Groundwater Application Review Summary Form

Application # G- 18554

GW Reviewer Benjamin Scandella, Dennis Orlowski **Date Review Completed:** 11/21/2017

Summary of GW Availability and Injury Review:

[ ] Groundwater for the proposed use is either over appropriated, will not likely be available in the amounts requested without injury to prior water rights, OR will not likely be available within the capacity of the groundwater resource per Section B of the attached review form.

Summary of Potential for Substantial Interference Review:

[ ] There is the potential for substantial interference per Section C of the attached review form.

Summary of Well Construction Assessment:

[ ] The well does not appear to meet current well construction standards per Section D of the attached review form. Route through Well Construction and Compliance Section.

This is only a summary. Documentation is attached and should be read thoroughly to understand the basis for determinations and for conditions that may be necessary for a permit (if one is issued).

INTEREST REVIEW FOR GROUNDWATER APPLICATIONS

TO: Water Rights Section Date 11/21/17

FROM: Groundwater Section Benjamin Scandella, Dennis Orlowski
Reviewer's Name

SUBJECT: Application G-18554 Supersedes review of _____
Date of Review(s)

PUBLIC INTEREST PRESUMPTION; GROUNDWATER

OAR 690-310-130 (1) *The Department shall presume that a proposed groundwater use will ensure the preservation of the public welfare, safety and health as described in ORS 537.525.* Department staff review groundwater applications under OAR 690-310-140 to determine whether the presumption is established. OAR 690-310-140 allows the proposed use be modified or conditioned to meet the presumption criteria. **This review is based upon available information and agency policies in place at the time of evaluation.**

A. GENERAL INFORMATION: Applicant's Name: **BRYAN AND AMY SCHURTER** County: **MARION**

A1. Applicant(s) seek(s) 1.120 CUBIC FEET PER SECOND from 2 well(s) in the Willamette Basin, **Pudding River above Howell Prairie** subbasin

A2. Proposed use IRRIGATION, SUPPLEMENTAL IRRIGATION Seasonality: MARCH 1 THROUGH OCTOBER 31

A3. Well and aquifer data (**attach and number logs for existing wells; mark proposed wells as such under logid**):

Well	Logid	Applicant's Well #	Proposed Aquifer*	Proposed Rate(cfs)	Location (T/R-S QQ-Q)	Location, metes and bounds, e.g. 2250' N, 1200' E fr NW cor S 36
1	**Proposed**	**1**	**CRB**	**1.12**	**T7S/R1W-S17 NW-NE**	**1,130' N, 580' W fr SE corner, DLC 49**
2	**Proposed**	**2**	**CRB**	**1.12**	**T7S/R1W-S17 NW-NE**	**1,095' N, 580' W fr SE corner, DLC 49**
3						
4						
5						

* Alluvium, CRB, Bedrock

Well	Well Elev ft msl	First Water ft bls	SWL ft bls	SWL Date	Well Depth (ft)	Seal Interval (ft)	Casing Intervals (ft)	Liner Intervals (ft)	Perforations Or Screens (ft)	Well Yield (gpm)	Draw Down (ft)	Test Type
1	**255**				**400**	**0-100**	**0-100**		**100-400**			
2	**255**				**400**	**0-100**	**0-100**		**100-400**			

Use data from application for proposed wells.

A4. **Comments:** The application requests water from the Columbia River Basalt Group aquifer system for both wells 1 and 2. The application requests a total rate of diversion of 500 gpm (1.12 cfs) for both primary (4.4 acres) and supplemental irrigation (84.88 acres). Given the maximum allowable rate of diversion of 1/80 cfs/ac, the maximum allowable rate for primary irrigation is 0.055 cfs, and similarly 1.061 cfs for supplemental irrigation.

A5. ☒ **Provisions of the** Willamette Basin rules relative to the development, classification and/or management of groundwater hydraulically connected to surface water ☐ **are**, *or* ☒ **are not**, activated by this application. (Not all basin rules contain such provisions.)
Comments: The applicant's proposed wells will produce from a confined aquifer system and are not located within ¼ mile of the nearest surface water source, so the pertinent basin rules do not apply (OAR 690-502-0240).

