

Groundwater Application Review Summary Form

Application # G- 18430

GW Reviewer Aurora Bouchier Date Review Completed: May 30, 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).

PUBLIC INTEREST REVIEW FOR GROUNDWATER APPLICATIONS

TO: Water Rights Section Date May 30, 2017
 FROM: Groundwater Section Aurora C Bouchier
 SUBJECT: Application G- 18430 Reviewer's Name Aurora C Bouchier
 Supersedes review of na 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: Robert W. Gabriel Trust County: Marion

A1. Applicant(s) seek(s) 0.46 cfs from 3 well(s) in the Willamette Basin,
Middle Willamette subbasin

A2. Proposed use Nursery (18.5 acres) Seasonality: Year round

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	MARI 58798	1	Alluvium	0.45	6S/3W-24 NW-NE	1085' S, 865' E fr N1/4 cor S 24
2	MARI 17269	2	Alluvium	0.45	6S/3W-24 NW-NE	330' S, 1690' E fr SW cor DLC 66
3	Proposed	3	Alluvium	0.45	6S/3W-24 NW-NE	215' S, 1235' E fr N1/4 cor S 24

* 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	173	76	37	4/12/1991	180	0-19	+1-180	Na	110-141	500+		Air
2	171	62	41	3/15/2005	140	0-50	+1-140	Na	110-140	500+		Air
3	169				Est 200	Est 0-50	Est 0-200		TBD			

Use data from application for proposed wells.

A4. **Comments:** Well 1 (MARI 58798) is authorized for a maximum rate of **0.15 cfs under Permit G-16056** for irrigation of 12 acres. This right is in the process of being certified. Well 1 is a proposed for a rate of 0.45 cfs (to be distributed amongst 3 wells) under application G-18294 which is proposed to be approved.

Well 2 (MARI 17269) appears to be the well currently used under **Certificate 83030, for a maximum rate of 0.668 cfs** for nursery uses and irrigation of 18.5 acres. Transfer T-12361 is currently being processed on Cert 83030 to include the three wells listed in this application. It appears that at the permit stage Permit G-10690 authorized used from well MARI 5167, and that at some point after the beginning of 1991 produced moved to well MARI 17269 and that MARI 17269 was the well that was certified. Well 2 is a proposed for a rate of 0.45 cfs (to be distributed amongst 3 wells) under application G-18294 which is proposed to be approved.

Well 2 (MARI 17269) also appears to the well currently used under **GR Claim 3312, for a claimed rate of 120 gpm (0.267 cfs)** for irrigation on 12 acres, 10.3 acres of which are affected by Transfer T-12360. Transfer T-12360 is currently being processed on GR 3312 to include the three wells listed on this application. It appears that the authorized well was MARI 5167. However, an August 16, 2016 email from Greg Kupillas states that the land owner says Well 5167 is no longer in use. Well 3 is a proposed for a rate of 0.45 cfs (to be distributed amongst 3 wells) under application G-18294 which is proposed to be approved.

This groundwater review evaluates a combined rate of 1.995 cfs to account for the stacking of water production from these wells.

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 wells in this application produce from a confined source, so the pertinent basin rules (OAR 690-502-0240) do not apply.

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) 7N, 7T, large water use;
 - 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 alluvial 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. Groundwater availability remarks: _____

The applicant’s wells are located in an area that contains fine-grained sediment (Willamette Silt) from land surface to a depth of approximately 80 feet (Gannett and Caldwell, 1998). A sequence of water-bearing sands and gravels beds with inter-fingered silt and clays beds exist under the silt with a combined thickness of approximately 100-110 feet locally (Gannett and Caldwell, 1998). Beneath this the alluvium becomes dominated by fine-grained material which progressively confines deeper water-bearing zones (Woodward et al., 1998) to a depth of approximately 600 feet below sea level (Gannett and Caldwell, 1998).

Observations from nearby wells indicate relatively stable long-term trends for alluvial wells in the immediate area of the proposed wells (see attached hydrograph), but increased groundwater development in the area indicates a need for additional water-level monitoring. In addition, the stated reason for related Transfer T-12361 is that “Production from the authorized Well 2 (MARI 17269) has decreased over time and no longer completely supplies our needs...” It is possible that the decrease in production is a result of decreased well efficiency. However, this speaks further to the need for additional water-level monitoring.

