APPLICATION FOR LIMITED WATER USE LICENSE FOR AR TESTING

For SeVein Water Association

March 11, 2020

March 11, 2020

Norm McKibben
SeVein Water Association
52108 Seven Hills Road
Milton-Freewater, OR 97862

Re: Application for Limited Water Use License for AR Testing
Aspect Project No. 170687-3

Dear Norm:

Accompanying this letter is a complete Application for Limited Water Use License for AR Testing that includes the associated documents required by Oregon Water Resources Department (OWRD).

Aspect Consulting, LLC (Aspect) appreciates the opportunity to help SeVein Water Association (SWA) prepare this application and looks forward to supporting you through the agency review process.

We have included two hardcopies of your application and two USB drives with a digital version of this document. Our intention is for you to submit one hardcopy and one USB drive to OWRD and retain one copy of each for your records.

Next Actions

Please complete the following steps to submit your application to OWRD:

1. Review the enclosed documents to confirm that they properly reflect the proposal that you would like to make on behalf of SWA. If you see anything that concerns you, please let me know immediately.
2. Sign the first page of the Application form.
3. Prepare a check payable to OWRD in the amount of **$1,460** for the application fee.
4. Send one copy of the application package and USB drive to OWRD at the address indicated at the top of the Application form.

Sincerely,

Aspect consulting, LLC

John Warinner, PE, CWRE
Associate Water Resources Engineer
jwarinner@aspectconsulting.com

Attachments:
1 – Application for Limited Water Use License for AR Testing
2 – Vicinity and Site Maps
3 – Land Use Information Form
4 – Water Availability Statement
5 – AR Project Description Report
6 – Hydrogeologic Feasibility Report

V:\170687 SeVein - Water Management Support\Deliverables\TO-3_GW Recharge WR\Application Submittal\Final Application Submittal

ATTACHMENT 1

Application for Limited Water Use License for AR Testing

Oregon Water Resources Department
725 Summer Street NE, Suite A
Salem Oregon 97301-1271
(503) 986-0900
www.wrd.state.or.us

Application for Limited Water Use License

License No.:___________

Applicant Information

NAME SeVein Water Association				PHONE (HM) N/A
PHONE (WK) (541) 938-0598	CELL (509) 386-3871			FAX N/A
ADDRESS 52108 Seven Hills Road				
CITY Milton-Freewater	STATE OR	ZIP 97862	E-MAIL * james@seveinwater.com	

Agent Information

NAME John Warinner, PE, CWRE			PHONE 541.306.3614	FAX N/A
ADDRESS 532 SW 13th Street, Suite 103				CELL 541.815.4103
CITY Bend	STATE OR	ZIP N/A	E-MAIL * jwarinner@aspectconsulting.com	

I (We) make application for a Limited License to use or store the following described surface waters or groundwater – not otherwise exempt, or to use stored water of for a use of a short-term or fixed-duration:

1. **SOURCE(S) OF WATER:** Dry Creek a tributary of Pine Creek
2. **AMOUNT OF WATER** to be diverted;
   Maximum and instantaneous rate (cubic feet or gallons per minute): 3.35 cfs / 8.7 cfs
   Total volume (gallons or acre-feet): 1,003/2,600 ac-ft. If water is to be used from more than one source, give the quantity from each: N/A
3. **INTENDED USE(S) OF WATER:** (check all that apply)
   - ☐ Road construction or maintenance
   - ☐ General construction
   - ☐ Forestland and rangeland management; or
   - ☒ Other: Artificial Groundwater Recharge (AR)
4. **DESCRIPTION OF PROPOSED PROJECT:** Include a description of the place of use as shown on the accompanying site map, the method of water diversion, the type of equipment to be used (including pump horsepower, if applicable), length and dimensions of supply ditches and pipelines:

   Water will be diverted from Dry Creek, treated and injected into the basalt aquifer system via existing groundwater well(s). Initial testing will inject into SeVein Well 1 (Well Tag L-76996). Future may include injection into SeVein Well 4 (Well Tag L-122502). Pumping from diversion and treatment facility to the injection well(s) will require 180 hp pump capacity and 6,300 LF of 14-inch mainline.
5. **PROJECT SCHEDULE: (List day, month, and year)**
   Date water use will begin: Dec 1, 2020
   Date water use will be completed: Apr 15, 2025
   Months of the year water would be diverted and used: December through mid-April
   If for other than irrigation from stored water, how and where will water be discharged after use:

   Irrigation

_______________________ _______________________ _______________
Applicant Signature | Print Name *and title if applicable* | Date

PLEASE READ CAREFULLY

NOTE: A completed water availability statement from the local watermaster, Land Use Information Form completed by the local Planning Department, fees and site map meeting the requirements of OAR 690-340-030 must accompany this request. The fee for this request is **$280** for the first point of diversion plus **$30** for each additional point of diversion. Please review the Department's fee schedule to view fees required to request a limited license for Aquifer Storage and Recovery testing purposes or for Artificial Groundwater Recharge testing purposes.

Failure to provide any of the required information will result in return of your application. The license, if granted, will not be issued or replaced by a new license for a period of more than five consecutive years. The license, if granted, will be subordinate to all other authorized uses that rely upon the same source, or water affected by the source, and may be revoked at any time it is determined the use causes injury to any other water right or minimum perennial streamflow.

If water source is well, well logs or adequate information for the Department to determine aquifer, well depth, well seal and open interval, etc. are required. The licensee shall indicate the intended aquifer. If for multiple wells, each map location shall be clearly tired to a well log.

If a limited license is approved, the licensee shall give notice to the Department (Watermaster) at least 15 days in advance of using the water under the Limited License and shall maintain a record of use. The record of use shall include, but need not be limited to, an estimate of the amount of water used, the period of use and the categories of beneficial use to which the water is applied. During the period of the Limited License, the record of use shall be available for review by the Department upon request.

**A summary of review criteria and procedures that are generally applicable to these applications is available at: http://www.oregon.gov/owrd/pages/pubs/forms.aspx*

Mapping Requirements (OAR 690-340-0030):

(1) A request for a limited license shall be submitted on a form provided by the Water Resources Department, and shall be accompanied by the following:

   a. A site map of reproducible quality, drawn to a standard, even scale of not less than 2 inches = 1 mile, showing:

      i. The locations of all proposed points of diversion referenced by coordinates or by bearing and distance to the nearest established or projected public land survey corner;

      ii. The general course of the source for the proposed use, if applicable;

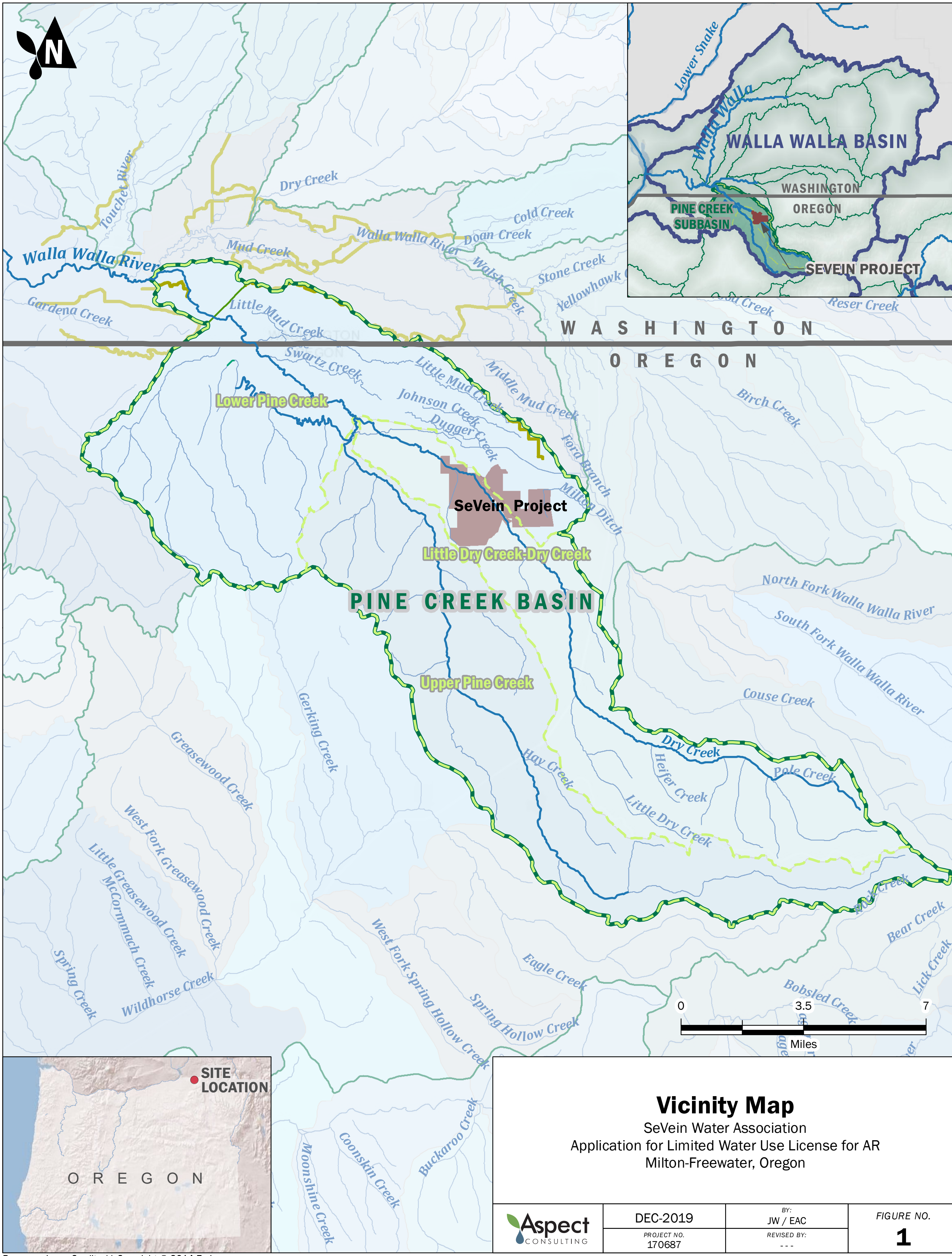
      iii. Other topographical features such as roads, streams, railroads, etc., which may be helpful in locating the diversion points in the field.

REMARKS:

For WRD Use Only

ATTACHMENT 2

Vicinity and Site Maps (3 maps)



Vicinity Map

SeVein Water Association
Application for Limited Water Use License for AR
Milton-Freewater, Oregon

Aspect CONSULTING	DEC-2019	BY: JW / EAC	FIGURE NO.
	PROJECT NO. 170687	REVISED BY: - - -	1

GIS Path: T:\projects_8\SeVeinWaterManagement_170687\D-3 Delivered\Application for Limited Water Use License\01_Vicinity Map_2019-12-22.mxd || Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet || Date Saved: 12/22/2019 || User: jwarinner || Print Date: 12/22/2019

Filter & Treatment

Injection Well 1

POD

Pipeline

N

0 600 1,200

Feet

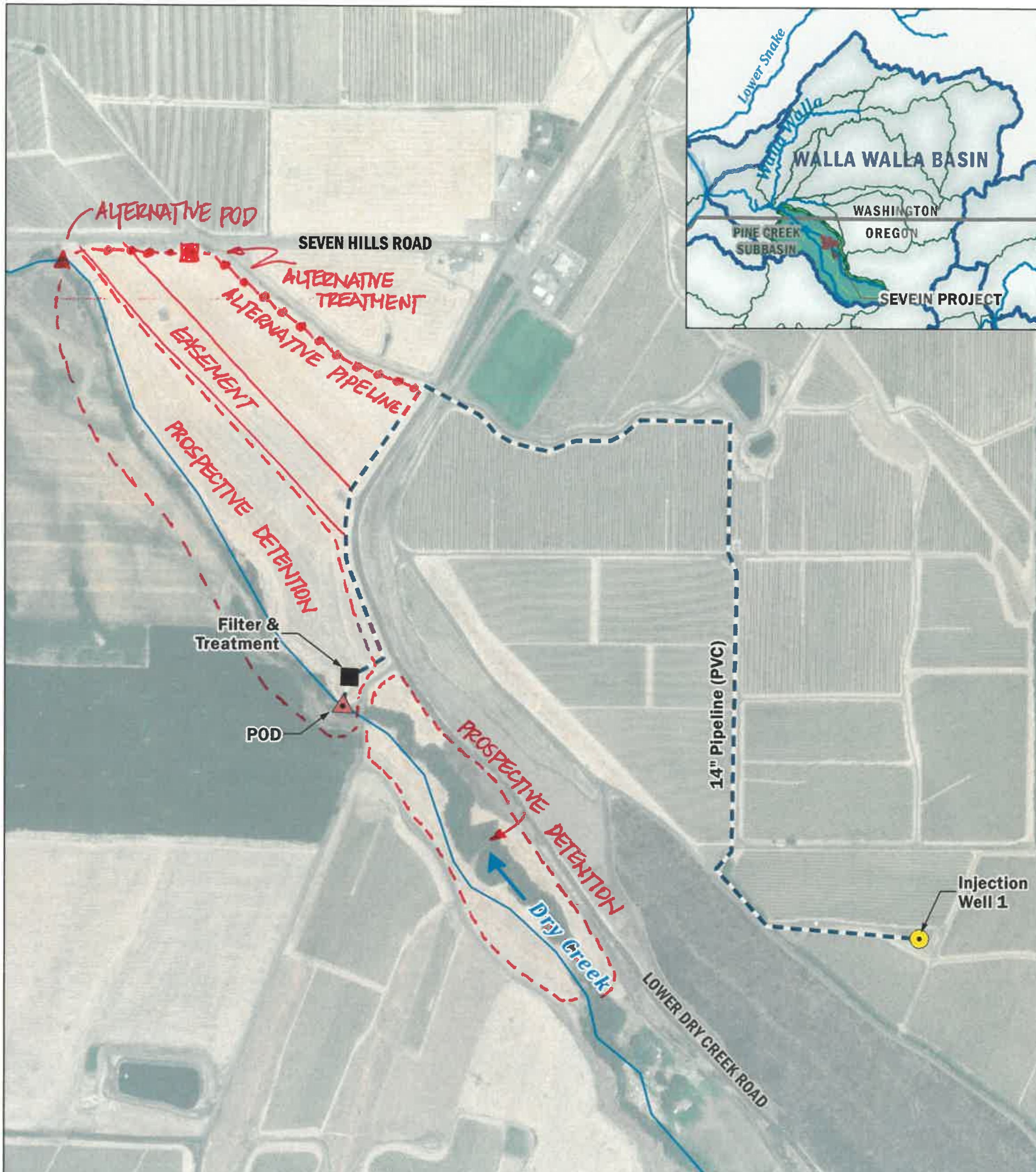
Site Map

SeVein Water Association
Application for Limited Water Use License for AR
Milton-Freewater, Oregon

Aspect CONSULTING

DEC-2019	BY: JW / EAC	FIGURE NO.
PROJECT NO. 170687	REVISED BY: TDR	2

GIS Path: T:\projects_8\SeVeinWaterManagement_170687\T0-3\Delivered\Application for Limited Water Use License\02_Site Map_2019-12-22.mxd || Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet || Date Saved: 12/22/2019 || User: jwarinner || Print Date: 12/22/2019



GIS Path: T:\projects_8\SeVeinWaterManagement_170687\T0-3\Delivered\Application for Limited Water Use License\03_Site Map_2019-12-22.mxd || Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet || Date Saved: 12/22/2019 || User: jwarinner || Print Date: 12/22/2019

■ Filter & Treatment

Injection Well 1

POD

Pipeline

N

0 600 1,200

Feet

Site Map

SeVein Water Association

Application for Limited Water Use License for AR

Milton-Freewater, Oregon

Aspect CONSULTING

DEC-2019	BY: JW / EAC	FIGURE NO.
PROJECT NO. 170687	REVISED BY: TDR	3

ATTACHMENT 3

Land Use Information Form

Land Use Information Form

Oregon Water Resources Department
725 Summer Street NE, Suite A
Salem, Oregon 97301-1266
(503) 986-0900
www.wrd.state.or.us

Applicant: SeVein Water Association (First) ______ (Last)

Mailing Address: 52108 Seven Hills Road, Milton-Freewater, OR 97862

City: Milton-Freewater State: OR Zip: 97862 Daytime Phone: (541) 938-0598

A. Land and Location

Please include the following information for all tax lots where water will be diverted (taken from its source), conveyed (transported), and/or used or developed. Applicants for municipal use, or irrigation uses within irrigation districts may substitute existing and proposed service-area boundaries for the tax-lot information requested below.

Township	Range	Section	¼ ¼	Tax Lot #	Plan Designation (e.g., Rural Residential/RR-5)	Water to be:	Proposed Land Use:
see	attached	table			All EFU	☐ Diverted ☐ Conveyed ☐ Used	
						☐ Diverted ☐ Conveyed ☐ Used	
						☐ Diverted ☐ Conveyed ☐ Used	
						☐ Diverted ☐ Conveyed ☐ Used	

List all counties and cities where water is proposed to be diverted, conveyed, and/or used or developed:

Umatilla County, Oregon

B. Description of Proposed Use

Type of application to be filed with the Water Resources Department:

☐ Permit to Use or Store Water ☐ Water Right Transfer ☐ Permit Amendment or Ground Water Registration Modification
☒ Limited Water Use License ☐ Allocation of Conserved Water ☐ Exchange of Water

Source of water: ☐ Reservoir/Pond ☐ Ground Water ☒ Surface Water (name) Dry Creek

Estimated quantity of water needed: 2,600 ☐ cubic feet per second ☐ gallons per minute ☒ acre-feet

Intended use of water: ☐ Irrigation ☐ Commercial ☐ Industrial ☐ Domestic for ______ household(s)
☐ Municipal ☐ Quasi-Municipal ☐ Instream ☒ Other Artificial Groundwater Recharge (AR)

Briefly describe:

Landowner(s) will divert water from Dry Creek during seasons when streamflow is abundant, store it in the basalt groundwater, then use it during the agricultural irrigation season. The intention of this practice of Artificial Groundwater Recharge (AR) is to stabilize and sustain groundwater levels within mandatory levels.

Note to applicant: If the Land Use Information Form cannot be completed while you wait, please have a local government representative sign the receipt at the bottom of the next page and include it with the application filed with the Water Resources Department.

See bottom of Page 3. →

For Local Government Use Only

The following section must be completed by a planning official from each county and city listed unless the project will be located entirely within the city limits. In that case, only the city planning agency must complete this form. This deals only with the local land-use plan. Do not include approval for activities such as building or grading permits.

Please check the appropriate box below and provide the requested information

☑ Land uses to be served by the proposed water uses (including proposed construction) are allowed outright or are not regulated by your comprehensive plan. Cite applicable ordinance section(s): UCDC Section 152.056(A)

☐ Land uses to be served by the proposed water uses (including proposed construction) involve discretionary land-use approvals as listed in the table below. (Please attach documentation of applicable land-use approvals which have already been obtained. Record of Action/land-use decision and accompanying findings are sufficient.) **If approvals have been obtained but all appeal periods have not ended, check "Being pursued."**

Type of Land-Use Approval Needed (e.g., plan amendments, rezones, conditional-use permits, etc.)	Cite Most Significant, Applicable Plan Policies & Ordinance Section References	Land-Use Approval:	
		☐ Obtained ☐ Denied	☐ Being Pursued ☐ Not Being Pursued
		☐ Obtained ☐ Denied	☐ Being Pursued ☐ Not Being Pursued
		☐ Obtained ☐ Denied	☐ Being Pursued ☐ Not Being Pursued
		☐ Obtained ☐ Denied	☐ Being Pursued ☐ Not Being Pursued
		☐ Obtained ☐ Denied	☐ Being Pursued ☐ Not Being Pursued

Local governments are invited to express special land-use concerns or make recommendations to the Water Resources Department regarding this proposed use of water below, or on a separate sheet.

Name: CAROl JOHNSON Title: Planner

Signature: Carol Johnson Phone: 541/278-6252 Date: 02/26/2020

Government Entity: Umatilla County

Note to local government representative: Please complete this form or sign the receipt below and return it to the applicant. If you sign the receipt, you will have 30 days from the Water Resources Department's notice date to return the completed Land Use Information Form or WRD may presume the land use associated with the proposed use of water is compatible with local comprehensive plans.

Receipt for Request for Land Use Information

Applicant name: SeVein Water Association

City or County: Umatilla County Staff contact: ______

Signature: ______ Phone: ______ Date: ______

				Water To Be...						
T-R-S	**QQ**	**Taxlot #**	**Plan Designation**	**X**	**Diverted**	**X**	**Conveyed**	**X**	**Used**	**Proposed Land Use**
5.00N-35.00E-4	NW NW	200	EFU			X	Conveyed			EFU
5.00N-35.00E-4	SW NW	200	EFU			X	Conveyed			EFU
5.00N-35.00E-4	NE SW	403	EFU			X	Conveyed	X	Used	EFU
5.00N-35.00E-4	NW SW	403	EFU			X	Conveyed			EFU
5.00N-35.00E-5	NE NE	300	EFU	X	Diverted	X	Conveyed			EFU
5.00N-35.00E-5	NW NE	300	EFU	X	Diverted	X	Conveyed			EFU
5.00N-35.00E-5	SE NE	300	EFU	X	Diverted	X	Conveyed			EFU

ATTACHMENT 4

Water Availability Memo

Project No.: 170687-3

February 28, 2020

To: Norm McKibben, SeVein Water Association

cc: Bob Rupar, SeVein Water Association
Marty Clubb, SeVein Water Association
Chris Figgins, SeVein Water Association
James Baker, SeVein Water Association

From:

John Warinner, PE, CWRE
Associate Water Resources Engineer
jwarinner@aspectconsulting.com

Re: **Water Availability**
Application for Limited Water Use License for AR Testing, SeVein Water Association

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Purpose

SeVein Water Association (SWA) is developing an Integrated Water Management Strategy (IWMS) to stabilize static water levels in the basalt aquifer system(s) that serves as the primary water source for the SeVein Project. One key element of this water strategy is to divert water from Dry Creek during the winter months and inject it into the basalt aquifer system for temporary storage. Oregon Water Resources Department (OWRD) refers to this practice as Artificial Groundwater Recharge (AR).

To request authorization from OWRD to divert and use water in this manner, SWA has prepared an Application for Limited Water Use License for AR Testing. One required element of this application is a *Water Availability Statement* completed by the local Watermaster.

Aspect Consulting, LLC (Aspect) prepared this memorandum to summarize available background information to:

1. Enable the Umatilla County Watermaster (Greg Silbernagel) to complete the *Water Availability Statement* for this proposal (attached as Appendix A).

2. Inform design of the water diversion, treatment and injection systems to be included in the SeVein AR system.

Proposed Rate(s) and Volume(s) of Water Diversion

SWA proposes to divert water from Dry Creek at a location within the SeVein Project, treat it to an appropriate degree to prevent degradation of the basalt aquifer, then inject it into the basalt aquifer system via one or more existing basalt groundwater wells. Details of the proposed project are documented in an associated AR Project Description Report.

In summary, SWA anticipates and proposes to implement the AR project in three phases:

- Phase 1 is a preparatory phase that will focus on testing the hydraulic response of the basalt aquifer system by pumping water from SeVein Well 4 and injecting it into SeVein Well 1 at the estimated rate of 3.35 cubic feet per second (cfs), which is half of the authorized production rate for the well.
- Phase 2 (subject to Phase 1 testing results) will focus on diverting streamflow from Dry Creek, treating it as appropriate to prevent degradation of the basalt aquifer system and well productivity, and injecting it into the basalt aquifer system at the estimated rate of 3.35 cfs for a total volume of 1,003 acre-feet in the 151-day streamflow diversion window (December through mid-April).
- Phase 3 (subject to Phase 2 testing results) will potentially focus on expanding diversion, treatment and injection capacity to divert and recharge up to the full demand volume anticipated for complete development of all planned vineyard blocks for the 1,528-acre SeVein Project. This volume is estimated as 1.7 feet per acre for a total of 2,600 acre-feet. For the 151-day streamflow diversion window, this requires a diversion/treatment/injection rate of 8.7 cfs. At full development, SWA proposes to only recharge the basalt aquifer system to the degree necessary to stabilize static water levels in the SeVein wells within established water right permit conditions.

Water Source

The proposed water source will be Dry Creek, which flows through the SeVein Project.

Streamflow Data

There are three main sources of data available to inform the occurrence and availability of streamflow within the SeVein Project:

1. Water Availability Report System
   Hosted on the Oregon Water Resources Department (OWRD) website at:
   https://apps.wrd.state.or.us/apps/wars/wars_display_wa_tables/MainMenu1.aspx

2. Peak Discharge Estimation Mapping Tool
   Hosted on the Oregon Water Resources Department (OWRD) website at:
   https://apps.wrd.state.or.us/apps/sw/peak_discharge_map/

3. Surface Water Monitoring Data
   Hosted on the Walla Walla Basin Watershed Council (WWBWC) website at:
   http://www.wwbwc.org/monitoring/surfacewater.html

Water Availability Report System (OWRD)

The OWRD Water Availability Report System computes and tabulates water availability based on 50 percent and 80 percent exceedance values. Two water availability reports for Dry Creek (50 and 80 percent exceedance) are summarized in Tables 1 and 2.

Table 1. Water Availability Calculation (OWRD)
Streamflow in Dry Creek (mouth) Above Pine Creek (50% Exceedance)

MONTH	NATURAL STREAM FLOW	CONSUMP. USES AND STORAGES	EXPECTED STREAM FLOW	RESERVED STREAM FLOW	INSTREAM FLOW REQMT	NET WATER AVAILABLE
JAN	13.10	0.36	12.70	0.00	0.00	12.70
FEB	33.40	0.91	32.50	0.00	0.00	32.50
MAR	44.60	1.21	43.40	0.00	0.00	43.40
APR	22.60	7.12	15.50	0.00	0.00	15.50
MAY	5.60	16.80	-11.20	0.00	0.00	-11.20
JUN	1.98	13.50	-11.60	0.00	0.00	-11.60
JUL	1.42	4.54	-3.12	0.00	0.00	-3.12
AUG	1.10	1.83	-0.73	0.00	0.00	-0.73
SEP	1.02	0.96	0.06	0.00	0.00	0.06
OCT	0.60	0.02	0.58	0.00	0.00	0.58
NOV	1.05	0.03	1.02	0.00	0.00	1.02
DEC	10.60	0.29	10.30	0.00	0.00	10.30
ANN	**8,190**	**2,880**	**6,930**	0	0	**6,930**

Notes:
Monthly rates in cubic feet per second (cfs). Annual volumes in acre-feet (ac-ft).

Table 2. Water Availability Calculation (OWRD)
Streamflow in Dry Creek (mouth) Above Pine Creek (80% Exceedance)

MONTH	NATURAL STREAM FLOW	CONSUMP. USES AND STORAGES	EXPECTED STREAM FLOW	RESERVED STREAM FLOW	INSTREAM FLOW REQMT	NET WATER AVAILABLE
JAN	4.97	0.36	4.61	0.00	0.00	4.61
FEB	11.80	0.91	10.90	0.00	0.00	10.90
MAR	19.80	1.21	18.60	0.00	0.00	18.60
APR	11.70	7.12	4.58	0.00	0.00	4.58
MAY	3.20	16.80	-13.60	0.00	0.00	-13.60
JUN	1.25	13.50	-12.30	0.00	0.00	-12.30
JUL	1.22	4.54	-3.32	0.00	0.00	-3.32
AUG	0.90	1.83	-0.93	0.00	0.00	-0.93
SEP	0.61	0.96	-0.35	0.00	0.00	-0.35
OCT	0.49	0.02	0.47	0.00	0.00	0.47
NOV	0.61	0.03	0.58	0.00	0.00	0.58
DEC	2.10	0.29	1.81	0.00	0.00	1.81
ANN	**8,190**	**2,880**	**6,930**	0	0	**6,930**

Notes:
Monthly rates in cubic feet per second (cfs). Annual volumes in acre-feet (ac-ft).

The water availability reports summarized in Tables 1 and 2 suggest that:

- No instream flows or streamflow reservations have been established for Dry Creek.
- Water is apparently available for diversion from December through April.
- While basin rules generally allow the practice of groundwater recharge in May, water does not appear to be available for diversion from Dry Creek during May.
- An annual volume of 6,930 acre-feet is apparently available for diversion during the months of December through April.
- Since instream flows and streamflow reservations have not been established for Dry Creek, it is unlikely that OWRD (and other state agencies such as Oregon Department of Fish and Wildlife) will allow allocation of this full amount without establishing some measure of baseflow to be left undiverted from the stream. The magnitude of this minimum perennial streamflow is currently unknown and will be established through the process of reviewing and responding to this Application for Limited Water Use License for AR Testing.

Peak Discharge Estimation Mapping Tool (OWRD)

The OWRD Peak Discharge Estimation Mapping Tool predicts peak discharges for ungagged watersheds using hydrologic prediction equations that relate peak discharges to physical watershed characteristics. Estimated peak discharges for Dry Creek in the vicinity of the SeVein Project are summarized in Table 3.

Table 3. Predicted Peak Discharge (OWRD)
Streamflow in Dry Creek in the Vicinity of SeVein Project
Drainage Area 40.7 square miles

RETURN PERIOD (years)	PEAK FLOW (cfs)	95% CONFIDENCE	
		LOWER LIMIT (cfs)	UPPER LIMIT (cfs)
2	337	110	1,040
5	724	318	1,650
10	1,080	526	2,230
20	1,500	754	2,990
25	1,650	829	3,290
50	2,150	1,060	4,380
100	2,720	1,280	5,790
500	4,380	1,750	10,900

The predicted peak discharges summarized in Table 3 illustrate the dynamic nature of streamflow in Dry Creek. The headwaters of Dry Creek occur at a relatively low elevation in the Blue Mountains, resulting in the potential for rapid release of runoff and snowpack during rain-on-snow events. This dynamic hydrological response is further illustrated by the surface water monitoring data captured by the Walla Walla Basin Watershed Council (WWBWC).

Surface Water Monitoring Data (WWBWC)

In 2011, WWBWC installed a streamflow monitoring station on Dry Creek at Seven Hills Road that continuously monitored streamflows from August 5, 2011 to April 6, 2018. The last meaningful discharge measurement (prior to download of data for this analysis) occurred on March 28, 2018.

The entire hydrograph monitored at this site is summarized on Figure 1. The data record appears to be relatively continuous except for a data gap occurring from the Fall 2016 through Spring 2017. The magnitude and frequency of peaks appear to be consistent with the predictions in Table 3.

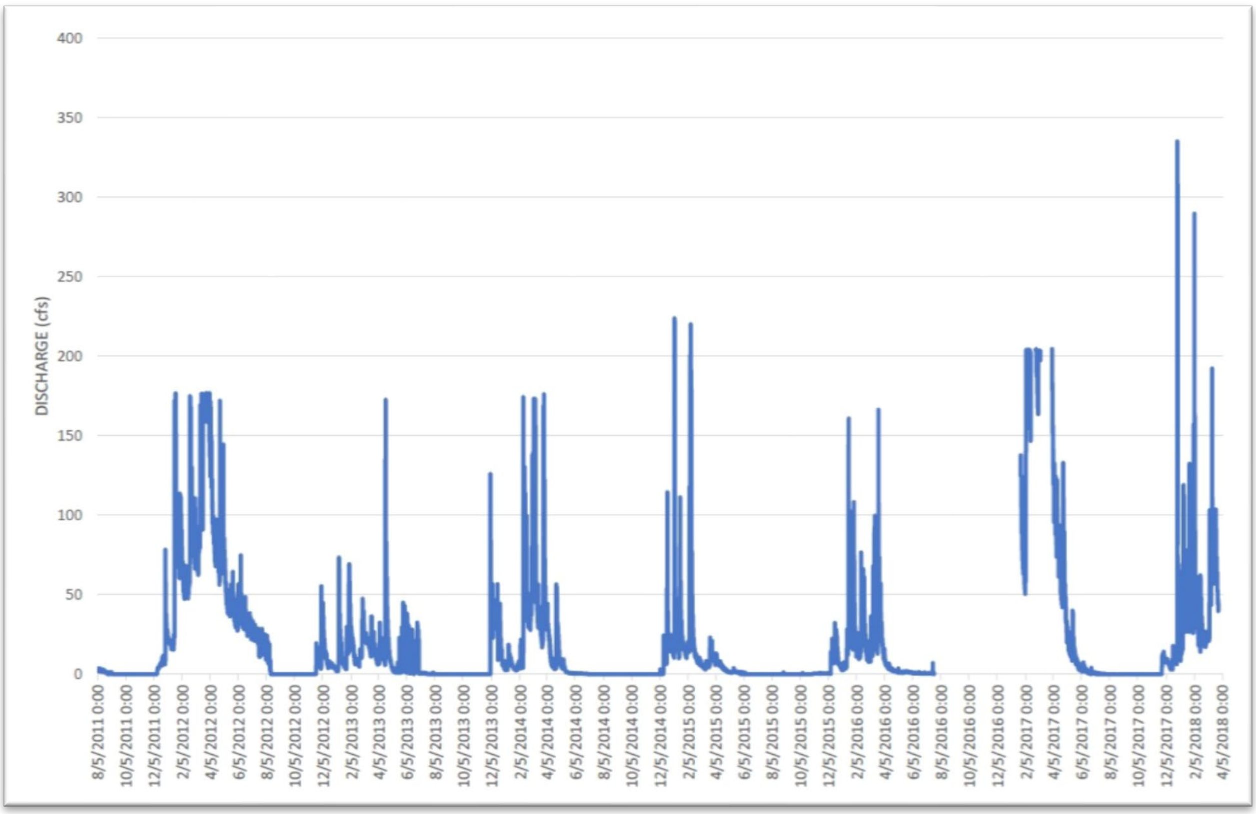

Figure 1. Streamflow Hydrographs for Dry Creek at Seven Hills Road (2011-2018)

This inquiry is focused on diversion of winter streamflows for groundwater recharge, and the laws governing water management in the Walla Walla Subbasin of the Umatilla Basin (OAR 690-507-0030) that limit artificial groundwater recharge to December 1 through May 15. Therefore, the streamflow measurements recorded during this time interval each year are of the greatest relevance and interest.

Two sample hydrographs measured during each of these time intervals for Water Years 2016 (lesser peak discharges) and 2018 (greater peak discharges) are illustrated on Figures 2 and 3 to allow closer inspection of the detailed streamflow dynamics, including peaks and troughs.

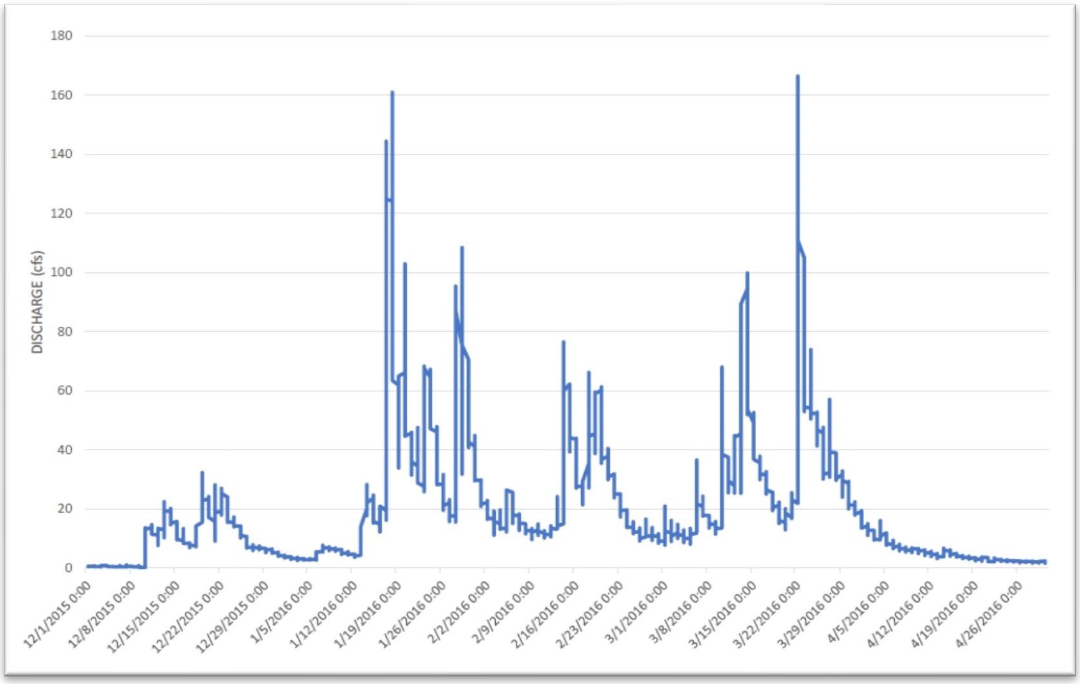

Figure 2. Streamflow in Dry Creek at Seven Hills Road (Dec 2015 – Apr 2016)

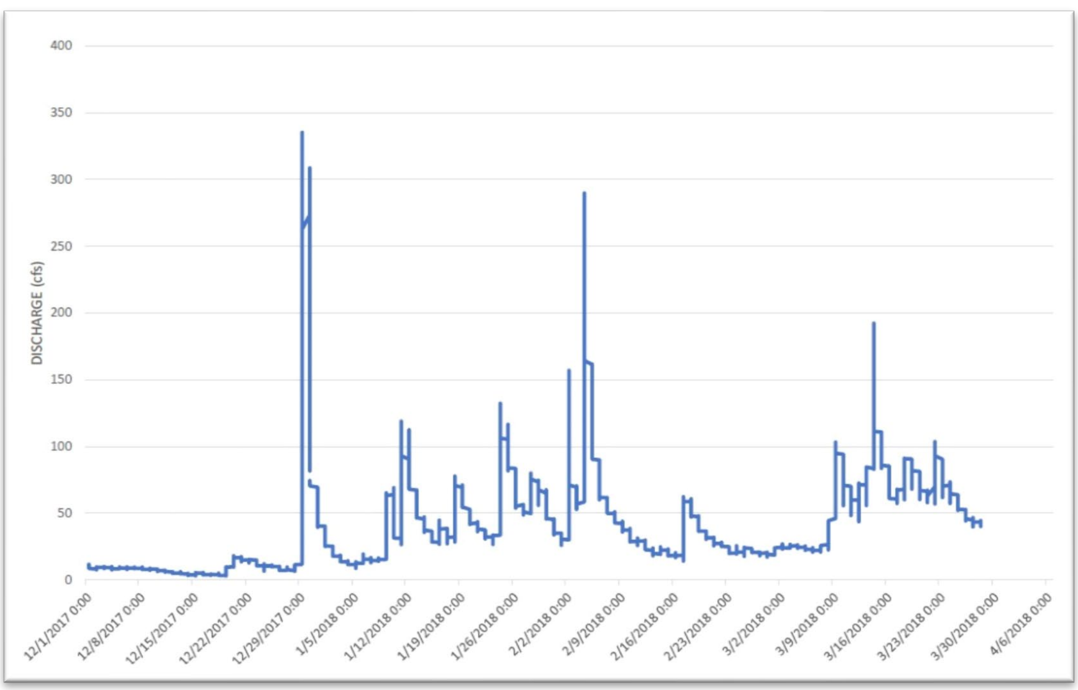

Figure 3. Streamflow in Dry Creek at Seven Hills Road (Dec 2017 – Apr 2018)

Annual volumes, peak discharges and base flows for the winter flow period of interest are summarized for comparison in Table 4.

Table 4. Comparison of Streamflow Hydrographs for Dry Creek at Seven Hills Road for December through April 2011-2018

TIME PERIOD	VOLUME (AC-FT)	MAXIMUM PEAK (CFS)	BASE FLOW (CFS)	PEAKS > 100 CFS	NOTES
Dec 2011 - Apr 2012	16,087	180	50	12	Full record
Dec 2012 - Apr 2013	4,978	175	5	1	Full record
Dec 2013 - Apr 2014	8,272	175	5	7	Full record
Dec 2014 - Apr 2015	4,760	225	5	5	Full record
Dec 2015 - Apr 2016	5,630	170	5	4	Full record
Dec 2016 - Apr 2017	10,066	N/A	N/A	N/A	Incomplete (data gap)
Dec 2017 - Apr 2018	9,305	340	10	8	Incomplete (ends in Mar)
AVERAGE VOL (ac-ft)	**8,443**				

Conclusions

Conclusions drawn from the various forms of available data are as follows:

- Water is apparently available for diversion from Dry Creek from December into April, a period of about 151 days.
- The total volume of flow occurring from December into April consistently exceed the volume(s) being proposed by SWA under the Application for Limited Water Use License for AR Testing. The annual volumes proposed for Phase 2 (1,003 acre-feet) and Phase 3 (2,600 acre-feet) are well within the measured volumes as well as the volume considered “available” by OWRD.
- During the proposed streamflow diversion period (Dec-Apr), streamflow appears to remain above the proposed rates of diversion on a consistent basis. The diversion rates proposed for Phase 2 (3.35 cfs) and Phase 3 (8.7 cfs) appear to be sustained in most years.
- Streamflow in Dry Creek is highly dynamic and a large portion of the annual yield (volume) occurs during relatively short time intervals at very high rates relative to the proposed rate of diversion. It is possible that streamflow could be detained within and potentially beyond the SeVein Project to improve the streamflow regime in Dry Creek. Opportunities for streamflow detention should be explored with project partners. This concept will be addressed in greater detail in the AR Project Description Report.

Water Availability Statement

The directions on Page 2 of the *Application for Limited Water Use License* state:

> *A completed water availability statement from the local Watermaster, Land Use Information Form completed by the local Planning Department, fees and site map meeting the requirements of OAR 690-340-030 must accompany this request.*

The *Water Availability Statement* completed by Umatilla County Watermaster Greg Silbernagel is attached to this memorandum as Appendix A. The attached *Water Availability Statement* confirms that water is available in the quantity and at the times needed to supply the use proposed by this application.

Limitations

Work for this project was performed for SeVein Water Association (Client), and this memorandum was prepared in accordance with generally accepted professional practices for the nature and conditions of work completed in the same or similar localities, at the time the work was performed. This memorandum does not represent a legal opinion. No other warranty, expressed or implied, is made.