A6. ☐ **Well(s) #** _____, _____, _____, _____, _____, tap(s) an aquifer limited by an administrative restriction.
Name of administrative area: _____
Comments: _____

B. GROUNDWATER AVAILABILITY CONSIDERATIONS, OAR 690-310-130, 400-010, 410-0070

B1. **Based upon available data**, I have determined that groundwater* for the proposed use:

a. ☐ **is** over appropriated, ☐ **is not** over appropriated, *or* ☒ **cannot be determined to be** over appropriated during any period of the proposed use. * This finding is limited to the groundwater portion of the over-appropriation determination as prescribed in OAR 690-310-130;

b. ☐ **will not** *or* ☐ **will** likely be available in the amounts requested without injury to prior water rights. * This finding is limited to the groundwater portion of the injury determination as prescribed in OAR 690-310-130;

c. ☐ **will not** *or* ☐ **will** likely to be available within the capacity of the groundwater resource; or

d. ☒ **will, if properly conditioned**, avoid injury to existing groundwater rights or to the groundwater resource:
   i. ☒ The permit should contain condition #(s) **Willamette Basin basalt groundwater condition 7I, Large water use reporting;**
   ii. ☒ The permit should be conditioned as indicated in item 2 below.
   iii. ☒ The permit should contain special condition(s) as indicated in item 3 below;

B2. a. ☐ **Condition** to allow groundwater production from no deeper than _____ ft. below land surface;

b. ☐ **Condition** to allow groundwater production from no shallower than _____ ft. below land surface;

c. ☒ **Condition** to allow groundwater production only from the **basalt** groundwater reservoir ~~between approximately _____ ft. and _____ ft. below land surface;~~

d. ☐ **Well reconstruction** is necessary to accomplish one or more of the above conditions. The problems that are likely to occur with this use and without reconstructing are cited below. Without reconstruction, I recommend withholding issuance of the permit until evidence of well reconstruction is filed with the Department and approved by the Groundwater Section.

Describe injury –as related to water availability– that is likely to occur without well reconstruction (interference w/ senior water rights, not within the capacity of the resource, etc): _____

B3. **SPECIAL CONDITIONS:**

1. Each basalt well shall be cased and continuously sealed from land surface to a depth of at least 250 feet below land surface to reduce the chances of forming a hydraulic connection to nearby streams.
2. Each basalt well shall be open to a single aquifer of the Columbia River Basalt Group and shall meet the applicable well construction standards (OAR 690-200 and OAR 690-210). In addition, the open interval in each well shall be no greater than 100 feet. However, an open interval of greater than 100 feet may be allowed if substantial evidence of a single aquifer completion can be demonstrated to the satisfaction of the Department hydrogeologists, using information from a video log, downhole flowmeter, water chemistry and temperature, or other downhole geophysical methods. These methods shall characterize the nature of the basalt rock and assess whether water is moving in the borehole. Any discernable movement of water within the well bore when the well is not being pumped shall be assumed as evidence of the presence of multiple aquifers in the open interval.
3. If during well construction it becomes apparent that the well can be constructed to eliminate interference with hydraulically connected streams in a manner other than specified in this permit (including but not limited to SPECIAL CONDITIONS 1 and 2 above), the permittee can contact the Department Hydrogeologist for this permit or the Groundwater Hydrology Section Manager to request approval of such construction. The request shall be in writing, and shall include a rough well log and a proposed construction design for approval by the Department. The request can be approved only if it is received and reviewed prior to placement of any permanent casing and sealing material. If the request is made after casing and seal are placed, the requested modification will not be approved. If approved, the new well depth and construction specifications will be incorporated into any certificate issued for this permit.

4. A dedicated water-level measuring tube shall be installed in each well. The measuring tube shall meet the standards described in OAR 690-215-0060. When requested, access to the wells shall be provided to Department staff in order to make water-level measurements.
5. The applicant shall coordinate with the driller to ensure that drill cuttings are collected at 10-ft intervals and at changes in formation in each well. A split of each sampled interval shall be provided to the Department.
6. Copies of all geologic and hydrogeologic reports completed for the permittee during the development of the wells, including geophysical well logs and borehole video logs, shall be provided to the Department. Except for borehole video logs, two paper copies, or a single electronic copy, shall be provided of each report. Digital tables of any data shall be provided upon request.
7. Prior to using water on this permit, the permittee shall ensure that the well on this permit has an OWRD Well Identification Number (Well ID or Well tag number). If a well does not have a Well ID, the permittee shall apply for one from the Department. The Well ID shall be attached to the well and shall be used as a reference identification number for any correspondence regarding the well including any water use, water level, or pump test reports.