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	Alluvium	<input checked="" type="checkbox"/>	<input type="checkbox"/>
2	Alluvium	<input checked="" type="checkbox"/>	<input type="checkbox"/>
3	Alluvium	<input checked="" type="checkbox"/>	<input type="checkbox"/>

Basis for aquifer confinement evaluation: A nearby aquifer test indicates a storativity of about 10E-4, which indicates confined conditions (Iverson, 2002). The coarse-grained sediments in the area are confined beneath about 70 to 80 feet of silt and clay (Gannett and Caldwell, 1998). The well logs for MARI 58798 and MARI 17269 both list a static water level above the water-bearing zone at which it was encountered, corroborating the finding of confined conditions.

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?			Potential for Subst. Interfer. Assumed?	
						YES	NO	ASSUMED	YES	NO
1	1	Unnamed trib to Labish Ditch	~120	158	1,430	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
2	1	Unnamed trib to Labish Ditch	~135	169	600	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
3	1	Unnamed trib to Labish Ditch	~120-140	169	75	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
1	2	Clear Lake/Claggett Creek/Labish Ditch	~120	106	8,500	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
2	2	Clear Lake/Claggett Creek/Labish Ditch	~135	106	8,375	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
3	2	Clear Lake/Claggett Creek/Labish Ditch	~120-140	106	9,560	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
1	3	Willamette River	~120	100	18,530	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
2	3	Willamette River	~135	100	18,260	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
3	3	Willamette River	~120-140	100	18,930	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

Basis for aquifer hydraulic connection evaluation: The unnamed tributary to Labish ditch is intermittent within a mile of the applicant's well and likely carries runoff from drain tiles. Water table maps in the area (Woodward and others, 1998, Conlon et al., 2005) indicate that the water table is at an elevation of about 140 feet in the area, which is below the elevation of nearby intermittent stream. Therefore, it is unlikely that surface water is connected to ground water within a mile of the applicant's proposed well. The water level in the wells is greater than the elevation of Clear Lake/Claggett Creek and of the Willamette River, indicating hydraulic connection with the groundwater contributing to the surface water bodies.

Water Availability Basin the well(s) are located within: 182: WILLAMETTE R > COLUMBIA R – AB MOLALLA R

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?
		<input type="checkbox"/>	<input type="checkbox"/>			<input type="checkbox"/>		<input type="checkbox"/>		<input type="checkbox"/>
		<input type="checkbox"/>	<input type="checkbox"/>			<input type="checkbox"/>		<input type="checkbox"/>		<input type="checkbox"/>
		<input type="checkbox"/>	<input type="checkbox"/>			<input type="checkbox"/>		<input type="checkbox"/>		<input type="checkbox"/>

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?
		<input type="checkbox"/>			<input type="checkbox"/>		<input type="checkbox"/>		<input type="checkbox"/>
		<input type="checkbox"/>			<input type="checkbox"/>		<input type="checkbox"/>		<input type="checkbox"/>
		<input type="checkbox"/>			<input type="checkbox"/>		<input type="checkbox"/>		<input type="checkbox"/>
		<input type="checkbox"/>			<input type="checkbox"/>		<input type="checkbox"/>		<input type="checkbox"/>

Comments: There are no hydraulically connected surface water sources within a mile of the wells listed on the application.

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
2	2	0.31 %	0.60 %	0.59 %	0.59 %	0.61 %	0.60 %	0.67 %	0.71 %	0.79 %	0.85 %	0.89 %	1.01 %
Well Q as CFS		1.995	1.995	1.995	1.995	1.995	1.995	1.995	1.995	1.995	1.995	1.995	1.995
Interference CFS		0.006	0.012	0.012	0.012	0.012	0.012	0.013	0.014	0.016	0.017	0.018	0.020
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													
(A) = Total Interf.		0.006	0.012	0.012	0.012	0.012	0.012	0.013	0.014	0.016	0.017	0.018	0.0206
(B) = 80 % Nat. Q		21400	23200	22400	19900	16600	8740	4980	3830	3890	4850	10200	19300
(C) = 1 % Nat. Q													
(D) = (A) > (C)													
(E) = (A / B) x 100		0.000028 %	0.000052 %	0.000054 %	0.000060 %	0.000072 %	0.000137 %	0.000261 %	0.000366 %	0.000411 %	0.000351 %	0.000176 %	0.000107 %

(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:

Interference to Clear Lake at 30 days was estimated using the Hunt 2003 model and the distance between Well 2 and the lake. The Hunt 2003 model simulates a confined aquifer, which is the case at the location of the wells. Where the Willamette Silt has been eroded away (in the meander belt/flood plain of the Willamette River, which includes Clear Lake) it is likely the aquifer is not confined. However, a 3 feet aquitard thickness below the stream was included to represent a streambed clogging layer. Interference from the other wells will be less than this due to their greater distance to Clear Lake.

