WATER RESOURCES DEPARTMENT MEMO March 6, 2015

TO: **Application G-** 17917

FROM: K. Wozniak / A. Boucher **- Groundwater Section**

SUBJECT: **Scenic Waterway Interference Evaluation**

_____ YES
✓ NO — The source of appropriation is within or above a Scenic Waterway

_____ YES
✓ NO — Use the Scenic Waterway condition (condition 7J)

_____ Per ORS 390.835, the Groundwater Section is able to calculate groundwater interference with surface water that contributes to a Scenic Waterway. The calculated interference distribution is provided below.

_____ Per ORS 390.835, the Groundwater Section is unable to calculate groundwater interference with surface water that contributes to a scenic waterway; therefore, the Department is unable to find that there is a preponderance of evidence that the proposed use will measurably reduce the surface flows necessary to maintain the free-flowing character of a scenic waterway.

DISTRIBUTION OF INTERFERENCE

Calculate interference as the monthly fraction of the annual consumptive use and fill in the table below. If interference cannot be calculated, per criteria in 390.839, do not fill in the table but check the "unable" option above, thus informing the Water Rights Section that the Department is unable to make a Preponderance of Evidence finding.

Exercise of this permit is calculated to reduce monthly flows in the _____ Scenic Waterway by the following amounts, expressed as a proportion of the annual consumptive use pumped from the well.

Monthly Fraction of Annual Consumptive Use

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

PUBLIC INTEREST REVIEW FOR GROUNDWATER APPLICATIONS

TO: Water Rights Section Date March 6, 2015

FROM: Groundwater Section Karl C. Wozniak / Aurora C. Bouchier
Reviewer's Name

SUBJECT: Application G- 17917 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: Frank Itel and David Itel County: Marion

A1. Applicant(s) seek(s) 1.7 cfs from 1 well(s) in the Willamette Basin, Middle Willamette subbasin Quad Map: Woodburn

A2. Proposed use Irrigation, 135.9 acres Seasonality: March 1 – 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	**MARI 334**	**1**	Alluvium	**1.7**	04S/01W-07 NW/NW	1100' S, 340' E fr NW cor S 7
2						
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	172		47	5/21/1970	212	36	+2 - 212	+1.7 - 72	72-112, 132-140, 152-192			

Use data from application for proposed wells.

A4. **Comments:** The applicants believed they had a supplemental water right to pump from MARI 334 which was constructed in May, 1970. For many years water from the well was used to supplement water from Case Creek. If it is determined that the well interferes with nearby surface waters, the Itels would like to explore the option of cancelling a portion of their existing water right, certificate 30722, in order to offset the interference to surface water.

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 well produces from a confined aquifer and is greater than ¼ miles from a surface water source so the pertinent 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) **7C, 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 _____ 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 area around the proposed well is underlain by about 70 feet of Willamette Silt which is underlain by a sequence of sands and gravels interbedded with silts and clays. The water table occurs near land surface in the Willamette Silt which acts as a regional confining unit. The shallowest sand and gravel beds in the subject well, MARI 334, were logged near the base of the Willamette Silt at depths of 72-107 feet which corresponds to elevations of 75-65 feet. The upper surface of the Willamette Silt forms a broad terrace at an elevation about 170 feet in the surrounding area. Local streams cut progressively through the terrace until they flow into the Willamette River at an elevation of about 55 feet, well below the top of the upper sand and gravel bed in MARI 334. A nearby observation well, MARI 308, shows no obvious declines over the period of record from 1960-2016. This suggests that alluvial aquifer groundwater levels are stable in the area. Seasonal groundwater-levels fluctuate 60-80 feet in the surrounding area in response to widespread irrigation pumping from the confined alluvial aquifer below the Willamette Silt. Anecdotal reports from local farmers and nearby interference complaints suggest that seasonal fluctuations are beginning to affect late summer well yields in the area. This suggests that the groundwater resource is probably close to being over appropriated. The subject well appears to have been used regularly since it was drilled in 1970 so its use has contributed to the current range of seasonal fluctuations. If future use under a permit does not exceed past use, a new permit is unlikely to increase seasonal fluctuations.