Groundwater Availability Remarks:

The applicant's proposed basalt wells will produce from one of the water-bearing zones in the Columbia River Basalt Group (CRBG), a series of lava flows with composite thickness around 200-500 feet in this area (Conlon et al., 2005). Each flow is characterized by a series of internal features, including a thin rubble zone at the contact between flows and a thick, dense, low porosity and low permeability interior zone. In some cases, sedimentary layers were deposited during the time between basalt flow emplacements. A flow top, sedimentary interbed (if present), and flow bottom are collectively referred to as an "interflow zone." Unconfined groundwater occurs near the weathered top of the basalts, but most water occurs in interflow zones under confined conditions at the contacts between lava flows. CRBG flow features result in a series of stacked, thin aquifers that are confined by dense flow interiors. Unless subjected to subsequent tectonic activity, the low permeability of the basalt flow interiors usually results in little connection between stacked aquifers, which generally results in tabular aquifers with unique water level heads (Reidel et al., 2002). In this area the CRBG overlies Tertiary marine sediments, which are typically low-permeability, fractured and consolidated rocks.

Well logs from nearby wells show typical yields of less than 100 gpm, though a number of wells completed in the 200-400' depth range have yields of 200-600 gpm (e.g. MARI 6312, 600 gpm with 65' of drawdown after 1.25 hours). This suggests that the basalt can potentially supply the requested rate of diversion and that both proposed wells may be required to do so.

Constructing a well that is open to multiple water-bearing zones with distinct water level heads can commingle multiple aquifers. When the pump is off, water migrates through the well bore from an aquifer of higher pressure to an aquifer of lower pressure. Over time, this can depressurize the aquifers and exacerbate water level decline. Well construction conditions are specified to protect the resource and other existing users.

Multiple northwest-trending faults are mapped in the vicinity of this well (see map in Figure 2), and the vertical offset between CRBG flows along those faults may impact the extent and pumping response of the CRBG interflow zones. Vertical offset of CRBG flows can cause juxtaposition of permeable interflows with dense flow interiors, resulting in a low-or no-flow boundary at the fault trace. The resultant compartmentalization could buffer or delay well-to-well impacts, while also limiting the aquifer extent. Additionally, fault systems can promote hydraulic connection between separate interflow zones via sub-vertical fractures associated with the fault. At the subject site, the degree to which this fault impedes horizontal flow or enhances vertical flow of groundwater is uncertain.

Evaluation of groundwater availability may be informed by water level data. Long term trends indicate relatively stable water levels in wells in the immediate area and on the west side of the north-northwest trending fault to the east of the proposed wells (e.g. MARI 6153 and 9942), with head losses limited to 10 feet since 1990 within the CRBG (Figure 2). Water levels in basalt wells to the northeast of the proposed well show declines typically ranging from 30 to 50 feet since 1990 (e.g. MARI 6161, MARI 8354, and MARI 17772, Figures 1 and 2), but their positioning on the east side of the fault suggests that this fault effectively isolates those eastern portions of the aquifer system from the western ones targeted by the applicant. These results suggest that the groundwater resources accessed by the wells in the lateral vicinity of the proposed wells are not over-appropriated. However, both the depth of the proposed wells and the well construction requirements indicate that the proposed wells may withdraw water from water-bearing zones beneath those accessed by the wells analyzed here, so the degree of over-appropriation in the actual target aquifer cannot be determined. The 7I decline condition, as stipulated by OAR 690-502-0250, should provide some protection for the resource and for senior users if declines become evident in the future.