All reports prepared by Aspect Consulting for the Client apply only to the services described in the Agreement(s) with the Client. Any use or reuse by any party other than the Client is at the sole risk of that party, and without liability to Aspect Consulting. Aspect Consulting's original files/reports shall govern in the event of any dispute regarding the content of electronic documents furnished to others.

Attachments: Appendix A – Water Availability Statement (completed and endorsed)

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APPENDIX A
Water Availability Statement

This page to be completed by the local Watermaster.

WATER AVAILABILITY STATEMENT

Name of Applicant: SeVein Water Association Limited License Number: ______________

1. To your knowledge, has the stream or basin that is the source for this application ever been regulated for prior rights?

☒ Yes ☐ No

If yes, please explain:

Pine Creek receives calls annually during summer months. Dry Creek has not been flowing into Pine Creek when these calls have been made.

2. Based on your observations, would there be water available in the quantity and at the times needed to supply the use proposed by this application?

☒ Yes ☐ No

3. Do you observe this stream system during regular fieldwork?

☒ Yes ☐ No

If yes, what are your observations for the stream?

Limited stream flow most of the year. It is a flashy system caused by winter precipitation events and snow melt.

4. If the source is a well and if WRD were to determine that there is the potential for substantial interference with nearby surface water sources, would there still be ground water and surface water available during the time requested and in the amount requested without injury to existing water rights?

☐ Yes ☐ No ☒ N/A

What would you recommend for conditions on a limited license that may be issued approving this application?

I would like to encourage applicant to make sure enough water is bypassed to meet downstream user needs. Applicant could be regulated off if a call is validated by a downstream certificated water right holder.

5. Any other recommendations you would like to make?

Signature [signature] WM District #: 5 Date: 2/25/2020

ATTACHMENT 5

AR Project Description Report

MEMORANDUM

Project No. 170687-3

March 11, 2020

To: Norm McKibben, SeVein Water Association (SWA)

From:

John Warinner, PE, CWRE
Associate Water Resources Engineer
jwarinner@aspectconsulting.com

Jon Turk, LHG, PG
Associate Hydrogeologist
jturk@aspectconsulting.com

Re: **AR Project Description Report**
Application for Limited Water Use License for AR Testing, SeVein Water Association

Purpose

SeVein Water Association (SWA) is developing an Integrated Water Management Program (IWMP) as a proactive effort to sustainably manage surface water and groundwater resources in the context of the SeVein Project.

One objective of this IWMP is to stabilize static water levels in the basalt aquifer system(s) that serves as the primary water source for the SeVein Project. The water rights authorizing the use of basalt groundwater for irrigation and temporary storage, include permit conditions that limit the degree to which static water levels in the production wells may decline below established baseline levels. To date, monitoring and reporting of static water levels indicate a general trend of decline(s) that have not yet exceeded the limits established in the water right permit conditions.

Under the SeVein IWMP, SWA is evaluating the feasibility of various strategies for sustaining static water levels within the established limits. One strategy, referred to as Artificial Groundwater Recharge (AR), involves diverting streamflow from Dry Creek during the winter months (December through March-April) and injecting the water into the basalt aquifer system via one or more existing production wells.

Oregon Water Resources Department (OWRD) authorizes groundwater recharge projects of this nature through a water rights instrument referred to as a Limited Water Use License. This AR Project Description Report is one element of an Application for Limited Water Use License for AR Testing.

Plans for Project Construction

The general plan is to adaptively design and implement an AR system that will divert streamflow from Dry Creek and inject the water into the basalt aquifer system (specifically the Grande Ronde Unit of the Columbia Basin Basalt Group). The following description references Figure 1 (Vicinity Map), Figure 2 (Site Map without streamflow detention) and Figure 3 (Site Map with streamflow detention) that were included with the Application for Limited Water Use License for AR Testing and are also attached at the end of this memorandum.

Process Flow

The proposed solution incorporates four main processes illustrated in Figure 4 below.

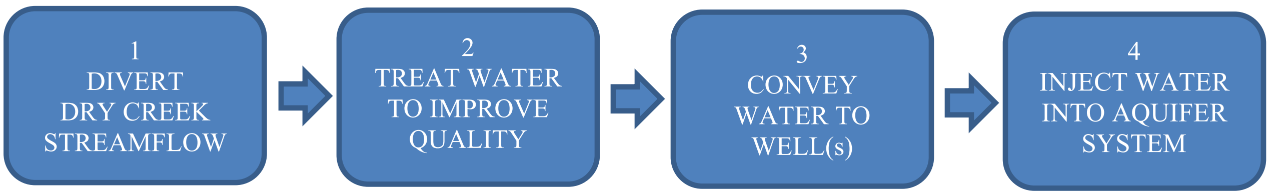

Figure 4. Process flow diagram for SeVein AR System

Each process step illustrated in Figure 4 is summarized as follows:

1. **Streamflow Diversion**
   This process will divert surface water from Dry Creek during the time period when water is available for diversion from the stream (December through March-April). Streamflow will be diverted in a manner that maintains continuous base streamflow and fish passage through the facility and prevents harm to present aquatic species.

   Streamflow patterns and water availability in Dry Creek are presented and evaluated in detail in a separate technical memorandum titled Water Availability. In summary, during the late fall, winter and early spring, streamflow in Dry Creek is highly dynamic, fluctuating variably in response to precipitation patterns. Depending on the minimum perennial streamflow established for Dry Creek, and the rate at which SWA is able to inject water into the basalt aquifer system, it may prove necessary to detain and regulate streamflow peaks in Dry Creek to improve the streamflow regime and increase the volume of water that can be diverted for AR. Streamflow detention can be accomplished in a manner that improves water quality, streamflow duration, ecological function and performance, flooding risk and increases passive recharge of the upper layer(s) of the basalt aquifer system (Wanapum Unit). Streamflow detention could also potentially extend the duration of streamflow availability.

2. **Water Treatment**
   This process will remove sediment, nutrients, chemicals and other contaminants from the surface water diverted from Dry Creek to prevent degradation of the water in the groundwater aquifer system. This process will also ensure chemical compatibility of the treated surface water (aerobic) with the receiving water in the basalt aquifer (anaerobic) to prevent fouling of the groundwater well.

3. **Water Conveyance**
   This process will convey or transport water from the water treatment facility to the existing groundwater well(s) where it will be injected into the basalt aquifer system. To the degree possible, SWA intends to utilize the existing water distribution infrastructure that currently distributes water throughout the SeVein Project.

4. **Water Injection**
   This process will inject the treated surface water into the basalt aquifer system currently serving as the primary source of irrigation water for the SeVein Project. The primary objective of injection is to seasonally recharge groundwater reserves to restore static water levels in SeVein wells to original reference levels and sustain static water levels within the 25-foot decline limit established as a water right permit condition.

The related process of groundwater recovery is not included in the proposed process flow diagram or the Application for Limited Water Use License for AR. SWA intends to continue withdrawing water from the basalt aquifer system under the existing certificated water rights. However, the water SWA injects into the basalt aquifer system will not be specifically protected for the purpose of recovery by SWA. The reason for this is a detail in Oregon water law and specific basin rules for the Walla Walla Subbasin (OAR 690-507-0030). Since the priority date of SWA's primary water rights falls after June 24, 1988, the subbasin rules prohibit protection of the injected water specifically for the purposes of recovery by SWA.

Project Uncertainties

Each process step in the proposed AR system involves uncertainties that will be addressed through an iterative permitting, design and implementation process referred to as AR Testing. Priority uncertainties that currently exist for each process step, as well as the overall legal and financial context, are summarized in Table 1 (attached).

SWA is particularly interested to address the legal and financial uncertainties summarized in the first column of Table 1. The SeVein Project represents a substantial investment that relies on developing a sustainable source of water to support this innovative agricultural development project. SWA has made a substantial additional investment investigating and developing potential solutions toward this end. SWA anticipates making additional investments in the implementation of this proposed program. Addressing the legal and financial uncertainties in a timely manner is key to the ongoing viability of this program.

Implementation Roadmap

Table 2 (attached) presents a roadmap for addressing each of the priority uncertainties in an appropriate sequence, with activities for each implementation track distributed over five phases. The start and end dates for each phase will be established collaboratively with the lead agencies involved in the review and development of the Limited Water Use License (OWRD, Oregon Department of Environmental Quality [ODEQ], Oregon Health Administration [OHA] and Oregon Department of Fish and Wildlife [ODFW]). SWA anticipates that the Confederated Tribes of the Umatilla Indian Reservation (CTUIR) and the Walla Walla Basin Watershed Council (WWBWC) may also be involved in the development and implementation of the proposed AR program.

Conceptual Design

The conceptual design of each component of the proposed AR system is summarized as follows. The system components are presented in the relative order of priority rather than the order in which they occur in the process flow diagram.

Aquifer Injection

Evaluation and characterization of the target basalt aquifer system is addressed in a separate technical memorandum titled Hydrogeological Feasibility Report that is included in the Application for Limited Water Use License for AR Testing.

One foundational hypothesis of the proposed AR program is that water injected into the basalt aquifer system will increase the static water level(s) in one or more SeVein production wells. The hydrogeological response of the basalt aquifer system to the proposed AR program is the highest priority uncertainty to address with the AR testing program. Considering the substantial costs of streamflow diversion (potentially including streamflow detention) and water treatment components, it is imperative to test the hydraulic response of the basalt aquifer system prior to investing in other system components.

SWA proposes to test the hydrogeological response to injection into SeVein Well 1 using water withdrawn from another existing production well (SeVein Well 4). Both existing production wells are developed wholly in the Grande Ronde Unit of the CRBG.

SWA anticipates that the optimal injection rate into SeVein Well 1 will be approximately half of the authorized production rate of this well (6.7 cubic feet per second [cfs]) or 3.35 cfs. SWA requests authorization from OWRD to withdraw 3.35 cfs from SeVein Well 4 and inject at this rate into SeVein Well 1. SWA also requests authorization from OWRD to withdraw/inject at a higher rate if testing results reveal that it is possible and desirable to inject at a higher rate. Injection is not anticipated to exceed the authorized production rates of SeVein Well 1 (6.7 cfs) or SeVein Well 4 (6.35 cfs).

The existing pumping and wellhead system will be modified as follows to control and measure the flow during injection to minimize air entrainment and prevent biofouling of the well:

- Downhole control valve and controls
- Bimodal flowmeter for monitoring injection/pumping volumes
- Bypass valve system
- Pump to waste for backflushing of the well
- Ancillary equipment related to the well (pressure sustaining valve, bypass valve, and adequate pressure transducer for injection and production water levels)
- Air and vacuum pressure relief
- Winterization of conveyance system at the wellhead

All SeVein wells are already equipped with flowmeters and water level monitoring sensors, which are connected to an automated supervisory control and data acquisition (SCADA) system. These instruments and/or the associated pipe manifold may need to be modified to enable measurement of flow in both directions, into and out of the well/aquifer.

Depending on the results of this initial test, and the feasibility, cost and perceived value, SWA may decide to reverse this test by withdrawing water from SeVein Well 1 and injecting it into SeVein Well 4. SWA requests authorization from OWRD to conduct this additional test if appropriate.

Depending on the results of this initial testing, SWA anticipates two potential stages of development of injection into the basalt aquifer system summarized in Table 3 below.

Table 3. Proposed Stages of Development for SeVein AR Program

Stage	Description	Rate	Volume
1	Initial testing and development of Well 1	3.35 cfs	1,003 AF/yr
2	Anticipated development of Wells 1 and 4	8.7 cfs	2,600 AF/yr

Notes: Stage 1 rate and volume may increase based on results of injection testing
Stage 2 represents complete development of 1,528 acres of vineyard.

Streamflow Diversion

The primary purpose or function of the streamflow diversion component is to divert streamflow from Dry Creek at the rate at which it can be injected into the basalt aquifer system.

Conceptual design criteria include:

- Operate under dynamic streamflow conditions in Dry Creek
  - Structurally withstand 500-year discharge of 4,380 cfs
  - Operationally manage 100-year discharge of 2,720 cfs (diverting as possible)
  - Operationally manage 10-year discharge of 1,080 cfs (diverting)
  - Anticipate/accommodate debris from upstream riparian areas
- Divert during period of streamflow availability
  - Details of streamflow availability are addressed under a separate memorandum titled Water Availability.
  - The Umatilla County Watermaster (Greg Silbernagel) has issued a Water Availability Statement (included in the Water Availability section of this application package) that confirms that streamflow is considered available for diversion for out-of-stream use during the proposed time period of December through March-April.
  - Under the current streamflow regime in Dry Creek, streamflow is available from December through March, extending into mid-April in some years, depending on climatic conditions and water demands of senior water right holders.
  - Streamflow detention improvements could potentially alter the streamflow regime to a degree that enables OWRD to broaden this existing window of water availability.
- Maintain minimum perennial streamflow in Dry Creek
  - Minimum perennial streamflow yet to be established by ODFW/agencies (Phase 1)
  - Base streamflow commonly drops to 5 cfs during Dec to Mar-Apr diversion period
- Divert up to rate at which water can be injected into basalt aquifer system
  - Subject to hydraulic testing (Phase 1)

    - Initial testing rate (Stage 1) is 3.35 cfs
    - Target development rate (Stage 2) is 8.7 cfs
- Prevent harm to fish and wildlife
    - Accommodate continuous passage of fish and other aquatic species through diversion facility in both upstream and downstream directions
    - Prevent diversion of fish and other out of stream per screening criteria to be established by ODFW/agencies (Phase 1)

Conceptual design of the streamflow diversion component will be informed substantially by regulatory parameters that will be established during Phase 1 and the streamflow detention feasibility analysis in Phase 2.

Based on preliminary meetings, communication with regulatory agencies, and conceptual design activities to date, SWA currently anticipates utilizing a streamflow diversion system implemented in many settings within the John Day River basin. This general design features an adjustable weir to impound water with a bypass chute/ladder at one end of the structure to maintain continuous streamflow and fish passage around the impoundment structure. Upstream of the impoundment, SWA will divert water through a headgate screened to prevent fish and other aquatic species from leaving the stream channel. During excessively high flow events and during non-diversionary periods, the weir can be fully lowered to lie flat against the streambed.

An alternative diversion design that may be considered is a subsurface infiltration gallery that provides some initial filtration of sediment suspended in the streamflow. This alternative has also been implemented with some success in the John Day River basin, with the best performance in applications where the longitudinal slope of the stream is relatively high (for flushing of fine sediment) and the streambed substrate is comprised of relatively stable cobble in a layer deep enough to securely bed the infiltration manifold. Consideration of this alternative will require more detailed investigation of the streambed substrate in reach of Dry Creek running through the SeVein Project. Preliminary observation suggests that the longitudinal gradient in the SeVein reach may be adequate. However, the streambed substrate is currently assumed to be relatively shallow mantle with a high degree of exposed basalt bedrock. So the thickness of the streambed substrate may not be conducive to this method of streamflow diversion.

SWA proposes to refine the design of the streamflow diversion facility in Phase 3, in collaboration with ODFW and other agencies. If SWA and the agencies decide to pursue the streamflow detention concept, design of the streamflow detention measures may introduce an opportunity to integrate a subsurface infiltration gallery into the overall solution design.

Streamflow Detention

Streamflow patterns and water availability in Dry Creek are presented and evaluated in detail in a separate memorandum titled Water Availability.

Under current watershed management practices, Dry Creek is a highly dynamic, ephemeral stream, with wet-season peaks frequently on the order of 350 cfs and periodically much higher and base streamflow periodically and seasonally approaching zero flow. Throughout most of the Dry Creek corridor, streamflow is concentrated and retained within the banks of Dry Creek with little detention and/or inundation of the Dry Creek floodplain. As a result, most of the streamflow volume occurring in in Dry Creek occurs in the form of 7 to 10 peak events each lasting several days to a week. When precipitation occurs in back-to-back events, or over an extended period, base streamflow levels can remain elevated for weeks to months. However, under drier or less-frequent precipitation patterns, base streamflow declines toward zero base flow.

Analyses of Dry Creek streamflow suggest there may be winter seasons where continuous diversion of 5 to 10 cfs is possible. Depending on the minimum perennial streamflow established by ODFW, it may prove necessary to introduce streamflow detention on Dry Creek to extend the periods of adequate streamflow and improve system reliability.

The primary function of the streamflow detention component is to maintain adequate base flow in the stream to sustain populations of fish and wildlife while also improving the efficiency and reliability of diverting streamflow for AR. This is accomplished by controlling streamflow discharge rates and facilitate short-term impoundment and storage of streamflow during peak flow events while maintaining a continuous flow of water in the stream. Proposed measures for detaining streamflow include introduction of instream weir structures to impound streamflow in combination with discharge controls and modifications to stream channels sections to accommodate both above-ground and below-ground storage of accumulated flows.

Secondary goals and benefits of this component include trapping/removal of sediment to reduce turbidity, passive physical and biological removal of other water-borne pollutants, as well as improved downstream water supply, flood mitigation, passive recharge of the Wanapum unit of the Columbia River Basalt Group (CRBG), which is the hydrogeological unit closest to the surface at this project location. Local hydrogeological conditions are presented in detail in an associated technical memorandum, but it is worth noting that a vertical fault (Dry Creek Fault) appears to provide some degree of hydraulic connectivity between Dry Creek and the Wanapum unit of the CRBG. Any measures that detain streamflow in Dry Creek will increase, to some degree, the volume of groundwater recharge occurring from Dry Creek into the Wanapum unit of the CRBG.

Conceptual design criteria include:

- Operate continuously and passively under dynamic streamflow conditions in Dry Creek
    - Structurally and operationally withstand 500-year discharge of 4,380 cfs
    - Avoid increasing flooding risk to the SeVein Project and/or any adjacent or downstream neighbors
    - Anticipate, accommodate and remove debris released from upstream riparian areas
- Maintain minimum perennial streamflow in Dry Creek
    - Minimum perennial streamflow yet to be established by ODFW/agencies (Phase 1)
    - Base streamflow commonly drops to 5 cfs during Dec to Mar-Apr diversion period
- Control streamflow discharge to ecologically and economically optimal levels
    - Optimal streamflow discharge levels will be established by ODFW and other agencies and project partners during the evaluation of streamflow detention feasibility (Phase 2 or sooner if desired by the agencies).

- Reduce discharge below undesirable levels that cause flooding and streambank erosion
- Maintain seasonally-varying flow (SVF) that flushes sediment from streambed substrate and triggers fish migration during various life stages
- Consider opportunities for streamflow detention to broaden this existing window of water availability for SWA and downstream water users
    - *Note: Detention of Dry Creek streamflow within the SeVein Project could potentially increase the opportunity for storage and utilization of Dry Creek streamflow in the context of the Walla Walla Flow Study.*

- Accommodate temporarily impounded and detained streamflow
    - Facilitate floodplain connectivity and soil storage of water for slow release of detained streamflow
    - Excavate and reshape floodplain soils to increase pool storage of impounded streamflow
    - Respect existing easements (power line) that restrict the adjacent lands that can be included in the streamflow detention area
- Prevent harm to fish and wildlife
    - Accommodate continuous passage of fish and other aquatic species through detention facility(ies) in both upstream and downstream directions
    - Minimize or mitigate stranding of fish and other aquatic species in out-of-stream areas

Conceptual design of the streamflow detention component (Phase 3) will be informed substantially by regulatory parameters that will be established during Phase 1 and the streamflow detention feasibility analysis in Phase 2.

At this point in the project, SWA anticipates that the streamflow detention component may involve a series of detention impoundments that incrementally control and detain streamflow throughout the SeVein reach of Dry Creek as conceptually illustrated in Figure 3.

The furthest upstream facility will focus on debris removal through natural treatment processes that can be enabled through geomorphological improvements in the stream corridor. Subsequent downstream facilities could incrementally reduce the streamflow to desirable degrees, integrating impoundments and discharge controls with streambank excavation and geomorphological improvements that accommodate impounded streamflow during peak events while also facilitating removal of sediment and other associated pollutants and improving stream ecology during lower flow periods. SWA anticipates that the greatest opportunity for water storage will occur in the stream reach upstream of Seven Hills Road and downstream of the SeVein Bridge as illustrated in Figure 3. Additional streamflow detention opportunities exist downstream of Seven Hills Road.

In association with an impoundment structure, a side-channel or orifice positioned at the bottom of the stream channel would be designed to allow continuous base flow through the impoundment structure(s) at a yet-to-be-determined rate of discharge. During periods when streamflow exceeds this base discharge, this low-level orifice will throttle flow and the impoundment would cause excess water to be stored upstream of the impoundment. Depending on additional design criteria introduced, the impoundment(s) would be equipped with at least one more overflow spillway, allowing excessive discharges to pass the impoundment without damage to the structure or neighboring properties.

The height of the impoundment(s) and excavation of soil upstream of the impoundment(s) will be designed to provide a temporary storage volume that enables diversion of a greater volume of the streamflow, while also moderating downstream peak streamflow.

Determination of the minimum perennial streamflow is a critical design parameter that must be established with OWRD and ODFW. Once the minimum perennial streamflow has been established, other key design criteria can also be determined, including:

- Location/siting relative to land parcel boundaries, stream channel characteristics, floodplain and upland characteristics, proximity and adjacency of neighboring properties (including consideration of real property and other land uses (air strip, etc…)).
- Detention volume(s) and associated excavation and earthwork
- Orifice and spillway sizing
- Impoundment geometry and geotechnical design

Depending on the extent and design of the streamflow detention facilities, it may prove preferable to locate the streamflow diversion facility further downstream near Seven Hills Road (also illustrated in Figure 3).

Given the substantial benefits to downstream property owners and water users, as well as fish and wildlife, SWA proposes to pursue this project component in partnership with other community members. The implementation path will include partnership, design, permitting, funding, construction and ongoing implementation and adaptive management. SWA has identified some conceptual design concepts and intends to pursue detailed design of this component once appropriate partnerships have been established. SeVein envisions the Confederated Tribes of the Umatilla Indian Reservation (CTUIR), Walla Walla Basin Watershed Council (WWBWC), City of Milton-Freewater and Umatilla County as priority partners for this project component.

Source Water Treatment

The primary function of the source water treatment component is to remove sediment, nutrients, chemicals and other contaminants from the surface water diverted from Dry Creek to prevent degradation of the water in the groundwater aquifer system. This component will also be designed to ensure chemical compatibility of the treated surface water (aerobic) with the receiving water in the basalt aquifer (anaerobic) to prevent fouling of the groundwater well.

At an earlier stage of this project, SWA performed preliminary sampling and analysis of surface water in Dry Creek and completed conceptual design of a source water treatment system based on the results of this preliminary sampling and analysis. The initial conceptual design focused on construction of a mechanical treatment facility, including filtration and disinfection treatment elements, and considered both membrane and sand filtration. The preliminary cost estimate for the conceptual design was on the order of $3 million. SeVein is currently investigating various alternatives to reduce the cost of water treatment.

During pre-application meetings, a representative of ODEQ clarified the need for a more formal and complete water quality sampling and analysis plan (SAP) to characterize water quality in Dry Creek and the basalt aquifer system. A complete draft of this water quality SAP is included as Appendix A. Water quality sampling and analysis will be initiated during Phase 1 and continued through Phase 2 to cover the entire streamflow diversion period. During Phase 3, SWA will use the results of the water quality sampling and analysis to confirm water treatment requirements and refine design of the water treatment component of the AR system.

SWA anticipates designing the source water treatment system to accommodate two potential stages of development previously summarized in Table 3. Depending on testing results regarding aquifer injection and decisions made regarding streamflow diversion/detention and the reliability of streamflow available for diversion from Dry Creek, the source water treatment system may need to be capable of intermittent operation during discrete time periods when streamflow is available for diversion. As discussed in the next section, SWA anticipates that it may be helpful to utilize existing storage bulges to maintain continuous water flow through the source water treatment system.

Regional patterns of static water level decline currently observed in the basalt aquifer system in Walla Walla Valley raise the possibility that other parties may adopt the practice of artificial recharge of the basalt aquifer system. Expanded adoption of this practice will present additional needs for source water treatment. The growth of this practice may introduce partnership opportunities for implementation of source water treatment facilities. SWA has initiated discussions with several parties in the Walla Walla Valley who could potentially partner on the design and implementation of one or more regional water treatment facilities.

Water Conveyance

The function of the water conveyance component is to convey treated surface water from the water treatment facilities to the target injection well(s) (SeVein Wells 1 and 4). This conveyance pipeline must provide capacity for transmission of the various discharge rates occurring during the anticipated three stages of project development. An existing pipeline network already connects SeVein Wells 1 and 4 with the remainder of the SWA water distribution system and is expected to provide the required capacity for water conveyance. SWA intends to connect the streamflow diversion and source water treatment facilities with this existing pipe network to convey treated source water to the injection well(s).

During Phase 2, SWA intends to clarify the degree to which it is feasible, desirable and allowable to use existing pipelines and storage bulges to optimize management of Dry Creek streamflow. SWA intends to design any required improvements to the water conveyance system during Phase 3 and construct designed improvements during Phase 4.

Operational Plans

Implementation Sequence and Timeline

As previously discussed, Table 2 presents an implementation roadmap for addressing each of the priority uncertainties in an appropriate sequence, with activities for each implementation track distributed over five phases. The start and end dates for each phase will be established collaboratively with the lead agencies involved in the review and development of the Limited Water Use License and summarized in Table 3 (following page).

Water Storage Volumes and Durations

Streamflow Diversion Rate

SWA anticipates designing the source water treatment system to accommodate the three potential stages of development previously identified and summarized in Table 4.

During the initial phase of AR testing, SWA proposes to inject water into the target injection well (SeVein Well 1) at a rate of 3.35 cfs. Depending on the results of the AR testing, SWA may need to inject water at a greater rate than this. Therefore, SWA requests authorization to inject into Well 1 up to the full authorized production rate of SeVein Well 4 (6.3 cfs).

Streamflow Diversion and Aquifer Injection Volume

The volume of water to be diverted, injected and temporarily stored in the basalt aquifer system will depend on the results of testing the hydraulic performance of the injection well, as well as the streamflow diversion period, minimum perennial instream flow, and maximum rates and volumes established by the regulatory agencies. The proposed volumes presented in Table 4 represent injection at the specified rate for a duration of 151 days (Dec-Apr).

Water Storage Duration

SWA currently anticipates that injection will occur from December through March/April. Historically, the irrigation season for SeVein has extended from April through October. However, climate variability could result in a need for irrigation as early as March or as late as November. So water storage will occur during the injection period and will extend through the withdrawal period.

Recovery Rates and Schedule

Recovery is not included as an element of this AR program.

Water Quality Monitoring Plan

A draft water quality sampling and analysis plan (SAP) to characterize water quality in Dry Creek and the basalt aquifer system is included as Appendix A.

SWA intends to implement water quality sampling and analysis according to this SAP. The source water treatment system will be designed, pilot tested and implemented in due course based on the results of the water quality sampling and analysis.

Ongoing water quality monitoring will be required to detect any substantial changes in the source water occurring in Dry Creek, as well as the efficacy of water treatment, adherence with water quality standards and compatibility of the treated surface water with the receiving water in the basalt aquifer system.

The water quality SAP will be refined at a later stage of system design and adaptively managed throughout implementation of the project.

Water Level Monitoring Plan

All four SeVein wells and the neighboring WWVA well are currently equipped with water level monitoring sensors connected to an automated supervisory control and data acquisition (SCADA) system. This existing system records measurements on a continuous basis. The time interval between water level measurements can be configured to satisfy the needs of the proposed hydraulic testing. No additional water level monitoring is anticipated or proposed at this time.

Water Quantity Measurement Plan

All four SeVein wells are currently equipped with flowmeters that are also connected to the SCADA system that records discharge measurements on a continuous basis. The piping manifold at the target injection well (SeVein Well 1) will be reconfigured to measure the rate and volume of water flowing into (injection) and out of (withdrawal) the well.

A similar flowmeter configuration will be installed as one element of the streamflow diversion facility to measure the rate and volume of water diverted from Dry Creek. This flowmeter will also be connected to the existing SCADA system. This collection of flow meters will provide a continuous and complete record of the quantities of water diverted from Dry Creek, injected into the target well, and withdrawn from all four production wells.

Table 4. Proposed Project Implementation Timeline

Phase	Description	Start Date	End Date
1	Clarify regulatory foundation to facilitate ongoing development and implementation of the proposed SeVein AR Program. Authorize hydraulic testing of injection into SeVein Well 1 using water withdrawn from SeVein Well 4, and design required modifications to Well 1. Establish minimum perennial instream flow and authorized streamflow diversion period, rate(s) and volume(s). Complete development of water quality SAP and initiate sampling of surface and groundwater.	Mar 2020	TBD
2	Modify Well 1 and conduct hydraulic testing of injection into Well 1 using water withdrawn from Well 4. Evaluate feasibility of diverting Dry Creek streamflow based on established minimum perennial streamflow and authorized diversion period, rate(s) and volume(s). Evaluate the feasibility of detaining streamflow to increase divertable rate(s) and volume(s). Complete sampling and analysis of surface and groundwater.	TBD	TBD
3	Establish relationships with desired partners for funding and design of system components. Refine design of system components.	TBD	TBD
4	Establish relationships with desired partners for funding and construction of system components. Construct system components.	TBD	TBD
5	Establish relationships with desired partners for funding and operation of system components. Operate and maintain system components for initial stage(s) of AR Program implementation. Clarify details for additional program stages.	TBD	TBD

Limitations

Work for this project was performed for the SeVein Water Association (Client), and this memorandum was prepared in accordance with generally accepted professional practices for the nature and conditions of work completed in the same or similar localities, at the time the work was performed. This memorandum does not represent a legal opinion. No other warranty, expressed or implied, is made.

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Attachments:
Table 1 – Priority Uncertainties
Table 2 – implementation Roadmap
Figure 1 – Vicinity Map
Figure 2 – Site Map (without streamflow detention)
Figure 3 – Site Map (with streamflow detention)
Appendix A – Water Quality Sampling and Analysis Plan

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TABLES

TABLE 1

PRIORITY UNCERTAINTIES

SeVein Water Association (SWA)
Artificial Groundwater Recharge (AR) Program
Version 2. 2019-12-22

PRIORITY PERFORMANCE GOAL
Restore static water levels in SeVein wells to original reference levels and sustain static water levels within the 25-foot decline established as a water right permit condition.

LEGAL AND FINANCIAL CONTEXT	STREAMFLOW DIVERSION	WATER TREATMENT	WATER CONVEYANCE	INJECTION INTO WELL
TIME Will Oregon Water Resources Department (OWRD) formally allow SWA ample time without regulatory action to determine and develop a sustainable solution?	MINIMUM PERENNIAL STREAMFLOW What minimum streamflow (cfs) will ODFW/agencies require SWA to leave in Dry Creek on a continuous basis during the allowable diversion period?	SURFACE WATER QUALITY What contaminants of concern are present in Dry Creek streamflow and to what degree do they vary throughout the allowable diversion period?	UTILIZATION OF EXISTING FACILITIES To what degree is it feasible, desirable and allowable for SWA to use existing pipeline(s) and storage bulges to optimize management of Dry Creek streamflow?	USE OF EXISTING PRODUCTION WELLS Can one or more of the existing SeVein production wells be modified to serve as injection wells to inject water into the basalt aquifer system?
CERTAIN ACCESS TO WINTER WATER Will OWRD formally grant SWA a secure priority date to impound, detain, divert and/or store Dry Creek streamflow to accomplish the stated performance goal?	AUTHORIZED DIVERSION PERIOD During what time period will OWRD/agencies allow SWA to divert streamflow from Dry Creek?	GROUNDWATER QUALITY How does groundwater quality in SeVein Well 1 compare to groundwater in SeVein Well 4 (the two wells anticipated to be involved in the proposed AR program)?		PRODUCTION AND INJECTION Can the existing SeVein production wells be modified to function effectively as both an injection well and production well?
TIMELY GUIDANCE/EVALUATION/DECISIONS Will OWRD, ODFW, ODEQ, OHA, CTUIR and other relevant agencies provide SWA with timely guidance, evaluation and decisions necessary to accomplish the stated goal?	AUTHORIZED DIVERSION RATE At what rate will OWRD/agencies allow SWA to divert above the minimum perennial streamflow rate?	WATER QUALITY COMPARISON How does the quality of surface water in Dry Creek compare to the quality of groundwater in the basalt aquifer system (SeVein Wells 1 and 4)?		GROUNDWATER WELL MODIFICATIONS To what degree must the SeVein well(s) be modified in order to inject water into the well(s) on a sustained basis?
FINANCIAL ASSISTANCE To what degree will OWRD, OWEB, ODFW, ODEQ, OHA, CTUIR, Walla Walla Basin Watershed Council, et al., provide financial assistance to accomplish the stated goal?	AUTHORIZED DIVERSION VOLUME What annual volume will OWRD/agencies allow SWA to divert from Dry Creek?	WATER TREATMENT REQUIREMENTS (1) In what ways and to what degree must surface water diverted from Dry Creek be treated to prevent degradation of the groundwater in the basalt aquifer system?		INJECTION RATES At what rate can SWA inject water into SeVein Well 1 (and possibly SeVein Well 4) on a sustained basis?
FINANCIAL STRATEGY How much will it cost to implement this proposed program, who will pay for it, and how will the financial element(s) be structured and accomplished?	ACTUAL DIVERTABLE VOLUME What volume of streamflow can SWA divert, given the streamflow dynamics on Dry Creek (see Water Availability memo), and minimum perennial streamflow?	WATER TREATMENT REQUIREMENTS (2) To what degree must treated surface water be further treated or conditioned to prevent degradation of the groundwater well performance (biofouling, etc.)?		AQUIFER RESPONSE TO INJECTION (1) To what degree does injection of water into the SeVein well(s) accomplish the stated performance goal (restoring and sustaining static water levels at required levels)?
	ACTUAL DIVERTABLE VOLUME To what degree is the actual divertable volume sufficient to achieve the stated performance goal?	WATER TREATMENT SYSTEM What are the most cost-effective ways to treat and/or condition the surface water diverted from Dry Creek prior to injection into the groundwater well(s)?		AQUIFER RESPONSE TO INJECTION (2) To what degree does injected water remain available for subsequent withdrawal by SWA?
	STREAMFLOW DETENTION To what degree can SWA detain streamflow to moderate streamflow peaks, expand duration and volume of diversion, and optimize benefits?			

TABLE 2

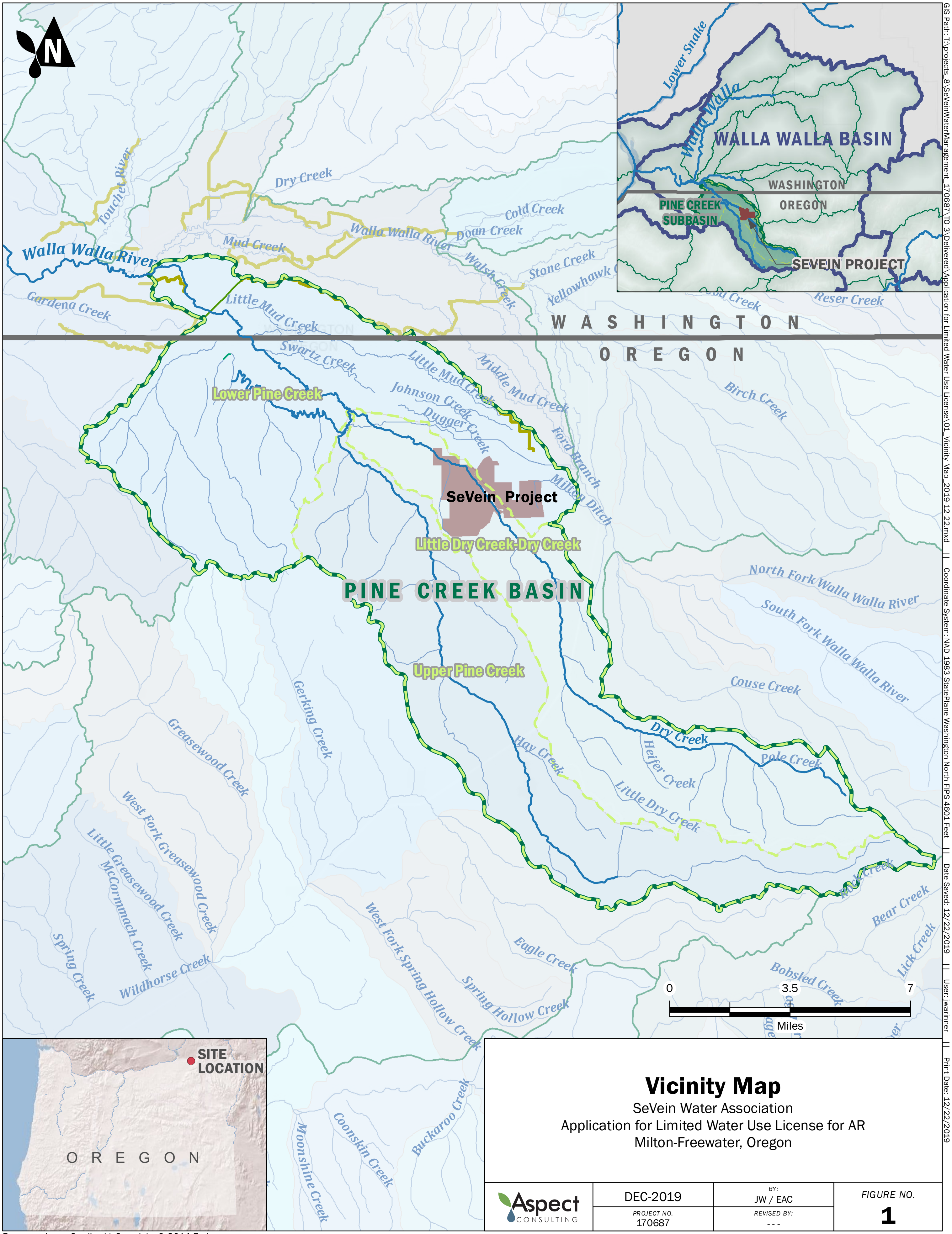
IMPLEMENTATION ROADMAP

SeVein Water Association (SWA)
Artificial Groundwater Recharge (AR) Program
Version 2. 2019-12-22

PRIORITY PERFORMANCE GOAL
Restore static water levels in SeVein wells to original reference levels and sustain static water levels within the 25-foot decline established as a water right permit condition.

IMPLEMENTATION TRACK	PHASE 1	PHASE 2	PHASE 3	PHASE 4	PHASE 5
1. LEGAL & FINANCIAL STRATEGY	TIME. OWRD formally grant SWA ample time to achieve stated performance goal. GUIDANCE. OWRD/agencies commit to provide timely guidance and decisions. CERTAINTY. OWRD formally grant SWA secure priority date to use Dry Creek streamflow. FUNDING. Agencies provide initial guidance regarding program elements qualifying for public funding support.	PARTNERS. Establish relationships with desired partners for funding and implementation of activities scheduled for Phase 2. FUNDING. Secure funding for scheduled activities in Phase 2, collaborating with partners to the appropriate degree.	PARTNERS. Establish relationships with desired partners for funding and implementation of activities scheduled for Phase 3. FUNDING. Secure funding for scheduled activities in Phase 3, collaborating with partners to the appropriate degree.	PARTNERS. Establish relationships with desired partners for funding and implementation of activities scheduled for Phase 4. FUNDING. Secure funding for scheduled activities in Phase 4, collaborating with partners to the appropriate degree.	PARTNERS. Establish relationships with desired partners for funding and implementation of activities scheduled for Phase 5. FUNDING. Secure funding for scheduled activities in Time Phase 5, collaborating with partners to the appropriate degree.
2. INJECTION INTO WELL(s)	AUTHORIZATION. OWRD authorize SWA to test hydraulic response of SeVein Well 1 to injection of water withdrawn from SeVein Well 4. INJECTION DESIGN. SWA design required modifications to SeVein Well 1 to perform as both production and injection well.	GROUNDWATER WELL MODIFICATIONS. Modify SeVein Well 1 for initial hydraulic testing using water withdrawn from SeVein Well 4. HYDRAULIC TESTING. Test hydraulic response of SeVein Well 1 using water withdrawn from SeVein Well 4. *Consider feasibility, cost, value of reversing this test to withdraw water from SeVein Well 1 and inject into SeVein Well 4.*	WELL IMPROVEMENT DESIGN. Design any required improvements to the existing groundwater wells and associated headworks.	WELL IMPROVEMENT DESIGN. Construct designed improvements to the existing groundwater wells and associated headworks.	WELL INJECTION OPERATIONS. Initiate well injection operations and associated monitoring and reporting.
3. STREAMFLOW DIVERSION (potentially including Streamflow Detention)	MINIMUM INSTREAM FLOW. ODFW/agencies establish minimum perennial instream flow. AUTHORIZED DIVERSION PERIOD. OWRD establish streamflow diversion period. AUTHORIZED DIVERSION RATE. OWRD establish maximum diversion rate. AUTHORIZED DIVERSION VOLUME. OWRD establish maximum diversion volume.	ACTUAL DIVERTABLE VOLUME. Determine volume SWA can divert from Dry Creek. ACTUAL DIVERTABLE VOLUME. Evaluate degree to which detention is necessary to divert volume to achieve stated performance goal. STREAMFLOW DETENTION FEASIBILITY. Establish feasibility of detaining streamflow to increase divertable volume and improve ecological performance of Dry Creek.	*STREAMFLOW DETENTION DESIGN. Subject to feasibility, desirability and funding, design improvements/treatments to the Dry Creek stream corridor to detain peak streamflows, improve the streamflow regime, increase the volume of water that can be diverted for storage/recharge, and improve ecological performance of Dry Creek.* STREAMFLOW DIVERSION DESIGN. Design facility(ies) to divert streamflow from Dry Creek.	*STREAMFLOW DETENTION IMPROVEMENTS. Subject to feasibility, desirability and funding, implement the designed improvements/treatments to the Dry Creek stream corridor .* STREAMFLOW DIVERSION FACILITIES. Construct the designed streamflow diversion facility(ies).	STREAMFLOW DETENTION/DIVERSION OPERATIONS. Initiate operations and maintenance of streamflow detention and diversion improvements, including associated monitoring and reporting.
4. WATER TREATMENT	WATER QUALITY SAMPLING/ANALYSIS PLAN. SWA continue developing WQ SAP in collaboration with ODEQ. WATER QUALITY SAMPLING. Initiate sampling of surface water in Dry Creek and groundwater in SeVein Wells 1 and 4. GROUNDWATER EVALUATION. Compare water quality in SeVein Wells 1 and 4 to evaluate compatibility for hydraulics test.	WATER QUALITY SAMPLING/ANALYSIS. Continue/complete sampling and analysis of surface water in Dry Creek.	WATER TREATMENT REQUIREMENTS. Establish required treatment/conditioning of surface water from Dry Creek prior to injection into basalt aquifer system to prevent degradation of groundwater quality (contamination) and well performance (biofouling, etc.). WATER TREATMENT SYSTEM DESIGN. Design optimal system for treatment and conditioning of surface water diverted from Dry Creek prior to injection into basalt aquifer system. Will include bench-scale and pilot testing to refine and finalize the design.	WATER TREATMENT SYSTEM CONSTRUCTION. Construct system for treatment and conditioning of surface water diverted from Dry Creek prior to injection into basalt aquifer system.	WATER TREATMENT SYSTEM OPERATIONS. Initiate operations and maintenance of water treatment facilities, including associated monitoring and reporting.
5. WATER CONVEYANCE		UTILIZATION OF EXISTING FACILITIES. Determine the degree to which it is feasible, desirable and allowable for SWA to use existing pipeline(s) and storage bulges to optimize management of Dry Creek streamflow?	WATER CONVEYANCE DESIGN. Design any required improvements to the existing water conveyance system.	WATER CONVEYANCE CONSTRUCTION. Construct designed improvements to the existing water conveyance system.	WATER CONVEYANCE OPERATIONS. Initiate operations and maintenance of water conveyance facilities, including associated monitoring and reporting.