Because the productive sand and gravel beds are confined, the cone of depression from the well will spread over a broad area and interact with multiple streams. In most areas south of the well, more than 20 feet of saturated Willamette Silt occurs between local streambeds and the productive sand and gravel beds at depth. These fine-grained sediments will decrease the efficiency of the groundwater/surface water connection in those areas. However, to the north, local streams cut to deeper levels that are equivalent in elevation to the sand and gravel beds found from 72-107 ft in MARI 334. In these areas, the groundwater/surface water connection is expected to be more efficient.

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**	☒	☐
		☐	☐
		☐	☐
		☐	☐
		☐	☐

Basis for aquifer confinement evaluation: Published reports indicate that the Willamette Silt is a regional confining unit which hosts the water table at shallow depths. This is consistent with information on the well log for MARI 334 which shows a static water level many feet above the top of the first productive sand at 72 feet.

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	**Yergen/Ryan Creek**	**117**	**55-130**	**2350**	☒	☐	☐	☐	☒
1	2	**Case/Champoeg Creek**	**117**	**55-80**	**3500**	☒	☐	☐	☐	☒
1	3	**Willamette River**	**117**	**55**	**3700**	☒	☐	☐	☐	☒
						☐	☐	☐	☐	☐
						☐	☐	☐	☐	☐
						☐	☐	☐	☐	☐
						☐	☐	☐	☐	☐

Basis for aquifer hydraulic connection evaluation: Published water table maps and reports indicate that groundwater flows toward and discharges into local perennial streams.

Water Availability Basin the well(s) are located within: **The well is in WAB** 182 (Willamette R> Columbia R- AB Molalla R) but pumping will impact Case and Champoeg Creeks which are in WAB30200708 (Champoeg Cr> Willamette R – at mouth). Therefore, the well was evaluated against both WABs.

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?
1	**1**	☐	☐			☐	**3830.00**	☐	**6**	☐
1	**2**	☐	☐			☐	**1.00**	☒	**5**	☒
1	**3**	☐	☐	**MF182**	**1500**	☐	**3830.00**	☐	**16**	☐
		☐	☐			☐		☐		☐
		☐	☐			☐		☐		☐

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:

Interference with nearby streams was estimated using the Hunt 2003 model in order to account for the widespread occurrence of the Willamette Silt confining layer throughout most of the area. Yerger and Ryan Creeks were treated as a single stream at an average distance of 2350 ft from the well. Similarly, Case and Champoeg Creeks were treated as a single stream in the model at an average distance of 3500 feet. Although the Willamette Silt appears to be completely incised by these streams north of the well, a 0.5 foot confining layer was modeled between the stream and the aquifer to account for the presence of fine-grained materials in the streambed. This is consistent with the low-flow characteristics of these streams and field inspections of Case Creek in the mid-1990s. A confining layer of about 5 feet was assumed at the base of the Willamette River based on the presence of clays at the same elevation in MARI 334. Model results indicate interferences of 6% for Yergen/Ryan Creek, 5% for Case/Champoeg Creek, and 16% for the Willamette River after 30 days of pumping. This suggests that only about 19% of the total pumping impacts are realized in the Champoeg Creek WAB (5% of a total of 27% impacts at 30 days). In addition, the model results suggest that the maximum monthly impacts are about 0.1 cfs during the first year of pumping. Long-term steady-state monthly impacts will be somewhat higher.

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													
(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: Impacts to streams beyond 1 mile were not estimated as most impacts are likely to be to the local stream network.

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** Most of the impacts to the Champoeg WAB are likely to occur north of the well where Champoeg and Case Creeks are incised to the level of the productive zone in MARI 334.

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, Marshall W., and Caldwell, Rodney R., 1998, Geologic Framework of the Willamette Lowland Aquifer System, Oregon and Washington: U. S. Geological Survey Professional Paper 1424-A.