Well logs show nearby wells completed over 500 feet below land surface, suggesting that the water-bearing zones targeted by the proposed wells may be shared by other groundwater users. Because the aquifers are confined (storativity is estimated to be 0.0001), pumping impacts will propagate outward at rapid rates and are likely to reach aquifer boundaries (streams, faults, and truncated basalt flow margins) within a few minutes. Using aquifer parameters appropriate for the basalts, it can be shown that the cone of depression from a pumped well can produce measureable impacts at a distance of 1 mile within minutes. Therefore, hydraulic interference with nearby wells, springs, and streams will likely occur rapidly once pumping begins if nearby streams and wells are connected to the same aquifer that is open in the well. For these reasons, the potential for the proposed use to interfere with senior groundwater rights, both permitted and exempt, is significant. To protect existing users and monitor the resource, the condition 7I (Willamette Basin Basalt Groundwater Condition) is recommended.

C. GROUNDWATER/SURFACE WATER CONSIDERATIONS, OAR 690-09-040

C1. **690-09-040 (1):** Evaluation of aquifer confinement:

Well	Aquifer or Proposed Aquifer	Confined	Unconfined
1	**Columbia River Basalt**	☒	☐
2	**Columbia River Basalt**	☒	☐
		☐	☐
		☐	☐
		☐	☐

Basis for aquifer confinement evaluation: The Columbia River basalt aquifers are confined by the dense flow interiors that restrict vertical movement of groundwater. Nearby CRBG well logs (MARI 6139, 6309, and 6312) report static water levels above the water-bearing zone, indicating a confined aquifer or series of aquifers.

C2. **690-09-040 (2) (3):** Evaluation of distance to, and hydraulic connection with, surface water sources. All wells located a horizontal distance less than ¼ mile from a surface water source that produce water from an unconfined aquifer shall be assumed to be hydraulically connected to the surface water source. Include in this table any streams located beyond one mile that are evaluated for PSI.

Well	SW #	Surface Water Name	GW Elev ft msl	SW Elev ft msl	Distance (ft)	Hydraulically Connected? YES	NO	ASSUMED	Potential for Subst. Interfer. Assumed? YES	NO
1	**1**	**Beaver Creek**	**150-160**	**170-240**	**1850**	☐	☒	☐	☐	☒
1	**2**	**Drift Creek**	**150-160**	**190-240**	**3170**	☐	☒	☐	☐	☒
1	**3**	**Pudding River**	**150-160**	**150-200**	**3090**	☐	☒	☐	☐	☒
2	**1**	**Beaver Creek**	**150-160**	**170-240**	**1850**	☐	☒	☐	☐	☒
2	**2**	**Drift Creek**	**150-160**	**190-240**	**3170**	☐	☒	☐	☐	☒
2	**3**	**Pudding River**	**150-160**	**150-200**	**3090**	☐	☒	☐	☐	☒
						☐	☐	☐	☐	☐
						☐	☐	☐	☐	☐
						☐	☐	☐	☐	☐

Basis for aquifer hydraulic connection evaluation: Water levels in multiple wells on the same side of the nearest fault lie within the same range as the elevations of local incision by the Pudding River (e.g. MARI 6153, MARI 9942, MARI 52780, and MARI 63039, as seen in Figure 1), and the correspondence suggests that at least some of the water-bearing zones accessed by these wells are hydraulically connected with SW#3. Potential pathways that could enable this hydraulic connection include vertical conductivity along the regional fault network and through wells open to multiple water-bearing zones. The well construction requirements specified in section B should reduce the chances of establishing a hydraulic connection with surface waters by sealing off the well from the shallower water-bearing zones.

Water Availability Basin the well(s) are located within: 152: PUDDING R > MOLALLA R – AB HOWELL PRARIE; 70781: DRIFT CR > PUDDING R – AT MOUTH

C3a. **690-09-040 (4):** Evaluation of stream impacts for each well that has been determined or assumed to be **hydraulically connected and less than 1 mile** from a surface water source. Limit evaluation to instream rights and minimum stream flows that are pertinent to that surface water source, and not lower SW sources to which the stream under evaluation is tributary. Compare the requested rate against the 1% of 80% *natural* flow for the pertinent Water Availability Basin (WAB). If Q is not distributed by well, use full rate for each well. Any checked ☒ box indicates the well is assumed to have the potential to cause PSI.