Interference to the Willamette River at 30 days was not estimated since the distances are even greater than to Clear Lake and therefore interference will be less.

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 large distance between the wells and the hydraulically connected surface water bodies will likely result in an inefficient connection between the wells and the surface water bodies. However, stream depletion will increase over time.

References Used:

Application files: G-18430, G-18294, T-12360, T-12361, and nearby GR-3312, application G-11611, application G-16408.

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

Hunt, B., 2003, Unsteady stream depletion when pumping from semiconfined aquifer: Journal of Hydrologic Engineering, January/February, 2003.

Iverson, J., 2002, Investigation of the hydraulic, physical, and chemical buffering capacity of Missoula Flood deposits for water quality and supply in the Willamette Valley of Oregon: Oregon State University, Unpublished Master's thesis, 147 p.

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, 82p.

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: _____

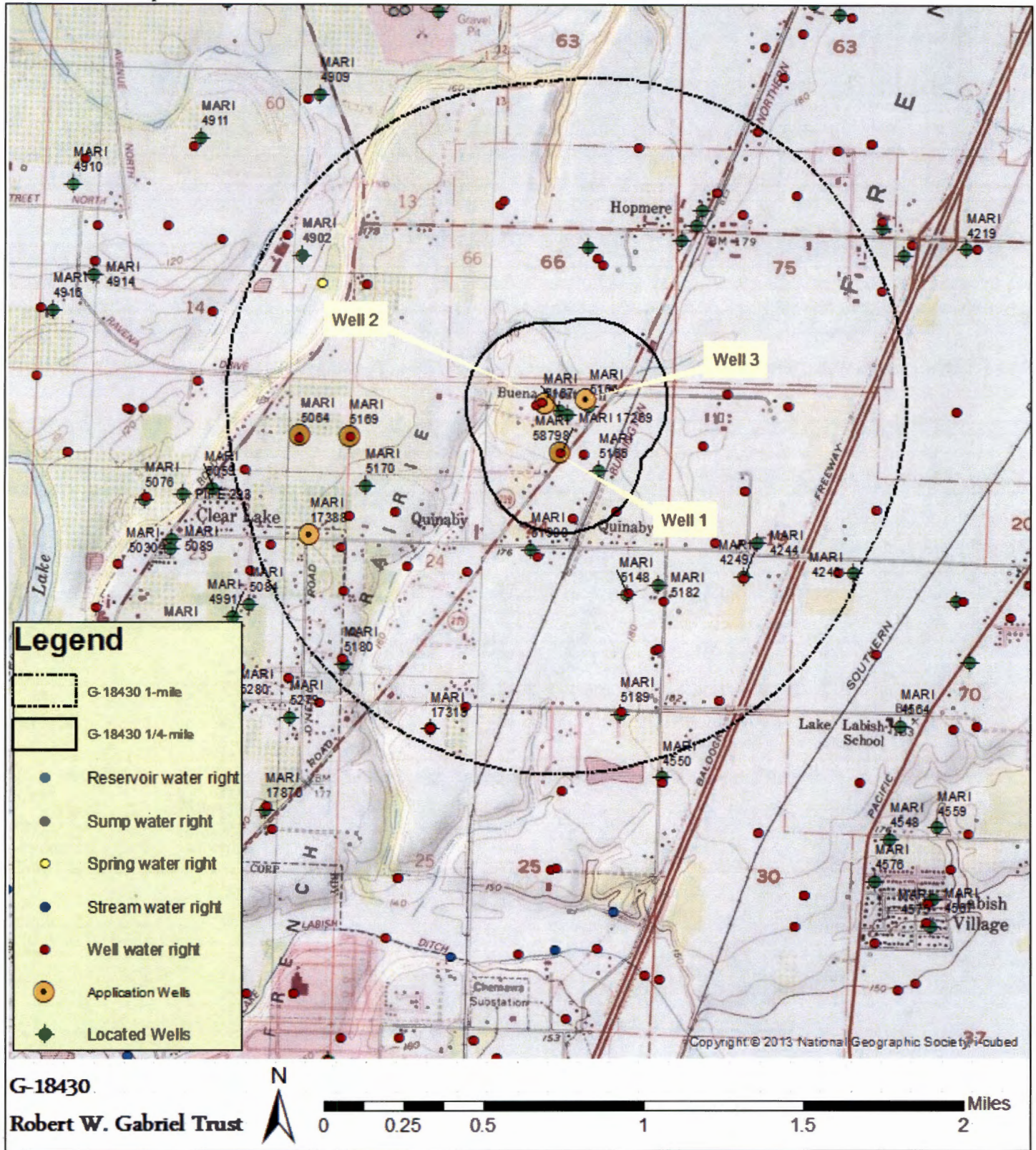
D4. Route to the Well Construction and Compliance Section for a review of existing well construction.