Herrera, N.B., Burns, E.R., and Conlon, T.D., 2014, Simulation of groundwater flow and the interaction of groundwater and surface water in the Willamette Basin and Central Willamette subbasin, Oregon: U.S. Geological Survey Scientific Investigations Report 2014–5136, 152 p., *http://dx.doi.org/10.3133/sir20145136*.

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: Unpublished M.S. thesis, Oregon State University, 147 p.

Woodward, Dennis BG., Gannett, Marshall W., and Vaccaro, John J., 1998 Hydrogeologic Framework of the Willamette Lowland Aquifer System, Oregon and Washington: U. S. Geological Survey Professional Paper 1424-B.

D. WELL CONSTRUCTION, OAR 690-200

D1. **Well #:** 1 **Logid:** MARI 334

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:** The well has a 6-inch gravel feed tube installed from land surface to 72 feet. I don't think that this meets our current well construction standards.

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

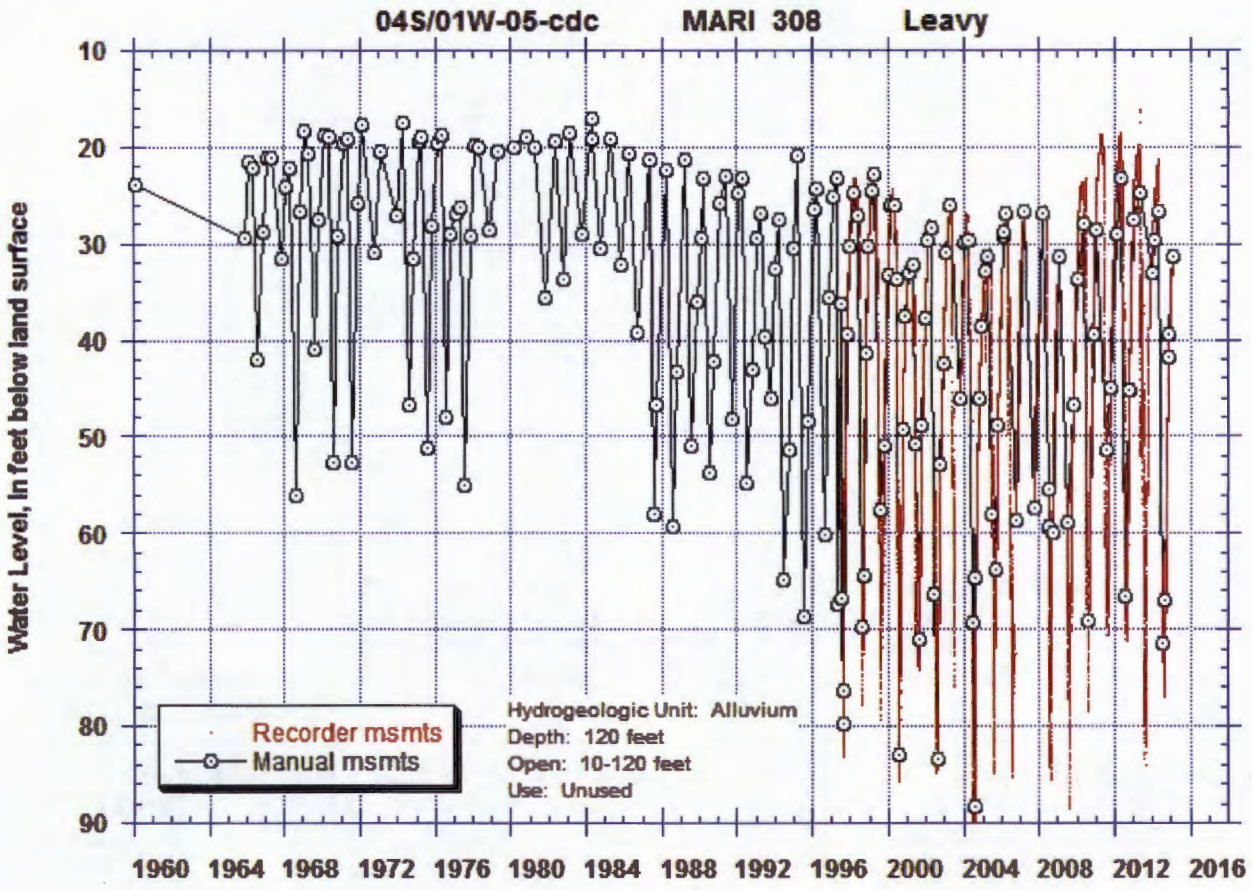
WILLAMETTE R > COLUMBIA R - AB MOLALLA R
Watershed ID #: 182 Basin: WILLAMETTE Exceedance Level: 80
Time: 2:56 PM Date: 03/05/2015