FIGURES



Vicinity Map

SeVein Water Association
Application for Limited Water Use License for AR
Milton-Freewater, Oregon

Aspect Consulting	DEC-2019	BY: JW / EAC	FIGURE NO. 1
	PROJECT NO. 170687	REVISED BY: - - -	

■ Filter & Treatment

● Injection Well 1

▲ POD

- - - Pipeline

N

0 600 1,200

Feet

Site Map

SeVein Water Association
Application for Limited Water Use License for AR
Milton-Freewater, Oregon

Aspect CONSULTING

DEC-2019	BY: JW / EAC	FIGURE NO.
PROJECT NO. 170687	REVISED BY: TDR	2

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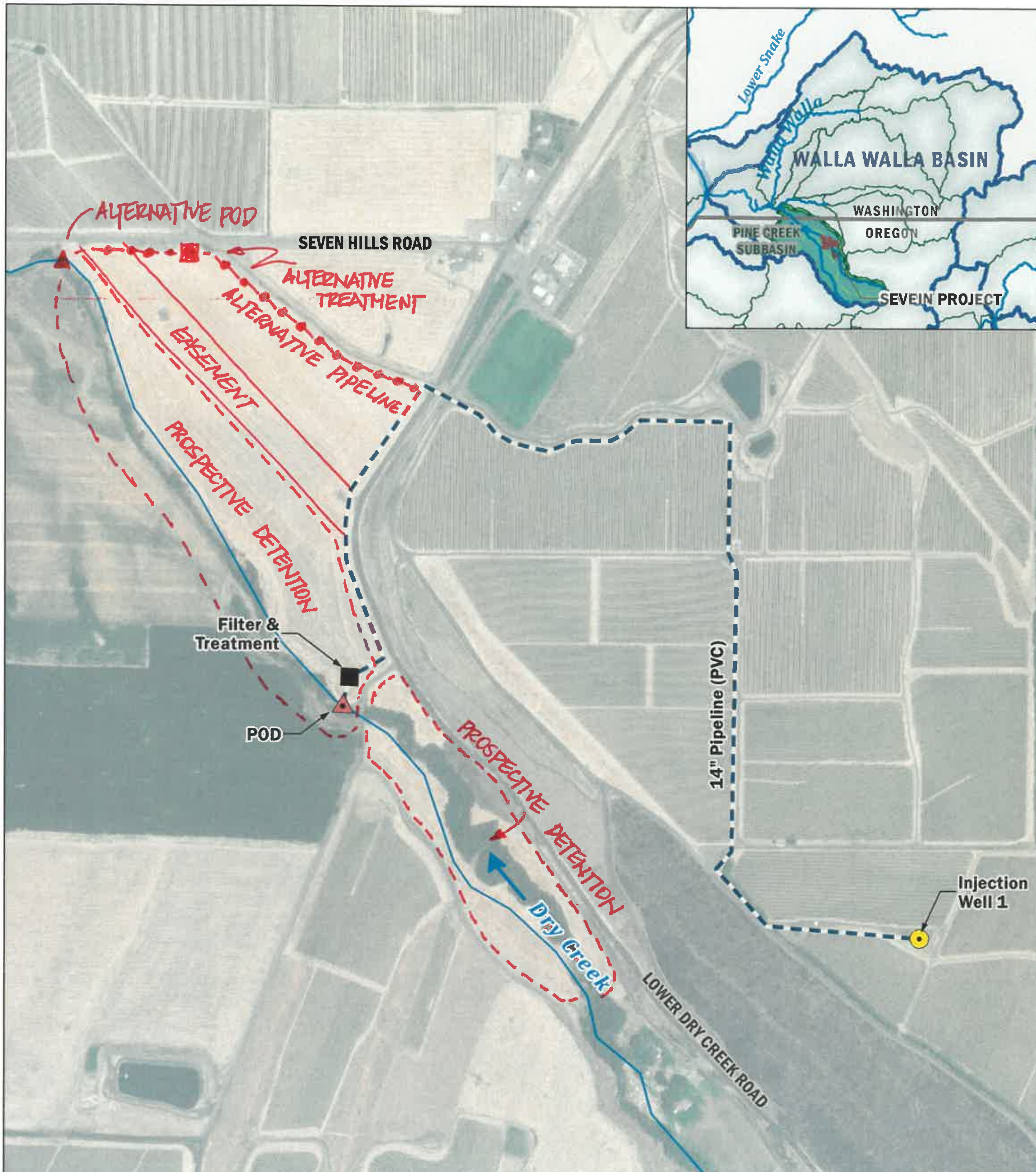
GIS Path: T:\projects_8\SeVeinWaterManagement_170687\D-3 Delivered\Application for Limited Water Use License\02_Site Map_2019-12-22.mxd || Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet || Date Saved: 12/22/2019 || User: jwarinner || Print Date: 12/22/2019



Filter & Treatment

Injection Well 1

POD

Pipeline

0 600 1,200

Feet

Site Map

SeVein Water Association

Application for Limited Water Use License for AR

Milton-Freewater, Oregon

Aspect CONSULTING	DEC-2019	BY: JW / EAC	FIGURE NO.
	PROJECT NO. 170687	REVISED BY: TDR	3

GIS Path: T:\projects_8\SeVeinWaterManagement_170687\T0-3\Delivered\Application for Limited Water Use License\03_Site Map_2019-12-22.mxd || Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet || Date Saved: 12/22/2019 || User: jwarinner || Print Date: 12/22/2019

APPENDIX A

Water Quality Sampling and Analysis Plan

WATER QUALITY SAMPLING AND ANALYSIS PLAN

Dry Creek Basin Artificial Groundwater Recharge

Prepared for: SeVein Water Association

Project No. 170687-13 • March, 2020 DRAFT

Aspect CONSULTING

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WATER QUALITY SAMPLING AND ANALYSIS PLAN

Dry Creek Basin Artificial Groundwater Recharge

Prepared for: SeVein Water Association

Project No. 170687-13 • March, 2020 DRAFT

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Acronyms and Abbreviations

AR	Artificial groundwater recharge
Aspect	Aspect Consulting, LLC
ASR	Aquifer storage and recharge
cfs	cubic feet per second
CRBG	Columbia River Basalt Group
EDD	electronic data deliverable
DI	deionized
Ecology	Washington State Department of Ecology
gpm	gallons per minute
IWMP	Integrated Water Management Program
mg/L	milligrams per liter
MS	Matrix spike
MSD	Matrix spike duplicate
OAR	Oregon Administrative Rules
ODEQ	Oregon Department of Environmental Quality
OWRD	Oregon Water Resources Department
QAPP	Quality assurance project plan
RD	Relative difference
SAP	Sampling and Analysis Plan
SWA	SeVein Water Association
µg/L	micrograms per liter
USGS	U.S. Geological Survey
WWBWC	Walla Walla Basin Watershed Council

Distribution List

Phil Richerson, Hydrogeologist, Oregon Department of Environmental Quality

Jennifer Woody, Hydrogeologist, Oregon Water Resources Department

James Baker, General Manager, SeVein Water Association

Executive Summary

[to be written during preparation of final SAP]

Background

This section provides the project background and purpose along with a description of the project location, related studies and data, and the applicable state and federal regulations.

Purpose

The purpose of this Water Quality Sampling and Analysis Plan (SAP) is to detail sampling and analyses that will be conducted to inform the design, permitting and implementation of a proposed Artificial Groundwater Recharge (AR) system to be owned, constructed and operated by SeVein Water Association (SWA or SeVein).

The proposed AR system is one component of an Integrated Water Management Program (IWMP) to sustainably manage surface water and groundwater resources in the context of the SWA Project, an innovative agricultural development project located west of Milton-Freewater in Umatilla County, Oregon. A primary objective of the IWMP is to replenish and sustain static water levels in the basalt aquifer system that underlays the Walla Walla watershed.

This SAP is one element of an Application for Limited Water Use License for AR Testing that SWA is submitting to Oregon Water Resources Department (OWRD). The license is to secure authorization to divert streamflow from Dry Creek and use it to replenish and sustain static water levels in the basalt aquifer system that serves as the primary water source for the SWA.

Project Location

SeVein is situated on an upland slope overlooking the Walla Walla Valley that is bisected by the Dry Creek drainage, as illustrated in Figure 1 (Vicinity Map). The project features 1,528 acres of irrigated land subdivided into approximately 40 land parcels owned by multiple landowners. SWA owns and operates four basalt groundwater wells, five water storage reservoirs and a common water distribution pipe network that supplies water to the individual landowners and water users.

The proposed AR system is intended to divert streamflow from Dry Creek, treat the water if necessary, transport it to the target injection well(s) and inject it into the Grande Ronde unit of the Columbia River Basalt Group (CRBG) as conceptually illustrated in Figure 2 (Surface Water Diversion and Injection Locations).

Problem Description

The primary objective of the IWMP is to stabilize static water levels in the basalt aquifer system that serves as the primary water source for the SWA. Permit conditions included in the water right certificates authorizing the use of basalt groundwater for irrigation and temporary storage, include conditions that require annual measurement and reporting of static water levels in the production wells, and limit the degree to which static water levels in the wells may decline below established baseline levels. Water level measurements reported to date, for the SeVein wells and other groundwater wells in the Walla Walla subbasin, indicate a general trend of decline. SWA is proposing AR as a proactive strategy to cease and reverse the historic pattern of static water level decline in the deep basalt aquifer.

Existing Data and Similar Projects

Several relevant documents were reviewed to inform the water quality monitoring approach and evaluation for this project. These include plans, reports, and data for the Walla Walla watershed from SWA and the Walla Walla Basin Watershed Council (WWBWC). Also reviewed were guidance documents from the State of Oregon Department of Environmental Quality and Water Resources Department and a report from a similar project in the Umatilla Basin for aquifer recharge.

- SeVein Water Company Surface Water Treatment, September 2018, memo from J-U-B Engineers
- Walla Walla Basin Aquifer Recharge Strategic Plan, January 2013, WWBWC
- Walla Walla Basin Aquifer Recharge Water Quality and Water Level Monitoring Quality Assurance Project Plan, June 2015, WWBWC
- WWBWC Watershed Monitoring Program Standard Operating Procedures, September 2018, WWBWC
- Surface Water and Groundwater Monitoring and Reporting Plan, May 2016, WWBWC
- Water Monitoring and Assessment Mode of Operations Manual, March 2009, State of Oregon Department of Environmental Quality
- Milton-Freewater Aquifer Storage and Recovery Project Phase 1 Feasibility Study, June 2019, prepared by WWBWC for the Oregon Water Resources Department
- April 1999 Milton-Freewater Groundwater Quality Study, June 2000, Oregon Department of Environmental Quality
- Quality Assurance Project Plan, Statewide Toxics Monitoring Program, September 2012, State of Oregon Department of Environmental Quality
- Walla Walla Subbasin Stream Temperature Total Maximum Daily Load and Water Quality Management Plan, August 2005, State of Oregon Department of Environmental Quality
- Umatilla Basin Aquifer Recharge Project, Limited License, September 2011
- Excerpts from Rudd Farms ASR Water Quality Evaluation memorandum, with Attachment D Geochemical Mixing Evaluation, Papadopulos and Associates

Applicable Regulations

The Walla Walla watershed includes areas in both Oregon and Washington. Because the proposed AR project here would occur solely in the Oregon part of the watershed, the Oregon water quality regulations take precedence. This SAP is being submitted to the State of Oregon as part of the project's Limited Water Use License application as required under Oregon Administrative Rules (OAR) 690-350. Applicable regulations from include the following:

- OAR 690-350, Aquifer Storage and Recovery (ASR) and Artificial Groundwater Recharge (AR)
- OAR 340-040 Groundwater Quality Protection
- OAR 340-044 Underground Injection Control

Definition of AR per OAR 690-350:

> "Artificial Groundwater Recharge" means the intentional addition of water diverted from another source to a groundwater reservoir. (Applications to obtain permits for artificial groundwater recharge uses submitted pursuant to OAR 690-350-0110 to 690-350-0130 are not subject to provisions governing aquifer storage and recovery projects or programs pursuant to OAR 690-350-0010 to 690-350-0030.)

In addition, Oregon water quality standards will be used in the assessment and analysis of the data, including:

- OAR 340-041 Water Quality Standards: Beneficial Uses, Policies, and Criteria
- OAR 333-061 Drinking Water Regulations (includes Groundwater Rules)

Water quality results will be analyzed and compared among surface water and groundwater to determine compatibility for injection and if treatment is needed. The compatibility analysis will address the antidegradation requirements in the water quality standards to demonstrate how the geochemistry of the aquifer water won't be detrimentally affected by injection of surface water.

Water Quality Monitoring Goals, Objectives, Design, and Schedule

This section describes the goals and objectives of the water quality analysis as well as the design, organization, and schedule.

Monitoring Goals

The goals of the water quality monitoring for the proposed SeVein AR are:

- Determine if surface water from Dry Creek is compatible for injection into the deep basalt aquifer
- Determine water quality compatibility between groundwater monitoring wells for well-to-well transfer
- Identify what, if any, treatment of surface water may be needed for injection to the deep basalt aquifer to ensure compatibility with groundwater quality
- Contribute to other Walla Walla watershed AR and groundwater management efforts to help ensure water supply while meeting water quality regulations

Monitoring Objectives

The monitoring objectives were determined to meet the goals stated above.

- Measure water quality of Dry Creek at the diversion point (after treatment if needed).
- Measure groundwater quality from the basalt aquifer at the injection well prior to injection beginning to establish the "background" water quality condition of the aquifer.
- Measure groundwater at a down-gradient well in the basalt aquifer before and during injection to characterize the hydraulic and water quality effects of injection.
- Compare groundwater and surface water quality data to determine compatibility.
- Recommend treatment options, if needed, to ensure compatibility of surface water and groundwater for recharge.

Monitoring Design

Prior to diverting and injecting surface water into the basalt aquifer, flows in Dry Creek and in groundwater will be measured and sampled to characterize water quality, discharge (for Dry Creek), and hydraulic conductivity (groundwater). For this initial characterization, the following sampling design will be used.

- Background condition of the surface water will be determined from Dry Creek samples collected and analyzed prior to injection occurring.

- Collect water samples from Dry Creek:
  - Eight samples collected during the periods of proposed streamflow diversion from December through April.
  - Some analytes will be collected as grab samples at the beginning of each sampling event.
  - Remaining analytes will be collected as 24-hour composite with hourly aliquots (one large sample bottle).
  - Target sample collection events during periods of elevated flow from runoff due to precipitation or snowmelt.
  - Do not sample during periods outside of the diversion window (May through November).
- Samples will be collected at one station on Dry Creek or from the pipeline into which the diversion water would be routed.
- Sampling events will be planned considering the timing of wet weather, key land use activities, and seasonal flow patterns in order to characterize typical water quality. Sample events will be targeted during:
  - Storm events with precipitation-driven runoff and seasonally elevated creek flows
  - Snowmelt during spring months
  - Periods of tilling, planting, irrigating, and harvesting crops
  - Periods of pesticide, herbicide, and fertilizer application

For groundwater:

- Background condition of the groundwater will be determined from water samples and *in-situ* data from SeVein Well 1.
  - Note: the decision to use Well 1 for background determination is based on the lack of a known up-gradient well on SeVein property developed in the same aquifer. SeVein Well 2 (see Figure 3) is up-gradient of Well 1 but it is not considered suitable to serve as background since it is believed to be developed in more aquifer units than just the one desired for recharge (lower Grande Ronde unit).
- Collect water samples from SeVein Well 1 (Figure 2), which is developed in the deep basalt aquifer:
  - Monthly samples for one year prior to injection
- Timing considerations:
  - Seasonal fluctuations in water level
  - Timing of other recharge in basin (if any)
- To address the antidegradation policy in the Oregon water quality standards (OAR 340-041-0004), down-gradient conditions of the aquifer after injection of surface water will be assessed by samples and *in-situ* data from the WWVA Well, which is about half a mile downgradient of the injection well (Figure 3)

- Monthly samples for one year prior to and following the beginning of injection

Monitoring Schedule and Organization

The proposed monitoring schedule is as follows.

Time Frame	Targeted Tasks
January 2020 – March 2020	• Complete SAP and coordinate agency review and approval • Design monitoring station on Dry Creek • Confirm functionality of existing monitoring and sampling equipment in existing SeVein wells • Plan for installation of new wells if necessary
April 2020 – June 2020	• Prepare and install monitoring station on Dry Creek • Begin sampling surface water from Dry Creek • Begin sampling groundwater from existing wells • Prepare technical memo with initial water quality results and preliminary compatibility analysis
November 2020 – April 2021	• Continue monitoring surface water and groundwater • Implement SAP, including sampling, data collection, data review and management, and quality controls
May 2021	• Prepare final water quality report with full water quality results and compatibility analysis • Send report to ODEQ, OWRD, and WWBWC

The project contact list is as follows.

Name	Affiliation	Project Role
John Warinner	Aspect Consulting LLC	Consultant Project Lead
James Packman	Aspect Consulting LLC	Surface Water/Water Quality Lead
Jonathan Turk	Aspect Consulting LLC	Groundwater/Aquifer Hydraulic Assessment Lead
Norm McKibben	SeVein Water Association	Partner (primary contact)
Bob Rupar	SeVein Water Association	Partner (primary contact)
Marty Clubb	SeVein Water Association	Partner (secondary contact)
Chris Figgins	SeVein Water Association	Partner (secondary contact)
James Baker	SeVein Water Association	General Manager (primary contact)
Phil Richerson	Oregon Department of Environmental Quality	AR Regulation
Jennifer Woody	Oregon Department of Water Resources	ASR and UIC Regulation

Sampling Methods and Instrumentation

This section describes methods and instrumentation to be used for collecting and analyzing water quality samples and data for both surface water from Dry Creek and groundwater from the basalt aquifer. Sample field sheets are included in Appendix A.

Surface Water

This section describes the surface water quality monitoring of Dry Creek. Monitoring will include automated sampling during the diversion window of December to April with the goal of sampling wet weather events, snowmelt, and periods of typical agricultural land use. Monitoring will also include water sampling and continuous *in-situ* data collection with a multiparameter sonde.

Sample Event Planning

For surface water samples, wet weather events will be identified by tracking weather forecasts and targeting samples over a 24-hour period during and following precipitation when Dry Creek flow is elevated from runoff. The following definitions of three types of sampling events are being used for this project based on professional judgment and climate records for the Walla Walla area from the Western Region Climate Center.

- A wet weather event will be defined as 0.30 inches of rainfall (liquid, not frozen) or more forecasted within a 24-hour period.
- A snowmelt event will be defined as forecasted air temperatures greater than 50 F on average for 24 hours or more prior to sampling between April and June.

Weather forecasts from the National Weather Service for Walla Walla Regional Airport[1] will be used to determine if qualifying precipitation will occur and to plan for sample collection. Rainfall data for the project will be obtained from the National Weather Service gauge at the Walla Walla Regional Airport, ID KALW[2].

Sample Timing

Surface water samples will be collected to characterize Dry Creek water quality over eight wet weather and/or snowmelt events during one diversion period (December to April). The table below provides the anticipated sampling schedule.

Month(s)	Sampling Events	Relative Discharge	Watershed Activities	Runoff Characteristics
December	2	Elevated wet weather flow	Surface water diversion	Wet weather
January-March	2	Elevated flow from wet weather	Surface water diversion	Wet weather

[1] https://forecast.weather.gov/MapClick.php?lat=46.09430000000003&lon=-118.28801999999996#.XmkcaKhKhhF
[2] https://mesowest.utah.edu/cgi-bin/droman/meso_base_dyn.cgi?stn=kalw

Month(s)	Sampling Events	Relative Discharge	Watershed Activities	Runoff Characteristics
March	2	Elevated flow from wet weather	Surface water diversion, crop tilling and planting	Wet weather
April	2	Elevated flow from snowmelt and wet weather	Surface water diversion, crop planting and fertilizing	Wet weather or snowmelt

Sample Collection

Surface water samples from Dry Creek will be collected at a designated monitoring station established on the creek bank or sampled from the pipe that collects and conveys the diversion water. The station will be equipped with a pressure transducer, programmable sampler, a controller and data logger, battery, and suction line into the creek. The sampler will be fitted with a single bottle (large glass) and sample aliquots will be collected hourly during sample events to represent a time-weighted composite over 24 hours. Some analytes will be collected as grab samples per laboratory recommendations and will be collected and submitted to the laboratory at the beginning of the sampling event.

Sample Analysis

Surface water samples will be analyzed for the chemicals and compounds listed in Table 1, which were selected to be consistent with similar studies on AR and ASR and with similar projects in the Walla Walla basin. Table 1 also indicates the number of sample events for which each parameter will be analyzed. Some parameters will be analyzed in samples from multiple events while others will be analyzed in samples from selected events based on the parameter, the time of year, and the anticipated watershed activities. For purposes of sample analysis, the time of the last aliquot added to the composite sample will be used to represent the composite sample time and for holding time considerations prior to analysis.

Sample parameters are listed in Table 1 and analyte groups include:

- Bacteria
- Geochemical parameters to assess reduction-oxidation potential and precipitates
- Metals
- Nutrients
- Regulated synthetic organic compounds (SOCs)
- Other volatile and semi volatile organic chemicals (VOCs and SVOCs)
- Pesticides
- Radionuclides
- Disinfection by-products (if treatment is needed)

In addition to analytes in Table 1, additional pesticides will be analyzed per the Oregon Pesticide Partnership Program list. The list includes numerous compounds analyzed by three methods and is included in Appendix D.

Sonde Water Quality Measurements

In addition to samples analyzed for water quality, continuous water quality data will be collected with a sonde deployed *in-situ* at the monitoring station. Parameters will be measured and logged at 15-minute intervals, and the sonde data will be downloaded monthly. The sonde will be checked and calibrated once a month per manufacturer directions. Parameters measured by the sonde will include the following in the table below.

Continuous Water Quality Parameters	
Parameter	**Units**
Water temperature	°C
Dissolved oxygen (DO)	mg/L
pH	pH units
Conductivity	μS/cm @ 25°C
Turbidity	NTU

μS/cm @ 25°C = microSiemens per centimeter at 25 degrees Celsius,
NTU = nephelometric turbidity units

Data Types Generated

- Measured stage:
    - An arbitrary zero datum will be chosen at the monitoring station to verify the continuous stage measurements
    - Stage noted during manual discharge measurements
- Continuous stage measurement:
    - A pressure transducer will measure water column pressure and convert it to a digital value with a measurement accuracy of ±0.03 ft
    - Stage logged every 15 minutes
- Discharge measurements:
    - A stage-discharge rating curve will be established by manually measuring creek flow over a range of discharge rates and correlating flow values to stage (water depth)
    - Data corrections are done on the rating curve to account for change in channel conditions
- Continuous water quality (sonde):
    - Parameters measured and logged every 15 minutes: dissolved oxygen, temperature, conductivity, pH

- Water sample analytical lab results

Groundwater

This section describes the sampling methods and instrumentation to be used for groundwater measurement and sampling.

Sample Collection

Groundwater quality monitoring to be done to characterize the chemistry of the deep basalt aquifer at SeVein Well 1 (Figures 2 and 3). Monitoring will include samples collected on a monthly basis, and continuous *in-situ* water quality and groundwater level measurement with a multiparameter sonde to record hourly readings.

Groundwater sampling includes using existing submersible pumps for sampling, measuring the depth to water, collecting and labeling all required samples, maintaining an appropriate storage environment for collected samples, and delivering the collected samples to the lab. Detailed instructions for the groundwater pump and sonde operation are in Appendix C.

Sample Analysis

Analytes to be determined on groundwater samples include some of the same parameters as for surface water, but form a smaller list. Table 2 lists all groundwater analytes, which includes the following groups.

- Bacteria
- Geochemical to assess reduction-oxidation potential and precipitates
- Metals
- Other volatile and semi volatile organic chemicals (VOCs and SVOCs)
- Pesticides (including the Oregon Pesticide Partnership Analyte list, Appendix D)
- Radionuclides
- Disinfection by-products (if treatment is needed)

Sonde Water Quality Measurements

Data from the sondes will be downloaded once a month, concurrent with groundwater sampling. The downloaded files will be opened onsite to ensure the sonde is working properly. The sonde will be calibrated per manufacturer instructions.

Continuous Water Quality Parameters	
Parameter	Units
Pressure due to water column	ft
Water temperature	°C
DO	mg/L
pH	pH units
Conductivity	µS/cm @ 25°C

Continuous Water Quality Parameters	
Parameter	Units
Pressure due to water column	ft
Turbidity	NTU

µS/cm @ 25°C = microSiemens per centimeter at 25 degrees Celsius,
NTU = nephelometric turbidity units

Data Types Generated

The following data will be generated by this groundwater monitoring program, measurement frequency is also noted:

- Measured groundwater level:
  - Will be collected at each site visit (monthly)
- Continuous groundwater levels:
  - A pressure transducer or bubbler will measure water column pressure and convert it to a digital value with a measurement accuracy of ±0.03 ft
  - Measurements will be recorded every one hour
- Continuous water quality (sonde):
  - Parameters measured and logged every one hour: dissolved oxygen, temperature, conductivity, pH
- Analyte concentration on a monthly basis

Field Notes and Observations

Field log entries shall include the following:

- Name of the project and location
- Identity of field personnel
- Sequence of events
- Changes to the sampling procedures
- Site and weather conditions
- Number and types of samples collected
- Date, time, location, identification, and description for each sample
- Instrument calibration procedures
- Field measurement results
- Identity of QC samples
- Unusual circumstances which affect interpretation of the data
- If any photographs were taken, the time, location, subject matter, and purpose for the photo

Data Management

This section describes how data will be generated, acquired, managed, and stored. Data will be stored in databases for discharge and water quality results.

Stream Discharge and Water Level Data

Discharge data from Dry Creek and water level data from groundwater will be downloaded directly to a laptop computer (or remotely if telemetered). Data will be pulled into a spreadsheet database for initial review. Data will be reviewed for data gaps and periods when maintenance was occurring on the instruments. Erroneous data with a known explanation will be flagged for removal, and questionable data will be flagged for further review.

Field sheets with observations and notes will be scanned and kept in a project folder. In addition, field notes about conditions that could affect the discharge and level readings will be added to the notes in the database.

Sample Analysis Results and Sonde Data

Sample analysis results will be entered into a water quality database from the electronic data deliverable provided by the lab (EDD, see Appendix B). Data from the sondes deployed at the surface water and ground water monitoring stations will also be added to the water quality database.

Quality Control and Quality Assurance

Data for quality control (QC) and quality assurance (QA) will be collected to meet the monitoring objectives. Field QC samples will be collected for approximately 10 percent of the total number of samples (minimum of one). Field QC samples will include blanks and duplicates. Field blank samples will be collected using deionized water and pumping it through the sampling equipment. Blanks will be submitted to the lab openly with labels indicating duplicate from parent samples.

Duplicate samples will be collected as two sets from the same sampling event. For surface water samples, duplicate grabs will be collected in two sets of bottles, and duplicate composite samples will be analyzed as a split from the parent sample.

Laboratory quality control and quality assurance testing on the samples will also be done following standard procedures from the lab. Lab QC and QA samples will include checking standards, method blanks, matrix spikes, and duplicates. The lab (or labs) will be certified in the state of Oregon for the parameters to be analyzed.

The field and laboratory QA/QC samples will serve to ensure that the water quality data will meet project objectives and be precise, accurate, representative, and comparable (defined below) to other data collected for similar projects.

Precision

- Precision is a measure of the reproducibility of the result.

- QC samples will be used to analyze random errors like instrumental error or sample variation and confirm the precision and consistency of the data.

Accuracy

- Accuracy is a measure of how close the measured value is to the true value.
- Duplicate samples will be used to determine the accuracy by comparing the values of matrix spiked lab samples with the field samples.

Representativeness

- Representativeness is achieved by maximizing sampling variability within the scope of the project.
- Hydrologic variability is captured by monitoring during the conditions under which diversion of surface water and injection of groundwater would occur.
- Temporal variability is captured by sampling under different seasonal conditions and measuring diurnal variability through continuous monitoring.
- The use of a continuous monitoring sonde will complement grab and composite samples in characterizing how water quality changes over time.

Comparability

- Comparability is a qualitative parameter that expresses the confidence with which one data set can be compared to another.
- Comparability will be achieved by:
    - Carefully following documented procedures
    - QA/QC
    - Data verification and reporting procedures
    - Comparing field data to available historical data in similar water bodies, especially those in the Walla Walla basin.

Laboratory Quality Control

Each type of laboratory QC sample will be analyzed at a minimum frequency of one per sample batch:

- Check standards are used to verify that analytical precision is in control and the level of bias due to calibration is acceptable. If the results for check standards do not fall within established control limits, the measurement system will be recalibrated.
- Laboratory duplicates are derived from a single sample and used to verify measurement system precision.
- Matrix spikes are a sample aliquot to which a known amount of analyte is added at the start of the procedure. Matrix spike recoveries may provide an indication of bias due to interference from components of the sample matrix. Matrix spike duplicates will be used to estimate analytical precision at the spiked sample concentrations.

- Method blanks are standards prepared by the laboratory that contain none of the analytes of interest. A blank is run with each sample batch to document that the measurement system responds accurately to such samples.

Field Quality Control

Discharge Monitoring

Discharge monitoring will use the following quality control measures:

- Conduct a monthly pressure transducer cleaning and calibration check.
- Field equipment will be maintained and calibrated to ensure proper operation and reduce bias.
- Primary and secondary stage height values are referenced to benchmarks to ensure no elevation changes in the gauge.
- A comparison of primary, secondary and surveyed level stage height values.

Groundwater Monitoring

Groundwater monitoring will use the following quality control measures:

- Comparison of monthly water level readings against other SeVein Wells in the deep basalt aquifer (see Figures 2 and 3).
- Duplicate groundwater level measurements during every field visit.

Surface Water Quality Monitoring

Water quality monitoring will use the following quality control measures:

- Field equipment will be maintained and calibrated to ensure proper operation and accuracy according to manufacturer's recommendations.
- Duplicate samples will be collected for approximately 10% of the total number of samples (minimum of one).
- Equipment blanks will be taken at the start and end of the project.
- A comparison of field and laboratory values.

Data Review and Verification

Data will be reviewed at a basic level to identify data gaps if they occur, remove bad or erroneous data under known circumstances, adjust data with defensible reasoning, and provide a verified final dataset for analysis and graphing.

Water level data will be reviewed by comparing it to level data for the period of record for general accuracy and to observed staff gauge readings for calibration and adjustment.

Discharge/flow data will be reviewed by comparing it to precipitation data, discharge data for the period of record, and level data for general tracking of flow increase and decrease.

Water quality data will be reviewed by considering lab notes and analysis flags, lab and field QC results, and field notes. Formal data validation is not planned for this project.

Data Analysis

This section describes how data collected for the project will be analyzed to determine compatibility of surface water and groundwater for the proposed recharge. Data analyzed will include surface water discharge and quality and groundwater flow characteristics and quality. A numerical compatibility analysis will be done using a geochemical mixing model, PHREEQCI, that was developed and published by the U.S. Geological Survey (USGS, 1994).

Surface Water Discharge

The surface water discharge data will be used to characterize the magnitude of the runoff events and seasonal discharge rates. Discharge data from Dry Creek will be summarized in tables and hydrographs for each surface water sampling event and monthly for the monitoring period (December through April). The total and mean discharge per event and monthly will be reported and a hydrograph will be prepared that shows the flow rate, sample collection timing, and precipitation.

Surface Water Quality

Surface water quality data will be used to characterize the quality of Dry Creek water. If treatment is necessary, then the data will represent the treated water prior to what would be injected to aquifer recharge. Data will be summarized in tables for each sampling event with the results of the grab samples, composite samples, and quality control samples tabulated. Data will also be managed in a database, which will be used for the compatibility analysis (see below).

Water quality data will also be compared to Oregon state water quality standards (OAR 340-041) and drinking water regulations (OAR 333-061) with any exceedances highlighted.

Field samples with duplicates and blanks will be assessed to verify consistency of results. If sample data requires adjusting, the rationale and changes will be documented and considered in the interpretation of results.

Groundwater Quality

Ground water data will be used to characterize the chemical quality of groundwater in the deep basalt aquifer as sampled and measured in SeVein Well 1. Data will be tabulated by month and compared to Oregon water quality standards.

Compatibility Analysis Between Surface and Groundwater

Surface water and groundwater chemistry will be assessed to determine the compatibility for injection. The compatibility analysis will be based on using the PHREEQCi model published by the United States Geological Survey (Parkhurst and Appelo, 1999) to assess potential geochemical interactions. The model results will be used to determine the feasibility of mixing surface water and groundwater by predicting the interaction of dissolved constituents and the reduction and oxidation potential of mineral saturation. Results from the water compatibility analysis will also inform the potential treatment needs of the surface water prior to injection for aquifer recharge. The compatibility analysis will also consider which, if any, water quality parameters exceeded state standards for aquatic and drinking water uses.

References

[still to be written…]

Limitations

Work for this project was performed for the SeVein Water Association (Client), and this report was prepared in accordance with generally accepted professional practices for the nature and conditions of work completed in the same or similar localities, at the time the work was performed. This report does not represent a legal opinion. No other warranty, expressed or implied, is made.

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TABLES

Note:
- Tables still need some information filled in for some parameters
- Lab will advise which parameters will be grabs vs composites based on holding times for analysis

Table 1. Sample Analytes for Surface Water

Analyte	Method	Grab or Composite	Reporting Limit	Minimum Quantity	Preservative	Holding Time	Container	Units	Number of Samples
Microorganisms/Microparticulate									
Total Coliforms (fecal coliform and E. Coli)	SM 9221 D and 9222 B			250 or 500 mL	Store at 4 C	24 hours	Polypropylene or glass	CFU/mL	8
Coliform Bacteria	SM 9221 C							CFU/mL	8
Cryptosporidium									8
Giardia lamblia									8
Geochemical									
Alkalinity (as CaCO3)	SM 2320 B-2011							mg/L	8
Bicarbonate	SM 2320B		10 mg/L	500 mL; No headspace	Store at 4 C	14 days	Polypropylene	mg/L	8
Calcium	SM 3125B							mg/L	8
Carbonate	SM 2320B		10 mg/L	500 mL; No headspace	Store at 4 C	14 days	Polypropylene	mg/L	8
Chloride	SM 4110		0.1 mg/L	500 mL	Store at 4 C	28 days	Polypropylene	mg/L	8
Cyanide (as free cyanide)	D7237-10 or D4282-02							mg/L	8
Total Organic Carbon	SM 5310B							mg/L	8
Dissolved Organic Carbon	SM 5310							mg/L	8
Fluoride	SM 4110		0.1 mg/L	N/A	N/A	N/A	N/A	mg/L	8
Hardness (as CaCO3)	SM 2340B							mg/L	8
Magnesium	SM 3125B							mg/L	8
Total Solids (TS)	SM 2540			1 L	Store at 4 C	7 days	HDPE	mg/L	8
Total Dissolved Solids (TDS)	SM 4110		2 mg/L	N/A	Store at 4 C	24 hours	Glass or Plastic	mg/L	8
Turbidity	SM 2130		1 NTU	500 mL	Store at 4 C	48 hours	Polypropylene	NTU	8
Potassium	SM 3125							mg/L	8

Note:
- Tables still need some information filled in for some parameters
- Lab will advise which parameters will be grabs vs composites based on holding times for analysis

Analyte	Method	Grab or Composite	Reporting Limit	Minimum Quantity	Preservative	Holding Time	Container	Units	Number of Samples
Silica	SM 3125							mg/L	8
Sodium	SM 3125							mg/L	8
Sulfate	SM 4110		0.5 mg/L	N/A	N/A	N/A	N/A	mg/L	8
Metals									
Aluminum	SM 3125							mg/L	8
Arsenic	SM 3125		0.01 ug/L	N/A	N/A	N/A	N/A	ug/L	8
Barium	SM 3125		0.1 ug/L	500 mL	Nitric Acid, store at 4 C	6 months	Teflon FEP	ug/L	8
Chromium (Total)	SM 3125		0.5 ug/L	500 mL	Nitric Acid, store at 4 C	6 months	Teflon FEP	ug/L	8
Copper	SM 3125		0.1 ug/L	500 mL	Nitric Acid, store at 4 C	6 months	Teflon FEP	ug/L	8
Iron (Total)	SM 3125							mg/L	8
Iron (Dissolved)	SM 3120 B		0.03 mg/L	500 mL	Nitric Acid, store at 4 C	6 months	Teflon FEP	mg/L	8
Manganese (Total)	SM 3120 B							mg/L	8
Manganese (Dissolved)	SM 3120 B		0.005 mg/L	500 mL	Nitric Acid, store at 4 C	6 months	Teflon FEP	mg/L	8
Mercury (Inorganic)	SM 3112 B		0.05 ug/L	500 mL	Nitric Acid, store at 4 C	6 months		mg/L	8
Nickel	SM 3120 B							mg/L	8
Lead	SM 3125		0.1 ug/L	500 mL	Nitric Acid, store at 4 C	6 months	Teflon FEP	ug/L	8
Selenium	SM 3125 B		0.5 ug/L	500 mL	Nitric Acid, store at 4 C	6 months	Teflon FEP	ug/L	8
Zinc	SM 3150 B		5 ug/L	500 mL	Nitric Acid, store at 4 C	6 months	Teflon FEP	ug/L	8
Disinfection by-Products									
Total Trihalomethanes									only if treatment
Haloacetic acids									
Residual chlorine									
Nutrients									
Total nitrogen	SM 4500-NO3		0.01 mg/L	125 mL	H2SO4 to pH<2; Cool to 4ºC	28 days	Polypropylene	mg/L	8
Nitrate-Nitrate (measured as Nitrogen)	SM 4500-NO3		0.01 mg/L	125 mL	H2SO4 to pH<2; Cool to 4 C	28 days	Polypropylene	mg/L	8

Note:
- Tables still need some information filled in for some parameters
- Lab will advise which parameters will be grabs vs composites based on holding times for analysis

Analyte	Method	Grab or Composite	Reporting Limit	Minimum Quantity	Preservative	Holding Time	Container	Units	Number of Samples
Total Phosphorus (Dissolved and Particulate)	SM 4500-P		0.005 mg/L	60 mL	Store at 4 C	14 days	Polypropylene	mg/L	8
Soluble reactive phosphorus									8
Regulated Synthetic Organic Compounds (SOCs)									
Alachlor	Method TBD							ug/L	2
Atrazine	Method TBD							ug/L	2
Bis(2-ethylhexyl)phthalate	EPA Method 606							ug/L	2
Carbofuran	Method TBD							ug/L	2
Chlordane	SM 6630 or 6410							ug/L	2
2,4-D	EPA Method 8151		0.1 ug/L	1 L	Store at 4 C	N/A	Amber glass	ug/L	2
Dalapon	EPA Method 552.3							ug/L	2
1,2-Dibromo-3-chloropropane (DBCP)	SM 6231							ug/L	2
Di(2-ethylhexyl) adipate								ug/L	2
Di(2-ethylhexyl) phthalate	EPA Method 606							ug/L	2
Dinoseb	Method TBD							ug/L	2
Dioxin (2,3,7,8-TCDD)	EPA Method 613							ug/L	2
Diquat	EPA Method 549.2							ug/L	2
Endothall	EPA Method 548							ug/L	2
Endrin	EPA Method 8081		0.1 ug/L	1 L	Store at 4 C	N/A	Amber glass	ug/L	2
Ethylene dibromide (EDB)	SM 6231							ug/L	2
Glyphosate	EPA Method 547							ug/L	2
Heptachlor	Method TBD							ug/L	2
Heptachlor epoxide	SM 6630 B or 6410 B							ug/L	2
Hexachlorocyclopentadiene	EPA Method 625.1							ug/L	2
Lindane (BHC-gamma)	SM 6630 B or 6410 B							ug/L	2
Methoxychlor	EPA Method 8081		0.1 ug/L	1 L	Store at 4 C	N/A	Amber glass	ug/L	2

Note:
- Tables still need some information filled in for some parameters
- Lab will advise which parameters will be grabs vs composites based on holding times for analysis