Water Availability Tables

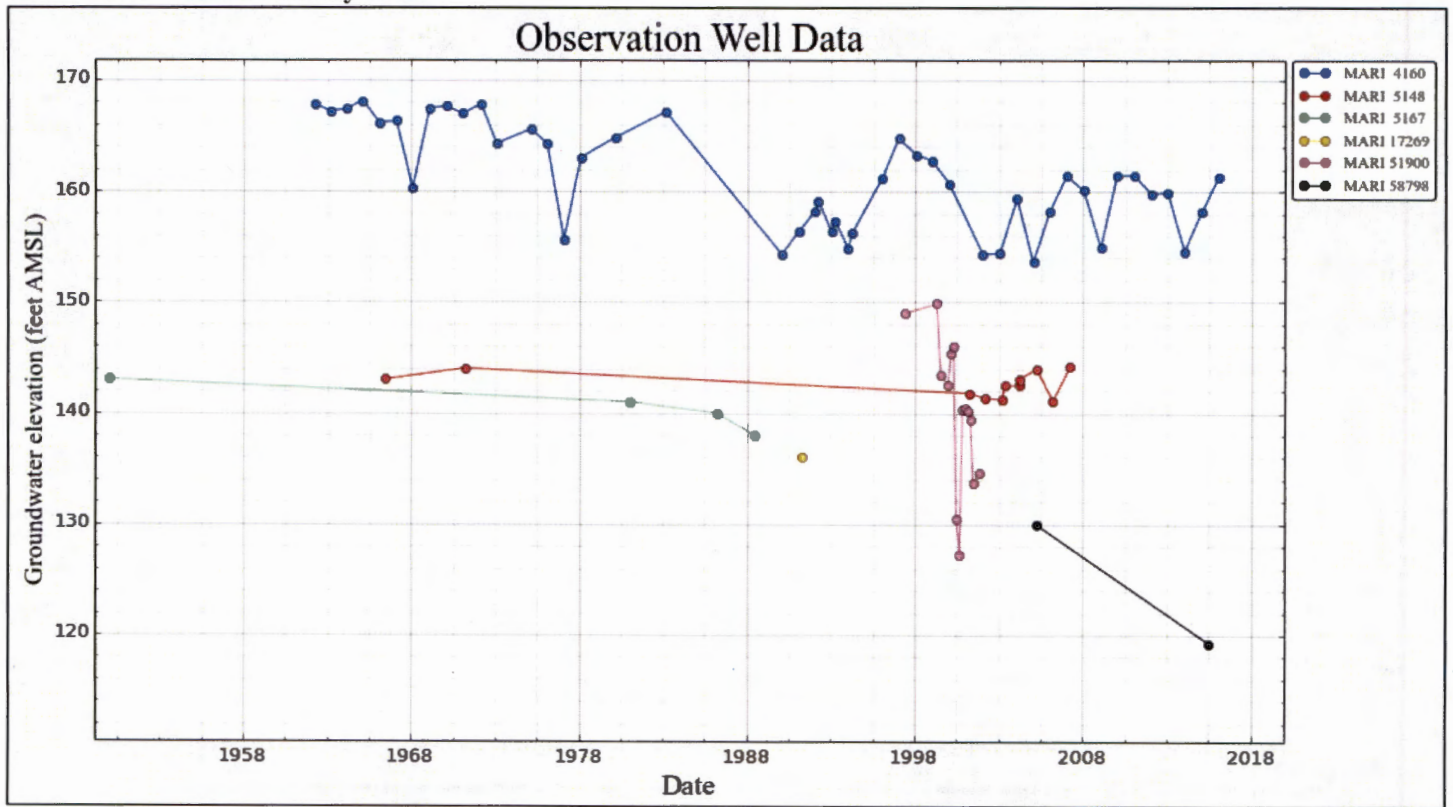
DETAILED REPORT ON THE WATER AVAILABILITY CALCULATION						
Watershed ID #: 182 Time: 11:36 AM		WILLAMETTE R > COLUMBIA R - AB MOLALLA R Basin: WILLAMETTE			Exceedance Level: 80 Date: 05/30/2017	
Month	Natural Stream Flow	Consumptive Use and Storage	Expected Stream Flow	Reserved Stream Flow	Instream Requirements	Net Water Available
Monthly values are in cfs. Storage is the annual amount at 50% exceedance in ac-ft.						
JAN	21,400.00	2,290.00	19,100.00	0.00	1,500.00	17,600.00
FEB	23,200.00	7,480.00	15,700.00	0.00	1,500.00	14,200.00
MAR	22,400.00	7,250.00	15,100.00	0.00	1,500.00	13,600.00
APR	19,900.00	6,910.00	13,000.00	0.00	1,500.00	11,500.00
MAY	16,600.00	4,230.00	12,400.00	0.00	1,500.00	10,900.00
JUN	8,740.00	1,980.00	6,760.00	0.00	1,500.00	5,260.00
JUL	4,980.00	1,800.00	3,180.00	0.00	1,500.00	1,680.00
AUG	3,830.00	1,640.00	2,190.00	0.00	1,500.00	685.00
SEP	3,890.00	1,390.00	2,500.00	0.00	1,500.00	996.00
OCT	4,850.00	748.00	4,100.00	0.00	1,500.00	2,600.00
NOV	10,200.00	882.00	9,320.00	0.00	1,500.00	7,820.00
DEC	19,300.00	964.00	18,300.00	0.00	1,500.00	16,800.00
ANN	15,200,000	2,250,000	13,000,000	0	1,090,000	11,900,000