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	7,470.00	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	1,650.00	2,180.00	0.00	1,500.00	683.00
SEP	3,890.00	1,400.00	2,490.00	0.00	1,500.00	993.00
OCT	4,850.00	750.00	4,100.00	0.00	1,500.00	2,600.00
NOV	10,200.00	880.00	9,320.00	0.00	1,500.00	7,820.00
DEC	19,300.00	961.00	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 ON THE WATER AVAILABILITY CALCULATION
Water Availability as of 3/11/2005 for
CHAMPOEG CR > WILLAMETTE R - AT MOUTH
Watershed ID #: 30200708 Basin: WILLAMETTE Exceedance Level: 80
Time: 08:37 Date: 03/11/2005

Month	Natural Stream Flow	CU + Stor Prior to 1/1/93	CU + Stor After 1/1/93	Expected Stream Flow	Reserved Stream Flow	Instream Water Rights	Net Water Available
1	37.30	6.59	0.00	30.70	0.00	0.00	30.70
2	51.70	6.11	0.00	45.60	0.00	0.00	45.60
3	22.40	3.06	0.00	19.30	0.00	0.00	19.30
4	10.90	1.88	0.00	9.02	0.00	0.00	9.02
5	6.15	3.87	0.00	2.28	0.00	0.00	2.28
6	3.04	6.45	0.00	-3.41	0.00	0.00	-3.41
7	2.94	10.60	0.00	-7.65	0.00	0.00	-7.65
8	1.88	8.41	0.00	-6.53	0.00	0.00	-6.53
9	1.08	4.11	0.00	-3.03	0.00	0.00	-3.03
10	1.00	0.30	0.00	0.70	0.00	0.00	0.70
11	10.10	3.74	0.00	6.36	0.00	0.00	6.36
12	47.80	9.46	0.00	38.30	0.00	0.00	38.30
Stor	28100	3910	0	25100	0	0	25100