Analyte	Method	Grab or Composite	Reporting Limit	Minimum Quantity	Preservative	Holding Time	Container	Units	Number of Samples
Oxamyl (Vydate)	SM 6610							ug/L	2
Pentachlorophenol	Method TBD							ug/L	2
Picloram	EPA Method 664							ug/L	2
Simazine	Method TBD							ug/L	2
Toxaphene	Method TBD							ug/L	2
2,4,5-TP (Silvex)	EPA Method 8151		0.1 ug/L	1 L	Store at 4 C	N/A	Amber glass	ug/L	2
Additional Pesticides, Herbicides, and VOCs									
Thifensulfuron methyl, Tribenuron methyl, Metsulfuron methyl (Ally)								ug/L	2
MCPA (Clearmax)	Method TBD							ug/L	2
Dicamba (Banvel)	EPA Method 615							ug/L	2
Perchlorate	EPA Method 6860							ug/L	2
Dacthal	SM 6640							ug/L	2
Chlorpyrifos	Method TBD							ug/L	2
Terbacil (Sinbar)	Method TBD							ug/L	2
Radionuclides									
Gross Alpha	EPA Method 900.0							pCi/L	1
Gross Beta	EPA Method 900.0							pCi/L	1
Uranium	SM 7500-U							ug/L	1
Radium 226	EPA Method 903.1							pCi/L	1
Radium 228	SM 7500-Ra							pCi/L	1

Note:
- Tables still need some information filled in for some parameters
- Lab will advise which parameters will be grabs vs composites based on holding times for analysis

Table 2. Sample Analytes for Groundwater

Analyte	Method	Grab or Composite	Reporting Limit	Minimum Quantity	Preservative	Holding Time	Container	Units	Number of Samples
Microorganisms/Microparticulate									
Total Coliforms (fecal coliform and E. Coli)	SM 9221 D and 9222 B			250 or 500 mL	Store at 4 C	24 hours	Polypropylene or glass	CFU/mL	8
Coliform Bacteria	SM 9221 C							CFU/mL	8
Cryptosporidium									8
Giardia lamblia									8
Geochemical									
Alkalinity (as CaCO3)	SM 2320 B-2011							mg/L	8
Bicarbonate	SM 2320B		10 mg/L	500 mL	Store at 4 C	14 days	Polypropylene	mg/L	8
Calcium	SM 3125B							mg/L	8
Carbonate	SM 2320B		10 mg/L	500 mL	Store at 4 C	14 days	Polypropylene	mg/L	8
Chloride	SM 4110		0.1 mg/L	500 mL	Store at 4 C	28 days	Polypropylene	mg/L	8
Fluoride	SM 4110		0.1 mg/L	N/A	N/A	N/A	N/A	mg/L	8
Magnesium	SM 3125B							mg/L	8
Nitrate-Nitrite (measured as Nitrogen)	SM 4500-NO3		0.01 mg/L	125 mL	H2SO4 to pH<2; Cool to 4ºC	28 days	Polypropylene	mg/L	8
Potassium	SM 3125							mg/L	8
Sodium	SM 3125							mg/L	8
Sulfate	SM 4110		0.5 mg/L	N/A	N/A	N/A	N/A	mg/L	8
Total Solids	SM 2540			1 L	Store at 4 C	7 days	HDPE	mg/L	8
Total Organic Carbon	SM 5310B							mg/L	2
Metals									
Aluminum	SM 3125							mg/L	4
Arsenic	SM 3125		0.01 ug/L	N/A	N/A	N/A	N/A	ug/L	4

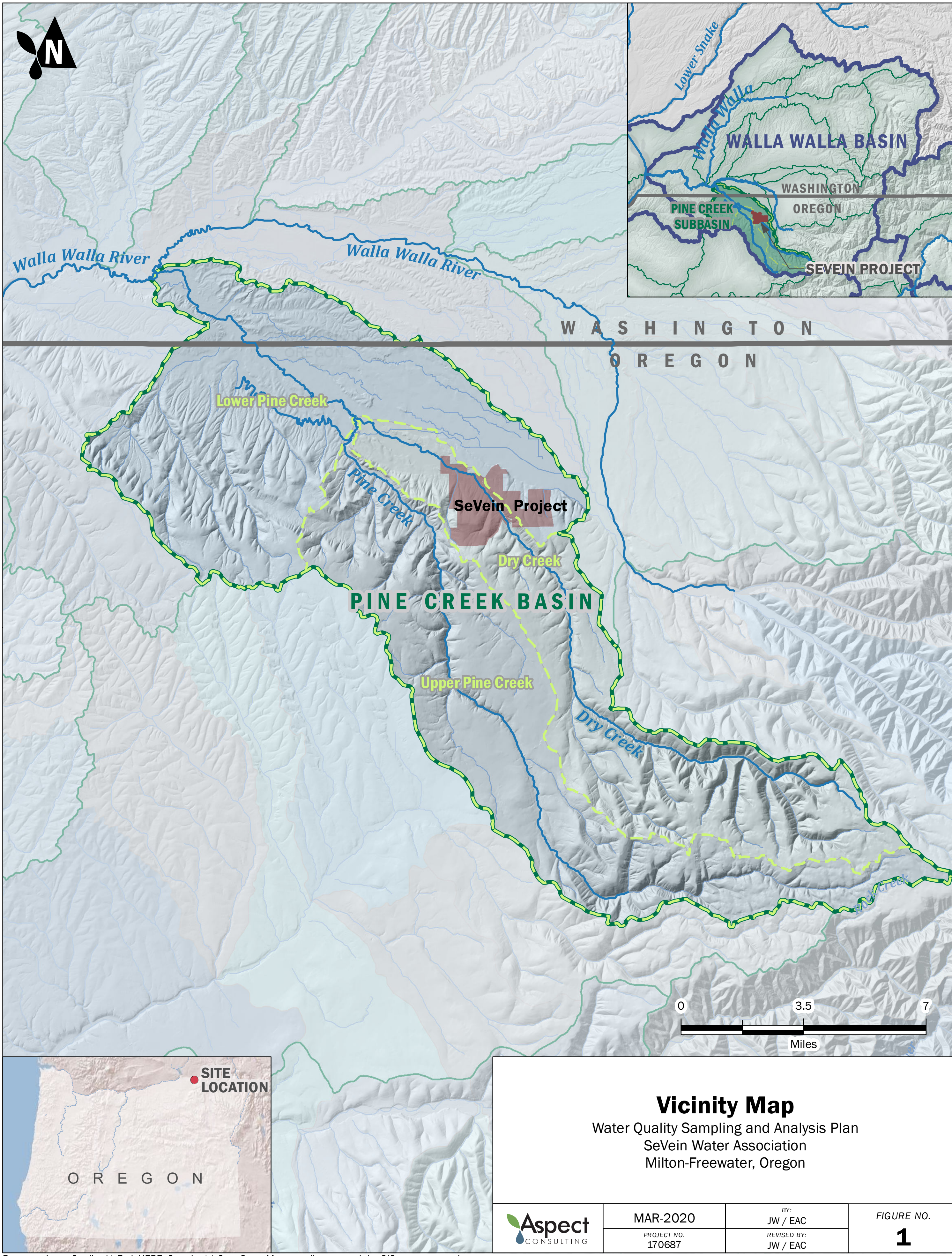
Note:
- Tables still need some information filled in for some parameters
- Lab will advise which parameters will be grabs vs composites based on holding times for analysis

Analyte	Method	Grab or Composite	Reporting Limit	Minimum Quantity	Preservative	Holding Time	Container	Units	Number of Samples
Barium	SM 3125		0.1 ug/L	500 mL	Nitric Acid, store at 4 C	6 months	Teflon FEP	ug/L	4
Chromium (Total)	SM 3125		0.5 ug/L	500 mL	Nitric Acid, store at 4 C	6 months	Teflon FEP	ug/L	4
Copper	SM 3125		0.1 ug/L	500 mL	Nitric Acid, store at 4 C	6 months	Teflon FEP	ug/L	4
Iron (Total)	SM 3125							mg/L	4
Iron (Dissolved)	SM 3120 B		0.03 mg/L	500 mL	Nitric Acid, store at 4 C	6 months	Teflon FEP	mg/L	4
Manganese (Total)	SM 3120 B							mg/L	4
Manganese (Dissolved)	SM 3120 B		0.005 mg/L	500 mL	Nitric Acid, store at 4 C	6 months	Teflon FEP	mg/L	4
Mercury (Inorganic)	SM 3112 B		0.05 ug/L	500 mL	Nitric Acid, store at 4 C	6 months		mg/L	4
Nickel	SM 3120 B							mg/L	4
Zinc	SM 3150 B		5 ug/L	500 mL	Nitric Acid, store at 4 C	6 months	Teflon FEP	ug/L	4
Disinfection by-Products									
Total Trihalomethanes									only if treatment
Haloacetic acids									
Residual chlorine									
Additional Pesticides, Herbicides, and VOCs									
Perchlorate	EPA Method 6860							ug/L	2
Thifensulfuron methyl, Tribenuron methyl, Metsulfuron methyl (Ally)								ug/L	2
MCPA (Clearmax)	Method TBD							ug/L	2
Dicamba (Banvel)	EPA Method 615							ug/L	2
Perchlorate	EPA Method 6860							ug/L	2
Dacthal	SM 6640							ug/L	2
Chlorpyrifos	Method TBD							ug/L	2
Terbacil (Sinbar)	Method TBD							ug/L	2
Radionuclides									

Note:
- Tables still need some information filled in for some parameters
- Lab will advise which parameters will be grabs vs composites based on holding times for analysis

Analyte	Method	Grab or Composite	Reporting Limit	Minimum Quantity	Preservative	Holding Time	Container	Units	Number of Samples
Gross Alpha	EPA Method 900.0							pCi/L	1
Gross Beta	EPA Method 900.0							pCi/L	1
Uranium	SM 7500-U							ug/L	1
Radium 226	EPA Method 903.1							pCi/L	1
Radium 228	SM 7500-Ra							pCi/L	1

FIGURES



Vicinity Map

Water Quality Sampling and Analysis Plan
SeVein Water Association
Milton-Freewater, Oregon

Aspect CONSULTING	MAR-2020	BY: JW / EAC	FIGURE NO.
	PROJECT NO. 170687	REVISED BY: JW / EAC	1

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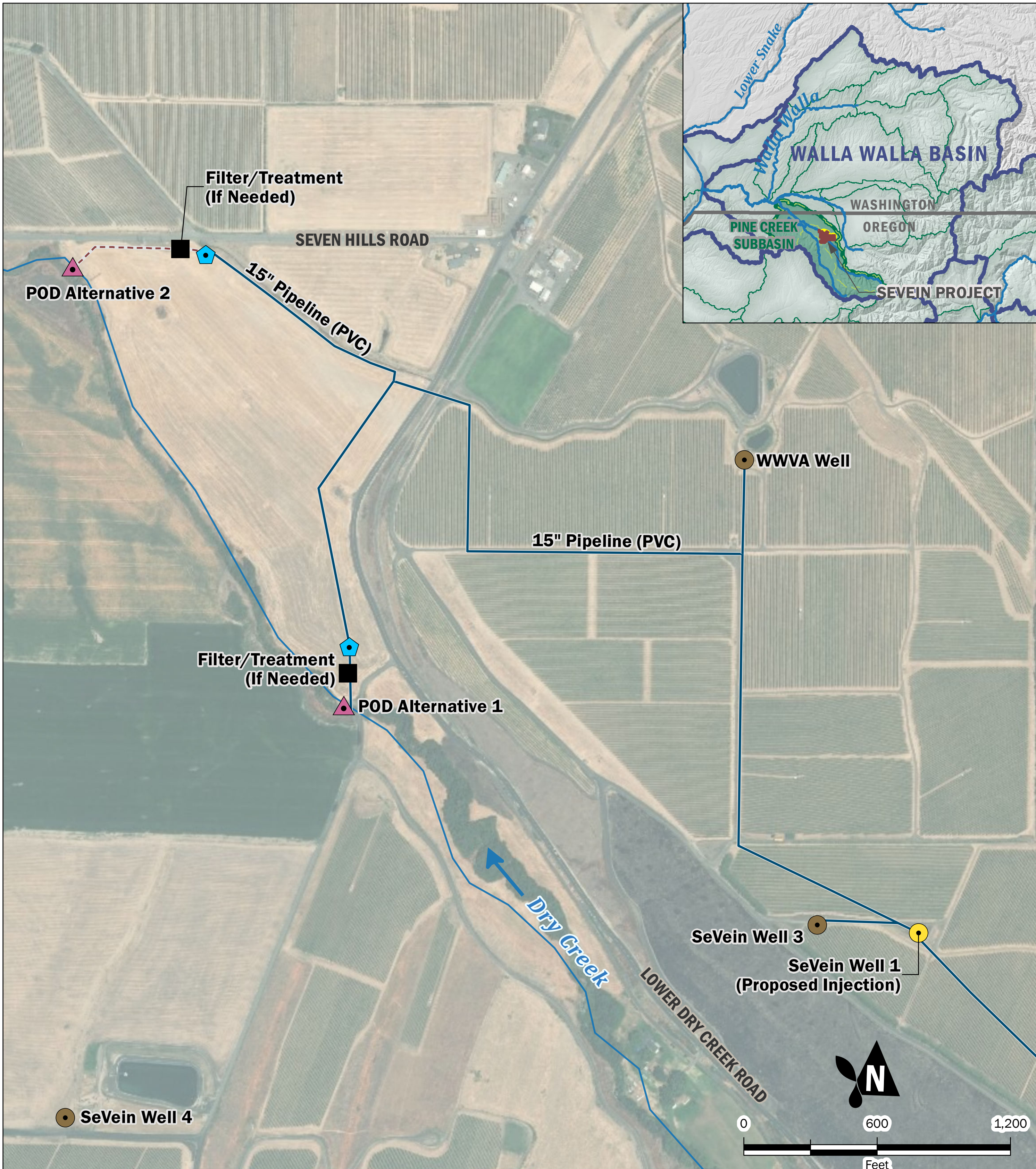

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- Filter & Treatment
- Point of Diversion (POD)
- Surface Water Monitoring Station
- Basalt Aquifer Well
- Basalt Aquifer Well Proposed for Injection
- Pipeline
- Proposed Pipeline

Surface Water Diversion and Injection Locations (Proposed)

Water Quality Sampling and Analysis Plan
SeVein Water Association
Milton-Freewater, Oregon

Aspect CONSULTING	MAR-2020	BY: JW / EAC	FIGURE NO.
	PROJECT NO. 170687	REVISED BY: EAC	2

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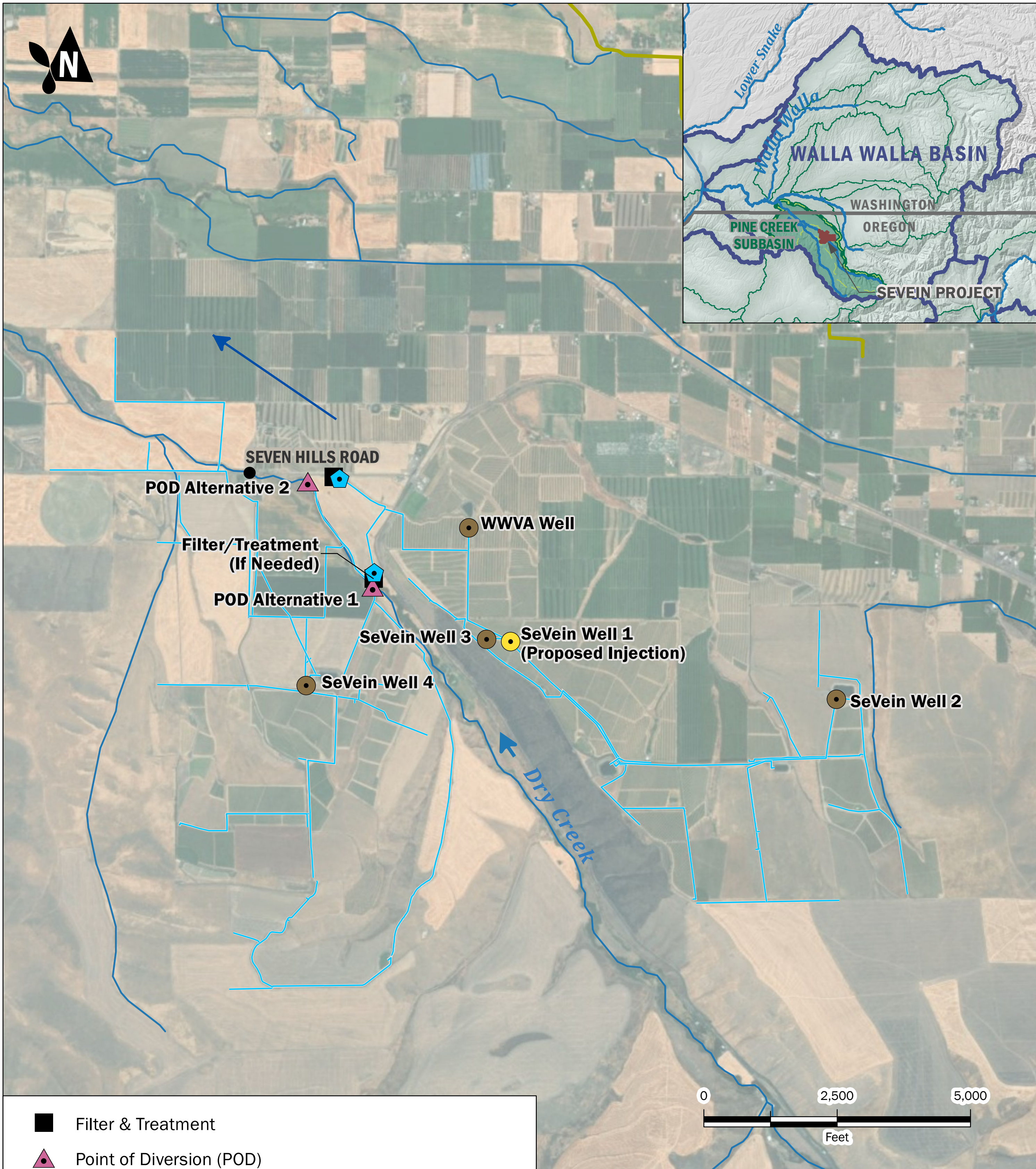
Airbus, USGS, NGA, NASA, CGIAR,N Robinson,NCEAS,NLS,OS,NMA,Geodatastyrelsen and the GIS User Community



Basalt Groundwater Wells

Water Quality Sampling and Analysis Plan
SeVein Water Association
Milton-Freewater, Oregon

Aspect CONSULTING	MAR-2020	BY: JW / EAC	FIGURE NO.
	PROJECT NO. 170687	REVISED BY: JW / EAC	3

GIS Path: T:\projects_8\SeVeinWaterManagement_170687\0-13\Delivered\WaterQualitySamplingAnalysisPlan\03_DeepWellsBasaltGrandeRondeFormation.mxd || Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet || Date Saved: 3/4/2020 || User: ecrunbaker || Print Date: 3/4/2020

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Airbus, USGS, NGA, NASA, CGIAR,N Robinson,NCEAS,NLS,OS,NMA,Geodatastyrelsen and the GIS User Community

APPENDIX A
Field Forms

SeVien Surface Water Monitoring

Storm Sampling Field Sheet

Station:

Page:___of___

Storm Setup				
Personnel:	Weather:		Arrival Date/Time:	
Carry-over maintenance to do prior to set-up:			done?	
Station Battery Voltage				

Datalogger / Flow Meter			**Sampler**			
Date/time correct?			Date/time correct?			
Desiccant OK?			Pump tube count? Replaced?			
Level (ft) (measured, datalogger)			Sample tubing & strainer ok?			
Level calibrated? If Y, final level (ft)			Sampler calibrated?			
Flow rate (cfs)			Sample tubing backflushed with DI?			
Enable level (ft)			Suction line & quick connect attached?			
Pacing interval (cf)			Clean Propak installed / Lid off / Ice?			
Storm Reset (reset to "1")?			Last screen… *(should say "disabled")*			

Notes:

Blank Sample Collection			
Blank Sample Collected (Yes/No)?			
Blank Sample Date/Time:			
Blank Sample Labeled?			

Notes:

Sample Collection/Post Storm		
Personnel:	Weather:	Arrival Date/Time:
Logger battery voltage		
Sampler battery voltage		
Sample begin time (date/time)		
Last sample taken (aliquot #, date/time)		
Sample labeled? (Station-Date-number)		
Sample volume collected		
Pump Tube Count		
Suction line, pump tubing, distributor tube and strainer removed		

Aliquots missed/NLD (date/time/aliq #) continue on back if needed

Sample Valid (Yes/No)	

Station conditions/observations:

Notes/Maintenance Needed:

SeVein Surface Water Monitoring
Flow Measurement Field Sheet

Station			
Personnel			
Date			
Weather			
General Flow Observations			
Time begin		**Stage begin (ft)**	
Time end		**Stage end (ft)**	
Prop no.		**Prop calibration**	
Spin Test			

Station No.	Horizontal Stn (ft)	Water Depth (ft)	Velocity (ft/s)	Area (ft^2)	Discharge (cfs)	Notes
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						

Total Discharge (cfs) ______

NOTES

For water depths greater than about 2.5 feet, velocity should be measured at 0.2 and 0.8 depths below water surface and then averaged.

Left bank (LB) and right bank (RB) determined by facing downstream

A single horizontal station should have no more than about 5% of flow

SeVein Surface Water Monitoring
Flow Measurement Field Sheet

Aspect CONSULTING

Qualitative Field Assessment of Flow	
Cross Section Condition	
Velocity Conditions	
Equipment Operation	
Distribution of flow across sections	
Change in Stage	
Wind	

Overall Assessment Excellent Good Fair Poor

Qualitative Conditions	Ideal	Non-Ideal
Cross-section condition	-smooth, stable channel -uniform depths across channel -deep enough for propeller -no upstream obstruction altering flow paths	-loose or unstable channel -too shallow for propeller -large rocks or debris affecting flow paths
Velocity	-uniform across channel -perpendicular to cross-section	-large back-eddies -too fast or too slow for propeller -too fast for accurate depth -turbulent
Equipment	-smooth propeller -recent propeller calibration -propeller and shaft in good condition	-damaged propeller -floating debris or grit affecting propeller during measurement -outdated propeller calibration
Distribution of flow	-no single section with more than 5% of the flow	-5-10% in any section=fair ->10%=poor
Change in stage	-stable or small change in stage during measurement	-change of more than 0.1 ft. during measurement
Wind	-calm or no effect	-wind altering current direction -wind affecting depth measurements

SeVien SW Monitoring

Sampling Control Field Sheet

Station: Page:___of___

Sample Event Setup			
Personnel:		Connection Date/Time	
Current Level (ft)		Enable level (ft)	
Current flow rate (cfs)		Pacing interval (CF)	
Data Downloaded?		Antecedent (<0.04" in 6hrs)	
Station Battery (v)		Storm_Reset raised? (=1)	
Field QC Samples (Y/N, type)			

Notes:

Mid-Event Check			
Personnel:		Connection Date/Time	
Current Level (ft)		Enable date/time	
Current flow rate (cfs)		Pulse Count	
Data Downloaded?		Sample Count	
Station Battery (v)		Rain start date/time	
		Recorded rainfall (inches)	

Notes:

Sample Collection			
Personnel:		Connection Date/Time	
Current Level (ft)		Pulse Count	
Current flow rate (cfs)		Sample Count	
Data Downloaded?		First Sample Date/Time	
Station Battery (v)		Last Sample (date/time)	
		Storm_End raised? (=1)	

Notes:

Sample Validation				
Personnel:			Date/Time	
	Y / N	Value	24-hour Runoff Volume (cf)	
Rainfall Depth ≥ 0.15			Sampled Volume (cf)	
Rainfall Duration > 1 hr			sampled vol./24hr vol (%)=	
Antecedent (<0.04" in 6hrs)			> 75% sampled?	
Aliquots ≥ 10			Sample Valid Y / N?	
Sample Volume ≥ 1 liter				

Notes:

SeVien Surface Water Monitoring Station Maintenance

Routine Station Maintenance

Station:

Page:___of___

Station Maintenance				
Personnel:	Weather:		Arrival Date/ Time:	
Carry-over maintenance to do prior to set-up:				
Flow Meter/Data Logger				
Datalogger date/time correct? (Yes/No)				
Desiccant packets OK (Yes/No)				
Pressure transducer cables OK?				
Battery Voltage	Replaced?		**Sonde**	
Transducer	***Pre clean/cal***	***Post***	Stilling well ok?	
Datalogger level (ft)			Calibration Check (Yes/No) If Yes, see below	
Staff gauge level (ft)				
Difference (ft)			Photos Taken?	
Transducer cleaned?				
Level calibrated?				
Post calibration Level (ft)				
Flow rate (cfs)				
Sampler				
Desiccant OK?				
Date/time correct? (Yes/No)				
Suction line and strainer OK?				
Notes:				

Sonde Calibration Check*

Station Sonde Drift Check			Calibration Check			
	Pre-cleaning	Post-Cleaning		Hand held	Station Sonde	Calibrate?
pH			pH			
Sp Cond (ms/cm)			Sp Cond (ms/cm)			
Temp (C)			Temp (C)			
DO mg/L			DO mg/L			
DO %			DO %			
Turbidity (NTU)			Turbidity (NTU)			

Final Check			Notes:
Calibration	Standard	Sonde	Additional calibration needed? Notes
pH			
Sp Cond (mS/cm)			
Temp (C)			
DO %			
DO mg/L			
Turbidity (NTU)			

Calibration file saved? (Y/N)

Notes:

Maintenance/repairs needed	**Completed or Deferred?**	**Result, if completed/worked on**
1.		
2.		
3.		

*Use below Table 7 from USGS Water Quality Monitoring Guidelines for sonde calibration criteria

Table 7 - Sonde Calibration Criteria

Parameter	**Calibration Criteria**
Temperature	+- 0.2 C
Sp. Conductivity	+- 5 uS/cm or 3% of measured value (greatest of the 2)
DO	+- 0.3 mg/L
pH	+- 0.2 pH
Turbidity	+- 0.5 NTU or 5% of measured value (greatest of the 2)

CHAIN OF CUSTODY RECORD

Sample Collection by: Aspect Consulting

Immediate client: SeVein Water Association

Ultimate client:

Laboratory:

Page: ___1____ of _____1___

Project: ____

Analysis Required

Sample ID	Date Collected	Time Collected	Comp or Grab	Number of containers	Matrix												Notes

Comments/Special Notes:

Relinquished by:	Relinquished by:
Print name	Print name
Company	Company
Date/Time	Date/Time
Received by:	Received by:
Print name	Print name
Company	Company
Date/Time	Date/Time

Aspect CONSULTING

Sample number ______________________________

GROUNDWATER SAMPLING RECORD	WELL NUMBER: _______	Page:____ of ____

Project Name: ______________________________ Project Number: ______________________________

Date: ______________________

Sampled by: ______________________________

Measuring Point of Well: ______________________________

Screened Interval (ft. TOC) ______________________________

Filter Pack Interval (ft. TOC) ______________________________

Starting Water Level (ft TOC): ________________

Casing Stickup (ft): ________________

Total Depth (ft TOC): ________________

Casing Diameter (inches): ________________

Casing Volume __________ (ft Water) x __________ (Lpfv)(gpf) = __________ (L)(gal)

Casing volumes: 3/4"= 0.02 gpf 2" = 0.16 gpf 4" = 0.65 gpf 6" = 1.47 gpf

3/4"= 0.09 Lpf 2" = 0.62 Lpf 4" = 2.46 Lpf 6" = 5.56 Lpf

Sample Intake Depth (ft TOC): __________

PURGING MEASUREMENTS

Time	Cumul. Volume (gal or L)	Purge Rate (gpm or Lpm)	Water Level (ft)	Temp. (°C)	Specific Conductance (µS/cm)	Dissolved Oxygen (mg/L)	pH	ORP (mv)	Turbidity (NTU)	Comments
Criteria:		Typical 0.1-0.5 Lpm	Stable	na	± 3%	± 10%	± 0.1	± 10 mV	± 10%	

Total Gallons Purged: ______________________________ Total Casing Volumes Removed: ______________

Ending Water Level (ft TOC): ______________________________ Ending Total Depth (ft TOC): ______________

SAMPLE INVENTORY

Time	Volume	Bottle Type	Quantity	Filtration	Preservation	Appearance: Color	Appearance: Turbidity & Sediment	Remarks

METHODS

Parameters measured with (instrument model & serial number): ______________________________

Purging Equipment: ______________________________ Decon Equipment: ______________________________

Disposal of Discharged Water: ______________________________

Observations/Comments: ______________________________

____

GROUNDWATER SAMPLING

Field Procedures

Gauging Water Levels

- Decontaminate the water level meter tape and probe.
- Don the appropriate PPE as defined in the Site-specific Health and Safety Plan.
- Unlock and open the well monument and remove the well cap. Observe the well and document any damage to the monument, monument cover, or well cap in the daily field log.
- Remove any water that may have accumulated inside well monument using a hand pump (e.g. thirsty mate).
- Open the well and remove any dedicated equipment.
- Wait at least 30 minutes after opening/removing equipment to allow water levels to equilibrate to atmospheric pressure.
- Measure and record the depth to water from the marked reference point, or the north side of the well casing if no reference point is marked, to the nearest 0.01 foot.
- Record the time and water level measurement in a field logbook or on a field form. All times and water level measurements should be in one place (not on individual purge forms).

Low-Flow Purging and Sample Collection

Unless directed otherwise by the Project Manager or a site-specific work plan, all monitoring wells should be purged using the standard low-flow purge techniques[1]. The purging equipment will vary depending on the water level in the well and the screened interval.

- If using an aboveground pump, attach and secure the dedicated tubing to the sampling pump. Lower the tubing or, if using a submersible pump, the pump slowly into the well.
- Set the water intake (end of the tubing or pump intake) at the approximate middle of the saturated screened interval, unless directed otherwise by the Project Manager.
- Slowly lower the water level probe until it is just at the water surface and record initial water level on the purge form.
- Connect the discharge end of the tubing to a flow-through cell containing the water quality meter.

[1] United States Environmental Protection Agency (EPA). 1996. Low Stress (low flow) Purging and Sampling Procedures for the Collection of Ground Water Samples from Monitoring Wells. Revision 2. July 30.

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- Start pumping the well by selecting the lowest pump speed. Ideally, the pump rate should equal to the recharge rate with little or no water level drawdown in the well (total drawdown should be 0.3 foot or less).

- The maximum flow rate during purging should be 0.1 to 0.5 liters (100 to 500 milliliters) per minute. Measure the pumping rate using a graduated cylinder and stopwatch. Record the pumping rate and depth to water.

- Allow the flow-through cell to be "flushed" with purged groundwater twice. Monitor field parameters (temperature, pH, ORP, specific conductance and dissolved oxygen) in 3- to 5-minute intervals during purging, maintaining a consistent time interval for a single well.

- The well is considered stabilized and ready for sample collection when the indicator parameters have stabilized for three consecutive readings, as follows[2]:

    - ±0.1 for pH

    - ±3-percent for specific conductance

    - ±10-percent for dissolved oxygen

    - ±10mV for ORP

- If the recharge rate of the well is very low, do not purge the well dry. Lower the flow rate if the water level drops more than 0.3 foot or if air bubbles are observed in the purge stream. Do not lower the water intake. Turn off the pump and allow the well to recover before sampling.

- Once the field parameters have stabilized, disconnect the tubing from the flow-through cell in preparation for sampling. Gloves should be changed between purging and sampling.

- Samples should be collected by filling laboratory-supplied containers to the top. Samples for volatiles should be collected first - VOAs should be filled with no headspace or bubbles. For dissolved metals analysis, field filtering may be necessary prior to sample collection (check with your Project Manager).

- After samples have been collected, measure and record the final water level.

- Stop the pump and disconnect the tubing from the pump. Dedicated tubing can be left inside the well for future sampling events; secure the tubing so that it doesn't fall down the well.

- Close and lock the well.

- Once samples are collected, label each sample and record them on the COC form. Sample labels should be smudge-proof or covered with transparent tape. Place sample containers

[2] In some cases, duration of purging may be appropriate to determine sampling. Contact the Project Manager if parameters do not stabilize after 1 hour of purging.

into a Ziploc bag and immediately put into an iced cooler for shipment to the laboratory. Segregate larger bottles with bubble wrap. Ice in coolers should be double-bagged to prevent leakage. Coolers should be paced to the top with bagged ice to prevent warming and bottle breakage.

Documentation

Daily field logbook or field notes
Water level summary form (or single logbook page/notes)
Groundwater Purge Form
COC copy

APPENDIX B

Electronic Data Delivery (EDD) Format

APPENDIX C
Sample Collection Instructions

GROUNDWATER SAMPLING SETUP

- Sampling field data sheets
- Field notebook
- Chain of Custody forms
- Waterproof pens
- Water level measuring equipment and spare batteries
- Water quality meter with appropriate probes (temperature, conductivity, pH, and dissolved oxygen) and flow through cell
- Sampling pump
- Pump controller (and gas if bladder pump)
- Tubing and connectors
- Sample bottles (including extras in case of breakage or contamination)
- Cooler
- Ice
- Sealable plastic bags (such as Ziploc bags)
- Deionized water
- Diluted bleach solution
- Non-phosphate soap
- Nitrile gloves
- First aid kit
- Well keys
- Camera
- Paper towels
- Plastic sheet for keeping equipment clean
- Buckets
- Volumetric flask or graduated cylinder to measure purge rate
- Socket set
- Screwdrivers
- Trash bags

The following procedures will be followed when collecting groundwater samples.

1. Check the well for any potential hazards or changes.

2. Unlock and open the well monument and remove the well cap. Observe the well and document any damage to the monument, monument cover, or well cap in the field log. If well is equipped with a pressure transducer, note how it is installed and its position to replace after sampling. If the transducer is moved note time of disturbance in the field notebook

3. Clean and decontaminate equipment. Spread the plastic sheet and place equipment on the sheet.

4. Wear clean nitrile gloves while performing purging and sampling. If gloves become contaminated or dirty replace with new gloves.

5. Calibrate or verify that the water quality meter(s) are calibrated according to the manufacturer's instructions.
6. Measure the static water level in the well and record in field book and on field data sheet.
7. Calculate the length of the water column from the bottom of the well to the static water level. Calculate the volume of water in the well using the following equation: Volume (gal/ft) = water column height *π *r2 *(7.48 gal/ft3) where r is the radius of the well in feet and 7.48 is the conversion factor from ft3 to gallons).
8. If using an above-ground pump, attach and secure the dedicated tubing to the sampling pump and lower the tubing slowly into the well. If using a submersible pump lower the pump slowly to avoid stirring up particulates. Place the pump in the middle of the screened section of the well (refer to well log to determine the open interval for pump placement).
9. Once the pump is correctly installed, re-measure the static water level and record as the initial water level on the field data sheet.
10. Connect the discharge end of the tubing to a flow-through cell containing the water quality meter.
11. Start purging the well by selecting the lowest pump speed. Ideally, the pump rate should equal the recharge rate with little or no water level drawdown in the well.
12. The maximum flow rate during purging should be 0.1 to 0.5 liters per minute. Refer notes from previous sampling for pumping rate. Measure the purging rate using a graduated cylinder and stopwatch. Record the pumping rate and depth to water.
13. Discharge evacuated water on the ground as far as possible from the wellhead and work area.
14. During purging and sampling, water flow should be smooth and consistent without bubbles in the tubing.
15. Allow the flow-through cell to be flushed with purged groundwater twice. Once pumping rate has been determined and flow has stabilized, start recording field parameters (water temperature, conductivity, pH and dissolved oxygen) in a 5-minute interval, maintaining a consistent interval for each well.
16. Record field parameters, water level, and estimated amount of water purged. Note any changes in purged water's appearance (clear, turbid, odor, etc.) on the field data sheet.
17. Continue purging well until field parameters stabilize. See table below.
18. If the recharge rate of the well is very low, do not purge the well dry. Lower the flow rate if the water level drops more than 0.3 feet or if air bubbles are observed in the purge stream. Turn off the pump and allow well to recover before sampling.

19. Once the field parameters have stabilized, disconnect the tubing from the flow-through cell in preparation for sampling. Gloves should be changed between purging and sampling. Do not stop or change pumping rate during the final phase of purging and sampling (unless recharge rates are very low, see step 19).
20. Samples should be collected by filling laboratory-supplied containers to the top. Samples for volatiles should be collected first – VOA bottles should be filled with no headspace or bubbles. For dissolved metals analysis, field filtering may be necessary prior to sample collection. After collecting the sample make sure the container is properly sealed to prevent leakage.
21. Label the sample bottle with the well name, date, time, parameter, matrix, field staff initials, preservative, and any other fields on the bottle label with a waterproof pen. The groundwater sample labeling schema will be as follows:

    GW-XX-YYYYYY, where GW stands for groundwater, XX stands for the well (W1 or W2), and YYYYYY stands for the six-digit date.

22. Collect any duplicate or quality control samples.
23. After samples have been collected, measure and record the final water level along with the sample date and time.
24. Stop the pump.
25. Once samples are collected make sure all sample labels are completed. Sample labels should be smudge-proof or covered with transparent tape. Place sample containers into a Ziploc bag and immediately put into an ice-bath in a cooler for delivery to the lab or shipping company. Segregate larger bottles with bubble wrap. Ice in coolers should be double-bagged to prevent leakage. Coolers should be packed to the top with bagged ice to prevent warming and bottle leakage. Make sure samples do not freeze during transport.
26. Complete chain of custody form. Record the estimated total purge volume on the data sheet. Also record any comments or observations regarding the purging and sampling process.
27. Replace pressure transducer if the well was equipped with one. Note re-install time in the field notebook. Close and lock the well.
28. Clean and disinfect sampling equipment. Wash the equipment in a solution of non-phosphate detergent (Liquinox or equivalent) and distilled or deionized water. All surfaces that may come in direct contact with the samples shall be washed. Use a clean Nalgene and/or plastic tub to contain the wash solution and a scrub brush to mechanically remove loose particles. Wear clean latex, plastic, or equivalent gloves during all washing and rinsing operations. Rinse twice with distilled or deionized water. Dry the equipment before use, to the extent practicable.

Sample bottles will be filled with the pumped water once parameters have stabilized per the following table.

Field Parameter	Stabilized Range
Temperature	± 0.1 ° Celsius
Conductivity <1000 µs/cm	± 10 µs/cm
Conductivity >1000 µs/cm	± 20 µs/cm
Dissolved Oxygen < 1 mg/L	± 0.05 mg/L
Dissolved Oxygen > 1 mg/L	± 0.2 mg/L
pH	± 0.1 pH units

SURFACE WATER SAMPLING SETUP

Station setup prior to each sampling event will include:

- Calibration of autosampler volume
- Pump tubing physical check
- Backflushing with DI water
- Pressure transducer calibration
- Battery check
- Clean bottles in place with lids off and ice
- Programming autosampler
- Complete sample collection field sheet
- Properly label containers
- Complete chain of custody (COC)
- Place samples in an ice bath in a cooler
- Deliver samples to laboratory within holding time

Standard sample handling practices will be used at all stages of surface water monitoring:

- Decontamination of sampling equipment with deionized or distilled water
- Calibration of field equipment per manufacturer's guidelines
- Use of nitrile gloves and best practices to eliminate sample contamination
- Bottles will be cleaned by laboratory after each sample collection

Sample labeling will be as follows:

- SW-YY-ZZZZZZ, where SW stands for surface water, YY, stands for the type of event (WW for wet weather, SM for snowmelt, or BF for baseflow), and ZZZZZZ us the six-digit date (i.e. 011521 for January 15, 2021).

