yakima County, Washington in the penal sum [illegible] Dollars ($ 177,862.36) for the payment of which by these presents we jointly and severally bind ourselves, our heirs, executors, administrators, assigns, and successors.

THE CONDITION of this bond is such that WHEREAS, on September 12, 2018, the PRINCIPAL executed a certain Contract with the County, by the terms of which PRINCIPAL agrees to furnish all material and labor and will undertake and complete the construction of FC 3463 – Lower Yakima Valley GWMA Monitoring Wells, according to the maps, plans and specifications made a part of said Contract, which Contract is attached hereto and by this reference is incorporated herein and made a part hereof. FURTHER, the SURETY agrees to be bound by the laws of the State of Washington and subjected to the jurisdiction of the State of Washington.

NOW, THEREFORE, if the PRINCIPAL shall faithfully perform all the provisions of such contract and pay all laborers, mechanics, subcontractors and materialmen, and all persons who supply such persons or subcontractors with provisions or supplies for the carrying on of such work, then this obligation to be void, otherwise to remain in full force and effect.

Dated this 13th day of September, 2018.

R. LeBlanc

PRINCIPAL Yellow Jacket Drilling Services

By: Richard LeBlanc

Title: Principal Managing Member

SURETY Nationwide Mutual Insurance Company

By: Richard B. Usher Richard B. Usher
Attorney-in-Fact

Hill & Usher LLC
Name of Local Office of Agent

3030 N 44th St #300, Phoenix, AZ 85018
Address of Local Office Agent

BD758572
BOND NUMBER

APPROVED: YAKIMA COUNTY

By: [signature]

Vice Chair of the Board of Yakima County Commissioners

Date: October 2 2018

Approved as to form:

Don L. Anderson
Deputy Prosecuting Attorney

YAKIMA COUNTY CONTRACT NUMBER

YELLO-2 OP ID: DS

ACORD

CERTIFICATE OF LIABILITY INSURANCE

DATE (MM/DD/YYYY) 09/13/2018

THIS CERTIFICATE IS ISSUED AS A MATTER OF INFORMATION ONLY AND CONFERS NO RIGHTS UPON THE CERTIFICATE HOLDER. THIS CERTIFICATE DOES NOT AFFIRMATIVELY OR NEGATIVELY AMEND, EXTEND OR ALTER THE COVERAGE AFFORDED BY THE POLICIES BELOW. THIS CERTIFICATE OF INSURANCE DOES NOT CONSTITUTE A CONTRACT BETWEEN THE ISSUING INSURER(S), AUTHORIZED REPRESENTATIVE OR PRODUCER, AND THE CERTIFICATE HOLDER.

IMPORTANT: If the certificate holder is an ADDITIONAL INSURED, the policy(ies) must be endorsed. If SUBROGATION IS WAIVED, subject to the terms and conditions of the policy, certain policies may require an endorsement. A statement on this certificate does not confer rights to the certificate holder in lieu of such endorsement(s).

PRODUCER
Hill & Usher LLC
Insurance. Bonds. Benefits.
3033 North 44th Street, #300
Phoenix, AZ 85018
Steve R. Shields

CONTACT NAME: Commercial Service Team
PHONE (A/C, No, Ext): 602-956-4220 FAX (A/C, No): 602-956-4418
E-MAIL ADDRESS: doccontrol@hillusher.com

INSURER(S) AFFORDING COVERAGE	NAIC #
INSURER A : Travelers Property Casualty Co	25674
INSURER B : Travelers Property Casualty Co	25674
INSURER C : Travelers Indemnity Co	25658
INSURER D : Homeland Insurance Co of NY	34452
INSURER E :	
INSURER F :	

INSURED
Yellow Jacket Drilling Services LLC
Richard LeBlanc dba
Yellow Jacket Drilling
PO Box 801
Gilbert, AZ 85299-0801

COVERAGES CERTIFICATE NUMBER: REVISION NUMBER:

THIS IS TO CERTIFY THAT THE POLICIES OF INSURANCE LISTED BELOW HAVE BEEN ISSUED TO THE INSURED NAMED ABOVE FOR THE POLICY PERIOD INDICATED. NOTWITHSTANDING ANY REQUIREMENT, TERM OR CONDITION OF ANY CONTRACT OR OTHER DOCUMENT WITH RESPECT TO WHICH THIS CERTIFICATE MAY BE ISSUED OR MAY PERTAIN, THE INSURANCE AFFORDED BY THE POLICIES DESCRIBED HEREIN IS SUBJECT TO ALL THE TERMS, EXCLUSIONS AND CONDITIONS OF SUCH POLICIES. LIMITS SHOWN MAY HAVE BEEN REDUCED BY PAID CLAIMS.