Water Level Trends

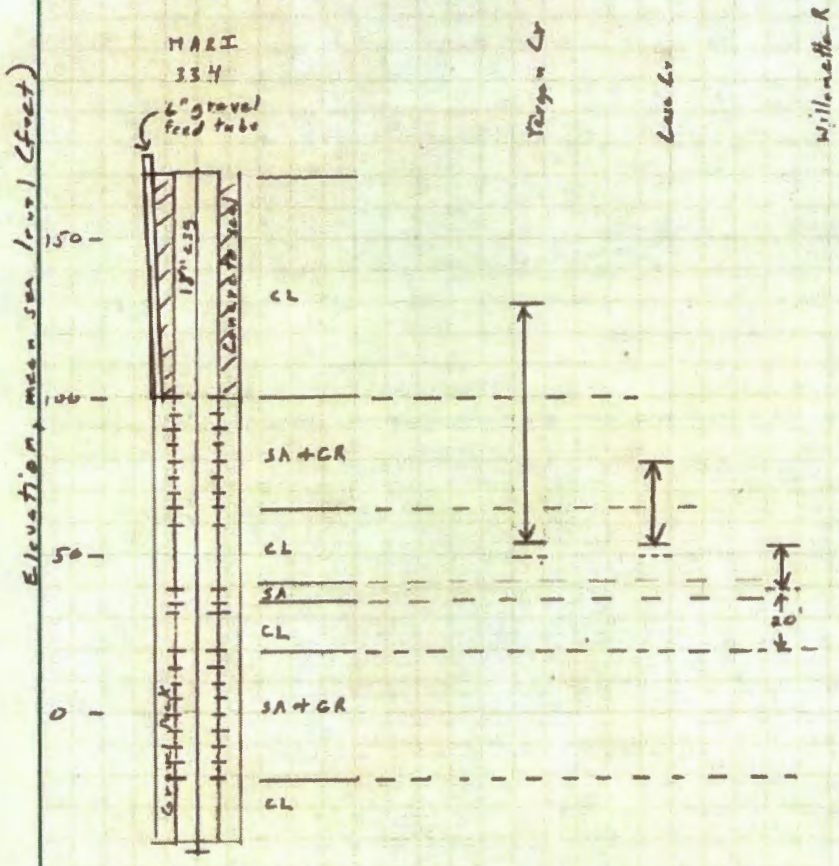


Elevation Profile for Well and Local Streams

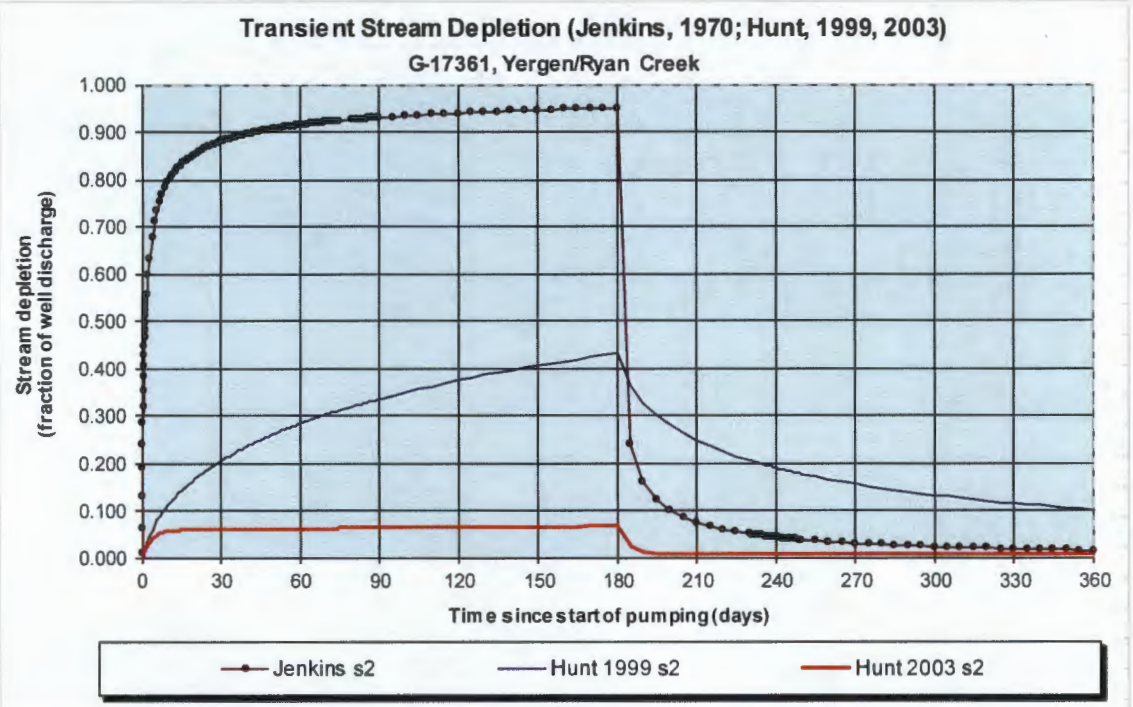
G-17917 Itel

	Distance	SW Elevation	Width	Average Distance
Yergen/Ryan Creek	1380	55-130	10	2350
Lost/Champoeg Cr	2600	55-80	10	3500
Willamette R	3700	55	500	3700