APPENDIX D

Oregon Pesticide Partnership Analyte List

Pesticide Stewardship Partnership Program Analyte List

Analysis	Analyte	MRL	Units
Pesticides by LCMSMS SOP 11-0031	Acetamiprid	4	ng/L
Pesticides by LCMSMS SOP 11-0031	Acetochlor	10	ng/L
Pesticides by LCMSMS SOP 11-0031	Alachlor	10	ng/L
Pesticides by LCMSMS SOP 11-0031	Ametryn	4	ng/L
Pesticides by LCMSMS SOP 11-0031	Aminocarb	4	ng/L
Pesticides by LCMSMS SOP 11-0031	Atrazine	4	ng/L
Pesticides by LCMSMS SOP 11-0031	Azinphos-methyl (Guthion)	20	ng/L
Pesticides by LCMSMS SOP 11-0031	Baygon (Propoxur)	4	ng/L
Pesticides by LCMSMS SOP 11-0031	Carbaryl	5	ng/L
Pesticides by LCMSMS SOP 11-0031	Carbofuran	4	ng/L
Pesticides by LCMSMS SOP 11-0031	DEET	30	ng/L
Pesticides by LCMSMS SOP 11-0031	Deisopropylatrazine	4	ng/L
Pesticides by LCMSMS SOP 11-0031	Desethylatrazine	4	ng/L
Pesticides by LCMSMS SOP 11-0031	Diuron	4	ng/L
Pesticides by LCMSMS SOP 11-0031	Fluometuron	4	ng/L
Pesticides by LCMSMS SOP 11-0031	Imazapyr	40	ng/L
Pesticides by LCMSMS SOP 11-0031	Imidacloprid	20	ng/L
Pesticides by LCMSMS SOP 11-0031	Linuron	4	ng/L
Pesticides by LCMSMS SOP 11-0031	Methiocarb	4	ng/L
Pesticides by LCMSMS SOP 11-0031	Methomyl	4	ng/L
Pesticides by LCMSMS SOP 11-0031	Metolachlor	10	ng/L
Pesticides by LCMSMS SOP 11-0031	Metribuzin	4	ng/L
Pesticides by LCMSMS SOP 11-0031	Metsulfuron Methyl	4	ng/L
Pesticides by LCMSMS SOP 11-0031	Mexacarbate	4	ng/L
Pesticides by LCMSMS SOP 11-0031	Neburon	5	ng/L
Pesticides by LCMSMS SOP 11-0031	Oxamyl	4	ng/L
Pesticides by LCMSMS SOP 11-0031	Prometon	4	ng/L
Pesticides by LCMSMS SOP 11-0031	Prometryn	4	ng/L
Pesticides by LCMSMS SOP 11-0031	Propazine	4	ng/L
Pesticides by LCMSMS SOP 11-0031	Propiconazole	20	ng/L
Pesticides by LCMSMS SOP 11-0031	Pyraclostrobin	4	ng/L
Pesticides by LCMSMS SOP 11-0031	Siduron	4	ng/L
Pesticides by LCMSMS SOP 11-0031	Simazine	4	ng/L
Pesticides by LCMSMS SOP 11-0031	Simetryn	4	ng/L
Pesticides by LCMSMS SOP 11-0031	Sulfometuron-methyl	4	ng/L
Pesticides by LCMSMS SOP 11-0031	Terbutryn (Prebane)	4	ng/L
Pesticides by LCMSMS SOP 11-0031	Terbutylazine	4	ng/L
Pesticides-HV by GCMS 8270	2,6-Dichlorobenzamide	20	ng/L
Pesticides-HV by GCMS 8270	4,4´-DDD	20	ng/L
Pesticides-HV by GCMS 8270	4,4´-DDE	20	ng/L
Pesticides-HV by GCMS 8270	4,4´-DDT	20	ng/L
Pesticides-HV by GCMS 8270	Acephate	40	ng/L
Pesticides-HV by GCMS 8270	Aldrin	20	ng/L
Pesticides-HV by GCMS 8270	alpha-BHC	20	ng/L
Pesticides-HV by GCMS 8270	Azoxystrobin	20	ng/L
Pesticides-HV by GCMS 8270	beta-BHC	20	ng/L
Pesticides-HV by GCMS 8270	Bifenthrin	20	ng/L
Pesticides-HV by GCMS 8270	Bromacil	20	ng/L

Pesticide Stewardship Partnership Program Analyte List

Analysis	Analyte	MRL	Units
Pesticides-HV by GCMS 8270	Butachlor	20	ng/L
Pesticides-HV by GCMS 8270	Butylate	20	ng/L
Pesticides-HV by GCMS 8270	Chlorobenzilate	20	ng/L
Pesticides-HV by GCMS 8270	Chloroneb	20	ng/L
Pesticides-HV by GCMS 8270	Chlorothalonil	20	ng/L
Pesticides-HV by GCMS 8270	Chlorpropham	20	ng/L
Pesticides-HV by GCMS 8270	Chlorpyrifos	20	ng/L
Pesticides-HV by GCMS 8270	cis-Chlordane	20	ng/L
Pesticides-HV by GCMS 8270	Cyanazine	20	ng/L
Pesticides-HV by GCMS 8270	Cycloate	20	ng/L
Pesticides-HV by GCMS 8270	Dacthal (DCPA)	20	ng/L
Pesticides-HV by GCMS 8270	delta-BHC	20	ng/L
Pesticides-HV by GCMS 8270	Diazinon	20	ng/L
Pesticides-HV by GCMS 8270	Dichlobenil	20	ng/L
Pesticides-HV by GCMS 8270	Dichlorvos	20	ng/L
Pesticides-HV by GCMS 8270	Dieldrin	20	ng/L
Pesticides-HV by GCMS 8270	Dimethenamid	20	ng/L
Pesticides-HV by GCMS 8270	Dimethoate	20	ng/L
Pesticides-HV by GCMS 8270	Diphenamid	20	ng/L
Pesticides-HV by GCMS 8270	Endosulfan I	20	ng/L
Pesticides-HV by GCMS 8270	Endosulfan II	20	ng/L
Pesticides-HV by GCMS 8270	Endosulfan sulfate	20	ng/L
Pesticides-HV by GCMS 8270	Endrin	20	ng/L
Pesticides-HV by GCMS 8270	Endrin aldehyde	20	ng/L
Pesticides-HV by GCMS 8270	EPTC	20	ng/L
Pesticides-HV by GCMS 8270	Ethoprop	20	ng/L
Pesticides-HV by GCMS 8270	Etridiazole	20	ng/L
Pesticides-HV by GCMS 8270	Fenamiphos	50	ng/L
Pesticides-HV by GCMS 8270	Fenarimol	20	ng/L
Pesticides-HV by GCMS 8270	Fenvalerate+Esfenvalerate	200	ng/L
Pesticides-HV by GCMS 8270	Fluridone	20	ng/L
Pesticides-HV by GCMS 8270	gamma-BHC (Lindane)	20	ng/L
Pesticides-HV by GCMS 8270	Heptachlor	20	ng/L
Pesticides-HV by GCMS 8270	Heptachlor epoxide	20	ng/L
Pesticides-HV by GCMS 8270	Hexazinone	20	ng/L
Pesticides-HV by GCMS 8270	Malathion	20	ng/L
Pesticides-HV by GCMS 8270	Methoxychlor	20	ng/L
Pesticides-HV by GCMS 8270	Methyl paraoxon	20	ng/L
Pesticides-HV by GCMS 8270	Mevinphos	20	ng/L
Pesticides-HV by GCMS 8270	MGK 264	20	ng/L
Pesticides-HV by GCMS 8270	Mirex	20	ng/L
Pesticides-HV by GCMS 8270	Molinate	20	ng/L
Pesticides-HV by GCMS 8270	Napropamide	20	ng/L
Pesticides-HV by GCMS 8270	Norflurazon	20	ng/L
Pesticides-HV by GCMS 8270	Oxyfluorfen	20	ng/L
Pesticides-HV by GCMS 8270	Parathion-ethyl	20	ng/L
Pesticides-HV by GCMS 8270	Parathion-methyl	20	ng/L
Pesticides-HV by GCMS 8270	Pebulate	20	ng/L

Pesticide Stewardship Partnership Program Analyte List

Analysis	Analyte	MRL	Units
Pesticides-HV by GCMS 8270	Pendimethalin	20	ng/L
Pesticides-HV by GCMS 8270	Permethrin	40	ng/L
Pesticides-HV by GCMS 8270	Pronamide	20	ng/L
Pesticides-HV by GCMS 8270	Propachlor	20	ng/L
Pesticides-HV by GCMS 8270	Pyraflufen ethyl	20	ng/L
Pesticides-HV by GCMS 8270	Pyriproxyfen	100	ng/L
Pesticides-HV by GCMS 8270	Tebuthiuron	20	ng/L
Pesticides-HV by GCMS 8270	Terbacil	20	ng/L
Pesticides-HV by GCMS 8270	Terbufos	20	ng/L
Pesticides-HV by GCMS 8270	Tetrachlorvinphos (Stirophos)	50	ng/L
Pesticides-HV by GCMS 8270	trans-Chlordane	20	ng/L
Pesticides-HV by GCMS 8270	trans-Nonachlor	20	ng/L
Pesticides-HV by GCMS 8270	Triadimefon	20	ng/L
Pesticides-HV by GCMS 8270	Tricyclazole	50	ng/L
Pesticides-HV by GCMS 8270	Trifloxystrobin	20	ng/L
Pesticides-HV by GCMS 8270	Trifluralin	20	ng/L
Pesticides-HV by GCMS 8270	Tris (1,3-dichloro-2-propyl) phosphate (TDCP)	40	ng/L
Pesticides-HV by GCMS 8270	Tris (2-chloroethyl) phosphate (TCEP)	20	ng/L
Pesticides-HV by GCMS 8270	Vernolate	20	ng/L
Glyphosate by LCMSMS	Glyphosate	50	ng/L
Glyphosate by LCMSMS	Aminomethylphosphonic acid (AMPA)	50	ng/L
Phenoxy Herbicides by GCECD 6640	2,4,5-T	0.3	µg/L
Phenoxy Herbicides by GCECD 6640	2,4,5-TP (Silvex)	0.1	µg/L
Phenoxy Herbicides by GCECD 6640	2,4-D	0.1	µg/L
Phenoxy Herbicides by GCECD 6640	2,4-DB	0.6	µg/L
Phenoxy Herbicides by GCECD 6640	3,5-Dichlorobenzoic acid	0.3	µg/L
Phenoxy Herbicides by GCECD 6640	Acifluorfen	0.2	µg/L
Phenoxy Herbicides by GCECD 6640	DCPA acid metabolites	0.6	µg/L
Phenoxy Herbicides by GCECD 6640	Dicamba	0.3	µg/L
Phenoxy Herbicides by GCECD 6640	Dichloroprop	0.3	µg/L
Phenoxy Herbicides by GCECD 6640	Dinoseb	0.3	µg/L
Phenoxy Herbicides by GCECD 6640	MCPA	20	µg/L
Phenoxy Herbicides by GCECD 6640	MCPP	60	µg/L
Phenoxy Herbicides by GCECD 6640	Pentachlorophenol	0.1	µg/L
Phenoxy Herbicides by GCECD 6640	Picloram	0.6	µg/L
Phenoxy Herbicides by GCECD 6640	Triclopyr	0.3	µg/L
Solids - Total by SM2540B	Total Solids	20	mg/L

ATTACHMENT 6

Hydrogeologic Feasibility Report

MEMORANDUM

Project No. 170687-3

January 10, 2020

To: SeVein Water Association (SWA)

From:

John Warinner, PE, CWRE
Associate Water Resources Engineer
jwarinner@aspectconsulting.com

Jon Turk, LHG, PG
Associate Hydrogeologist
jturk@aspectconsulting.com

Re: **Hydrogeologic Feasibility Report**
Application for Limited Water Use License for AR Testing, SeVein Water Association

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Purpose

SeVein Water Association (SWA) owns and operates four basalt groundwater wells that withdraw water from the basalt aquifer system(s) that serve as the primary source of water for the SeVein Project:

- SeVein Well 1. Well Tag L-76996. Well Log UMAT 55523.
- SeVein Well 2. Well Tag L-76997. Well Log UMAT 55526.
- SeVein Well 3. Well Tag L-59002. Well Log UMAT 56382.
- SeVein Well 4. Well Tag L-122502. Well Log UMAT 57714.

SWA is evaluating the feasibility of an Artificial Groundwater Recharge (AR) program to stabilize static water levels in the basalt aquifer system(s) that serves as the water source for the SeVein wells. The proposed AR program involves diverting streamflow from Dry Creek during the winter months (December through March/April) and injecting the water into the basalt aquifer system via one or more existing production wells.

Oregon Water Resources Department (OWRD) authorizes groundwater recharge projects of this nature through a water rights instrument referred to as a Limited Water Use License. This Hydrogeologic Feasibility Report is one element of an Application for Limited Water Use License for AR Testing. This memorandum is informed by other complementary application documents.

The purpose of this memorandum is to present details relating to the hydrogeological aspects of the proposed program, including the conceptual hydrogeologic model, description and assessment of current conditions in the basalt aquifer system, anticipated changes to the groundwater system, and description of how these factors affect the anticipated feasibility of the proposed AR program.

Project Context

As described in the associated application documents, the general plan is to construct and test a system that will divert water from Dry Creek, treat/purify the water to acceptable water quality standards, convey the treated water from the point of diversion and treatment to the designated injection well, and inject the water into the Grande Ronde Unit of the Columbia Basin Basalt Group. The proposed project is described in detail in an associated AR Project Description Report, which outlines a five-phase testing plan and three potential stages of development.

Local Geology and Conceptual Hydrogeologic Model

Introduction

Establishing a conceptual hydrogeologic model (CHM) and water budget framework for the system is a necessary preliminary step to evaluate alternative groundwater management strategies by defining the assumed aquifer properties and boundary conditions. The CHM will be used to anticipate and estimate the degree to which alternative aquifer recharge strategies will result in stabilization of static water levels in the aquifer system. Through this process, data gaps are identified, and testing is conducted to validate CHM assumptions and confirm the factors affecting groundwater flow. As a result, CHMs are updated as new data are acquired through each phase of the study.

This technical memorandum summarizes a desktop assessment of existing data, identifies data gaps, and recommends hydraulic testing of the SeVein wells to confirm model assumptions and input. The content from this technical memorandum will inform an Application for Limited Water Use License for AR Testing that SWA intends to submit to OWRD. Subject to the review and authorization of OWRD, SWA will pursue hydraulic testing and refinement of the groundwater management strategy under the terms of the Limited Water Use License for AR Testing.

The goal of this CHM is to provide a framework to assess the hydrogeologic benefits and constraints of alternative strategies to manage and/or divert wet-season streamflow in Dry Creek to recharge the basalt aquifer within the SeVein groundwater production zones to mitigate declining aquifer levels in the vicinity of the SeVein irrigation wells. Project feasibility must therefore be defined by the magnitude of benefits achieved through aquifer recharge, as a function of predicted trends in aquifer levels expected to result from the induced recharge.

Within the basalt aquifer units in the Milton-Freewater area, the Walla Walla Basin Watershed Council (WWBWC) has documented approximately 3 to 4 feet of groundwater declines per year. To protect SWA from future aquifer level declines and water right limitations, the proposed aquifer recharge must at a minimum stabilize static water levels, and at best raise groundwater levels to optimal levels for sustained withdrawal and beneficial use.

Hydrogeologic Conditions

The following summary of the regional and local hydrogeologic conditions is based on publicly available publications and GIS datasets, as well as consultant reports provided by SWA, including:

- Hydrogeology Report, Seven Hills Wells 1 and 2, Consultant Report by Kennedy/Jenks for Seven Hills Properties, dated September 19, 2005 (Kennedy/Jenks, 2005).

- Well Testing at Seven Hills Vineyards Summary Report, Consultant Report by GSI Water Solutions for Seven Hills Properties, dated April 2, 2007 (GSI, 2007).
- Milton-Freewater Basalt Aquifer Interference Test Summary, UMAT 50939 and UMAT 5530, by Jennifer Woody, Oregon Water Resources Department, pumping test completed March 8 and 9, 2018.
- Seven Hills West Pond Well Completion Report, Consultant Report by EA Engineering, Science, and Technology for Seven Hills Properties, dated November 3, 2016 (EA, 2016).
- SeVein Water Association Aquifer Boundary Assessment, Consultant Report by EA Engineering, Science, and Technology, for Seven Hills Properties, dated January 20, 2017 (EA, 2017).

Three of the four SeVein wells (Wells 1, 3 and 4) withdraw groundwater sourced from the Grande Ronde formation of the Columbia River Basalt Group (CRBG). The fourth well (Well 2) withdraws water from both the Grande Ronde formation as well as the lowermost flow zone in the overlying Wanapum formation. In the Walla Walla Valley, groundwater is primarily pumped from shallower alluvial/sedimentary aquifer units. Fewer water supply wells rely on the CRBG wells in the Walla Walla valley, and where present they pump from the Wanapum formation.

Locally, the alluvial/sedimentary aquifer system in the Milton-Freewater area is recharged from direct infiltration and seepage from surface waters, and discharges to surface water based on location and seasonal variability. In areas where coarse alluvium is in direct contact with fractured basalts, the alluvial system also provides a source of recharge to the underlying basalt aquifers. However, much of the CRBG is mantled by clays and weathered basalts, with little direct hydraulic connection to the alluvial aquifer systems.

Subsequent to the CRBG deposition, local uplift created structural deformities and discontinuities within the broad layered basalt system, forming the original mountains and valleys that were sculpted into the terrain of today by Pleistocene glaciation. Where alluvium is absent or very thin at the surface, primarily in uplifted and folded areas, the basalt aquifer systems are recharged from direct infiltration. Structural deformities function as localized boundary conditions for aquifers by:

- Providing recharge to uplifted areas where surface infiltration may occur.
- Creating high permeability fault zones that function as local conduits for recharge or low-permeability zones that impede or function as barriers to flow.
- Widespread igneous intrusions can create no-flow barriers.
- Offsets along faults can create discontinuities:
- Barriers to flow
- Hydraulic cross connection

The CRBG consists of layered basalt flows and serves as a source of groundwater supply where thin highly permeable interflow zones exist. The interflows are regionally consistent, except where local structural deformities dominate the local aquifer boundary conditions. Interflows have low to very low storage capacity, very low recharge rates and corresponding older groundwater age.

Surface Soils

According to USDA soil survey map data (Attachment A), soils at the SeVein properties are generally of the Walla Walla silt loam series, with the Lickskillet stony loam and Hermiston silt loam in the vicinity of Dry Creek. Relevant soil properties include:

- 12 to 15 inches of annual precipitation.
- Approximately 11.2 inches of soil water storage capacity.
- Well-drained soils with saturated hydraulic conductivity that ranges from 0.57 to 19.8 inches per hour.
- More than 80 inches to a restrictive soil layer or bedrock, except for the Lickskillet soils, where depth to bedrock is 12 to 20 inches.

The annual precipitation and soil storage properties suggest that little groundwater recharge occurs from surface percolation. Studies completed by the U.S. Geological Survey (USGS) indicate that surplus soil moisture may occur from November through March, a larger moisture deficit occurs from April through October, with the seasonal deficit approximately double to triple the winter surplus (USGS, 1963[1]; NOAA 1982[2]). As a result of the large seasonal deficit, and soil storage that is only slightly less than total precipitation, little groundwater recharge is expected from infiltration of precipitation.

Local Basalt Hydrogeology

The following hydrogeologic characteristics of the basalt system intersected by the SeVein wells are based on desktop analyses of existing public sources of information and consultant reports from previous testing of the SeVein and other nearby wells. The local hydrogeologic conditions are a function of the CRBG stratigraphy, specifically the number of flow-top structures that provide water bearing zones to the wells, and the surrounding network of faults that function both as hydraulic barriers and conduits.

Publicly available GIS data were acquired and used to support the hydrogeologic framework for this CHM. The location of the SeVein properties and well locations are shown on Figure 1, along with surface geology and fault networks. Figure 2 identifies the locations of the three primary faults assumed to influence the hydrogeologic conditions at the SeVein site, with the hydrogeologic conditions further described in the following sections.

- In the vicinity of the SeVein properties, the Frenchmen Springs member of the Wanapum Formation is present near the land surface, overlain by approximately 10 feet of soil.
- The transition between the Wanapum and the Grande Ronde occurs at depths of 600 to 700 feet below the surface at the SeVein well sites (Well logs included as Attachment B).
- The Frenchmen Springs Member of the Wanapum exhibits structural variability between each well site, resulting in different flow zone properties (see Attachment B).

[1] USGS, 1963, Temperature and the Water Balance for Oregon Weather Stations, Special Report 150, Oregon State University, Corvallis, May.

[2] NOAA, 1982, Mean Monthly, Seasonal, and Annual Pan Evaporation for the Unites States, NOAA Technical Report NWS 34, Washington, D.C., December.

- The SeVein wells are located within a small compartment of a large regional fault complex (Figure 1). All four SeVein wells are within a large regional fault complex that arcs towards the east, forming a long north-south curved band approximately one to two miles wide, and stretching tens of miles north and south from SeVein.
- SeVein Wells 1, 2, and 3 appear to be within the same localized fault block based on surface locations (Figure 2). However, this block appears to be lower in the down-dip direction of the curved fault to the north and east of Wells 1, 2, and 3.
- Surficial deposits mapped as Middle Miocene basalt within the localized fault block. Within the regional fault arc, early to middle Miocene basalts are mapped at the surface (Figures 1 and 2).
- Based on surface map location, Well 2 appears to be within the same fault block as Wells 1 and 3. However, Well 2 is the only well that appears to intersect the shear zone from the East Fault, suggesting a southwesterly dip to the fault bounding the northeast side of the SeVein aquifer zone. Both the Wanapum and Grande Ronde units contain shear zone influence as shown in the log of Well 2 (Attachment B). As a result, Well 2 appears in map view to be in the same fault block as the other SeVein wells, but the angle and offset of the fault result in the lower portions of Well 2 drilled within the fault zone or on the other side of the fault.
- The East Fault appears to function as a hydraulic barrier, based on pumping tests completed for Well 2.
- Well 4 is located on the opposite side of the Dry Creek Fault from the other SeVein wells. However, between the logs of Wells 3 and 4, on opposites sides of the fault, negligible influence of the fault was observed – no shear zones present, no significant elevation difference between flow zones.
- As confirmed by pumping test analyses and documented by EA, 2017, the Dry Creek Fault functions as a hydraulic connection between the basalt flow zones across the fault.

Aquifer Hydraulic Properties

Aquifer pumping tests have been completed on each of the SeVein and other nearby wells, documenting a range of aquifer hydraulic properties (summarized in Table 1) and boundary conditions. Well drilling and testing was completed for Wells 1 and 2 in 2005 (Kennedy/Jenks, 2005), and additional pumping tests were completed in 2007 (GSI, 2007). Additional pumping tests and analyses of long-term water level data were completed on Wells 1, 3, and 4 (EA 2016 and 2017). Beginning with the initial testing at Wells 1 and 2 in 2005 continuing through the more recent testing and analyses completed in 2017, estimates of aquifer hydraulic properties have increased with each subsequent analysis.

Aquifer transmissivity is the product of the aquifer hydraulic conductivity and the saturated thickness of the aquifer. In an unconfined aquifer the transmissivity changes with water level, while in a confined aquifer, transmissivity is constant until water levels drop below the top of the aquifer unit. The SeVein system has been described and tested as a confined or semi-confined aquifer system, and the ongoing declines in aquifer levels are not projected to drop below the top of the lower Wanapum units. Based on this conceptualization, we assume aquifer transmissivity is constant.

Table 1. Aquifer Hydraulic Properties

Date	Subject	Transmissivity (ft^2/day)	Storativity (unitless)	Other Notes	Reference
2005	Well 1	52,390 - 57,440	0.0026 - 0.0028	12-hour testing	KJ 2005
2005	Well 2	5,628 - 5,960	0.0004 - 0.0007	12-hour testing	KJ 2005
2007	Well 1	120,000 - 150,000		11-hour constant rate test at 3,850 gpm at Well 1	GSI 2007
2007	Well 2	9,500 - 10,700		6-hour constant rate test at Well 2 at 2,700 gpm	GSI 2007
2015	Wells 1 and 3	250,000	0.0001	2014-2015 operational data from Well 3 and water levels at Well 1	EA 2017
2016	Well 4	288,627	0.00018	24-hour constant rate test at 2,850 gpm	EA 2016

Based on the available testing reports, Well 2 appears to be hydraulically disconnected. During initial testing completed by GSI in 2007 on Well 2, a subdued (not quantifiable) response to pumping was observed. Additionally, EA 2017 documented that several prolonged pumping periods at Well 2 resulted in little or no response in Wells 1 and 3. The degree that the East Fault impedes localized flow has not been fully assessed, but has been documented to create a different hydraulic system for Well 2 from the other wells. Aquifer transmissivity estimates from Well 2 is approximately one to two orders of magnitude lower than other wells, with estimates ranging from 5,600 to 10,600 sq.ft/day for Well 2.

Aquifer storativity is the storage term used with confined aquifers to describe the volume of water released from a unit volume of aquifer per unit decline in water level. In confined aquifers, storage is related to the change in pressure within the aquifer unit, and not a change in the saturated volume. As a result, the storage properties of confined aquifer are generally orders of magnitude lower than unconfined systems. Similarly, confined aquifer storage is directly proportional to the compressibility of water and the aquifer material, with very little compressibility assumed for basalt units (compared to unconsolidated deposits).

Aquifer Recharge

Site soils and climate data suggest that negligible aquifer recharge is expected from precipitation. Historical pumping tests have shown that hydraulic continuity exists across the Dry Creek fault between Well 3 and Well 4. Based on the well logs and testing reports, it appears that the Dry Creek fault may be a primary source of recharge to the upper portions of the Wanapum Basalt intersected by the creek channel. Assuming the fault zone propagates to depths within the Grande Ronde units, it is possible that the fault may also function as a hydraulic conduit between the Wanapum and Grande Ronde Aquifer units. However, pumping tests confirmed that no hydraulic response was observed in nearby Wanapum wells when testing the SeVein Grande Ronde wells (GSI, 2007; EA, 2017).

Aquifer Boundary Conditions

Aquifer pumping tests and long-term monitoring data were assessed to document the assumed aquifer boundary conditions shown in Figure 3. The geologic formations, cased intervals, and production zones for the SeVein wells are depicted on the hydrogeologic cross-section in Figure 4.

Figure 4 also shows the assumed projection of the East Fault and Dry Creek Fault based on inferences from the site geologic logs. Based on previous site testing and analyses, this CHM considers the following fault boundary conditions influencing the SeVein wells:

- The East Fault serves as a no-flow boundary, or partial barrier to groundwater flow. This assumption is based on multiple lines of evidence; however, the degree of hydraulic disconnection has not been quantified.
- The West Fault is assumed to function as a no-flow boundary or partial barrier to groundwater flow. This assumption is based the regional fault pattern that indicates the East and West faults are the boundaries of a larger regional fault block.
- The Dry Creek Fault is assumed to function as a recharge boundary. Further assessment of the Dry Creek system is needed to quantify the recharge to the basalt aquifers.
- Groundwater discharge from this system is assumed to flow to the northwest. Further assessment is needed to estimate the regional hydraulic gradient and discharge rates.
- Groundwater pumping is also considered an aquifer discharge boundary condition.
- Seepage from overlying aquifer units and across fault boundary conditions may also contribute to aquifer recharge. Leakance between the Wanapum and Grande Ronde units has not been assessed in this area, but water level data indicate a downward vertical gradient exists (EA, 2017).

Recommendations

This CHM has documented the currently available data and assumptions for the SWA water system. Additional site testing is needed to verify assumptions and to quantify groundwater movement in the vicinity of the identified fault boundary conditions.

To facilitate preliminary testing, we recommend:

- Develop a surface water and seepage monitoring program for data collection and analysis of seepage recharge that occurs through the Dry Creek system.
    - Establish 5-7 monitoring locations where the Dry Creek channel geometry is surveyed to facilitate stage discharge measurements and seepage losses between segments.
    - Monitoring locations may be assessed using LiDAR data to estimate similar channel features and segments, but should be field verified to confirm appropriate conditions.
- Pumping and injection testing is recommended at Wells 1, 3, and 4 (including monitoring at Well 2). We recommend the development of an aquifer pumping and injection test plan, utilizing the following pumping and injection scenarios:
    - Pump from Well 4, inject into Well 1
    - Pump from Well 4, inject into Well 3
    - Pump from Well 3, inject into Well 4
    - Injection rates for each test are estimated to be approximately 50 percent of the pumping rate.

- Develop a generalized 3-dimensional groundwater flow model of the aquifer and boundary conditions using MODFLOW software. Explicitly simulate basalt flow zones, no-flow fault boundaries, Dry Creek Fault recharge, and proposed pumping/injection scenarios. We assume that this modeling tool will be an important component of evaluating the injection test data and facilitating permitting activities for the aquifer recharge limited license.

Description of Aquifer Targeted for Storage

The SeVein AR Program is currently focused on recharging the Grande Ronde Unit of the CRBG through injection into Well 1 (initial testing) and Well 4 (projected future development).

Assessment of Current Conditions in the Target Aquifer

The water rights authorizing SWA to use basalt groundwater for irrigation and temporary storage, include permit conditions that limit the degree to which static water levels in the production wells may decline below established baseline levels. In compliance with water right permit conditions, SWA has been monitoring and reporting annual static water level measurements in the SeVein production wells since 2005.

Annual monitoring and reporting results are summarized in Attachment C. The measurements indicate a general pattern of static water level decline until approximately 2015 when SWA began incorporating substantial changes to their water management program. To date, measured static water levels have not yet exceeded the limits established in the water right permit conditions.

The Walla Walla Valley Appelation (WWVA) well included in the original water right permit and certificate is no longer in use. This well was recently replaced by SeVein Well 4, for which construction was completed in 2019. In future years, SeVein Well 4 will be included in the permit condition water level measurement and reporting, and the WWVA well will be excluded.

Anticipated Changes to Groundwater System

The stated objective of the SeVein AR Program is to restore static water levels in the SeVein wells to original reference water levels and sustain static water levels within the 25-foot decline limits established in the associated water right certificates. The proposed AR testing is necessary to evaluate the degree to which this objective can be accomplished in practice.

Description of Feasibility of AR and Recoverability of Stored Water

The proposed AR testing is necessary to evaluate the feasibility of AR and recoverability of stored water.

Limitations

Work for this project was performed for the SeVein Water Association (Client), and this memorandum was prepared in accordance with generally accepted professional practices for the nature and conditions of work completed in the same or similar localities, at the time the work was performed. This memorandum does not represent a legal opinion. No other warranty, expressed or implied, is made.

All reports prepared by Aspect Consulting for the Client apply only to the services described in the Agreement(s) with the Client. Any use or reuse by any party other than the Client is at the sole risk of that party, and without liability to Aspect Consulting. Aspect Consulting's original files/reports shall govern in the event of any dispute regarding the content of electronic documents furnished to others.

Attachments: Figure 1 – Regional Geology
Figure 2 – Local Boundary Conditions
Figure 3 – Conceptual Hydrogeologic Model
Figure 4 – Hydrogeologic Cross-Section
Attachment A – USDA-NRCS Soil Survey Map
Attachment B – Well Logs
Attachment C – Permit Condition Water Level Measurements

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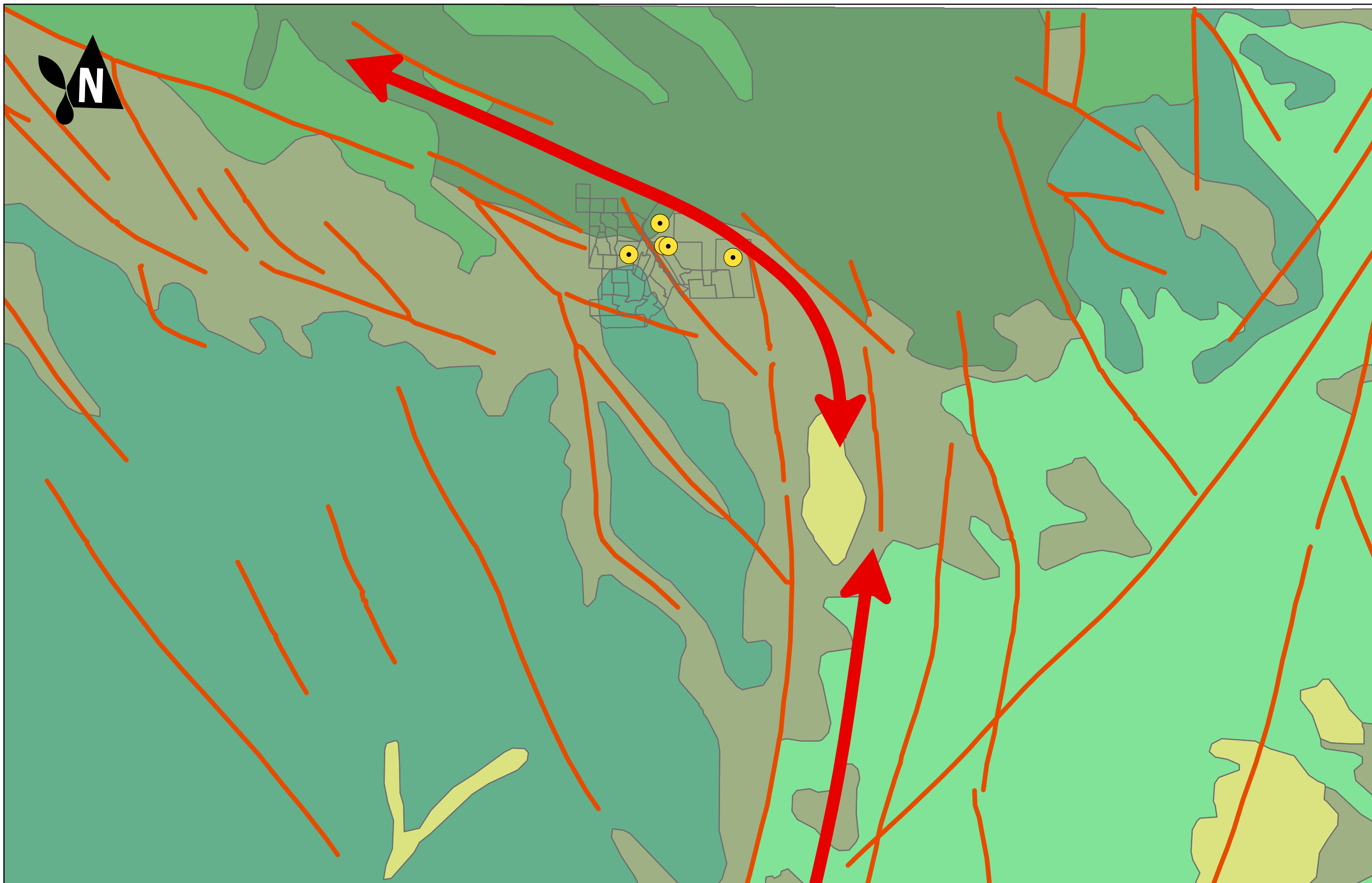
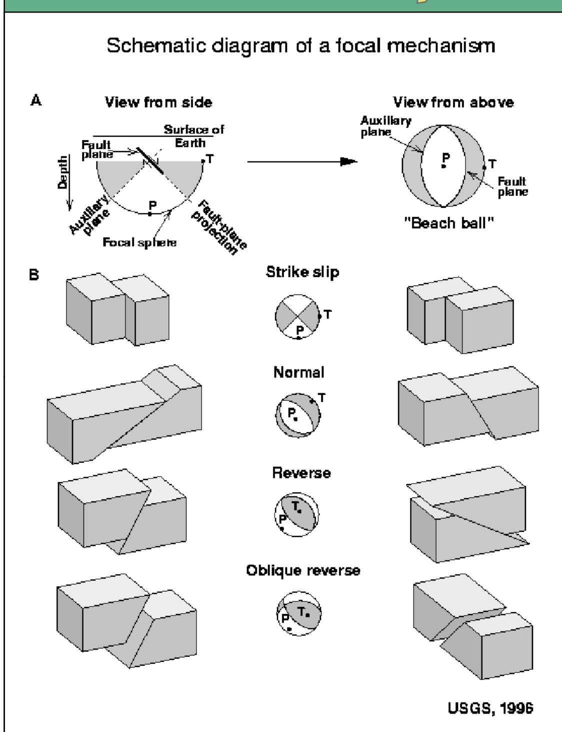
FIGURES





North-south oriented curved network of faults is a dominant structural control.

a. The eastern side of the curved fault network appears to dip to the west, with shear zone influence observed in the geologic log of Well 2.

b. Comparison of the geologic logs for Well 1 and 2 suggests approximately 100 - 150 feet of vertical offset has occurred along this fault.

c. Faulting assumed to be the result of large regional uplift originating from the southeast.

Geology

- **Qal**
- **Ql**
- **Qs**
- **Tcg**
- **Tcs**
- **Tcw**
- **Ts**
- **Well**
- **Faults**
- SeVein Parcels

Dominant Fault Network

0 1 2 3 4 5
Miles

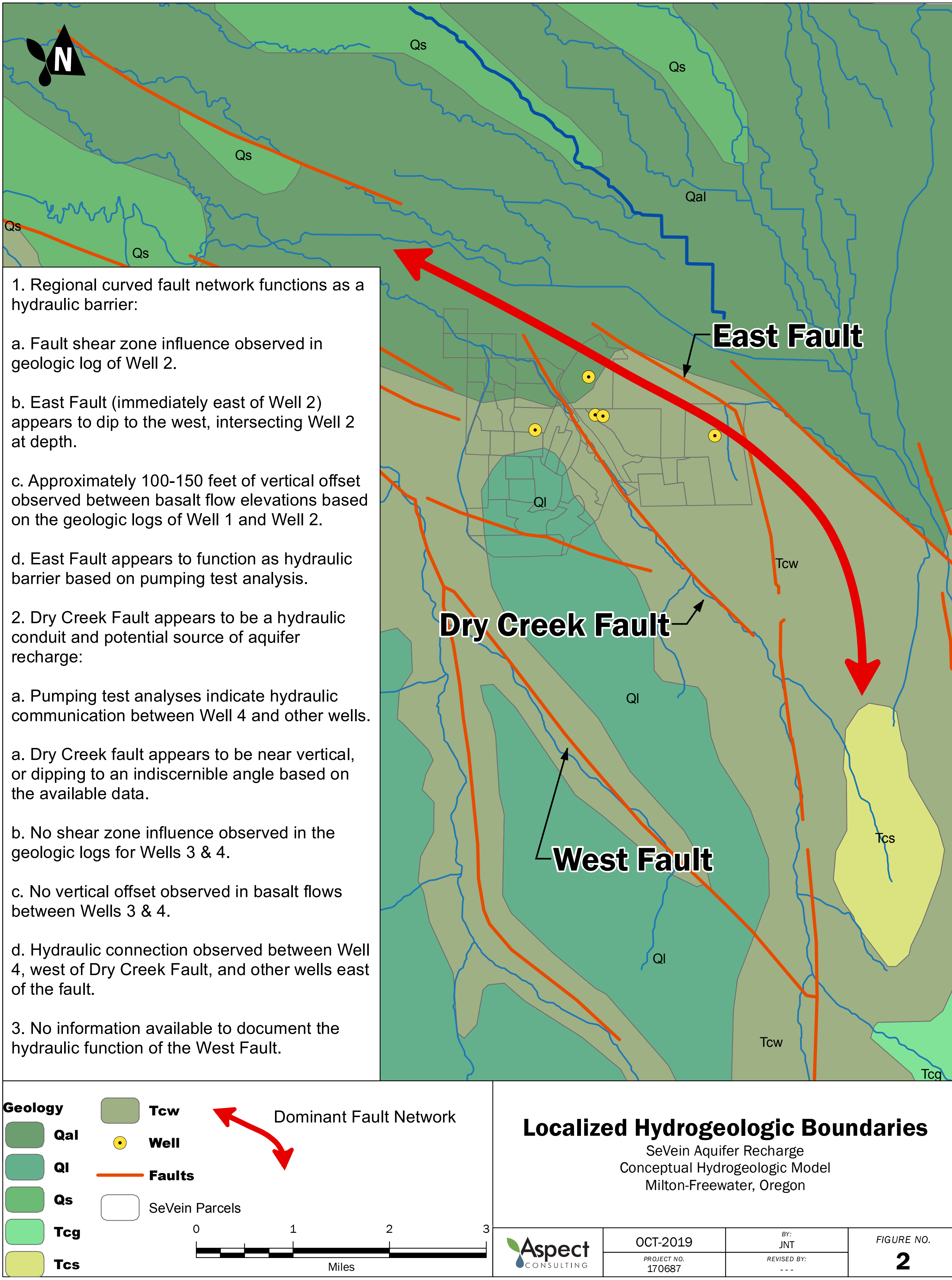
Geology and Faults

SeVein Aquifer Recharge
Conceptual Hydrogeologic Model
Milton-Freewater, Oregon

Aspect CONSULTING

OCT-2019	BY: JNT	FIGURE NO.
PROJECT NO. 170687	REVISED BY: - - -	1

GIS Path: T:\projects_8\SeVeinWaterManagement_170687\CHM\Regional Geology Map Figure.mxd || Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet || Date Saved: 10/2/2019 || User: jturk || Print Date: 10/2/2019



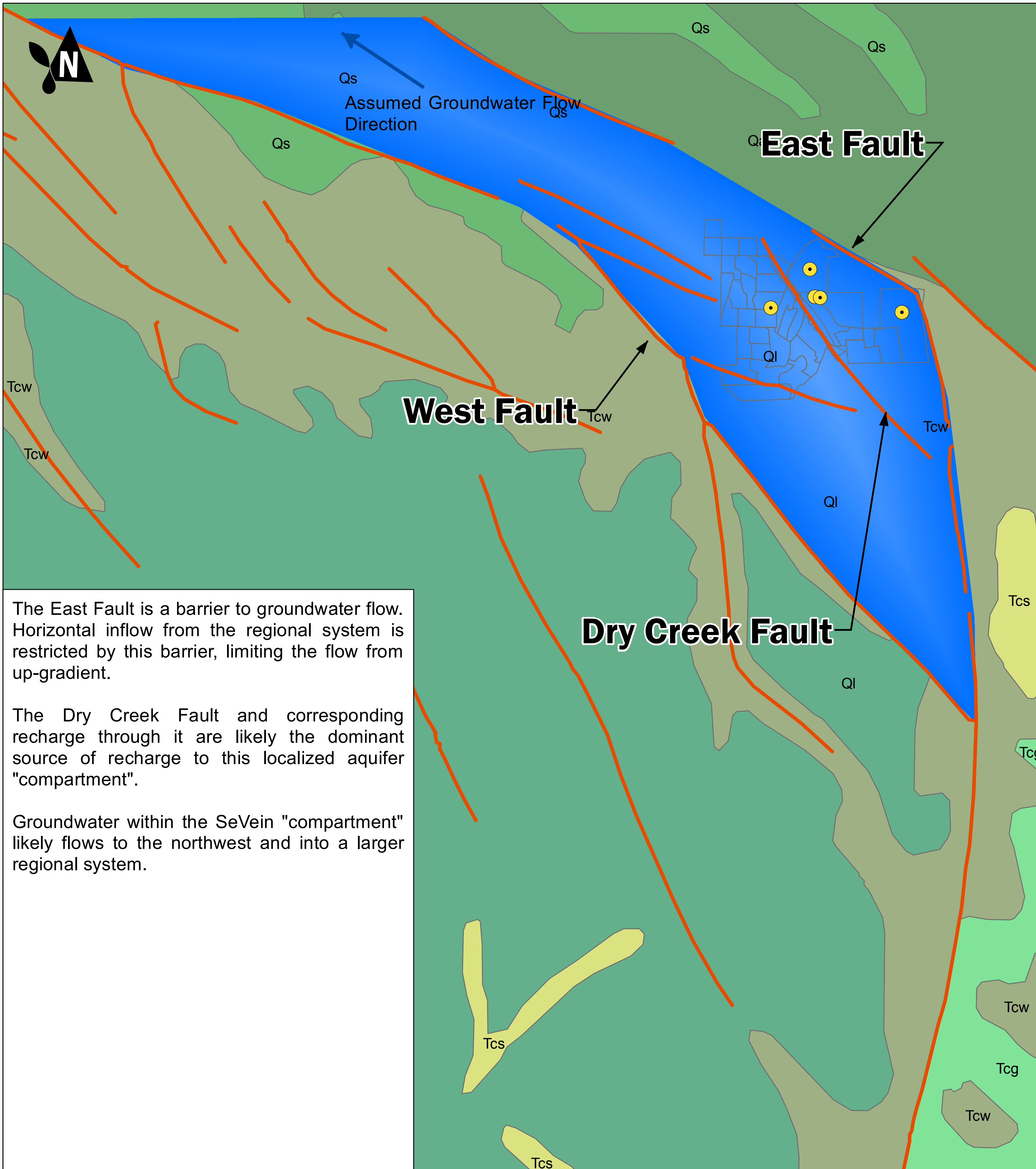
Localized Hydrogeologic Boundaries

SeVein Aquifer Recharge
Conceptual Hydrogeologic Model
Milton-Freewater, Oregon

Aspect CONSULTING

OCT-2019	BY: JNT	FIGURE NO.
PROJECT NO. 170687	REVISED BY: - - -	2

GIS Path: T:\projects_8\SeVeinWaterManagement_170687\CHM\Local Boundary Conditions.mxd || Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet || Date Saved: 10/2/2019 || User: jturk || Print Date: 10/2/2019



The East Fault is a barrier to groundwater flow. Horizontal inflow from the regional system is restricted by this barrier, limiting the flow from up-gradient.