Well	SW #	Well < ¼ mile?	Qw > 5 cfs?	Instream Water Right ID	Instream Water Right Q (cfs)	Qw > 1% ISWR?	80% Natural Flow (cfs)	Qw > 1% of 80% Natural Flow?	Interference @ 30 days (%)	Potential for Subst. Interfer. Assumed?
		☐	☐			☐		☐		☐

C3b. **690-09-040 (4):** Evaluation of stream impacts by total appropriation for all wells determined or assumed to be **hydraulically connected and less than 1 mile** from a surface water source. **Complete only if Q is distributed among wells**. Otherwise same evaluation and limitations apply as in C3a above.

	SW #		Qw > 5 cfs?	Instream Water Right ID	Instream Water Right Q (cfs)	Qw > 1% ISWR?	80% Natural Flow (cfs)	Qw > 1% of 80% Natural Flow?	Interference @ 30 days (%)	Potential for Subst. Interfer. Assumed?
			☐			☐		☐		☐
			☐			☐		☐		☐
			☐			☐		☐		☐
			☐			☐		☐		☐

Comments: ______________________________

C4a. **690-09-040 (5):** Estimated impacts on **hydraulically connected surface water sources greater than one mile** as a percentage of the proposed pumping rate. Limit evaluation to the effects that will occur up to one year after pumping begins. This table encompasses the considerations required by 09-040 (5)(a), (b), (c) and (d), which are not included on this form. Use additional sheets if calculated flows from more than one WAB are required.

Non-Distributed Wells

Well	SW#	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
		%	%	%	%	%	%	%	%	%	%	%	%
Well Q as CFS													
Interference CFS													

Distributed Wells

Well	SW#	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
		%	%	%	%	%	%	%	%	%	%	%	%
Well Q as CFS													
Interference CFS													
		%	%	%	%	%	%	%	%	%	%	%	%
Well Q as CFS													
Interference CFS													
		%	%	%	%	%	%	%	%	%	%	%	%
Well Q as CFS													
Interference CFS													
		%	%	%	%	%	%	%	%	%	%	%	%
Well Q as CFS													
Interference CFS													
		%	%	%	%	%	%	%	%	%	%	%	%
Well Q as CFS													
Interference CFS													
		%	%	%	%	%	%	%	%	%	%	%	%
Well Q as CFS													
Interference CFS													

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(A) = Total Interf.												
(B) = 80 % Nat. Q												
(C) = 1 % Nat. Q												
(D) = (A) > (C)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
(E) = (A / B) x 100	%	%	%	%	%	%	%	%	%	%	%	%

(A) = total interference as CFS; (B) = WAB calculated natural flow at 80% exceed. as CFS; (C) = 1% of calculated natural flow at 80% exceed. as CFS; (D) = highlight the checkmark for each month where (A) is greater than (C); (E) = total interference divided by 80% flow as percentage.

Basis for impact evaluation: ______________________________

C4b. **690-09-040 (5) (b) The potential to impair or detrimentally affect the public interest is to be determined by the Water Rights Section.**

C5. ☐ **If properly conditioned**, the surface water source(s) can be adequately protected from interference, and/or groundwater use under this permit can be regulated if it is found to substantially interfere with surface water:

i. ☐ The permit should contain condition #(s)_____;

ii. ☐ The permit should contain special condition(s) as indicated in "Remarks" below;

C6. **SW / GW Remarks and Conditions:** The chances of establishing an effective hydraulic connection with nearby streams should be reduced by casing and sealing to the depth specified in the special condition listed in section B3.
It is also noted that the application proposes to pump water into a pond as part of the distribution system. A storage permit may be required; caseworker to clarify.

References Used:

Conlon, T.D., Wozniak, K.C., Woodcock, D., Herrera, N.B., Fisher, B.J., Morgan, D.S., Lee, K.K., and Hinkle, S.R., 2005, Ground-water hydrology of the Willamette Basin, Oregon: U.S. Geological Survey Scientific Investigations Report 2005-5168.

Gannett, M.W. and Caldwell, R., 1998, Geologic framework of the Willamette Lowland aquifer system, Oregon and Washington: U.S. Geological Survey Professional Paper 1424-A, 32 p.