INSR LTR	TYPE OF INSURANCE	ADDL INSD	SUBR WVD	POLICY NUMBER	POLICY EFF (MM/DD/YYYY)	POLICY EXP (MM/DD/YYYY)	LIMITS	
A	X COMMERCIAL GENERAL LIABILITY; CLAIMS-MADE [X] OCCUR; GEN'L AGGREGATE LIMIT APPLIES PER: POLICY [X] PRO-JECT LOC; OTHER:			DT-CO-2J407688-PHX-18	04/01/2018	04/01/2019	EACH OCCURRENCE	$ 1,000,000
							DAMAGE TO RENTED PREMISES (Ea occurrence)	$ 300,000
							MED EXP (Any one person)	$ 5,000
							PERSONAL & ADV INJURY	$ 1,000,000
							GENERAL AGGREGATE	$ 2,000,000
							PRODUCTS - COMP/OP AGG	$ 2,000,000
								$
B	AUTOMOBILE LIABILITY; X ANY AUTO; ALL OWNED AUTOS; SCHEDULED AUTOS; X HIRED AUTOS; X NON-OWNED AUTOS			DT-810-2J354550-TIL-18	04/01/2018	04/01/2019	COMBINED SINGLE LIMIT (Ea accident)	$ 1,000,000
							BODILY INJURY (Per person)	$
							BODILY INJURY (Per accident)	$
							PROPERTY DAMAGE (Per accident)	$
								$
B	X UMBRELLA LIAB X OCCUR; EXCESS LIAB CLAIMS-MADE; DED X RETENTION $ 10000			CUP-2J444660-17-26	04/01/2018	04/01/2019	EACH OCCURRENCE	$ 10,000,000
							AGGREGATE	$ 10,000,000
								$
C	WORKERS COMPENSATION AND EMPLOYERS' LIABILITY; ANY PROPRIETOR/PARTNER/EXECUTIVE OFFICER/MEMBER EXCLUDED? (Mandatory in NH) Y/N: Y; If yes, describe under DESCRIPTION OF OPERATIONS below	N/A		UB-2J440716-17-26	04/01/2018	04/01/2019	X PER STATUTE OTH-ER	
							E.L. EACH ACCIDENT	$ 1,000,000
							E.L. DISEASE - EA EMPLOYEE	$ 1,000,000
							E.L. DISEASE - POLICY LIMIT	$ 1,000,000
B	Equipment Floater			6601367M582	04/01/2018	04/01/2019	Insd equi	as sched
D	POLL/PROF			7930060860001	04/01/2018	04/01/2019	Occ/Agg	10,000,000

DESCRIPTION OF OPERATIONS / LOCATIONS / VEHICLES (ACORD 101, Additional Remarks Schedule, may be attached if more space is required)

RE:PC 3463 LOWER YAKIMA COUNTY GWMA MONITORING WELLS
ADDITIONAL INSURED FORMS CGT246 & CAT474 ATTACHED.

CERTIFICATE HOLDER

YAKIMAC

YAKIMA COUNTY PUBLIC SERVICES
128 N 2ND STREET
4TH FLOOR COUNTY COURTHOUSE
YAKIMA, WA 98901

CANCELLATION

SHOULD ANY OF THE ABOVE DESCRIBED POLICIES BE CANCELLED BEFORE THE EXPIRATION DATE THEREOF, NOTICE WILL BE DELIVERED IN ACCORDANCE WITH THE POLICY PROVISIONS.

AUTHORIZED REPRESENTATIVE

Steve Shields

THIS ENDORSEMENT CHANGES THE POLICY. PLEASE READ IT CAREFULLY

BLANKET ADDITIONAL INSURED (CONTRACTORS)

This endorsement modifies insurance provided under the following:

COMMERCIAL GENERAL LIABILITY COVERAGE PART

1. WHO IS AN INSURED – (Section II) is amended to include any person or organization that you agree in a "written contract requiring insurance" to include as an additional insured on this Coverage Part, but:
   a) Only with respect to liability for "bodily injury", "property damage" or "personal injury"; and
   b) If, and only to the extent that, the injury or damage is caused by acts or omissions of you or your subcontractor in the performance of "your work" to which the "written contract requiring insurance" applies. The person or organization does not qualify as an additional insured with respect to the independent acts or omissions of such person or organization.
2. The insurance provided to the additional insured by this endorsement is limited as follows:
   a) In the event that the Limits of Insurance of this Coverage Part shown in the Declarations exceed the limits of liability required by the "written contract requiring insurance", the insurance provided to the additional insured shall be limited to the limits of liability required by that "written contract requiring insurance". This endorsement shall not increase the limits of insurance described in Section III – Limits Of Insurance.
   b) The insurance provided to the additional insured does not apply to "bodily injury", "property damage" or "personal injury" arising out of the rendering of, or failure to render, any professional architectural, engineering or surveying services, including:
      i. The preparing, approving, or failing to prepare or approve, maps, shop drawings, opinions, reports, surveys, field orders or change orders, or the preparing, approving, or failing to prepare or approve, drawings and specifications; and
      ii. Supervisory, inspection, architectural or engineering activities.
   c) The insurance provided to the additional insured does not apply to "bodily injury" or "property damage" caused by "your work" and included in the "products-completed operations hazard" unless the "written contract requiring insurance" specifically requires you to provide such coverage for that additional insured, and then the insurance provided to the additional insured applies only to such "bodily injury" or "property damage" that occurs before the end of the period of time for which the "written contract requiring insurance" requires you to provide such coverage or the end of the policy period, whichever is earlier.
3. The insurance provided to the additional insured by this endorsement is excess over any valid and collectible "other insurance", whether primary, excess, contingent or on any other basis, that is available to the additional insured for a loss we cover under this endorsement. However, if the "written contract requiring insurance" specifically requires that this insurance apply on a primary basis or a primary and non-contributory basis, this insurance is primary to "other insurance" available to the additional insured which covers that person or organization as a named insured for such loss, and we will not share with that "other insurance". But the insurance provided to the additional insured by this endorsement still is excess over any valid and collectible "other insurance", whether primary, excess, contingent or on any other basis, that is available to the additional insured when that person or organization is an additional insured under such "other insurance".
4. As a condition of coverage provided to the additional insured by this endorsement:
   a) The additional insured must give us written notice as soon as practicable of an "occurrence" or an offense which may result in a claim. To the extent possible, such notice should include:

i. How, when and where the "occurrence" or offense took place;

ii. The names and addresses of any injured persons and witnesses; and

iii. The nature and location of any injury or damage arising out of the "occurrence" or offense.

b) If a claim is made or "suit" is brought against the additional insured, the additional insured must:

i. Immediately record the specifics of the claim or "suit" and the date received; and

ii. Notify us as soon as practicable.

The additional insured must see to it that we receive written notice of the claim or "suit" as soon as practicable.

c) The additional insured must immediately send us copies of all legal papers received in connection with the claim or "suit", cooperate with us in the investigation or settlement of the claim or defense against the "suit", and otherwise comply with all policy conditions.

d) The additional insured must tender the defense and indemnity of any claim or "suit" to any provider of "other insurance" which would cover the additional insured for a loss we cover under this endorsement. However, this condition does not affect whether the insurance provided to the additional insured by this endorsement is primary to "other insurance" available to the additional insured which covers that person or organization as a named insured as described in paragraph 3. above.

5. The following definition is added to SECTION V. – DEFINITIONS:

"Written contract requiring insurance" means that part of any written contract or agreement under which you are required to include a person or organization as an additional insured on this Coverage Part, provided that the "bodily injury" and "property damage" occurs and the "personal injury" is caused by an offense committed:

a. After the signing and execution of the contract or agreement by you;

b. While that part of the contract or agreement is in effect; and

c. Before the end of the policy period.

Policy DT-810-2J354550-TIL-18

THIS ENDORSEMENT CHANGES THE POLICY. PLEASE READ IT CAREFULLY.

BLANKET ADDITIONAL INSURED – PRIMARY AND NON-CONTRIBUTORY WITH OTHER INSURANCE

This endorsement modifies insurance provided under the following:

BUSINESS AUTO COVERAGE FORM

PROVISIONS

1. The following is added to Paragraph **A.1.c., Who Is An Insured**, of **SECTION II – COVERED AUTOS LIABILITY COVERAGE**:

   This includes any person or organization who you are required under a written contract or agreement between you and that person or organization, that is signed by you before the "bodily injury" or "property damage" occurs and that is in effect during the policy period, to name as an additional insured for Covered Autos Liability Coverage, but only for damages to which this insurance applies and only to the extent of that person's or organization's liability for the conduct of another "insured".

2. The following is added to Paragraph **B.5., Other Insurance** of **SECTION IV – BUSINESS AUTO CONDITIONS**:

   Regardless of the provisions of paragraph **a.** and paragraph **d.** of this part **5. Other Insurance**, this insurance is primary to and non-contributory with applicable other insurance under which an additional insured person or organization is the first named insured when the written contract or agreement between you and that person or organization, that is signed by you before the "bodily injury" or "property damage" occurs and that is in effect during the policy period, requires this insurance to be primary and non-contributory.