The Dry Creek Fault and corresponding recharge through it are likely the dominant source of recharge to this localized aquifer "compartment".

Groundwater within the SeVein "compartment" likely flows to the northwest and into a larger regional system.

GIS Path: T:\projects_8\SeVeinWaterManagement_170687\CHM\CHM Figure.mxd || Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet || Date Saved: 10/2/2019 || User: jturk || Print Date: 10/2/2019

Geology

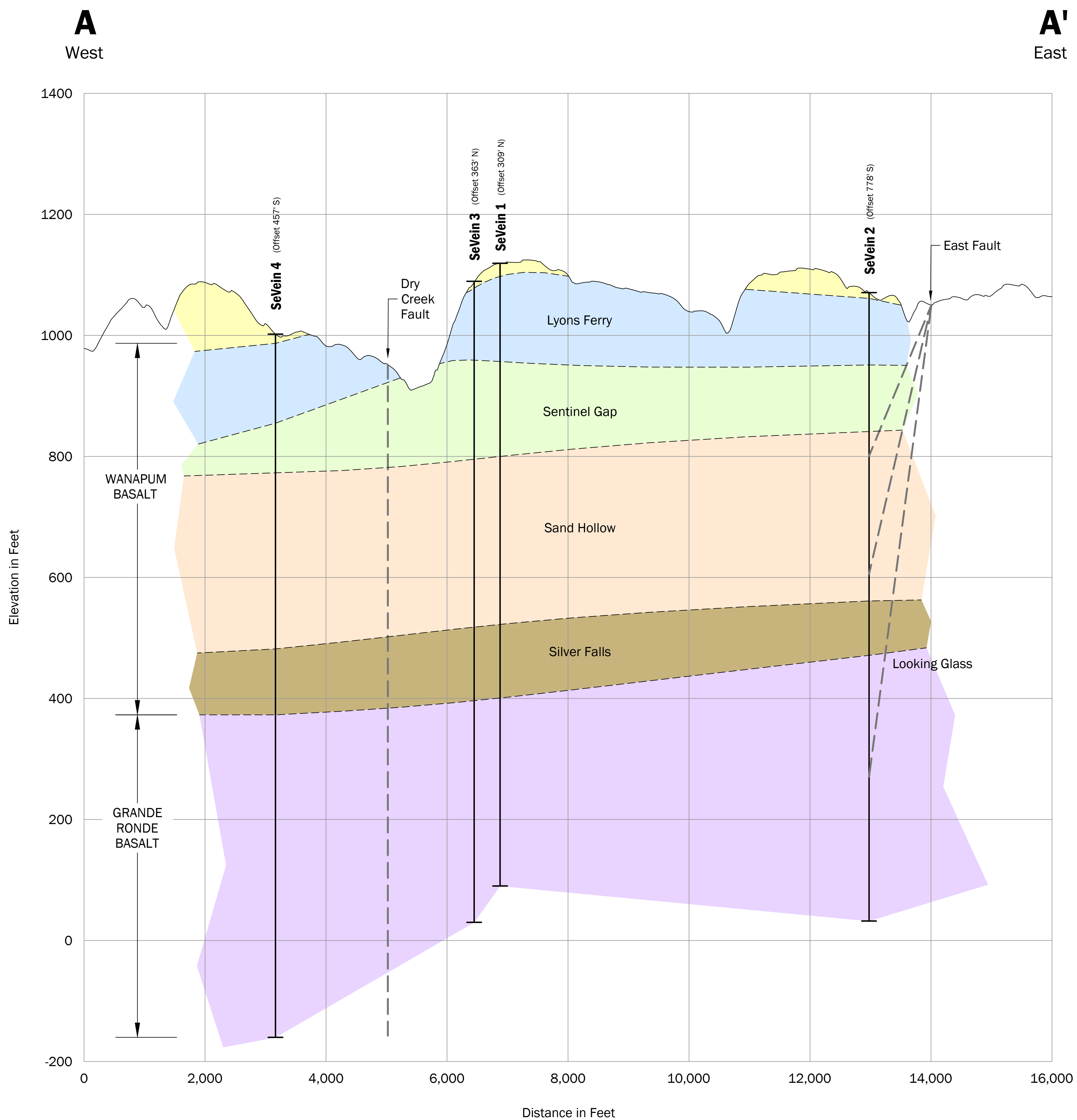
- **Qal**
- **Ql**
- **Qs**
- **Tcg**
- **Tcs**
- **Tcw**
- Estimate Aquifer Boundary
- SeVein Parcels
- **Faults**
- **Well**

0 1 2 3
Miles

Estimated Aquifer Area

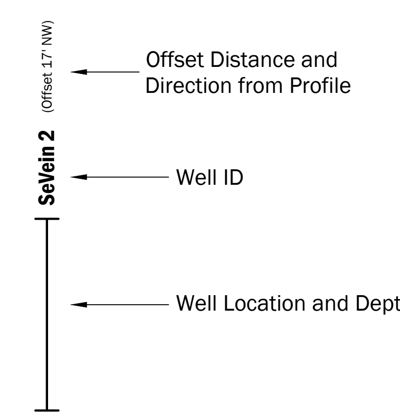
SeVein Aquifer Recharge
Conceptual Hydrogeologic Model
Milton-Freewater, Oregon

Aspect CONSULTING	OCT-2019	BY: JNT	FIGURE NO. 3
	PROJECT NO. 170687	REVISED BY: - - -	



Legend

- Estimated Geologic Contact
- Fault Location
- ????
- Lyons Ferry
- Sentinel Gap
- Sand Hollow
- Silver Falls
- ?????



Horizontal Scale: 1" = 2000'
Vertical Scale: 1" = 200'
Vertical Exaggeration 10x

0 2000 4000 Feet

DRAFT

Hydrogeologic Cross Section A-A'

SeVein Aquifer Recharge
Conceptual Hydrogeologic Model
Milton-Freewater, Oregon

Aspect CONSULTING	Nov-2019	BY: JNT/SCC	FIGURE NO.
	PROJECT NO. 170687	REVISED BY: -	4

ATTACHMENT A

USDA-NRCS Soil Survey Map

United States Department of Agriculture

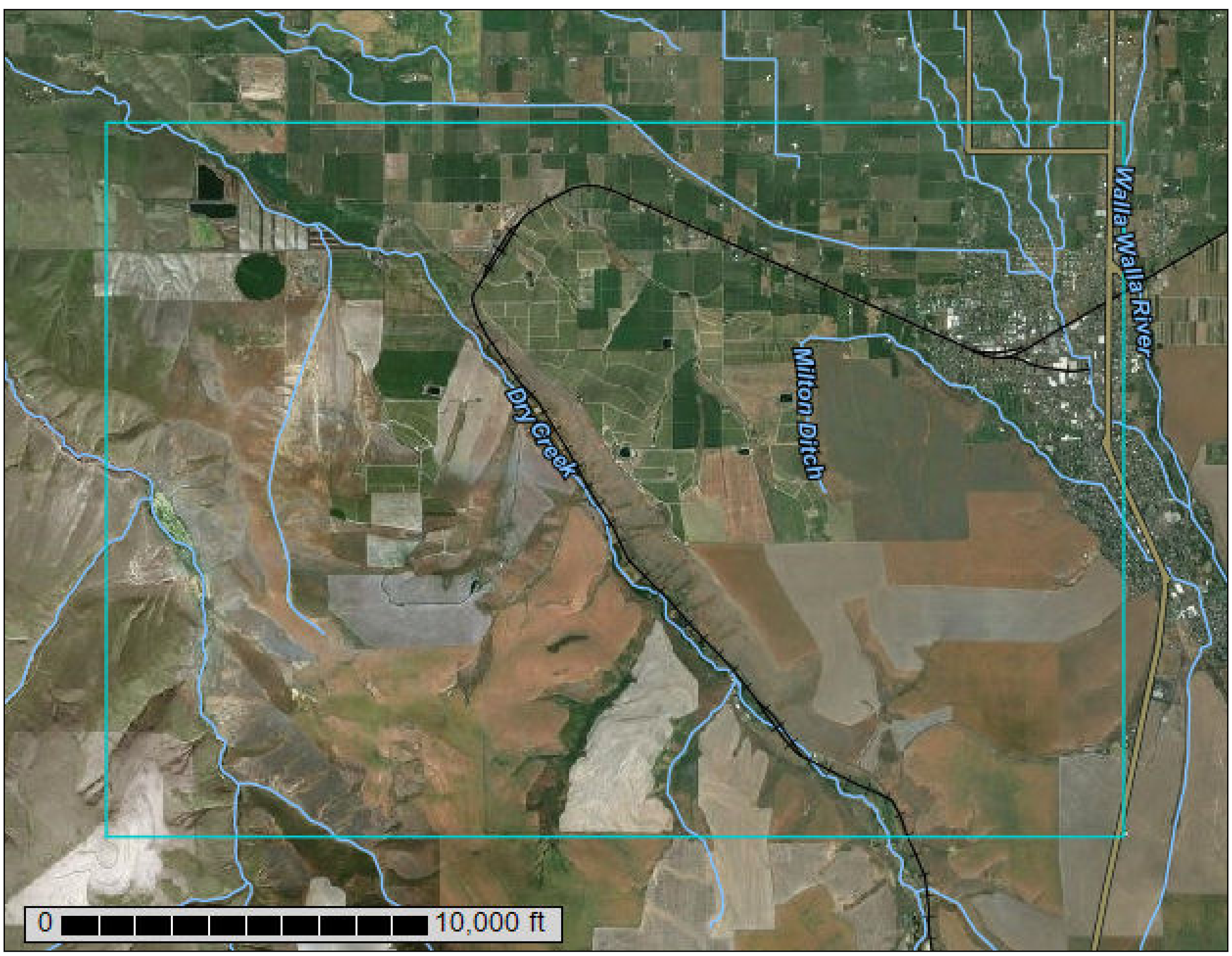
NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for
Umatilla County Area, Oregon

SeVein Water Management



October 11, 2019

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

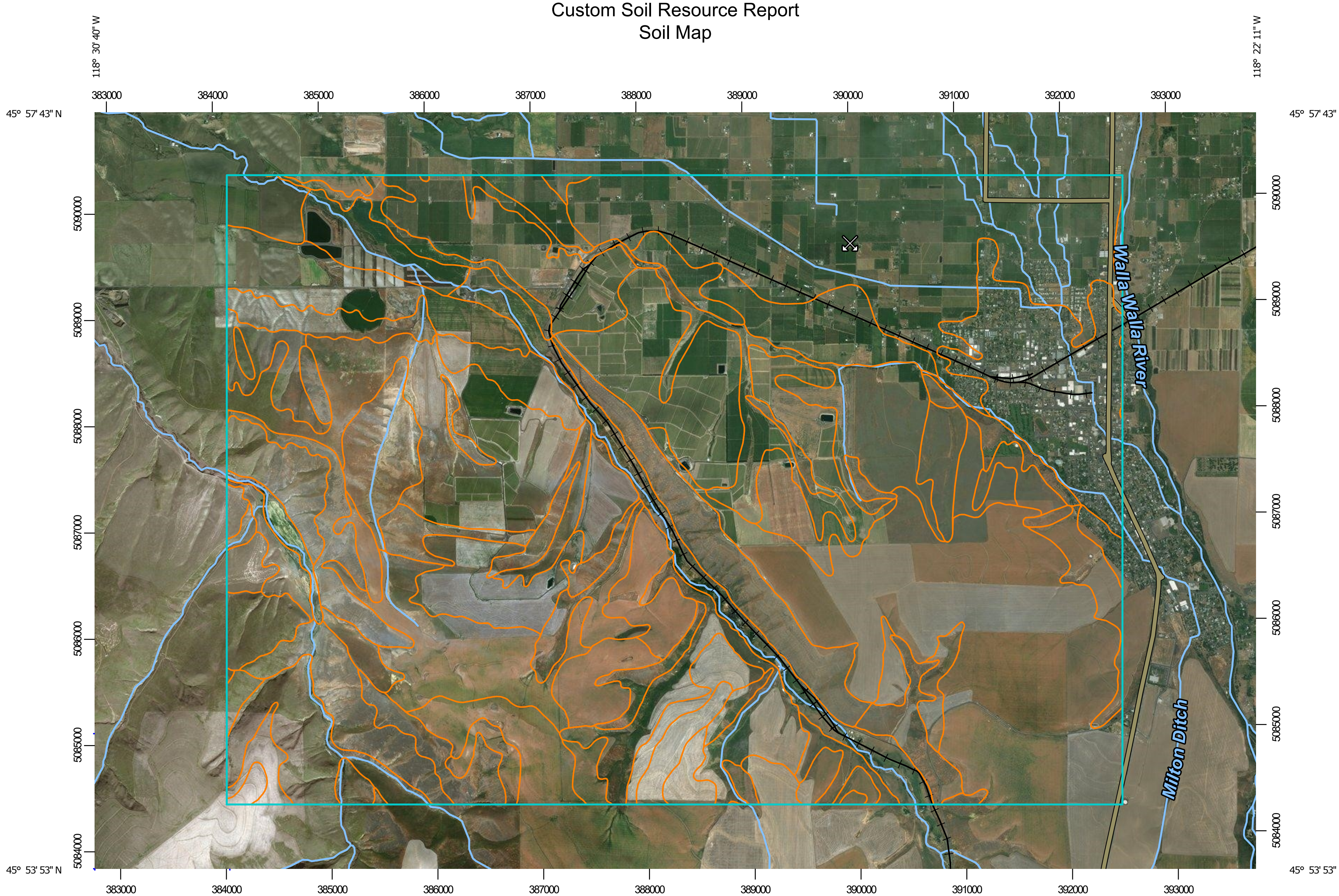
Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Soil Map



Map Scale: 1:50,200 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0, 500, 1000, 2000, 3000

Feet: 0, 2000, 4000, 8000, 12000

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 11N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Umatilla County Area, Oregon
Survey Area Data: Version 15, Sep 16, 2019

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jul 7, 2014—Oct 27, 2016

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
6C	Anderly silt loam, 7 to 12 percent slopes	51.1	0.4%
6D	Anderly silt loam, 12 to 20 percent slopes	15.5	0.1%
6E	Anderly silt loam, 20 to 35 percent slopes	314.7	2.5%
24B	Ellisforde silt loam, 1 to 7 percent slopes	691.7	5.6%
24C	Ellisforde silt loam, 7 to 20 percent slopes	253.7	2.0%
28A	Freewater gravelly silt loam, 0 to 3 percent slopes	238.4	1.9%
29A	Freewater very cobbly loam, 0 to 3 percent slopes	1,401.0	11.3%
30A	Freewater-Urban land complex, 0 to 3 percent slopes	595.5	4.8%
39A	Hermiston silt loam, 0 to 3 percent slopes	323.5	2.6%
48E	Lickskillet very stony loam, 7 to 40 percent slopes	829.3	6.7%
50F	Lickskillet-Rock outcrop complex, 40 to 70 percent slopes	392.7	3.2%
60F	Nansene silt loam, 35 to 70 percent slopes	411.0	3.3%
72A	Powder silt loam, 0 to 3 percent slopes	97.5	0.8%
84	Riverwash	11.6	0.1%
106A	Umapine silt loam, reclaimed, 0 to 3 percent slopes	65.7	0.5%
114B	Walla Walla silt loam, 1 to 7 percent slopes	1,826.9	14.7%
114C	Walla Walla silt loam, 7 to 12 percent slopes	1,343.7	10.8%
115D	Walla Walla silt loam, 12 to 25 percent north slopes	2,223.9	17.9%
115E	Walla Walla silt loam, 25 to 40 percent north slopes	988.9	7.9%
116D	Walla Walla silt loam, 12 to 25 percent south slopes	87.7	0.7%
126A	Xerofluvents, 0 to 3 percent slopes	48.3	0.4%
128A	Yakima silt loam, 0 to 3 percent slopes	228.3	1.8%

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
Totals for Area of Interest		**12,440.5**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Umatilla County Area, Oregon

6C—Anderly silt loam, 7 to 12 percent slopes

Map Unit Setting

National map unit symbol: 2553
Elevation: 1,000 to 2,500 feet
Mean annual precipitation: 11 to 14 inches
Mean annual air temperature: 50 to 54 degrees F
Frost-free period: 150 to 170 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Anderly and similar soils: 80 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Anderly

Setting

Landform: Hills
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve, nose slope, crest
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loess

Typical profile

H1 - 0 to 13 inches: silt loam
H2 - 13 to 24 inches: silt loam
H3 - 24 to 28 inches: unweathered bedrock

Properties and qualities

Slope: 7 to 12 percent
Depth to restrictive feature: 20 to 40 inches to lithic bedrock
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 5.3 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: C
Ecological site: LOAMY 12-14 PZ (R008XY120OR)
Hydric soil rating: No

6D—Anderly silt loam, 12 to 20 percent slopes

Map Unit Setting

National map unit symbol: 2554
Elevation: 1,000 to 2,500 feet
Mean annual precipitation: 11 to 14 inches
Mean annual air temperature: 50 to 54 degrees F
Frost-free period: 150 to 170 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Anderly and similar soils: 75 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Anderly

Setting

Landform: Hillslopes
Landform position (two-dimensional): Backslope, footslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loess

Typical profile

H1 - 0 to 13 inches: silt loam
H2 - 13 to 24 inches: silt loam
H3 - 24 to 28 inches: unweathered bedrock

Properties and qualities

Slope: 12 to 20 percent
Depth to restrictive feature: 20 to 40 inches to lithic bedrock
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 5.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: C
Ecological site: SOUTH 10-14 PZ (R008XY200OR)
Hydric soil rating: No

6E—Anderly silt loam, 20 to 35 percent slopes

Map Unit Setting

National map unit symbol: 2555
Elevation: 1,000 to 2,500 feet
Mean annual precipitation: 11 to 14 inches
Mean annual air temperature: 50 to 54 degrees F
Frost-free period: 150 to 170 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Anderly and similar soils: 75 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Anderly

Setting

Landform: Hillslopes
Landform position (two-dimensional): Footslope, backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loess

Typical profile

H1 - 0 to 13 inches: silt loam
H2 - 13 to 24 inches: silt loam
H3 - 24 to 28 inches: unweathered bedrock

Properties and qualities

Slope: 20 to 35 percent
Depth to restrictive feature: 20 to 40 inches to lithic bedrock
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 5.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: C
Ecological site: SOUTH 10-14 PZ (R008XY200OR)
Hydric soil rating: No

24B—Ellisforde silt loam, 1 to 7 percent slopes

Map Unit Setting

National map unit symbol: 252s
Elevation: 500 to 900 feet
Mean annual precipitation: 8 to 12 inches
Mean annual air temperature: 48 to 54 degrees F
Frost-free period: 160 to 190 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Ellisforde and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Ellisforde

Setting

Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Silty loess over calcareous, lacustrine deposits

Typical profile

H1 - 0 to 10 inches: silt loam
H2 - 10 to 28 inches: silt loam
H3 - 28 to 60 inches: stratified very fine sandy loam to silt loam

Properties and qualities

Slope: 1 to 7 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 15 percent
Salinity, maximum in profile: Nonsaline to slightly saline (0.0 to 4.0 mmhos/cm)
Available water storage in profile: High (about 11.6 inches)

Interpretive groups

Land capability classification (irrigated): 2e
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: C
Ecological site: LOAMY 10-12 PZ (R008XY110OR)
Hydric soil rating: No

24C—Ellisforde silt loam, 7 to 20 percent slopes

Map Unit Setting

National map unit symbol: 252t
Elevation: 500 to 900 feet
Mean annual precipitation: 8 to 12 inches
Mean annual air temperature: 50 to 54 degrees F
Frost-free period: 160 to 190 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Ellisforde and similar soils: 75 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Ellisforde

Setting

Landform: Terraces
Landform position (three-dimensional): Riser
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Silty loess over calcareous, lacustrine deposits

Typical profile

H1 - 0 to 10 inches: silt loam
H2 - 10 to 28 inches: silt loam
H3 - 28 to 60 inches: stratified very fine sandy loam to silt loam

Properties and qualities

Slope: 7 to 20 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 15 percent
Salinity, maximum in profile: Nonsaline to slightly saline (0.0 to 4.0 mmhos/cm)
Available water storage in profile: High (about 11.6 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: C
Ecological site: LOAMY 10-12 PZ (R008XY110OR)
Hydric soil rating: No

28A—Freewater gravelly silt loam, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 252y
Elevation: 800 to 1,400 feet
Mean annual precipitation: 12 to 16 inches
Mean annual air temperature: 50 to 54 degrees F
Frost-free period: 145 to 195 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Freewater and similar soils: 90 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Freewater

Setting

Landform: Flood plains
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Mixed, very gravelly alluvium

Typical profile

H1 - 0 to 4 inches: gravelly silt loam
H2 - 4 to 20 inches: very gravelly loam
H3 - 20 to 60 inches: extremely gravelly sand

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat excessively drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: Rare
Frequency of ponding: None
Available water storage in profile: Low (about 4.6 inches)

Interpretive groups

Land capability classification (irrigated): 3s
Land capability classification (nonirrigated): 4s
Hydrologic Soil Group: B
Hydric soil rating: No

29A—Freewater very cobbly loam, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 252z
Elevation: 800 to 1,400 feet
Mean annual precipitation: 12 to 16 inches
Mean annual air temperature: 50 to 54 degrees F
Frost-free period: 145 to 195 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Freewater and similar soils: 90 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Freewater

Setting

Landform: Flood plains
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Mixed, very gravelly alluvium

Typical profile

H1 - 0 to 4 inches: very cobbly loam
H2 - 4 to 20 inches: very gravelly loam
H3 - 20 to 60 inches: extremely gravelly sand

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat excessively drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: Rare
Frequency of ponding: None
Available water storage in profile: Low (about 4.4 inches)

Interpretive groups

Land capability classification (irrigated): 4s
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: B
Hydric soil rating: No

30A—Freewater-Urban land complex, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 2532
Elevation: 800 to 1,000 feet
Mean annual precipitation: 13 to 15 inches
Mean annual air temperature: 52 to 54 degrees F
Frost-free period: 160 to 195 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Freewater and similar soils: 60 percent
Urban land: 30 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Freewater

Setting

Landform: Flood plains
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Mixed, very gravelly alluvium

Typical profile

H1 - 0 to 4 inches: very cobbly loam
H2 - 4 to 20 inches: very gravelly loam
H3 - 20 to 60 inches: extremely gravelly sand

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat excessively drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: Rare
Frequency of ponding: None
Available water storage in profile: Low (about 4.4 inches)

Interpretive groups

Land capability classification (irrigated): 4s
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: B
Hydric soil rating: No

Description of Urban Land

Setting

Down-slope shape: Linear
Across-slope shape: Linear

Properties and qualities

Slope: 0 to 3 percent
Frequency of flooding: Rare

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8
Hydric soil rating: No

39A—Hermiston silt loam, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 253h
Elevation: 700 to 2,300 feet
Mean annual precipitation: 12 to 16 inches
Mean annual air temperature: 48 to 54 degrees F
Frost-free period: 150 to 195 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Hermiston and similar soils: 80 percent
Minor components: 1 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Hermiston

Setting

Landform: Flood plains
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Silty alluvium

Typical profile

H1 - 0 to 24 inches: silt loam
H2 - 24 to 60 inches: silt loam

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: Rare
Frequency of ponding: None
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: High (about 11.6 inches)

Interpretive groups

Land capability classification (irrigated): 1
Land capability classification (nonirrigated): 2c
Hydrologic Soil Group: B
Ecological site: LOAMY BOTTOM (R010XY005OR)
Hydric soil rating: No

Minor Components

Aquolls

Percent of map unit: 1 percent
Landform: Flood plains
Hydric soil rating: Yes

48E—Lickskillet very stony loam, 7 to 40 percent slopes

Map Unit Setting

National map unit symbol: 253x
Elevation: 1,000 to 3,100 feet
Mean annual precipitation: 10 to 16 inches
Mean annual air temperature: 46 to 52 degrees F
Frost-free period: 110 to 165 days
Farmland classification: Not prime farmland

Map Unit Composition

Lickskillet and similar soils: 70 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Lickskillet

Setting

Landform: Hillslopes
Landform position (two-dimensional): Backslope, shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loess mixed with colluvium from basalt

Typical profile

A - 0 to 6 inches: very stony loam
Bw - 6 to 18 inches: very gravelly loam
R - 18 to 22 inches: unweathered bedrock

Properties and qualities

Slope: 7 to 40 percent
Depth to restrictive feature: 12 to 20 inches to lithic bedrock
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches

Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 5 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Very low (about 1.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: D
Ecological site: SHALLOW SOUTH 10-14 PZ (R008XY210OR)
Hydric soil rating: No

50F—Lickskillet-Rock outcrop complex, 40 to 70 percent slopes

Map Unit Setting

National map unit symbol: 2540
Elevation: 1,000 to 3,100 feet
Mean annual precipitation: 10 to 16 inches
Mean annual air temperature: 46 to 52 degrees F
Frost-free period: 110 to 165 days
Farmland classification: Not prime farmland

Map Unit Composition

Lickskillet and similar soils: 55 percent
Rock outcrop: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Lickskillet

Setting

Landform: Hillslopes
Landform position (two-dimensional): Backslope, shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Loess mixed with colluvium from basalt

Typical profile

A - 0 to 6 inches: extremely stony loam
Bw - 6 to 18 inches: very gravelly loam
H3 - 18 to 22 inches: unweathered bedrock

Properties and qualities

Slope: 40 to 70 percent
Depth to restrictive feature: 12 to 20 inches to lithic bedrock
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None

Frequency of ponding: None
Calcium carbonate, maximum in profile: 5 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Very low (about 1.9 inches)

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: D
Ecological site: SHALLOW SOUTH 10-14 PZ (R008XY210OR)
Hydric soil rating: No

Description of Rock Outcrop

Setting
Landform: Hillslopes
Landform position (two-dimensional): Backslope, shoulder
Landform position (three-dimensional): Side slope, free face
Down-slope shape: Convex
Across-slope shape: Convex

Typical profile
R - 0 to 60 inches: unweathered bedrock

Properties and qualities
Slope: 40 to 70 percent
Depth to restrictive feature: 0 inches to lithic bedrock

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8
Hydric soil rating: No

60F—Nansene silt loam, 35 to 70 percent slopes

Map Unit Setting
National map unit symbol: 254j
Elevation: 900 to 2,500 feet
Mean annual precipitation: 11 to 14 inches
Mean annual air temperature: 48 to 52 degrees F
Frost-free period: 140 to 170 days
Farmland classification: Not prime farmland

Map Unit Composition
Nansene and similar soils: 75 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Nansene

Setting
Landform: Hillslopes

Landform position (two-dimensional): Shoulder, backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Loess

Typical profile

H1 - 0 to 20 inches: silt loam
H2 - 20 to 35 inches: silt loam
H3 - 35 to 60 inches: silt loam

Properties and qualities

Slope: 35 to 70 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: High (about 10.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: B
Ecological site: LOAMY 12-14 PZ (R008XY120OR)
Hydric soil rating: No

72A—Powder silt loam, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 2558
Elevation: 500 to 1,300 feet
Mean annual precipitation: 9 to 12 inches
Mean annual air temperature: 50 to 54 degrees F
Frost-free period: 160 to 180 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Powder and similar soils: 90 percent
Minor components: 1 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Powder

Setting

Landform: Flood plains
Landform position (three-dimensional): Tread
Down-slope shape: Linear

Across-slope shape: Linear
Parent material: Calcareous, silty alluvium

Typical profile

H1 - 0 to 15 inches: silt loam
H2 - 15 to 27 inches: silt loam
H3 - 27 to 60 inches: silt loam

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: About 48 to 72 inches
Frequency of flooding: Rare
Frequency of ponding: None
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Very high (about 13.2 inches)

Interpretive groups

Land capability classification (irrigated): 2c
Land capability classification (nonirrigated): 4c
Hydrologic Soil Group: B
Ecological site: LOAMY BOTTOM (R010XY005OR)
Hydric soil rating: No

Minor Components

Aquolls

Percent of map unit: 1 percent
Landform: Depressions
Hydric soil rating: Yes

84—Riverwash

Map Unit Setting

National map unit symbol: 255x
Elevation: 250 to 2,500 feet
Mean annual precipitation: 8 to 25 inches
Mean annual air temperature: 45 to 54 degrees F
Frost-free period: 100 to 190 days
Farmland classification: Not prime farmland

Map Unit Composition

Riverwash: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Riverwash

Setting

Landform: Flood plains
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Mixed alluvium

Typical profile

H1 - 0 to 60 inches: stratified sand to gravel

Properties and qualities

Slope: 0 to 2 percent
Natural drainage class: Poorly drained
Depth to water table: About 0 to 24 inches
Frequency of flooding: Frequent

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8
Hydric soil rating: Yes

106A—Umapine silt loam, reclaimed, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 250z
Elevation: 400 to 1,300 feet
Mean annual precipitation: 9 to 12 inches
Mean annual air temperature: 50 to 54 degrees F
Frost-free period: 150 to 195 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Umapine and similar soils: 80 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Umapine

Setting

Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Silty alluvium

Typical profile

H1 - 0 to 7 inches: silt loam
H2 - 7 to 60 inches: silt loam

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches

Natural drainage class: Somewhat poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: About 24 to 48 inches
Frequency of flooding: Rare
Frequency of ponding: None
Calcium carbonate, maximum in profile: 20 percent
Salinity, maximum in profile: Slightly saline to moderately saline (4.0 to 8.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 20.0
Available water storage in profile: High (about 11.9 inches)

Interpretive groups
Land capability classification (irrigated): 3w
Land capability classification (nonirrigated): 4s
Hydrologic Soil Group: C
Ecological site: SODIC BOTTOM (R010XY007OR)
Hydric soil rating: No

114B—Walla Walla silt loam, 1 to 7 percent slopes

Map Unit Setting
National map unit symbol: 251c
Elevation: 1,000 to 2,300 feet
Mean annual precipitation: 12 to 15 inches
Mean annual air temperature: 50 to 54 degrees F
Frost-free period: 135 to 170 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition
Walla walla and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Walla Walla

Setting
Landform: Hills
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve, crest, nose slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loess

Typical profile
H1 - 0 to 6 inches: silt loam
H2 - 6 to 44 inches: silt loam
H3 - 44 to 60 inches: silt loam

Properties and qualities
Slope: 1 to 7 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained

Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 10 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: High (about 11.2 inches)

Interpretive groups

Land capability classification (irrigated): 2e
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: B
Ecological site: LOAMY 12-14 PZ (R008XY120OR)
Hydric soil rating: No

114C—Walla Walla silt loam, 7 to 12 percent slopes

Map Unit Setting

National map unit symbol: 251d
Elevation: 1,000 to 2,300 feet
Mean annual precipitation: 12 to 15 inches
Mean annual air temperature: 50 to 54 degrees F
Frost-free period: 135 to 170 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Walla walla and similar soils: 75 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Walla Walla

Setting

Landform: Hills
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Crest, interfluve, nose slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loess

Typical profile

H1 - 0 to 6 inches: silt loam
H2 - 6 to 44 inches: silt loam
H3 - 44 to 60 inches: silt loam

Properties and qualities

Slope: 7 to 12 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)

Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 10 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: High (about 11.2 inches)

Interpretive groups
Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B
Ecological site: LOAMY 12-14 PZ (R008XY120OR)
Hydric soil rating: No

115D—Walla Walla silt loam, 12 to 25 percent north slopes

Map Unit Setting
National map unit symbol: 251f
Elevation: 1,650 to 2,300 feet
Mean annual precipitation: 12 to 15 inches
Mean annual air temperature: 50 to 54 degrees F
Frost-free period: 135 to 170 days
Farmland classification: Farmland of statewide importance

Map Unit Composition
Walla walla, north, and similar soils: 75 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Walla Walla, North

Setting
Landform: Hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loess

Typical profile
H1 - 0 to 6 inches: silt loam
H2 - 6 to 44 inches: silt loam
H3 - 44 to 60 inches: silt loam

Properties and qualities
Slope: 12 to 25 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None

Frequency of ponding: None
Calcium carbonate, maximum in profile: 10 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: High (about 11.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B
Ecological site: NORTH 10-14 PZ (R008XY220OR)
Hydric soil rating: No

115E—Walla Walla silt loam, 25 to 40 percent north slopes

Map Unit Setting

National map unit symbol: 251g
Elevation: 1,000 to 2,300 feet
Mean annual precipitation: 12 to 15 inches
Mean annual air temperature: 50 to 54 degrees F
Frost-free period: 135 to 170 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Walla walla, north, and similar soils: 75 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Walla Walla, North

Setting

Landform: Hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Loess

Typical profile

H1 - 0 to 6 inches: silt loam
H2 - 6 to 44 inches: silt loam
H3 - 44 to 60 inches: silt loam

Properties and qualities

Slope: 20 to 40 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 10 percent

Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: High (about 11.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: B
Ecological site: NORTH 10-14 PZ (R008XY220OR)
Hydric soil rating: No

116D—Walla Walla silt loam, 12 to 25 percent south slopes

Map Unit Setting

National map unit symbol: 251h
Elevation: 1,000 to 2,300 feet
Mean annual precipitation: 12 to 15 inches
Mean annual air temperature: 50 to 54 degrees F
Frost-free period: 135 to 170 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Walla walla, south, and similar soils: 70 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Walla Walla, South

Setting

Landform: Hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loess

Typical profile

H1 - 0 to 6 inches: silt loam
H2 - 6 to 44 inches: silt loam
H3 - 44 to 60 inches: silt loam

Properties and qualities

Slope: 12 to 25 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 10 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)

Available water storage in profile: High (about 11.2 inches)

Interpretive groups

Land capability classification (irrigated): 6e
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Ecological site: SOUTH 10-14 PZ (R008XY200OR)
Hydric soil rating: No

126A—Xerofluvents, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 251x
Elevation: 250 to 3,000 feet
Mean annual precipitation: 8 to 30 inches
Mean annual air temperature: 45 to 54 degrees F
Frost-free period: 110 to 190 days
Farmland classification: Not prime farmland

Map Unit Composition

Xerofluvents and similar soils: 80 percent
Minor components: 2 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Xerofluvents

Setting

Landform: Flood plains
Landform position (three-dimensional): Tread
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Mixed alluvium

Typical profile

H1 - 0 to 3 inches: cobbly loam
H2 - 3 to 7 inches: very cobbly loam
H3 - 7 to 22 inches: extremely gravelly sandy loam
H4 - 22 to 60 inches: extremely gravelly sand

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: About 12 to 36 inches
Frequency of flooding: Frequent
Frequency of ponding: None
Available water storage in profile: Low (about 4.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7w

Hydrologic Soil Group: C
Hydric soil rating: No

Minor Components

Riverwash

Percent of map unit: 1 percent
Landform: Flood plains
Hydric soil rating: Yes

Fluvaquents

Percent of map unit: 1 percent
Landform: Flood plains
Hydric soil rating: Yes

128A—Yakima silt loam, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 251z
Elevation: 600 to 1,600 feet
Mean annual precipitation: 9 to 14 inches
Mean annual air temperature: 50 to 54 degrees F
Frost-free period: 145 to 195 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Yakima and similar soils: 80 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Yakima

Setting

Landform: Flood plains
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Mixed alluvium

Typical profile

H1 - 0 to 10 inches: silt loam
H2 - 10 to 22 inches: silt loam
H3 - 22 to 60 inches: extremely gravelly sand

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: About 48 to 72 inches
Frequency of flooding: Rare

Frequency of ponding: None
Available water storage in profile: Moderate (about 6.0 inches)

Interpretive groups

Land capability classification (irrigated): 2s
Land capability classification (nonirrigated): 4s
Hydrologic Soil Group: B
Ecological site: LOAMY FAN 9-12 PZ (R010XY120OR)
Hydric soil rating: No

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ATTACHMENT B

Well Logs

Log of Borehole: Seven Hills No. 2

Also known as:

Project: 0448001

Well ID: UMAT

Location: Seven Hills Vineyards

Geologist: Terry L. Tolan, R.G.

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Depth	Lithologic Description	Elevation	Water Bearing Zones	Geochem Sample	Remarks
0	Ground Surface	1150			
	loess	1140			
	Frenchman Springs Member - Wanapum Basalt — Basalt of Lyons Ferry, flow 1			15	
		1110			
	deeply weathered dense interior - eroded no flow top	1100			40 ft. - interbed, brown claystone <1 ft.
	flow 2				
	flow top				
	dense interior - colonnade			75	
100					
		1030			120 ft. - interbed, yellow claystone >1 ft.
	Frenchman Springs Member - Wanapum Basalt — Basalt of Lyons Ferry, flow 1	1010			0 to 280 ft. - weathered to deeply weathered
	flow top				
	dense interior - colonnade			165	
		960			
200	flow 2				
	flow top	940			
	dense interior - colonnade			215	Blank Casing: 0-497 ft. Perforated Casing: 497-597ft. Blank Casing: 597-647 ft. Openhole: 647-1039 ft. Cement Seal: 0- ~490 ft.
		920			
	Frenchman Springs Member - Wanapum Basalt — Basalt of Sand Hollow, flow 1				
	shelly pahoe pahoe			275	
		850			
300	interbed - blue-green claystone				
	flow 2				
	flow top				
	dense interior - colonnade	820			
		810			
	flow 3				
	flow top	800			
	fault - gouge and shatter breccia				SWL - 355.66 ft. bgs 8/24/2005
	dense interior - colonnade				
400				395	
		740			
	flow 4				
	flow top breccia				
		710			
	dense interior - colonnade				
		690		455	
	flow 5				
	flow top	670			
	dense interior - colonnade			485	
500					
		640			
	Frenchman Springs Member - Wanapum Basalt — Basalt of Silver Falls		perforated WBZ		
		620			
	flow top				
	dense interior - colonnade				

Drilled By: Geo-Tech Exploration

Drill Method: Reverse Circulation Air Rotary

Drill Date: 8/2005

Total Depth: 1039 ft.

Log of Borehole: Seven Hills No. 2

Also known as:

Project: 0448001 **Well ID: UMAT**

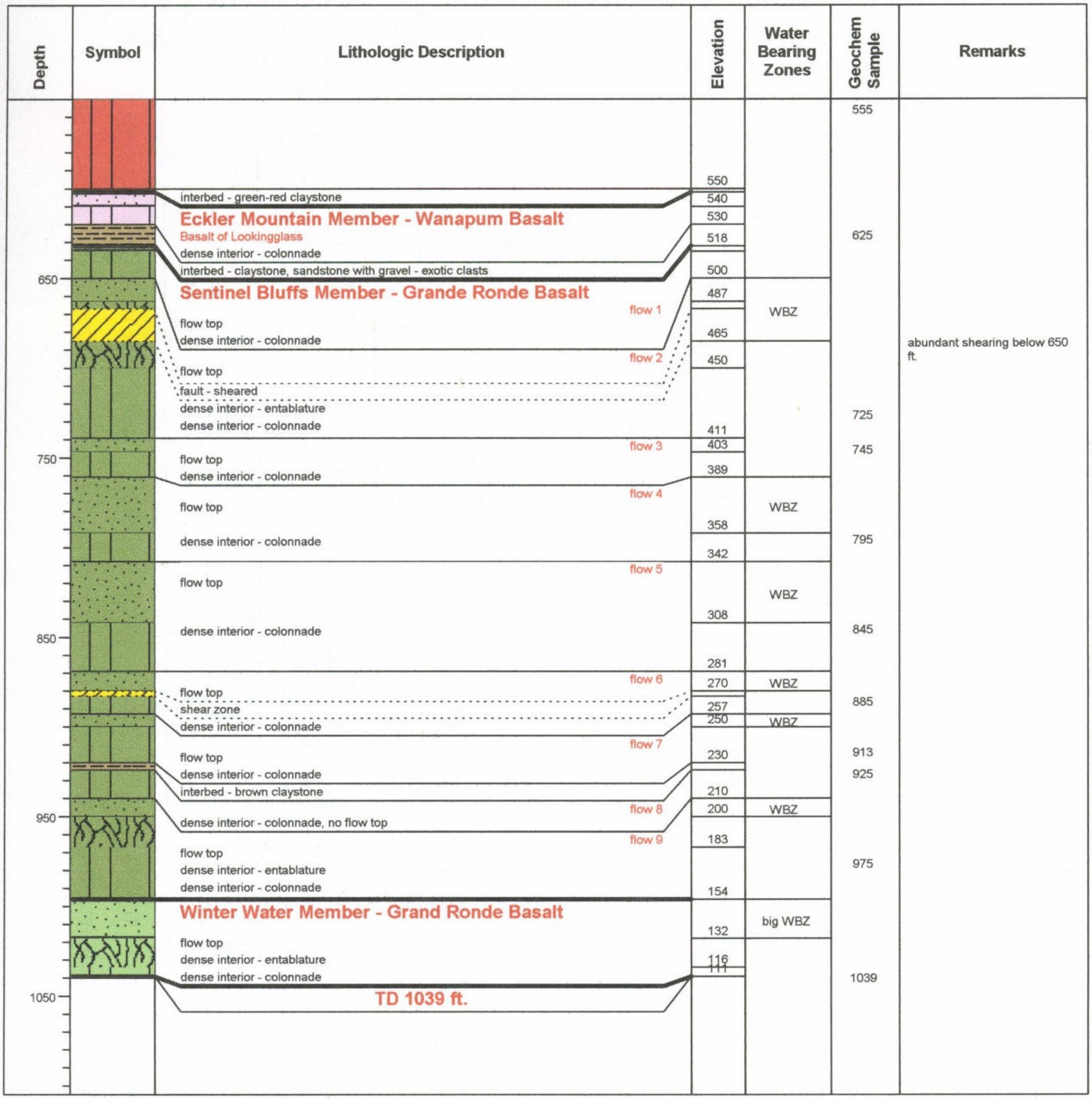
Location: Seven Hills Vineyards

Geologist: Terry L. Tolan, R.G.