Reidel, S.P., Johnson, V.G., and Spane, F.A., 2002, Natural gas storage in basalt aquifers of the Columbia Basin, Pacific Northwest USA—A guide to site characterization: Richland, Wash., Pacific Northwest National Laboratory, 277 p.

Tolan, Terry L. and Beeson, Marvin H., 1999, Geologic Map of the Stayton NE 7.5 Minute Quadrangles, Northwest Oregon: A Digital Database: USGS Open File Report 99-141.

Woodward, D.G., Gannett, M.W., and Vaccaro, J.J., 1998, Hydrogeologic framework of the Willamette Lowland aquifer system, Oregon and Washington: U.S. Geological Survey Professional Paper 1424-B, 82 p.

US Geological Survey Topographic Quadrangle Maps.

OWRD water level database, includes reported water levels, accessed October 2017.

D. WELL CONSTRUCTION, OAR 690-200

D1. **Well #:** _____ **Logid:** _____

D2. **THE WELL does not appear to meet current well construction standards based upon:**

a. ☐ review of the well log;
b. ☐ field inspection by _____;
c. ☐ report of CWRE _____;
d. ☐ other: (specify) _____

D3. **THE WELL construction deficiency or other comment is described as follows:** _____

D4. ☐ **Route to the Well Construction and Compliance Section for a review of existing well construction.**

Water Availability Tables

DETAILED REPORT ON THE WATER AVAILABILITY CALCULATION

PUDDING R > MOLALLA R - AB HOWELL PRAIRIE
Basin: WILLAMETTE

Watershed ID #: 152
Time: 10:07 AM
Exceedance Level: 80
Date: 10/17/2017

Monthly values are in cfs.
Storage is the annual amount at 50% exceedance in ac-ft.

Month	Natural Stream Flow	Consumptive Use and Storage	Expected Stream Flow	Reserved Stream Flow	Instream Requirements	Net Water Available
JAN	603.00	69.80	533.00	0.00	10.00	523.00
FEB	649.00	60.90	588.00	0.00	10.00	578.00
MAR	587.00	40.00	547.00	0.00	10.00	537.00
APR	451.00	21.40	430.00	0.00	10.00	420.00
MAY	235.00	14.30	221.00	0.00	10.00	211.00
JUN	111.00	29.30	81.70	0.00	10.00	71.70
JUL	43.60	44.80	-1.17	0.00	10.00	-11.20
AUG	24.70	37.20	-12.50	0.00	10.00	-22.50
SEP	22.70	22.30	0.42	0.00	10.00	-9.58
OCT	38.90	4.35	34.50	0.00	10.00	24.50
NOV	233.00	18.80	214.00	0.00	10.00	204.00
DEC	608.00	63.80	544.00	0.00	10.00	534.00
ANN	385,000	25,700	360,000	0	7,240	353,000

DETAILED REPORT ON THE WATER AVAILABILITY CALCULATION

DRIFT CR > PUDDING R - AT MOUTH
Basin: WILLAMETTE

Watershed ID #: 70781
Time: 1:59 PM
Exceedance Level: 80
Date: 11/07/2017

Monthly values are in cfs.
Storage is the annual amount at 50% exceedance in ac-ft.

Month	Natural Stream Flow	Consumptive Use and Storage	Expected Stream Flow	Reserved Stream Flow	Instream Requirements	Net Water Available
JAN	67.30	54.40	12.90	0.00	40.00	-27.10
FEB	74.90	46.40	28.50	0.00	40.00	-11.50
MAR	66.80	33.20	33.60	0.00	40.00	-6.36
APR	48.80	13.70	35.10	0.00	40.00	-4.93
MAY	24.20	0.22	24.00	0.00	30.10	-6.12
JUN	11.50	0.44	11.10	0.00	13.60	-2.54
JUL	5.51	0.77	4.74	0.00	3.00	1.74
AUG	3.34	0.61	2.73	0.00	2.00	0.73
SEP	3.09	0.30	2.79	0.00	2.00	0.79
OCT	4.27	0.02	4.25	0.00	5.26	-1.01
NOV	23.70	10.80	12.90	0.00	40.00	-27.10
DEC	65.80	48.80	17.00	0.00	40.00	-23.00
ANN	46,300	12,600	33,700	0	17,800	15,900

Figure 1: Water-level trends in nearby relevant wells. Water levels are taken from wells in 7S1W sections 7-9 and 16-18 with land surface elevation below 295' that have at least 3 measurements taken between January and March, not measured while pumping (static or unknown water level status), and not reviewed as unreliable. Wells MARI 6161, MARI 8354, and MARI 17772 all show significant declines beginning in the mid-1990s but are all located east of the north-northwest trending fault to the east of the proposed wells. The remaining wells show stable water levels or more limited declines.