Power of Attorney

KNOW ALL MEN BY THESE PRESENTS THAT:

Nationwide Mutual Insurance Company, an Ohio corporation
National Casualty Company, an Ohio corporation

AMCO Insurance Company, an Iowa corporation
Allied Property and Casualty Insurance Company, an Iowa corporation

hereinafter referred to severally as the "Company" and collectively as "the Companies" does hereby make, constitute and appoint:

RICHARD B. USHER TAYLOR B. USHER DEBORAH STREETER

PHOENIX AZ

each in their individual capacity, its true and lawful attorney-in-fact, with full power and authority to sign, seal, and execute on its behalf any and all bonds and undertakings, and other obligatory instruments of similar nature, in penalties not exceeding the sum of

ONE MILLION FIVE HUNDRED THOUSAND AND NO/100 DOLLARS $ 1,500,000.00

and to bind the Company thereby, as fully and to the same extent as if such instruments were signed by the duly authorized officers of the Company; and all acts of said Attorney pursuant to the authority given are hereby ratified and confirmed.

This power of attorney is made and executed pursuant to and by authority of the following resolution duly adopted by the board of directors of the Company:

"RESOLVED, that the president, or any vice president be, and each hereby is, authorized and empowered to appoint attorneys-in-fact of the Company, and to authorize them to execute and deliver on behalf of the Company any and all bonds, forms, applications, memorandums, undertakings, recognizances, transfers, contracts of indemnity, policies, contracts guaranteeing the fidelity of persons holding positions of public or private trust, and other writings obligatory in nature that the business of the Company may require; and to modify or revoke, with or without cause, any such appointment or authority; provided, however, that the authority granted hereby shall in no way limit the authority of other duly authorized agents to sign and countersign any of said documents on behalf of the Company."

"RESOLVED FURTHER, that such attorneys-in-fact shall have full power and authority to execute and deliver any and all such documents and to bind the Company subject to the terms and limitations of the power of attorney issued to them, and to affix the seal of the Company thereto; provided, however, that said seal shall not be necessary for the validity of any such documents."

This power of attorney is signed and sealed under and by the following bylaws duly adopted by the board of directors of the Company.

Execution of Instruments. Any vice president, any assistant secretary or any assistant treasurer shall have the power and authority to sign or attest all approved documents, instruments, contracts, or other papers in connection with the operation of the business of the company in addition to the chairman of the board, the chief executive officer, president, treasurer or secretary; provided, however, the signature of any of them may be printed, engraved, or stamped on any approved document, contract, instrument, or other papers of the Company.

IN WITNESS WHEREOF, the Company has caused this instrument to be sealed and duly attested by the signature of its officer the 1st day of May, 2017.

SEAL SEAL

National Casualty Company CORPORATE 1904 SEAL Ohio

SEAL

Antonio C. Albanese, Vice President of Nationwide Mutual Insurance Company, National Casualty Company, AMCO Insurance Company, Allied Property and Casualty Insurance Company

ACKNOWLEDGMENT

STATE OF NEW YORK, COUNTY OF NEW YORK: ss

On this 1st day of May, 2017, before me came the above-named officer for the Company aforesaid, to me personally known to be the officer described in and who executed the preceding instrument, and he acknowledged the execution of the same, and being by me duly sworn, deposes and says, that he is the officer of the Company aforesaid, that the seal affixed hereto is the corporate seal of said Company, and the said corporate seal and his signature were duly affixed and subscribed to said instrument by the authority and direction of said Company

BARRY T. BASSIS
Notary Public, State of New York
No. 02BA4656400
Qualified in New York County
Commission Expires April 30, 2019

Notary Public
My Commission Expires
April 30, 2019

CERTIFICATE

I, Laura B. Guy, Assistant Secretary of the Company, do hereby certify that the foregoing is a full, true and correct copy of the original power of attorney issued by the Company; that the resolution included therein is a true and correct transcript from the minutes of the meetings of the boards of directors and the same has not been revoked or amended in any manner; that said Antonio C. Albanese was on the date of the execution of the foregoing power of attorney the duly elected officer of the Company, and the corporate seal and his signature as officer were duly affixed and subscribed to the said instrument by the authority of said board of directors; and the foregoing power of attorney is still in full force and effect.

IN WITNESS WHEREOF, I have hereunto subscribed my name as Assistant Secretary, and affixed the corporate seal of said Company this 13th day of September 2018

This power of attorney expires April 30, 2019

Assistant Secretary

BDJ 1(05-17)00

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