Kennedy/Jenks Consultants

Engineers & Scientists

Kennedy/Jenks Consultants
1020 N. Center Parkway, Suite F
Kennewick, Washington 99336
509-734-9763
FAX 509-734-9764
www.kennedyjenks.com



Drilled By: Geo-Tech Exploration **Total Depth: 1039 ft.**

Drill Method: Reverse Circulation Air Rotary

Drill Date: 8/2005

Figure 2. Geologic Log of the West Pond Well

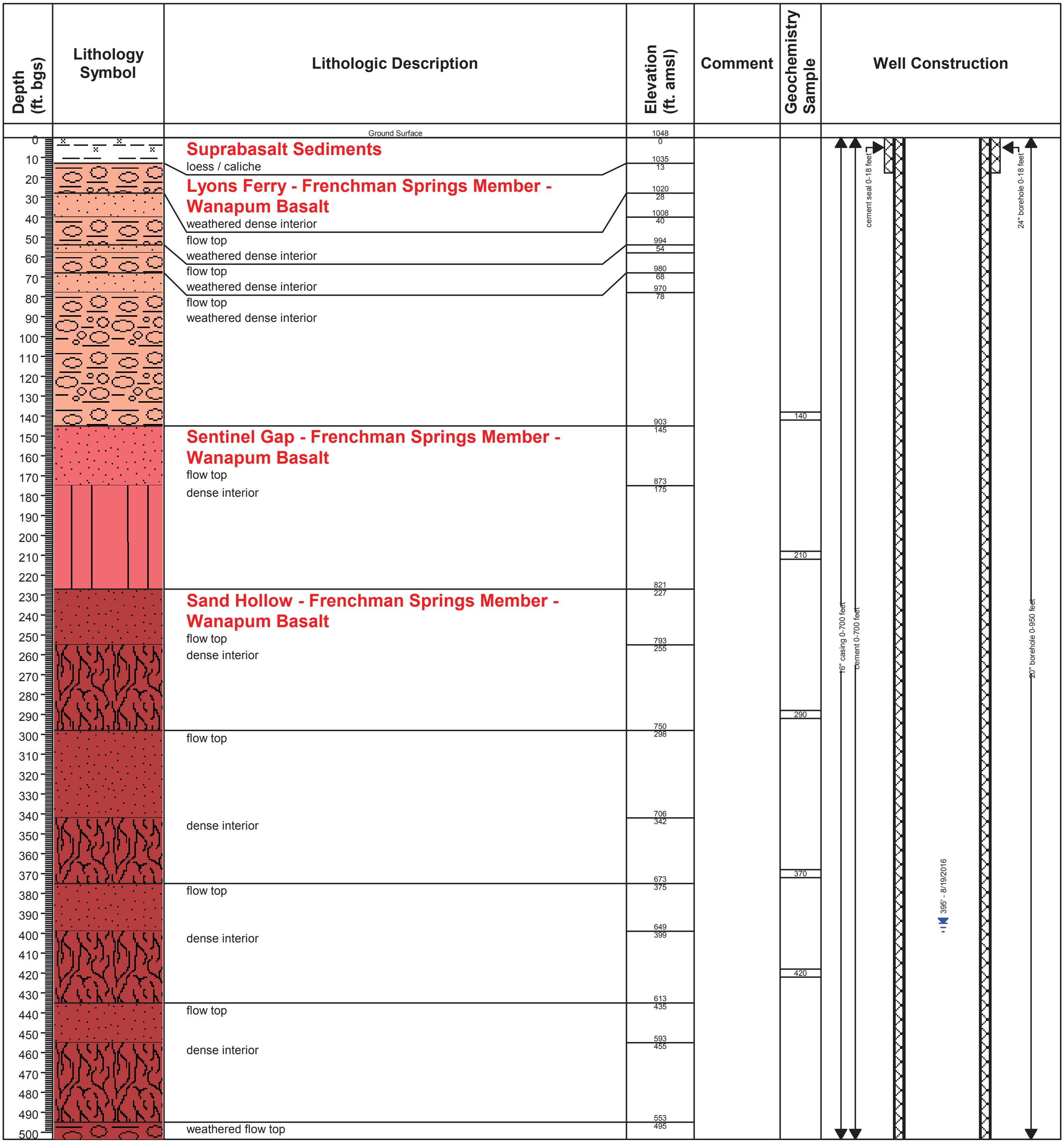
Geologic Log of: West Pond Well

Project: Seven Hills | **State Well ID:**

Logged By: P. Newman, J. Travis, RG | **Borehole Diameter: 20", 16", 14.75"**

Location: NW¼ SE¼, section 5, T5N R35E

EA Engineering, Science, and Technology, Inc., PBC
8019 W. Quinault Ave, Suite 201
Kennewick, WA 99336
Phone: 509.591.0264



Drilled By: Person Pump and Drilling | **Total Depth: 1160 ft**

Drilling Method: Direct and Reverse Rotary | **Static Water Level: 395.0 ft**

Date Completed:

Figure 2. Geologic Log of the West Pond Well

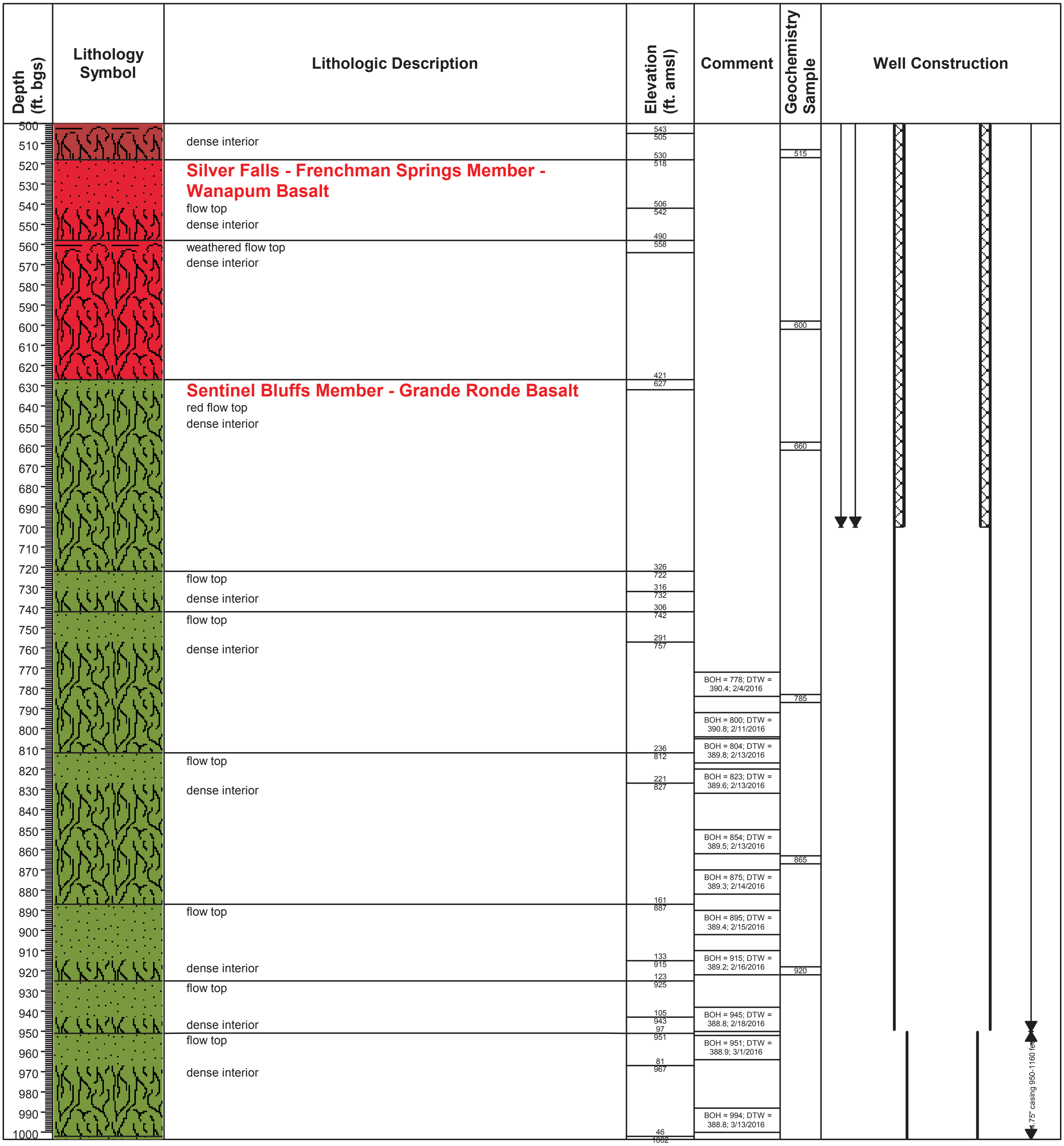
Geologic Log of: West Pond Well

Project: Seven Hills | **State Well ID:**

Logged By: P. Newman, J. Travis, RG | **Borehole Diameter: 20", 16", 14.75"**

Location: NW¼ SE¼, section 5, T5N R35E

EA Engineering, Science, and Technology, Inc., PBC
8019 W. Quinault Ave, Suite 201
Kennewick, WA 99336
Phone: 509.591.0264



Drilled By: Person Pump and Drilling | **Total Depth: 1160 ft**

Drilling Method: Direct and Reverse Rotary | **Static Water Level: 395.0 ft**

Date Completed: | **Page: 2 of 3**

Figure 2. Geologic Log of the West Pond Well

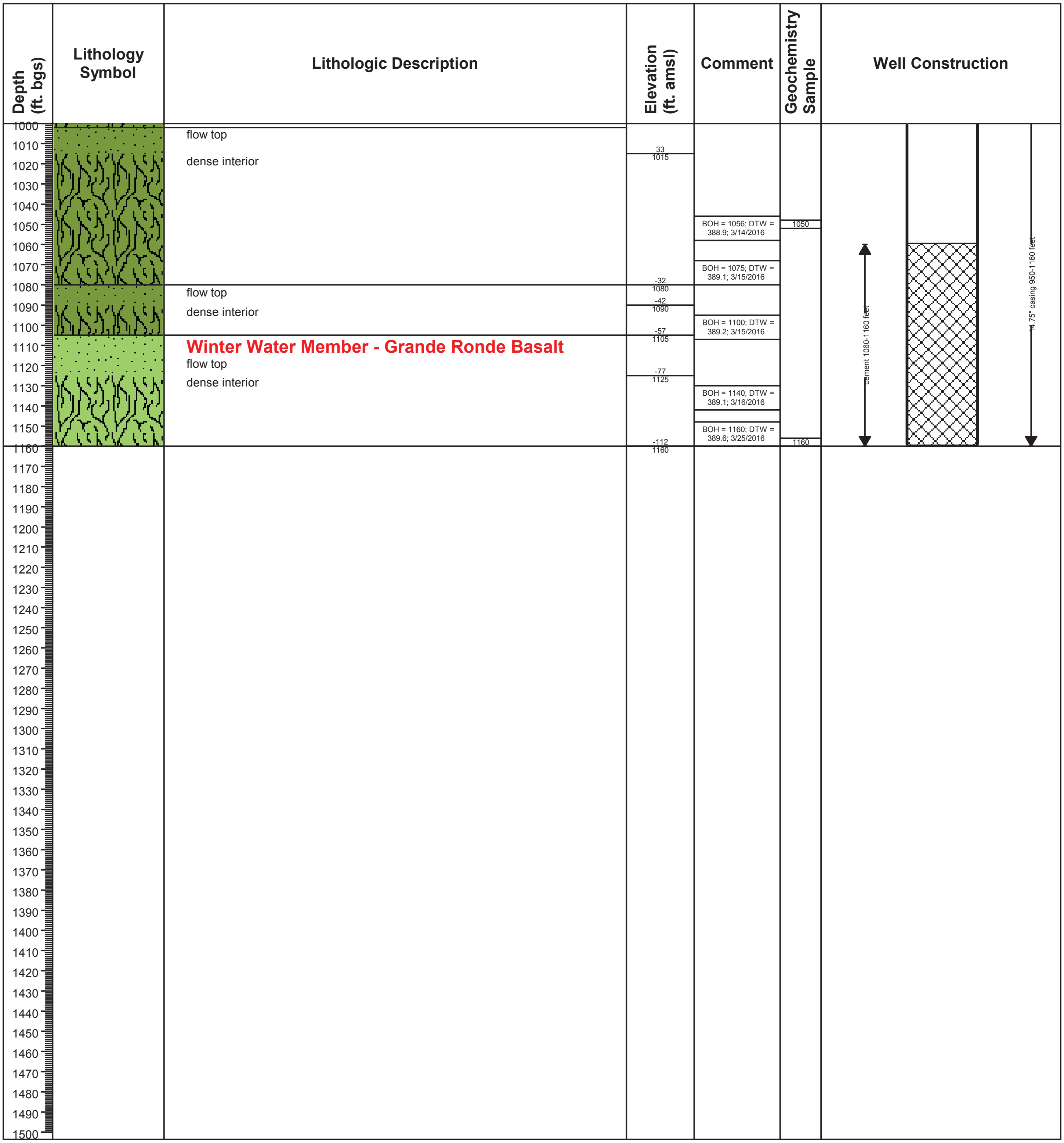
Geologic Log of: West Pond Well

Project: Seven Hills **State Well ID:**

Logged By: P. Newman, J. Travis, RG **Borehole Diameter: 20", 16", 14.75"**

Location: NW¼ SE¼, section 5, T5N R35E

EA Engineering, Science, and Technology, Inc., PBC
8019 W. Quinault Ave, Suite 201
Kennewick, WA 99336
Phone: 509.591.0264



Drilled By: Person Pump and Drilling **Total Depth: 1160 ft**

Drilling Method: Direct and Reverse Rotary **Static Water Level: 395.0 ft**

Date Completed:

Figure 3. Geologic Log of Well 1

Geologic Log of: Well 1

Project:

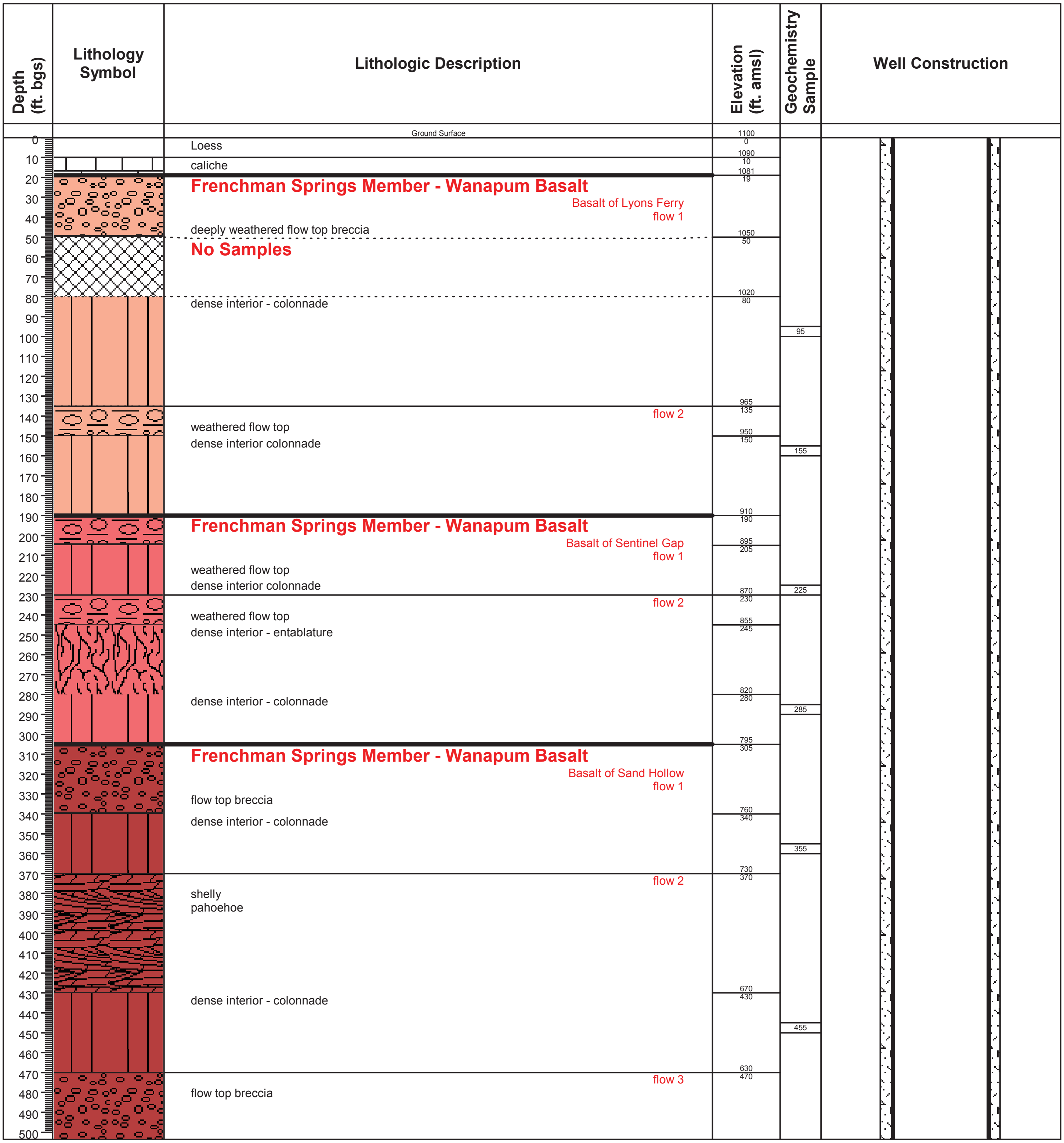
State Well ID: UMAT 55523

Logged By: Terry L. Tolan, R.G.

Borehole Diameter: 16-inch, 14.75-inch

Location: Seven Hills Vineyards

EA Engineering, Science, and Technology, Inc., PBC
8019 W. Quinault Ave, Suite 201
Kennewick, WA 99336
Phone: 509.591.0264



Drilled By: Geo-Tech Exploration

Drilling Method: Reverse Circulation Air Rotary

Date Completed: 8/2005

Total Depth: 1035 ft.

Static Water Level: 413.5 ft - 7-22-2005

Figure 3. Geologic Log of the Well 1

Geologic Log of: Well 1

Project:

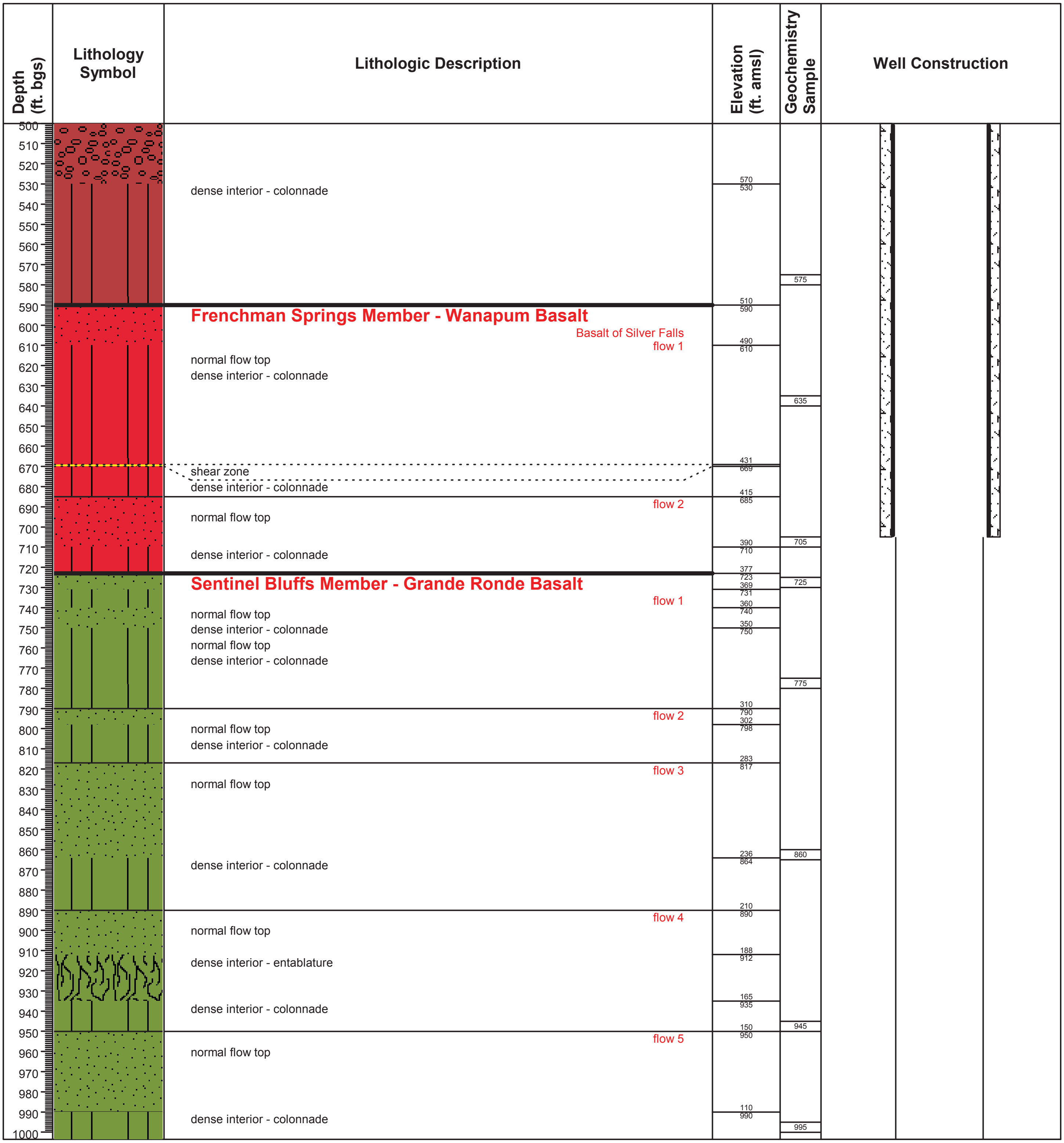
State Well ID: UMAT 55523

Logged By: Terry L. Tolan, R.G.

Borehole Diameter: 16-inch, 14.75-inch

Location: Seven Hills Vineyards

EA Engineering, Science, and Technology, Inc., PBC
8019 W. Quinault Ave, Suite 201
Kennewick, WA 99336
Phone: 509.591.0264



Drilled By: Geo-Tech Exploration

Drilling Method: Reverse Circulation Air Rotary

Date Completed: 8/2005

Total Depth: 1035 ft.

Static Water Level: 413.5 ft - 7-22-2005

Figure 3. Geologic Log of the Well 1

Geologic Log of: Well 1

Project:

State Well ID: UMAT 55523

Logged By: Terry L. Tolan, R.G.

Borehole Diameter: 16-inch, 14.75-inch

Location: Seven Hills Vineyards

EA Engineering, Science, and Technology, Inc., PBC
8019 W. Quinault Ave, Suite 201
Kennewick, WA 99336
Phone: 509.591.0264

Depth (ft. bgs)	Lithology Symbol	Lithologic Description	Elevation (ft. amsl)	Geochemistry Sample	Well Construction
1000		flow 6	95 1005		
1010		normal flow top			
1020		dense interior - colonnade	80 1020	1020	
1030		normal flow top			
1040		dense interior - colonnade	65 1035	1035	
1050		TD 1035 ft.			
1060					
1070					
1080					
1090					
1100					
1110					
1120					
1130					
1140					
1150					
1160					
1170					
1180					
1190					
1200					
1210					
1220					
1230					
1240					
1250					
1260					
1270					
1280					
1290					
1300					
1310					
1320					
1330					
1340					
1350					
1360					
1370					
1380					
1390					
1400					
1410					
1420					
1430					
1440					
1450					
1460					
1470					
1480					
1490					
1500					

Drilled By: Geo-Tech Exploration

Drilling Method: Reverse Circulation Air Rotary

Date Completed: 8/2005

Total Depth: 1035 ft.

Static Water Level: 413.5 ft - 7-22-2005

Figure 4. Geologic Log of Well 3

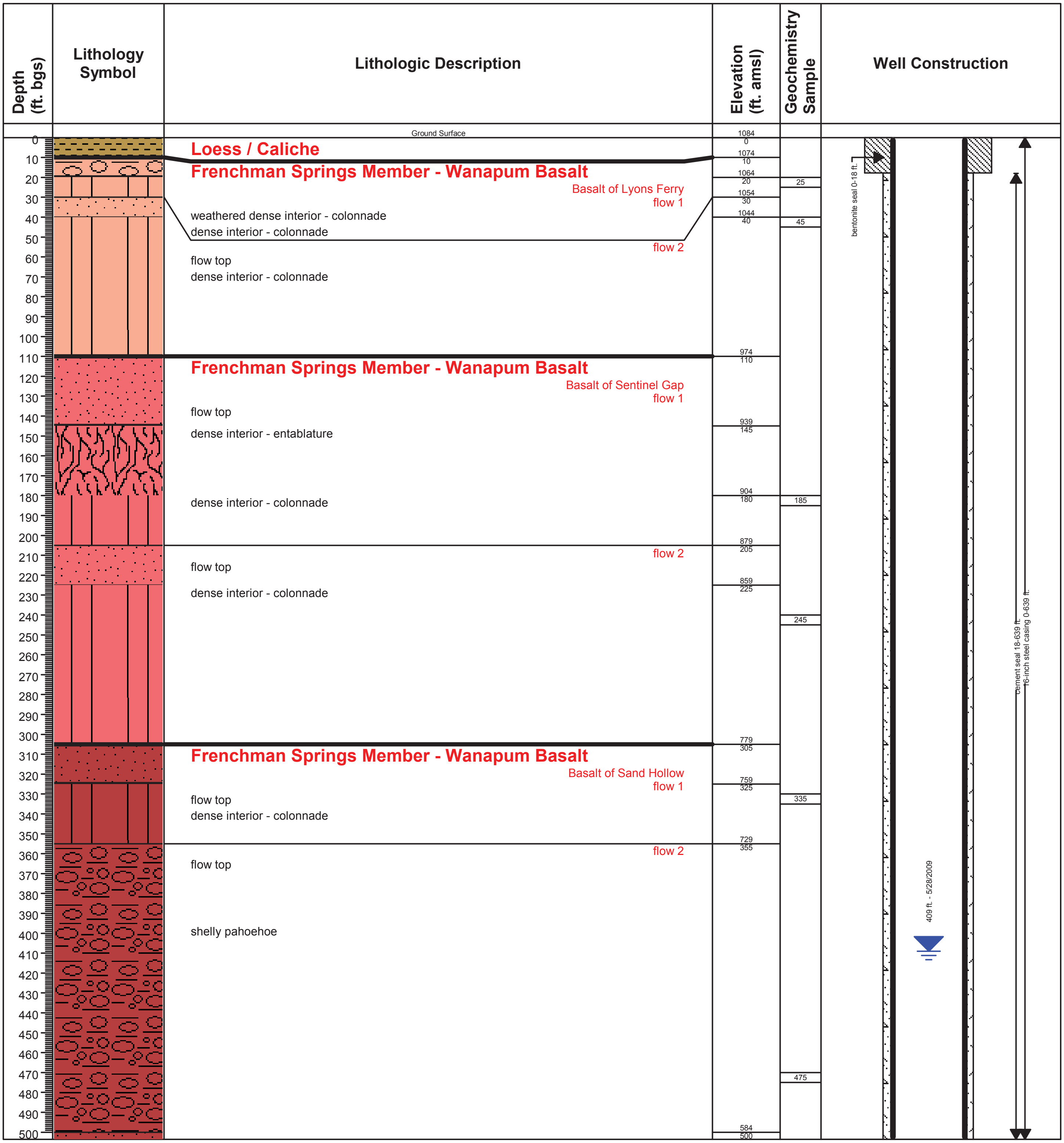
Geologic Log of: Well 3

Project: North Slope Management | **State Well ID: UMAT 56382**

Logged By: Terry L. Tolan, R.G. | **Borehole Diameter: 16-inch, 14.75-inch**

Location: Seven Hills Vineyard

EA Engineering, Science, and Technology, Inc., PBC
8019 W. Quinault Ave, Suite 201
Kennewick, WA 99336
Phone: 509.591.0264



Drilled By: Boart Longyear | **Total Depth: 1056 ft.**

Drilling Method: Reverse Air Rotary | **Static Water Level: 409 ft.**

Date Completed: 6-2009 |

Figure 4. Geologic Log of Well 3

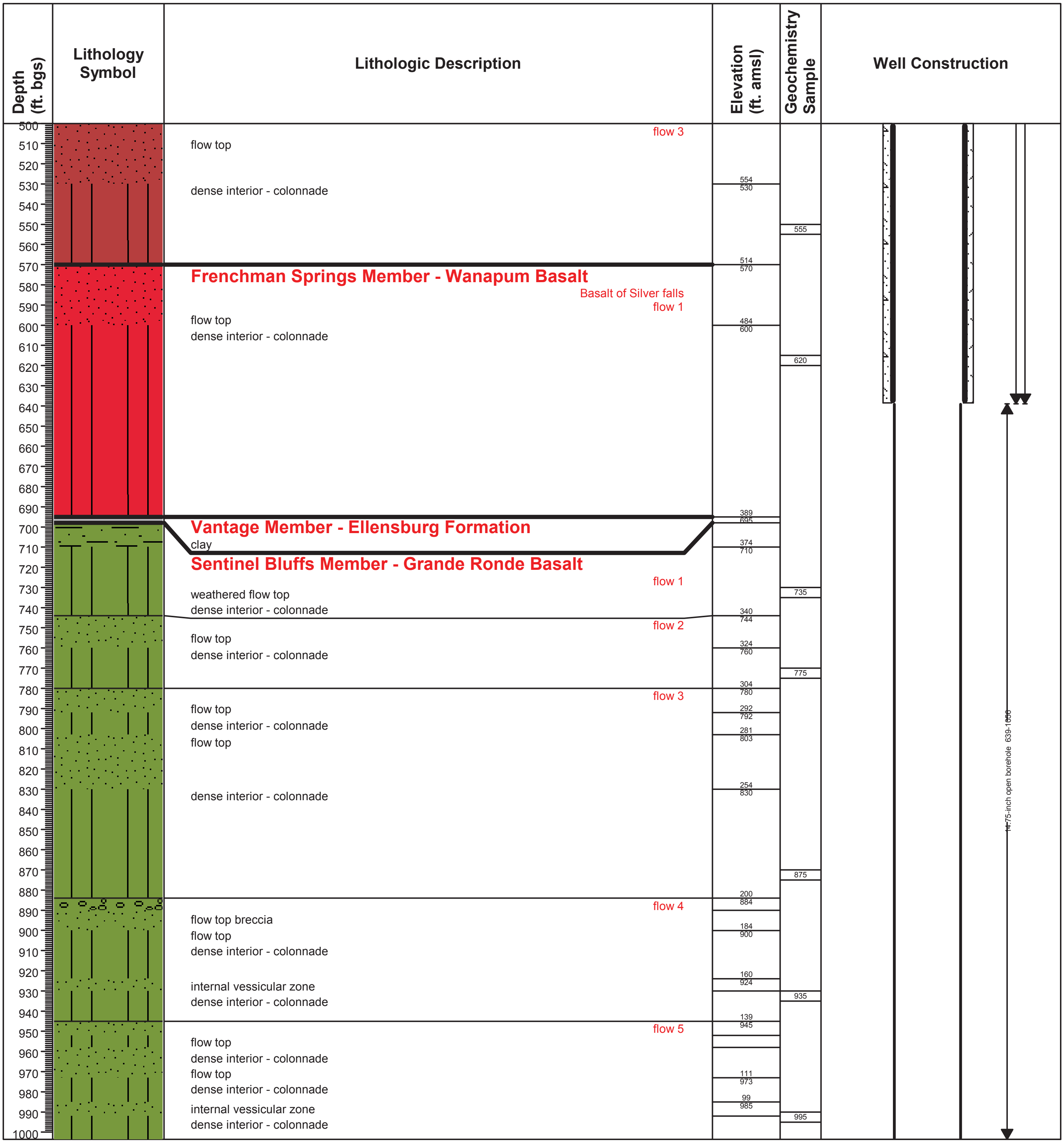
Geologic Log of: Well 3

Project: North Slope Management | **State Well ID: UMAT 56382**

Logged By: Terry L. Tolan, R.G. | **Borehole Diameter: 16-inch, 14.75-inch**

Location: Seven Hills Vineyard

EA Engineering, Science, and Technology, Inc., PBC
8019 W. Quinault Ave, Suite 201
Kennewick, WA 99336
Phone: 509.591.0264



Drilled By: Boart Longyear | **Total Depth: 1056 ft.**

Drilling Method: Reverse Air Rotary | **Static Water Level: 409 ft.**

Date Completed: 6-2009 | **Page: 2 of 3**

Figure 4. Geologic Log of Well 3

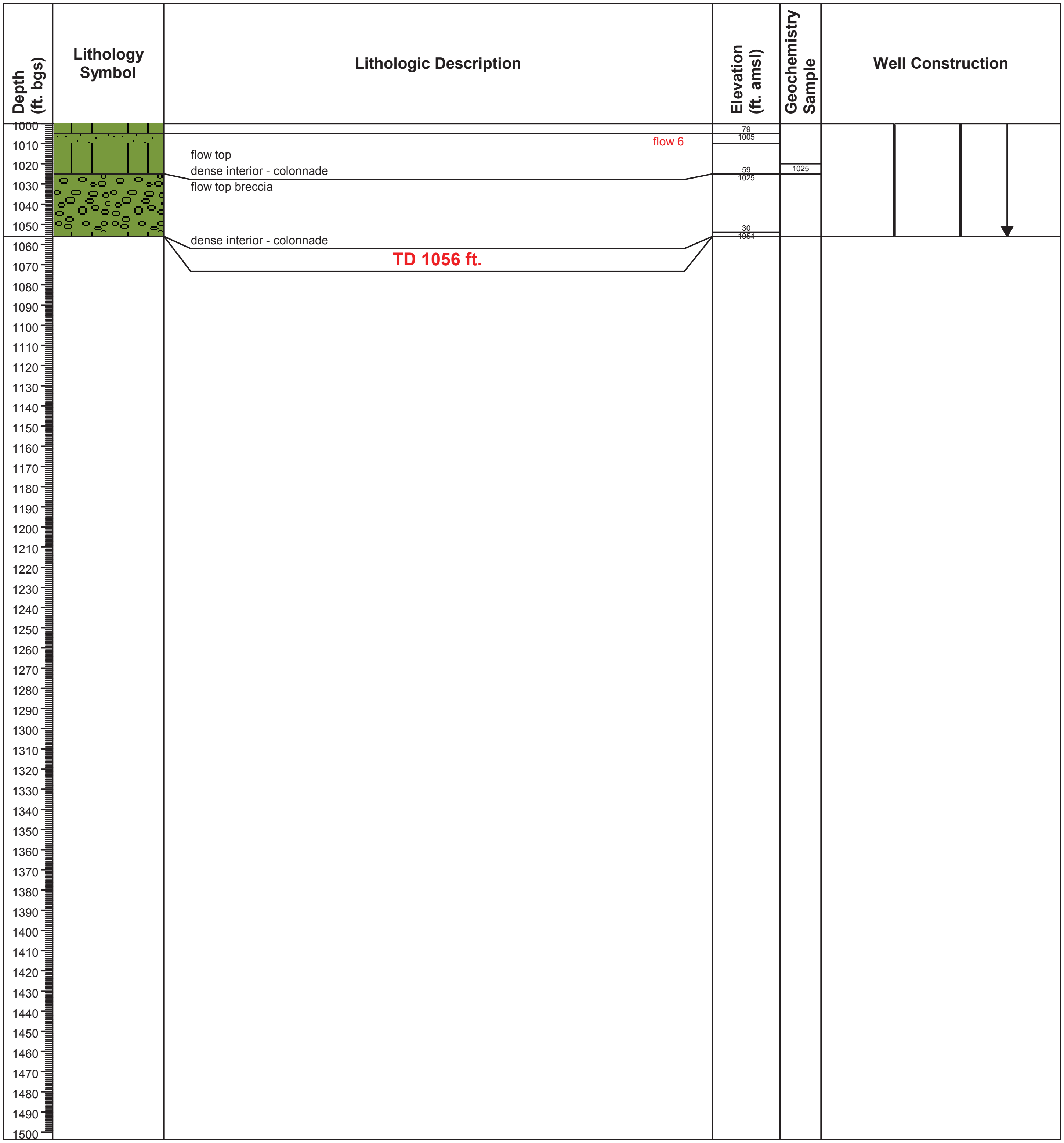
Geologic Log of: Well 3

Project: North Slope Management | **State Well ID: UMAT 56382**

Logged By: Terry L. Tolan, R.G. | **Borehole Diameter: 16-inch, 14.75-inch**

Location: Seven Hills Vineyard

EA Engineering, Science, and Technology, Inc., PBC
8019 W. Quinault Ave, Suite 201
Kennewick, WA 99336
Phone: 509.591.0264



Drilled By: Boart Longyear | **Total Depth: 1056 ft.**

Drilling Method: Reverse Air Rotary | **Static Water Level: 409 ft.**

Date Completed: 6-2009 | **Page: 3 of 3**

UMAT 55523

Amendment UMAT 55523

STATE OF OREGON
WATER SUPPLY WELL REPORT
(as required by ORS 537.765)
Instructions for completing this report are on the last page of this form.

(WELL I.D.)# L L76996 (Amended 1-24-06)
(START CARD) # 174355

(1) OWNER: Well Number 7H #1
Name Walla Walla Valley Appellation, LLC
Address 1244 Forest Land
City Walla Walla State WA Zip 99362

(2) TYPE OF WORK
☐ New Well ☐ Deepening ☐ Alteration (repair/recondition) ☐ Abandonment

(3) DRILL METHOD:
☑ Rotary Air ☐ Rotary Mud ☐ Cable ☐ Auger
☑ Other Reverse Circulation

(4) PROPOSED USE:
☐ Domestic ☐ Community ☐ Industrial ☑ Irrigation
☐ Thermal ☐ Injection ☐ Livestock ☐ Other

(5) BORE HOLE CONSTRUCTION:
Special Construction approval ☐ Yes ☑ No Depth of Completed Well 1035 ft.
Explosives used ☐ Yes ☑ No Type ____ Amount ____

HOLE Diameter	From	To	SEAL Material	From	To	Sacks or pounds
20"	0	705	Cement	0	705	1,034 sacks
14.75"	705	1035				

How was seal placed: Method ☐ A ☐ B ☑ C ☐ D ☐ E
☐ Other
Backfill placed from ____ ft. to ____ ft. Material ____
Gravel placed from ____ ft. to ____ ft. Size of gravel ____

(6) CASING/LINER:

	Diameter	From	To	Gauge	Steel	Plastic	Welded	Threaded
Casing:	16"	+1	705	.375	☑	☐	☑	☐
Liner:								

Final location of shoe(s) ____

(7) PERFORATIONS/SCREENS:
☐ Perforations Method ____
☐ Screens Type ____ Material ____

From	To	Slot size	Number	Diameter	Tele/pipe size	Casing	Liner
						☐	☐

(8) WELL TESTS: Minimum testing time is 1 hour
☑ Pump ☐ Bailer ☐ Air ☐ Flowing Artesian

Yield gal/min	Drawdown	Drill stem at	Time
			1 hr.
2,700	9.5 feet		24 hours

Temperature of water ____ Depth Artesian Flow Found ____
Was a water analysis done? ☐ Yes By whom ____
Did any strata contain water not suitable for intended use? ☐ Too little
☐ Salty ☐ Muddy ☐ Odor ☐ Colored ☐ Other ____
Depth of strata: ____

(9) LOCATION OF WELL by legal description:
County Umatilla Latitude ____ Longitude ____
Township ~~6~~ 5 N Range 35 E WM.
Section ~~25~~ 4 SW 1/4 NE 1/4
Tax Lot 400 Lot ____ Block ____ Subdivision ____
Street Address of Well (or nearest address) 83501 Lower Dry Creek Rd., Milton Freewater, OR 97862

(10) STATIC WATER LEVEL:
413.5 ft. below land surface. Date 7-22-05
Artesian pressure ____ lb. per square inch. Date ____

(11) WATER BEARING ZONES:
Depth at which water was first found 479

From	To	Estimated Flow Rate	SWL
479	612	500+	395
691	694	500+	395
719	751	3,000+	413.5
1021	1025	3,000+	413.5

(12) WELL LOG:
Ground Elevation ____

Material	From	To	SWL
See Attached Soil Profile Sheet			

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JAN 26 2006
WATER RESOURCES DEPT
SALEM, OREGON

Date started 5/10/05 Completed 8/18/05

(unbonded) Water Well Constructor Certification:
I certify that the work I performed on the construction, alteration, or abandonment of this well is in compliance with Oregon water supply well construction standards. Materials used and information reported above are true to the best of my knowledge and belief.
Signed [signature] WWC Number 1702 Date 9/23/05

(bonded) Water Well Constructor Certification:
I accept responsibility for the construction, alteration, or abandonment work performed on this well during the construction dates reported above. All work performed during this time is in compliance with Oregon water supply well construction standards. This report is true to the best of my knowledge and belief.
WWC Number 1523
Signed [signature] Date 08/18/05

ORIGINAL & FIRST COPY-WATER RESOURCES DEPARTMENT SECOND COPY-CONSTRUCTOR THIRD COPY-CUSTOMER

UMAT 55523

Umat 55523

STATE OF OREGON
WATER SUPPLY WELL REPORT
(as required by ORS 537.765)

Instructions for completing this report are on the last page of this form.