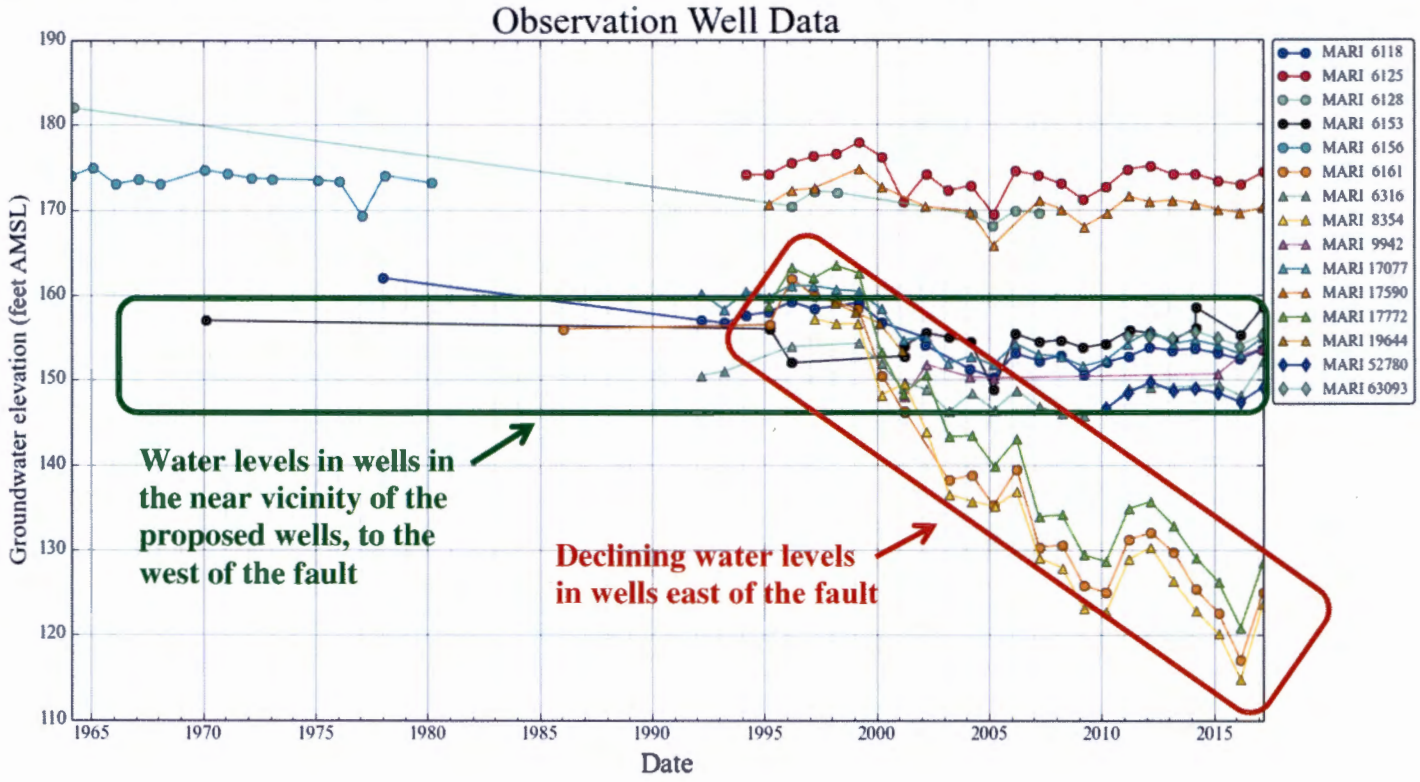
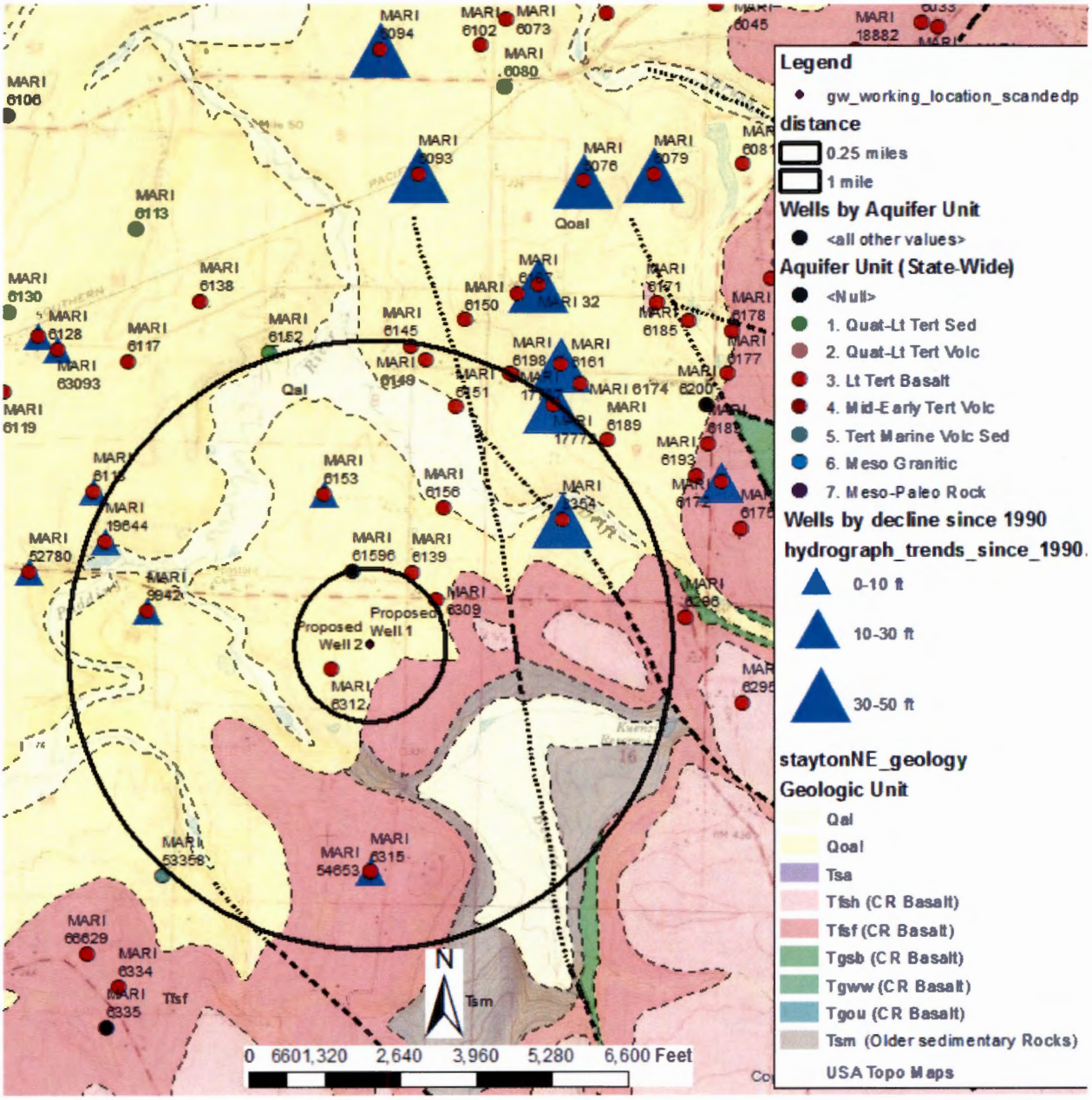


Figure 2: Well Location Map: blue triangles represent declines in water levels since 1990 for well with available data.



Key to faults in map:

- – – contact, inferred
- – – contact, inferred, queried
- ···· fault, concealed
- – – fault, inferred
- — map boundary
- ···· normal fault, concealed
- ···· normal fault, concealedm
- – – normal fault, inferred
- – – normal fault, inferredm