DETAILED REPORT OF INSTREAM REQUIREMENTS													
Watershed ID #: 182 Time: 11:36 AM		WILLAMETTE R > COLUMBIA R - AB MOLALLA R										Basin: WILLAMETTE Date: 05/30/2017	
Application Number	Status	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Monthly values are in cfs.													
MF182A	APPLICATION	1500.0	1500.0	1500.0	1500.0	1500.0	1500.0	1500.0	1500.0	1500.0	1500.0	1500.0	1500.0
	MAXIMUM	1500.0	1500.0	1500.0	1500.0	1500.0	1500.0	1500.0	1500.0	1500.0	1500.0	1500.0	1500.0

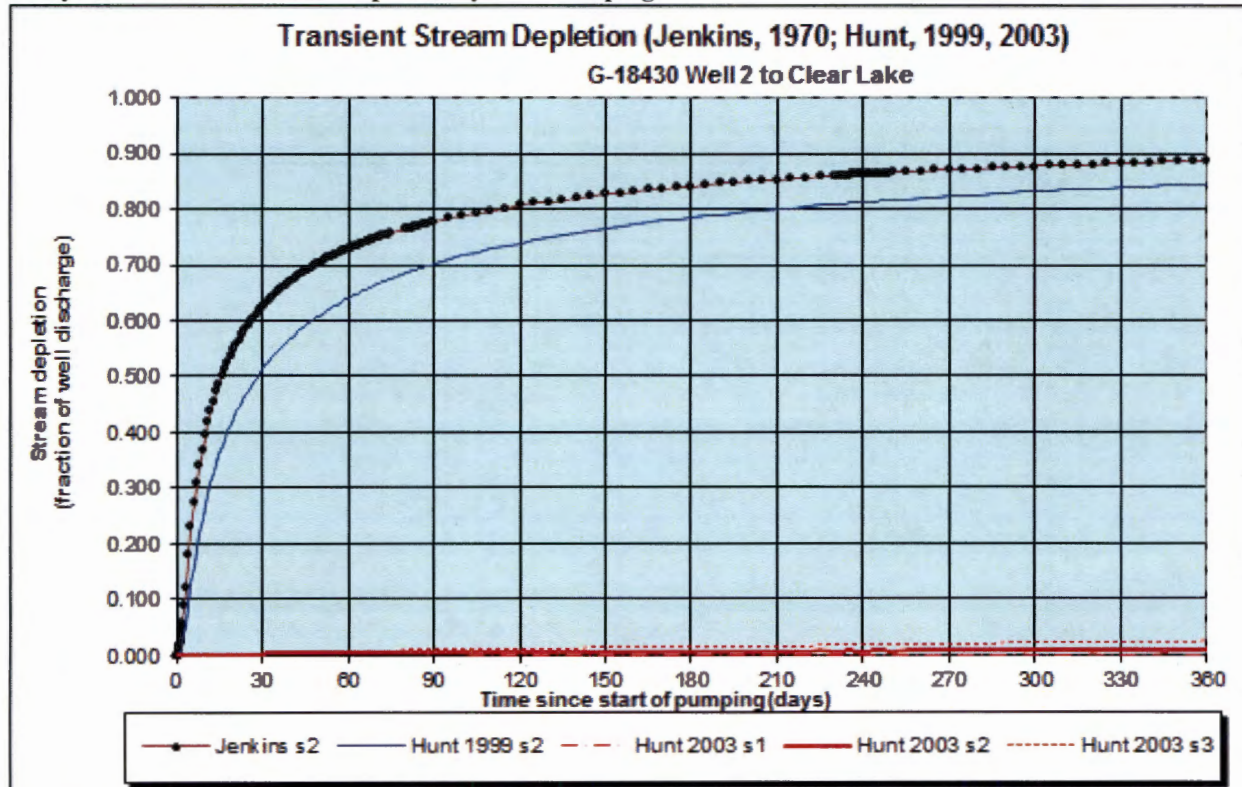
Well Location Map



Water-Level Trends in Nearby Wells



Analytical Model for Stream Depletion by Well Pumping



Output for Stream Depletion, Scenerio 2 (s2):					Time pump on (pumping duration) = 365 days							
Days	30	60	90	120	150	180	210	240	270	300	330	360
J SD	62.4%	72.9%	77.7%	80.6%	82.6%	84.1%	85.3%	86.2%	87.0%	87.7%	88.2%	88.7%
H SD 1999	51.3%	64.0%	70.1%	73.9%	76.5%	78.4%	80.0%	81.2%	82.2%	83.1%	83.8%	84.5%
H SD 2003	0.31%	0.60%	0.59%	0.59%	0.61%	0.60%	0.67%	0.71%	0.79%	0.85%	0.89%	1.01%
Qw, cfs	1.994	1.994	1.994	1.994	1.994	1.994	1.994	1.994	1.994	1.994	1.994	1.994
H SD 99, cfs	1.023	1.277	1.399	1.474	1.526	1.564	1.595	1.619	1.640	1.657	1.672	1.685