(WELL I.D.)# L L76996

(START CARD) # 174355

(1) OWNER: Well Number 7H #1

Name Walla Walla Valley Appellation, LLC

Address 1244 Forest Land

City Walla Walla State WA Zip 99362

(2) TYPE OF WORK

☐ New Well ☐ Deepening ☐ Alteration (repair/recondition) ☐ Abandonment

(3) DRILL METHOD:

☑ Rotary Air ☐ Rotary Mud ☐ Cable ☐ Auger

☑ Other Reverse Circulation

(4) PROPOSED USE:

☐ Domestic ☐ Community ☐ Industrial ☑ Irrigation

☐ Thermal ☐ Injection ☐ Livestock ☐ Other

(5) BORE HOLE CONSTRUCTION:

Special Construction approval ☐ Yes ☑ No Depth of Completed Well 1035 ft.

Explosives used ☐ Yes ☑ No Type ______ Amount ______

HOLE Diameter	From	To	SEAL Material	From	To	Sacks or pounds
20"	0	705	Cement	0	705	1,034 sacks
14.75"	705	1035				

How was seal placed: Method ☐ A ☐ B ☑ C ☐ D ☐ E

☐ Other

Backfill placed from ______ ft. to ______ ft. Material ______

Gravel placed from ______ ft. to ______ ft. Size of gravel ______

(6) CASING/LINER:

	Diameter	From	To	Gauge	Steel	Plastic	Welded	Threaded
Casing:	16"	+1	705	.375	☑	☐	☑	☐
					☐	☐	☐	☐
					☐	☐	☐	☐
					☐	☐	☐	☐
Liner:					☐	☐	☐	☐
					☐	☐	☐	☐

Final location of shoe(s) ______

(7) PERFORATIONS/SCREENS:

☐ Perforations Method ______

☐ Screens Type ______ Material ______

From	To	Slot size	Number	Diameter	Tele/pipe size	Casing	Liner
						☐	☐
						☐	☐
						☐	☐
						☐	☐
						☐	☐

(8) WELL TESTS: Minimum testing time is 1 hour

☑ Pump ☐ Bailer ☐ Air ☐ Flowing Artesian

Yield gal/min	Drawdown	Drill stem at	Time
			1 hr.
2,700	9.5 feet		24 hours

Temperature of water 63 F Depth Artesian Flow Found ______

Was a water analysis done? ☐ Yes By whom ______

Did any strata contain water not suitable for intended use? ☐ Too little

☐ Salty ☐ Muddy ☐ Odor ☐ Colored ☐ Other

Depth of strata: ______

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SALEM, OREGON

(9) LOCATION OF WELL by legal description:

County Umatilla Latitude ______ Longitude ______

Township 6 N Range 35 E WM.

Section 33 SW 1/4 NE 1/4

Tax Lot 400 Lot ______ Block ______ Subdivision ______

Street Address of Well (or nearest address) 83501 Lower Dry Creek Rd., Milton Freewater, OR 97862

(10) STATIC WATER LEVEL:

413.5 ft. below land surface. Date 7-22-05

Artesian pressure ______ lb. per square inch. Date ______

(11) WATER BEARING ZONES:

Depth at which water was first found 479

From	To	Estimated Flow Rate	SWL
479	612	500+	395
691	694	500+	395
719	751	3,000+	413.5
1021	1025	3,000+	413.5

(12) WELL LOG:

Ground Elevation ______

Material	From	To	SWL
See Attached Soil Profile Sheet			

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SALEM, OREGON

Date started 5/10/05 Completed 8/18/05

(unbonded) Water Well Constructor Certification:

I certify that the work I performed on the construction, alteration, or abandonment of this well is in compliance with Oregon water supply well construction standards. Materials used and information reported above are true to the best of my knowledge and belief.

WWC Number 1702

Signed [signature] Date 9/23/05

(bonded) Water Well Constructor Certification:

I accept responsibility for the construction, alteration, or abandonment work performed on this well during the construction dates reported above. All work performed during this time is in compliance with Oregon water supply well construction standards. This report is true to the best of my knowledge and belief.

WWC Number 1523

Signed [signature] Date 08/18/05

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UMAT 55523

Geo-Tech Explorations
A Division of ***Boart Longyear***
19700 SW Teton Ave
Tualatin, OR 97062
503-692-6400
503-692-4759 (fax)

Umat
55523

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SALEM, OREGON

Start Card: 174355
Well Label: L76996
Boring # : 7H #1

Soil Profile Continued from Log:

Material	From	To	SWL
Soii	0	17	
Weathered brown basalt	17	58	
Black Basalt	58	136	
Black w/ brown basalt	136	160	
Black Basalt	160	202	
Fractured black and brown basalt	202	235	
Black w/ brown basalt	235	257	
Black Basalt	257	335	
Black w/ brown weathered basalt	335	356	
Black basalt	356	405	
Black w/ black vesicular basalt	405	451	
Broken black basalt	451	479	
Broken vesicular basalt	479	550	
Fractured black basalt	550	612	
Black basalt	612	620	
Black w/ gray basalt	620	668	
Black w/ green claystone	668	675	
Black w/ gray basalt	675	691	
Vesicular basalt – red	691	694	
Black w/ gray basalt	694	719	
Fractured black basalt – vesicular	719	751	
Black basalt	751	883	
Black basalt – medium	883	889	
Black basalt w/ traces of brown	889	903	
Black basalt – vesicular w/ some green	903	995	
Gray basalt – medium to hard	995	1007	
Black basalt	1007	1021	
Black basalt – vesicular	1021	1025	
Black basalt	1025	1035	

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SALEM, OREGON

UMAT 55526

STATE OF OREGON
WATER SUPPLY WELL REPORT
(as required by ORS 537.765)
Instructions for completing this report are on the last page of this form.

(WELL I.D.)# L L76997 (amended UMAT 55526)
(START CARD) # 174329 (amended 3/27/06)

(1) OWNER: Well Number 7H #2
Name Walla Walla Valley Appellation, LLC
Address 1244 Forest Land
City Walla Walla State WA Zip 99362

(2) TYPE OF WORK
☑ New Well ☐ Deepening ☐ Alteration (repair/recondition) ☐ Abandonment

(3) DRILL METHOD:
☑ Rotary Air ☐ Rotary Mud ☐ Cable ☐ Auger
☑ Other reverse circulation

(4) PROPOSED USE:
☐ Domestic ☐ Community ☐ Industrial ☑ Irrigation
☐ Thermal ☐ Injection ☐ Livestock ☐ Other

(5) BORE HOLE CONSTRUCTION:
Special Construction approval ☑ Yes ☐ No Depth of Completed Well 1040 ft.
Explosives used ☐ Yes ☑ No Type ______ Amount ______

HOLE			SEAL			
Diameter	From	To	Material	From	To	Sacks or pounds
24"	0	20	Cement	0	20	26 sacks
20"	20	645	Cement	182	495	295 sacks
15"	645	1040				

How was seal placed: Method ☐ A ☐ B ☑ C ☐ D ☐ E
☐ Other
Backfill placed from ______ ft. to ______ ft. Material ______
Gravel placed from ______ ft. to ______ ft. Size of gravel ______

(6) CASING/LINER:

	Diameter	From	To	Gauge	Steel	Plastic	Welded	Threaded
Casing:	20"	+1	180	.375	☑	☐	☑	☐
	16"	0	645	.375	☑	☐	☑	☐
					☐	☐	☐	☐
					☐	☐	☐	☐
Liner:					☐	☐	☐	☐
					☐	☐	☐	☐

Final location of shoe(s) ______

(7) PERFORATIONS/SCREENS:
☑ Perforations Method Factory Perfs
☐ Screens Type ______ Material ______

From	To	Slot size	Number	Diameter	Tele/pipe size	Casing	Liner
495	595	1/8x3	6080	16"	PS	☑	☐
						☐	☐
						☐	☐
						☐	☐
						☐	☐

(8) WELL TESTS: Minimum testing time is 1 hour
☑ Pump ☐ Bailer ☐ Air ☐ Flowing Artesian

Yield gal/min	Drawdown	Drill stem at	Time
			1 hr.
2000 gpm	83.25'	pump @ 515'	12 hrs

Temperature of water ______ Depth Artesian Flow Found ______
Was a water analysis done? ☐ Yes By whom ______
Did any strata contain water not suitable for intended use? ☐ Too little
☐ Salty ☐ Muddy ☐ Odor ☐ Colored ☐ Other ______
Depth of strata: ______

(9) LOCATION OF WELL by legal description:
County Umatilla Latitude ______ Longitude ______
Township 5 N Range 35 E WM.
Section 3 SE 1/4 NW 1/4
Tax Lot 400 Lot ______ Block ______ Subdivision ______
Street Address of Well (or nearest address) 63501 Lower Dry Creek Rd., Milton Freewater, OR 97862

(10) STATIC WATER LEVEL:
356.4 ft. below land surface. Date 8-23-05
Artesian pressure ______ lb. per square inch. Date ______

(11) WATER BEARING ZONES:
Depth at which water was first found ______

From	To	Estimated Flow Rate	SWL
550	621	2000+	356.4
739	746	2000+	356.4
782	791	2000+	356.4
1000	1025	2000+	356.4

(12) WELL LOG:
Ground Elevation ______

Material	From	To	SWL
See Attached Soil Profile Sheet			

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WATER RESOURCES DEPT
SALEM, OREGON

Date started 5/10/05 Completed 8/23/05

(unbonded) Water Well Constructor Certification:
I certify that the work I performed on the construction, alteration, or abandonment of this well is in compliance with Oregon water supply well construction standards. Materials used and information reported above are true to the best of my knowledge and belief.
WWC Number 1702
Signed ______ Date 3/27/06

(bonded) Water Well Constructor Certification:
I accept responsibility for the construction, alteration, or abandonment work performed on this well during the construction dates reported above. All work performed during this time is in compliance with Oregon water supply well construction standards. This report is true to the best of my knowledge and belief.
WWC Number 1523
Signed ______ Date 3/27/06

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UMAT 55526

Amendment UMAT 55526

STATE OF OREGON
WATER SUPPLY WELL REPORT
(as required by ORS 537.765)
Instructions for completing this report are on the last page of this form.

(WELL I.D.)# L L76997 (Amended 1-24-06)
(START CARD) # 174329

(1) OWNER: Well Number 7H #2
Name Walla Walla Valley Appellation, LLC
Address 1244 Forest Land
City Walla Walla State WA Zip 99362

(2) TYPE OF WORK
☑ New Well ☐ Deepening ☐ Alteration (repair/recondition) ☐ Abandonment

(3) DRILL METHOD:
☑ Rotary Air ☐ Rotary Mud ☐ Cable ☐ Auger
☑ Other reverse circulation

(4) PROPOSED USE:
☐ Domestic ☐ Community ☐ Industrial ☑ Irrigation
☐ Thermal ☐ Injection ☐ Livestock ☐ Other

(5) BORE HOLE CONSTRUCTION:
Special Construction approval ☑ Yes ☐ No Depth of Completed Well 1040 ft.
Explosives used ☐ Yes ☑ No Type ______ Amount ______

HOLE Diameter	From	To	SEAL Material	From	To	Sacks or pounds
24"	0	20	Cement	0	20	26 sacks
20"	20	645	Cement	162	495	295 sacks
15"	645	1040				

How was seal placed: Method ☐ A ☐ B ☑ C ☐ D ☐ E
☐ Other
Backfill placed from ______ ft. to ______ ft. Material ______
Gravel placed from ______ ft. to ______ ft. Size of gravel ______

(6) CASING/LINER:

	Diameter	From	To	Gauge	Steel	Plastic	Welded	Threaded
Casing:	20"	+1	180	.375	☑	☐	☑	☐
	16"	0	645	.375	☑	☐	☑	☐
					☐	☐	☐	☐
					☐	☐	☐	☐
Liner:					☐	☐	☐	☐
					☐	☐	☐	☐

Final location of shoe(s) ______

(7) PERFORATIONS/SCREENS:
☐ Perforations Method ______
☐ Screens Type ______ Material ______

From	To	Slot size	Number	Diameter	Tele/pipe size	Casing	Liner
						☐	☐
						☐	☐
						☐	☐
						☐	☐
						☐	☐

(8) WELL TESTS: Minimum testing time is 1 hour
☑ Pump ☐ Bailer ☐ Air ☐ Flowing Artesian

Yield gal/min	Drawdown	Drill stem at	Time
			1 hr.
2000 gpm	83.25'	pump @ 515'	12 hrs

Temperature of water ______ Depth Artesian Flow Found ______
Was a water analysis done? ☐ Yes By whom ______
Did any strata contain water not suitable for intended use? ☐ Too little
☐ Salty ☐ Muddy ☐ Odor ☐ Colored ☐ Other ______
Depth of strata: ______

(9) LOCATION OF WELL by legal description:
County Umatilla Latitude ______ Longitude ______
Township ~~6~~ 5 N Range 35 E WM.
Section ~~26~~ 3 ~~SW~~ SE 1/4 ~~NE~~ NW 1/4
Tax Lot 400 Lot ______ Block ______ Subdivision ______
Street Address of Well (or nearest address) 83501 Lower Dry Creek Rd., Milton Freewater, OR 97862

(10) STATIC WATER LEVEL:
356.4 ft. below land surface. Date 8-23-05
Artesian pressure ______ lb. per square inch. Date ______

(11) WATER BEARING ZONES:
Depth at which water was first found ______

From	To	Estimated Flow Rate	SWL
550	621	2000+	356.4
739	746	2000+	356.4
782	791	2000+	356.4
1000	1025	2000+	356.4

(12) WELL LOG:
Ground Elevation ______

Material	From	To	SWL
See Attached Soil Profile Sheet			

RECEIVED
JAN 26 2006
WATER RESOURCES DEPT
SALEM, OREGON

Date started 5/10/05 Completed 8/23/05

(unbonded) Water Well Constructor Certification:
I certify that the work I performed on the construction, alteration, or abandonment of this well is in compliance with Oregon water supply well construction standards. Materials used and information reported above are true to the best of my knowledge and belief.
WWC Number 1702
Signed [signature] Date 9/26/05

(bonded) Water Well Constructor Certification:
I accept responsibility for the construction, alteration, or abandonment work performed on this well during the construction dates reported above. All work performed during this time is in compliance with Oregon water supply well construction standards. This report is true to the best of my knowledge and belief.
WWC Number 1523
Signed [signature] Date 9/26/05

ORIGINAL & FIRST COPY-WATER RESOURCES DEPARTMENT SECOND COPY-CONSTRUCTOR THIRD COPY-CUSTOMER

UMAT 55526

VMAT 55526 ✓

STATE OF OREGON
WATER SUPPLY WELL REPORT
(as required by ORS 537.765)
Instructions for completing this report are on the last page of this form.

(WELL I.D.)# L L76997
(START CARD) # 174329

(1) OWNER: Well Number 7H #2
Name Walla Walla Valley Appellation, LLC
Address 1244 Forest Land
City Walla Walla State WA Zip 99362

(2) TYPE OF WORK
☑ New Well ☐ Deepening ☐ Alteration (repair/recondition) ☐ Abandonment

(3) DRILL METHOD:
☑ Rotary Air ☐ Rotary Mud ☐ Cable ☐ Auger
☑ Other reverse circulation

(4) PROPOSED USE:
☐ Domestic ☐ Community ☐ Industrial ☑ Irrigation
☐ Thermal ☐ Injection ☐ Livestock ☐ Other

(5) BORE HOLE CONSTRUCTION:
Special Construction approval ☑ Yes ☐ No Depth of Completed Well 1040 ft.
Explosives used ☐ Yes ☑ No Type ____ Amount ____

HOLE Diameter	From	To	SEAL Material	From	To	Sacks or pounds
24"	0	20	Cement	0	20	26 sacks
20"	20	645	Cement	162	495	295 sacks
15"	645	1040				

How was seal placed: Method ☐ A ☐ B ☑ C ☐ D ☐ E
☐ Other
Backfill placed from ____ ft. to ____ ft. Material ____
Gravel placed from ____ ft. to ____ ft. Size of gravel ____

(6) CASING/LINER:

	Diameter	From	To	Gauge	Steel	Plastic	Welded	Threaded
Casing:	20"	+1	180	.375	☑	☐	☑	☐
	16"	0	645	.375	☑	☐	☑	☐
					☐	☐	☐	☐
					☐	☐	☐	☐
Liner:					☐	☐	☐	☐
					☐	☐	☐	☐

Final location of shoe(s) ____

(7) PERFORATIONS/SCREENS:
☐ Perforations Method ____
☐ Screens Type ____ Material ____

From	To	Slot size	Number	Diameter	Tele/pipe size	Casing	Liner
						☐	☐
						☐	☐
						☐	☐
						☐	☐
						☐	☐

(8) WELL TESTS: Minimum testing time is 1 hour

☑ Pump ☐ Bailer ☐ Air ☐ Flowing Artesian

Yield gal/min	Drawdown	Drill stem at	Time
			1 hr.
2000 gpm	83.25'	pump @ 515'	12 hrs

Temperature of water 61 Depth Artesian Flow Found ____
Was a water analysis done? ☐ Yes By whom ____
Did any strata contain water not suitable for intended use? ☐ Too little
☐ Salty ☐ Muddy ☐ Odor ☐ Colored ☐ Other ____
Depth of strata: ____

(9) LOCATION OF WELL by legal description:
County Umatilla Latitude ____ Longitude ____
Township 6 N Range 35 E WM.
Section 33 SW 1/4 NE 1/4
Tax Lot 400 Lot ____ Block ____ Subdivision ____
Street Address of Well (or nearest address) 83501 Lower Dry Creek Rd., Milton Freewater, OR 97862

(10) STATIC WATER LEVEL:
356.4 ft. below land surface. Date 8-23-05
Artesian pressure ____ lb. per square inch. Date ____

(11) WATER BEARING ZONES:
Depth at which water was first found ____

From	To	Estimated Flow Rate	SWL
550	621	2000+	356.4
739	746	2000+	356.4
782	791	2000+	356.4
1000	1025	2000+	356.4

(12) WELL LOG:
Ground Elevation ____

Material	From	To	SWL
See Attached Soil Profile Sheet			

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DEC 01 2005
WATER RESOURCES DEPT
SALEM, OREGON

RECEIVED
OCT 04 2005
WATER RESOURCES DEPT
SALEM, OREGON

RECEIVED
DEC 23 2005
WATER RESOURCES DEPT
SALEM, OREGON

Date started 5/10/05 Completed 8/23/05

(unbonded) Water Well Constructor Certification:
I certify that the work I performed on the construction, alteration, or abandonment of this well is in compliance with Oregon water supply well construction standards. Materials used and information reported above are true to the best of my knowledge and belief.
WWC Number 1702
Signed [signature] Date 9/26/05

(bonded) Water Well Constructor Certification:
I accept responsibility for the construction, alteration, or abandonment work performed on this well during the construction dates reported above. All work performed during this time is in compliance with Oregon water supply well construction standards. This report is true to the best of my knowledge and belief.
WWC Number 1523
Signed [signature] Date 9/26/05

ORIGINAL & FIRST COPY-WATER RESOURCES DEPARTMENT SECOND COPY-CONSTRUCTOR THIRD COPY-CUSTOMER

UMAT 55526 UMAT 55526

Geo-Tech Explorations
A Division of ***Boart Longyear***
19700 SW Teton Ave
Tualatin, OR 97062
503-692-6400
503-692-4759 (fax)

Start Card: 174329
Well Label: L76997
Boring # : 7H #2

Soil Profile Continued from Log:

Material	From	To	SWL
Soil	0	12	
Weathered brown basalt	12	209	
Black w/ brown weathered basalt	209	242	
Black basalt	242	370	
Black w/ blue claystone	370	385	
Black basalt	385	550	
Fractured black basalt	550	621	
Fractured brown basalt	621	625	
Black basalt	625	661	
Black vesicular basalt	661	672	
Fractured black basalt	672	725	
Fractured black basalt w/ some gravel	725	739	
Black vesicular basalt	739	746	
Black basalt	746	782	
Black vesicular basalt	782	791	
Black basalt	791	820	
Black basalt	820	846	
Black basalt – fracture, hard	846	856	
Fractured gray basalt - hard	856	870	
Gray basalt – vesicular	870	876	
Black basalt – vesicular	876	880	
Gray basalt – hard	880	896	
Black and brown basalt – vesicular	896	904	
Gray basalt – hard	904	907	
Fractured black basalt	907	911	
Fractured gray basalt	911	915	
Black basalt – medium	915	918	
Black basalt – vesicular	918	919	
Black & gray basalt w/ clay	919	921	
Sandstone – black w/ some brown fractured basalt	921	926	
Black & gray basalt w/ some green seams – hard	926	930	
Black & gray fractured basalt	930	944	
Black basalt – vesicular w/ some gray basalt	944	970	
Black basalt – fractured	970	980	
Black basalt – fractured w/ some green	980	985	
Black & gray weathered basalt	985	990	
Gray basalt – hard; fractured	990	999	
Black & gray fractured basalt	999	1000	
Black & gray fractured basalt – green seams; vesicular	1000	1025	
Black basalt	1025	1040	

UMAT 56382

STATE OF OREGON
WATER SUPPLY WELL REPORT
(as required by ORS 537.765 & OAR 690-205-0210)

WELL LABEL # L 59002

START CARD # 1006435

(1) LAND OWNER

Owner Well I.D. 3

First Name ______ Last Name ______

Company North Slope Management

Address 83501 Lower Dry Creek Road

City Milton Freewater State OR Zip 97862

(2) TYPE OF WORK

[X] New Well [ ] Deepening [ ] Conversion [ ] Alteration (repair/recondition) [ ] Abandonment

(3) DRILL METHOD

[X] Rotary Air [ ] Rotary Mud [ ] Cable [ ] Auger [ ] Cable Mud [X] Reverse Rotary [ ] Other

(4) PROPOSED USE

[ ] Domestic [X] Irrigation [ ] Community [ ] Industrial/ Commercial [ ] Livestock [ ] Dewatering [ ] Thermal [ ] Injection [ ] Other

(5) BORE HOLE CONSTRUCTION

Special Standard [ ] (Attach copy)

Depth of Completed Well 1,056 ft.

BORE HOLE Dia	From	To	SEAL Material	From	To	Amt	sacks/ lbs
28	0	18	Bentonite	0	18	48	S
19	18	640	Cement	18	460	506	S
14.75	640	1,056					

How was seal placed: Method [ ] A [ ] B [X] C [ ] D [ ] E [ ] Other

Backfill placed from ___ ft. to ___ ft. Material ___

Filter pack from ___ ft. to ___ ft. Material ___ Size ___

Explosives used: [ ] Yes Type ___ Amount ___

(6) CASING/LINER

Casing	Liner	Dia	+	From	To	Gauge	Stl	Plstc	Wld	Thrd
(•)	( )	20	[X]	2	18	0.375	(•)	( )	[X]	[ ]
(•)	( )	16	[X]	2	640	0.375	(•)	( )	[X]	[ ]

Shoe [ ] Inside [ ] Outside [ ] Other Location of shoe(s) ___

Temp casing [ ] Yes Dia ___ From ___ To ___

(7) PERFORATIONS/SCREENS

Perforations Method ___

Screens Type ___ Material ___

Perf/Screen	Casing/Liner	Screen Dia	From	To	Scrn/slot width	Slot length	# of slots	Tele/ pipe size

(8) WELL TESTS: Minimum testing time is 1 hour

(•) Pump ( ) Bailer ( ) Air ( ) Flowing Artesian

Yield gal/min	Drawdown	Drill stem/Pump depth	Duration (hr)
3,500	9	502	6

Temperature 52 °F Lab analysis [X] Yes By Owner

Water quality concerns? [ ] Yes (describe below)

From	To	Description	Amount	Units

(9) LOCATION OF WELL (legal description)

County UMATILLA Twp 5 N N/S Range 35 E E/W WM

Sec 4 SW 1/4 of the NE 1/4 Tax Lot 400

Tax Map Number ___ Lot ___

Lat ___ ° ___ ' ___ " or ___ DMS or DD

Long ___ ° ___ ' ___ " or ___ DMS or DD

( ) Street address of well (•) Nearest address

83501 Lower Dry Creek Road, Milton Freewater, OR 97862

(10) STATIC WATER LEVEL

	Date	SWL(psi)	+	SWL(ft)
Existing Well / Predeepening			[ ]	
Completed Well	05-28-2009		[ ]	409

Flowing Artesian? [ ] Dry Hole? [ ]

WATER BEARING ZONES Depth water was first found 280

SWL Date	From	To	Est Flow	SWL(psi)	+	SWL(ft)

(11) WELL LOG

Ground Elevation ___

Material	From	To
Silt and gravel - brownish	0	14
Weathered basalt - brown/black	14	20
Solid basalt - black	20	30
Fractured basalt - black	30	40
Solid basalt - black	40	110
Soft, fractured basalt - black/brown	110	180
Solid basalt - black	180	205
Softer basalt	205	225
Dense, brown and black basalt	225	305
Weathered basalt	305	325
Solid basalt	325	355
Fractured basalt - black	355	500
Highly fractured/weathered basalt	500	530
Solid, dense basalt	530	570
Weathered basalt	570	600
Solid basalt - black	600	697
Softer basalt - black	697	710
Hard basalt - highly fractured - black	710	885
Softer basalt, fractured - dark gray to black	885	930

Date Started 03-22-2009 Completed 06-01-2009

(unbonded) Water Well Constructor Certification

I certify that the work I performed on the construction, deepening, alteration, or abandonment of this well is in compliance with Oregon water supply well construction standards. Materials used and information reported above are true to the best of my knowledge and belief.

License Number 1672 Date 06-02-2009

Password : (if filing electronically)

Signed [signature]

(bonded) Water Well Constructor Certification

I accept responsibility for the construction, deepening, alteration, or abandonment work performed on this well during the construction dates reported above. All work performed during this time is in compliance with Oregon water supply well construction standards. This report is true to the best of my knowledge and belief.

License Number 1523 Date 06-02-2009

Password : (if filing electronically)

Signed [signature]

Contact Info (optional)

RECEIVED JUN 05 2009 WATER RESOURCES DEPT SALEM, OREGON

ORIGINAL - WATER RESOURCES DEPARTMENT

THIS REPORT MUST BE SUBMITTED TO THE WATER RESOURCES DEPARTMENT WITHIN 30 DAYS OF COMPLETION OF WORK

Form Version: 0.89

UMAT 56382

WATER SUPPLY WELL REPORT - continuation page

WELL I.D. # L 59002

START CARD # 1006435

(5) BORE HOLE CONSTRUCTION

BORE HOLE Dia	From	To

SEAL Material	From	To	Amt	sacks/ lbs

FILTER PACK

From	To	Material	Size

(6) CASING/LINER

Casing	Liner	Dia	+	From	To	Gauge	Stl	Plstc	Wld	Thrd

(7) PERFORATIONS/SCREENS

Perf/Screen	Casing/Liner	Screen Dia	From	To	Scrn/slot width	Slot length	# of slots	Tele/ pipe size

(8) WELL TESTS: Minimum testing time is 1 hour

Yield gal/min	Drawdown	Drill stem/Pump depth	Duration (hr)

Water Quality Concerns

From	To	Description	Amount	Units

(10) STATIC WATER LEVEL

Water Bearing Zones

SWL Date	From	To	Est Flow	SWL(psi)	+	SWL(ft)

(11) WELL LOG

Material	From	To
Hard baalt - multiple fractures	930	955
Softer basalt, fractured - black	955	999
Hard basalt - highly fractured - black	999	1,015
Softer basalt	1,015	1,055
Hard, dense basalt	1,055	1,056

Comments/Remarks

Trace water - 280'
Substantial water gain - 450' - 455'
Steadily increasing from 640' to 1056'

16-inch casing extends to the surface, annulus between 16" and 20" is neat cement, 20" seal is hydrated bentonite

RECEIVED
JUN 05 2009
WATER RESOURCES DEPT
SALEM, OREGON

STATE OF OREGON
WATER SUPPLY WELL REPORT
(as required by ORS 537.765 & OAR 690-205-0210)

UMAT 57714

11/24/2016

WELL I.D. LABEL# L 122502
START CARD # 1029475
ORIGINAL LOG #

(1) LAND OWNER

Owner Well I.D. WEST POND WELL
First Name Last Name
Company WALLA WALLA VALLEY APPELLATION
Address 83501 LOWER DRY CREEK ROAD
City MILTON-FREEWATER State OR Zip 97862

(2) TYPE OF WORK

[X] New Well [ ] Deepening [ ] Conversion
[ ] Alteration (complete 2a & 10) [ ] Abandonment(complete 5a)

(2a) PRE-ALTERATION

Casing: Dia + From To Gauge Stl Plstc Wld Thrd
Seal: Material From To Amt sacks/lbs

(3) DRILL METHOD

[X] Rotary Air [X] Rotary Mud [ ] Cable [ ] Auger [ ] Cable Mud
[X] Reverse Rotary [ ] Other

(4) PROPOSED USE

[ ] Domestic [X] Irrigation [ ] Community
[ ] Industrial/ Commericial [ ] Livestock [ ] Dewatering
[ ] Thermal [ ] Injection [ ] Other

(5) BORE HOLE CONSTRUCTION

Special Standard [ ] (Attach copy)
Depth of Completed Well 1034.00 ft.

BORE HOLE Dia	From	To	SEAL Material	From	To	Amt	sacks/lbs
24	0	19	Cement	0	15	8	S
19	19	950			Calculated	7.11	
15	950	1160	Cement	15	127	55	S
					Calculated	53.09	

How was seal placed: Method [ ] A [X] B [X] C [ ] D [ ] E
[ ] Other
Backfill placed from 1160 ft. to 1034 ft. Material NEAT CEMENT/PE/
Filter pack from ft. to ft. Material Size
Explosives used: [ ] Yes Type Amount

(5a) ABANDONMENT USING UNHYDRATED BENTONITE

Proposed Amount Actual Amount

(6) CASING/LINER

Casing	Liner	Dia	+	From	To	Gauge	Stl	Plstc	Wld	Thrd
(•)	( )	16	[X]	2	702	0.375	(•)	( )	[X]	[ ]
(•)	( )	20	[ ]	0	19	.375	(•)	( )	[X]	[ ]

Shoe [ ] Inside [ ] Outside [ ] Other Location of shoe(s)
Temp casing [ ] Yes Dia From To

(7) PERFORATIONS/SCREENS

Perforations Method
Screens Type Material

Perf/ Screen	Casing/ Liner	Screen Dia	From	To	Scrn/slot width	Slot length	# of slots	Tele/ pipe size

(8) WELL TESTS: Minimum testing time is 1 hour

( ) Pump ( ) Bailer ( ) Air ( ) Flowing Artesian

Yield gal/min	Drawdown	Drill stem/Pump depth	Duration (hr)

Temperature 52 °F Lab analysis [ ] Yes By
Water quality concerns? [ ] Yes (describe below) TDS amount 68 ppm

From	To	Description	Amount	Units

(9) LOCATION OF WELL (legal description)

County UMATILLA Twp 5.00 N N/S Range 35.00 E E/W WM
Sec 5 NW 1/4 of the SE 1/4 Tax Lot 1100
Tax Map Number 5N35B Lot
Lat ° ' " or 45.93663300 DMS or DD
Long ° ' " or -118.46127000 DMS or DD
(•) Street address of well ( ) Nearest address
83501 LOWER DRY CREEK ROAD, MILTON-FREEWATER OR 96862

(10) STATIC WATER LEVEL

	Date	SWL(psi)	+	SWL(ft)
Existing Well / Pre-Alteration				
Completed Well	8/16/2016			400

Flowing Artesian? [ ] Dry Hole? [ ]

WATER BEARING ZONES Depth water was first found 495.00

SWL Date	From	To	Est Flow	SWL(psi)	+	SWL(ft)
2/2/2016	515	558	500			390.8
2/4/2016	738	744	1000			390.2
2/14/2016	809	812				389.3
2/16/2016	887	914				389.2
2/18/2016	929	967	500			388.8

(11) WELL LOG

Ground Elevation 1050.00

Material	From	To
Loess/Caliche	0	13
weathered dense Basalt	13	28
weathered vesicular Basalt	28	40
weathered dense Basalt	40	54
weathered vesicular Basalt	54	58
weathered dense Basalt	58	68
weathered vesicular Basalt	68	78
weathered dense Basalt	78	145
vesicular Basalt	145	175
dense Basalt	175	225
vesicular Basalt	225	255
dense Basalt	255	298
vesicular Basalt	298	342
dense Basalt	342	375
vesicular Basalt	375	399
dense Basalt	399	435
vesicular Basalt	435	455
dense Basalt	455	495
weathered vesicular Basalt	495	505

Date Started 1/18/2016 Completed 8/16/2016

(unbonded) Water Well Constructor Certification

I certify that the work I performed on the construction, deepening, alteration, or abandonment of this well is in compliance with Oregon water supply well construction standards. Materials used and information reported above are true to the best of my knowledge and belief.

License Number Date
Signed

(bonded) Water Well Constructor Certification

I accept responsibility for the construction, deepening, alteration, or abandonment work performed on this well during the construction dates reported above. All work performed during this time is in compliance with Oregon water supply well construction standards. This report is true to the best of my knowledge and belief.

License Number 1937 Date 11/24/2016
Signed BRENDAN PECK (E-filed)
Contact Info (optional)

WATER SUPPLY WELL REPORT - continuation page

UMAT 57714

11/24/2016

WELL I.D. LABEL# L 107437
START CARD # 1029475
ORIGINAL LOG #

(2a) PRE-ALTERATION

Dia	+	From	To	Gauge	Stl	Plstc	Wld	Thrd

Material	From	To	Amt	sacks/lbs

(5) BORE HOLE CONSTRUCTION

BORE HOLE

Dia	From	To

SEAL

Material	From	To	Amt	sacks/lbs
Cement with 4% Bentoı	127	702	432	S
		Calculated	212.75	
		Calculated		
		Calculated		
		Calculated		

FILTER PACK

From	To	Material	Size

(6) CASING/LINER

Casing	Liner	Dia	+	From	To	Gauge	Stl	Plstc	Wld	Thrd

(7) PERFORATIONS/SCREENS

Perf/ Screen	Casing/ Liner	Screen Dia	From	To	Scrn/slot width	Slot length	# of slots	Tele/ pipe size

(8) WELL TESTS: Minimum testing time is 1 hour

Yield gal/min	Drawdown	Drill stem/Pump depth	Duration (hr)

Water Quality Concerns

From	To	Description	Amount	Units

(10) STATIC WATER LEVEL

SWL Date	From	To	Est Flow	SWL(psi)	+	SWL(ft)
3/16/2016	1078	1124.5				389.1

(11) WELL LOG

Material	From	To
dense Basalt	505	518
vesicular Basalt	518	542
dense Basalt	542	558
weathered vesicular Basalt	558	565
dense Basalt	565	627
oxidized vesicular Basalt	627	632
dense Basalt	632	722
vesicular Basalt	722	732
dense Basalt	732	742
vesicular Basalt	742	757
dense Basalt	757	812
vesicular Basalt	812	827
dense Basalt	827	887
vesicular Basalt	887	915
dense Basalt	915	925
vesicular Basalt	925	943
dense Basalt	943	951
vesicular Basalt	951	967
dense Basalt	967	1002
vesicular Basalt	1002	1015
dense Basalt	1015	1078
weathered vesicular Basalt	1078	1124.5
dense Basalt	1124.5	1160

Comments/Remarks

Bottom of lower borehole backfilled from 1160 to 1069 with neat cement.
Bottom of borehole backfilled with peagravel from 1069 to 1034.

ATTACHMENT C

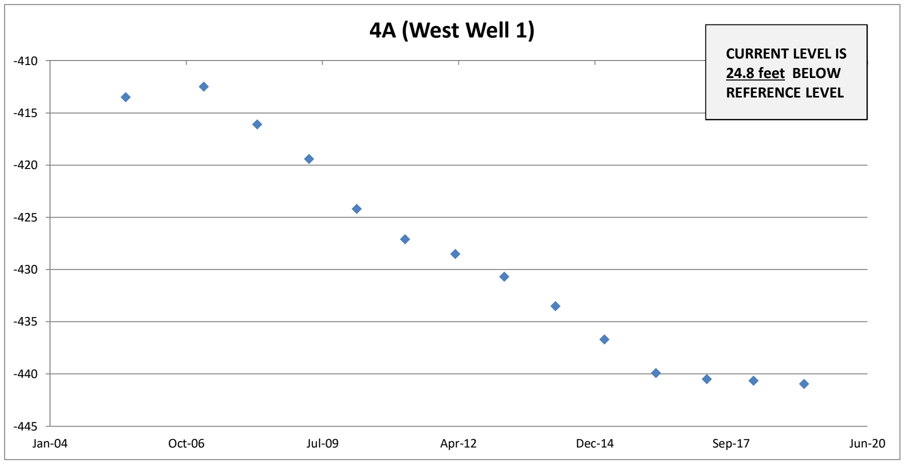
Permit Condition Water Level Measurements

Seven Hills Properties LLC

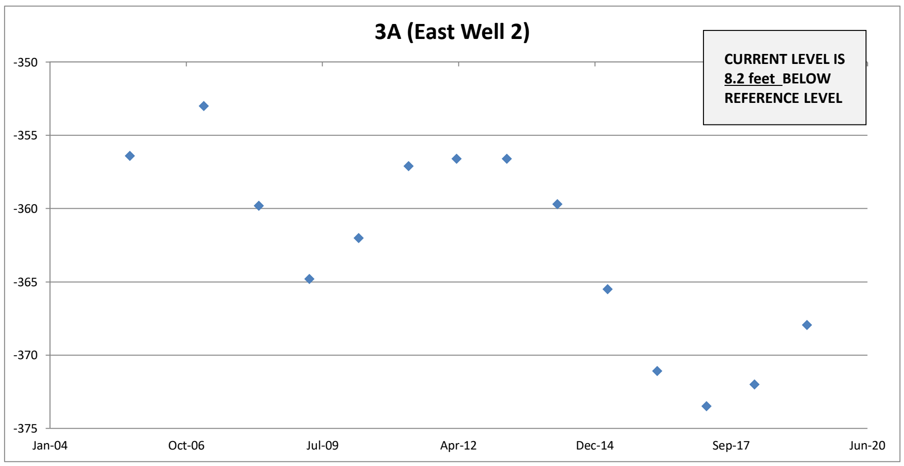
PERMIT CONDITION WATER-LEVEL REPORTING DATA

Revised: April 15, 2019 by John Warinner, PE, CWRE

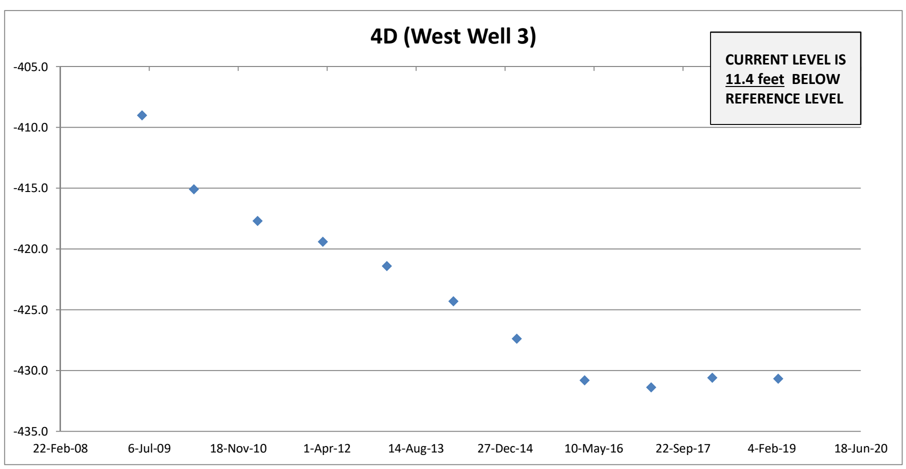
MEASURE DATE	WATER LEVEL (feet BLS) 4A (WEST)
REF LEVEL	-416.1
22-Jul-05	-413.5
17-Feb-07	-412.5
15-Mar-08	-416.1
30-Mar-09	-419.4
15-Mar-10	-424.2
4-Mar-11	-427.1
8-Mar-12	-428.5
1-Mar-13	-430.7
12-Mar-14	-433.5
6-Mar-15	-436.7
18-Mar-16	-439.9
28-Mar-17	-440.5
6-Mar-18	-440.7
11-Mar-19	-440.9
	-24.8



MEASURE DATE	WATER LEVEL (feet BLS) 3A (EAST)
REF LEVEL	-359.8
23-Aug-05	-356.4
17-Feb-07	-353.0
25-Mar-08	-359.8
31-Mar-09	-364.8
29-Mar-10	-362.0
31-Mar-11	-357.1
17-Mar-12	-356.6
20-Mar-13	-356.6
26-Mar-14	-359.7
31-Mar-15	-365.5
29-Mar-16	-371.1
24-Mar-17	-373.5
13-Mar-18	-372.0
31-Mar-19	-368.0
	-8.2



MEASURE DATE	WATER LEVEL (feet BLS) 4D (Well 3)
REF LEVEL	-419.3
28-May-09	**-409.0**
14-Mar-10	-415.1
8-Mar-11	-417.7
8-Mar-12	-419.4
4-Mar-13	-421.4
12-Mar-14	-424.3
4-Mar-15	-427.4
18-Mar-16	-430.8
28-Mar-17	-431.4
7-Mar-18	-430.6
11-Mar-19	-430.7
	-11.4



MEASURE DATE	WATER LEVEL (feet BLS) WWVA
REF LEVEL	-192.5
18-Apr-97	-191.0
17-Mar-05	-184.1
24-Mar-06	-185.9
25-Mar-08	-206.7
24-Mar-09	-214.8
27-Mar-10	-220.0
18-Mar-11	-217.0
23-Mar-12	-217.0
6-Mar-13	-225.2
5-Mar-14	-226.5
25-Mar-15	-225.7
30-Mar-16	-232.9
14-Mar-17	-232.0
22-Mar-18	-229.8
31-Mar-19	-230.1
	-37.6