H SD 03, cfs	0.006	0.012	0.012	0.012	0.012	0.012	0.013	0.014	0.016	0.017	0.018	0.020

Parameters:		Scenario 1	Scenario 2	Scenario 3	Units
Net steady pumping rate of well	Qw	895.00	895.00	895.00	gpm
Time pump on (pumping duration)	tpon	365	365	365	days
Perpendicular from well to stream	a	8500	8500	8500	ft
Well depth	d	180	180	180	ft
Aquifer hydraulic conductivity	K	25	50	100	ft/day
Aquifer saturated thickness	b	100	100	100	ft
Aquifer transmissivity	T	2500	5000	10000	ft*ft/day
Aquifer storativity or specific yield	S	0.001	0.001	0.001	
Aquitard vertical hydraulic conductivity	Kva	0.1	0.1	0.1	ft/day
Aquitard saturated thickness	ba	30	30	30	ft
Aquitard thickness below stream	babs	3	3	3	ft
Aquitard porosity	n	0.5	0.5	0.5	
Stream width	ws	100	100	100	ft
Streambed conductance (lambda)	sbc	3.333333	3.333333	3.333333	ft/day
Stream depletion factor	sdf	28.900000	14.450000	7.225000	days
Streambed factor	sbf	11.333333	5.666667	2.833333	
input #1 for Hunt's Q_4 function	t'	0.034602	0.069204	0.138408	
input #2 for Hunt's Q_4 function	K'	96.333333	48.166667	24.083333	
input #3 for Hunt's Q_4 function	epsilon'	0.002000	0.002000	0.002000	
input #4 for Hunt's Q_4 function	lamda'	11.333333	5.666667	2.833333	