Relative Elevation Profiles

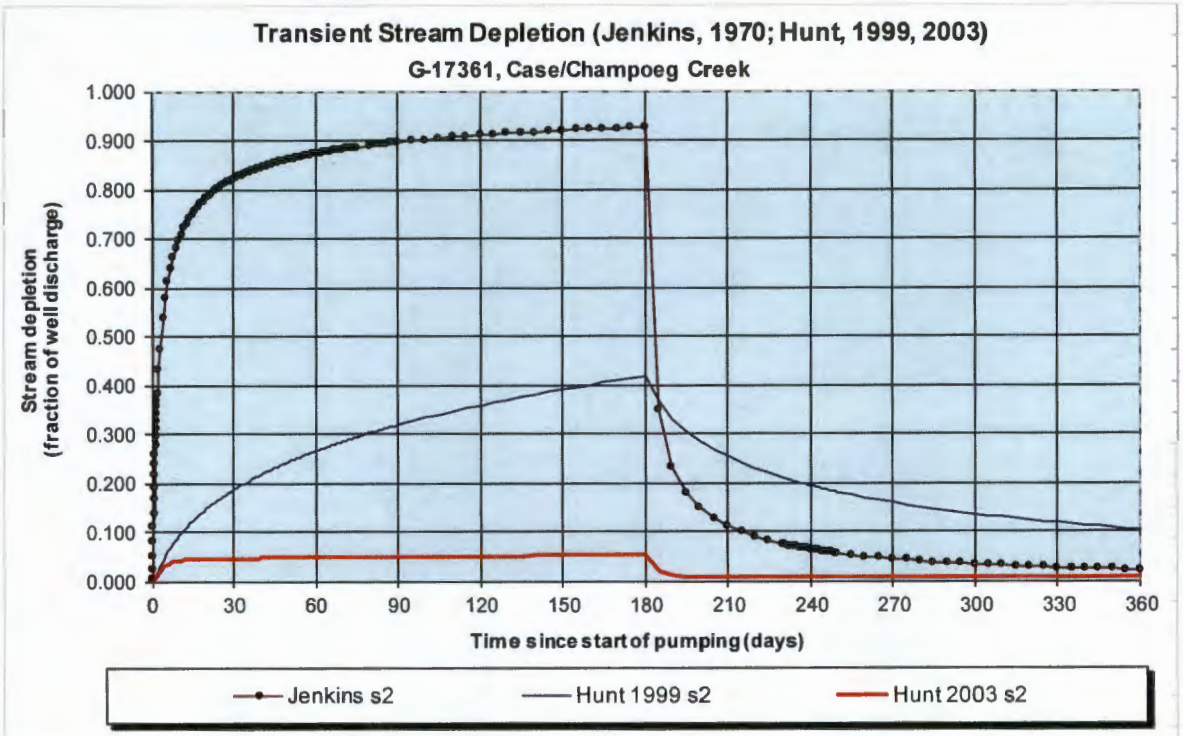


Stream Depletion Model Results



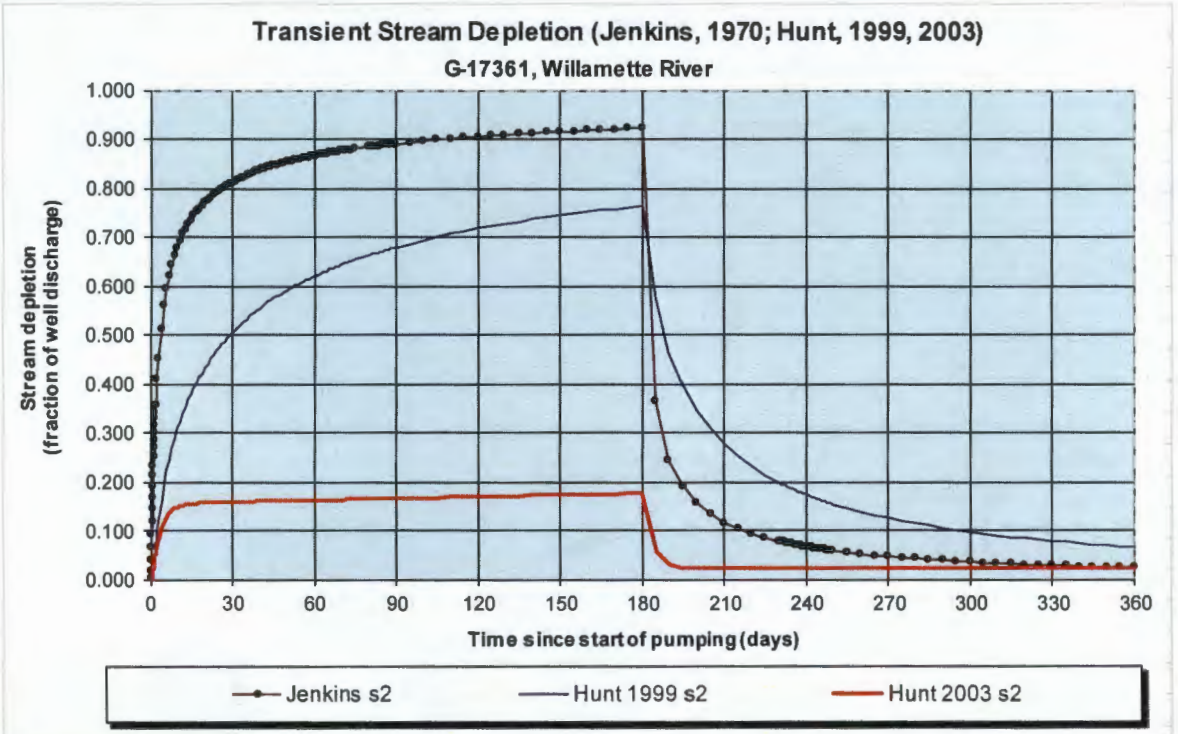
Output for Stream Depletion, Scenerio 2 (s2):						Time pump on (pumping duration) = 180 days						
Days	30	60	90	120	150	180	210	240	270	300	330	360
J SD	87.9%	91.5%	93.0%	94.0%	94.6%	95.1%	7.5%	4.3%	2.9%	2.2%	1.8%	1.4%
H SD 1999	20.5%	28.3%	33.5%	37.4%	40.5%	43.1%	24.9%	19.0%	15.5%	13.2%	11.4%	10.1%
H SD 2003	6.04%	6.17%	6.29%	6.41%	6.54%	6.66%	0.74%	0.73%	0.73%	0.72%	0.72%	0.71%
Qw, cfs	1.700	1.700	1.700	1.700	1.700	1.700	1.700	1.700	1.700	1.700	1.700	1.700
H SD 99, cfs	0.349	0.481	0.569	0.636	0.689	0.733	0.423	0.323	0.264	0.224	0.194	0.172
H SD 03, cfs	0.103	0.105	0.107	0.109	0.111	0.113	0.013	0.012	0.012	0.012	0.012	0.012

Parameters:		Scenario 1	Scenario 2	Scenario 3	Units
Net steady pumping rate of well	Qw	1.70	1.70	1.70	cfs
Time pump on (pumping duration)	tpon	180	180	180	days
Perpendicular from well to stream	a	2350	2350	2350	ft
Well depth	d	215	215	215	ft
Aquifer hydraulic conductivity	K	50	50	50	ft/day
Aquifer saturated thickness	b	80	80	80	ft
Aquifer transmissivity	T	4000	4000	4000	ft*ft/day
Aquifer storativity or specific yield	S	0.001	0.001	0.001	
Aquitard vertical hydraulic conductivity	Kva	0.01	0.01	0.01	ft/day
Aquitard saturated thickness	ba	50	50	50	ft
Aquitard thickness below stream	babs	0.5	0.5	0.5	ft
Aquitard porosity	n	0.2	0.2	0.2	
Stream width	ws	10	10	10	ft
Streambed conductance (lambda)	sbc	0.200000	0.200000	0.200000	ft/day
Stream depletion factor	sdf	1.380625	1.380625	1.380625	days
Streambed factor	sbf	0.117500	0.117500	0.117500	
input #1 for Hunt's Q_4 function	t'	0.724310	0.724310	0.724310	
input #2 for Hunt's Q_4 function	K'	0.276125	0.276125	0.276125	
input #3 for Hunt's Q_4 function	epsilon'	0.005000	0.005000	0.005000	
input #4 for Hunt's Q_4 function	lamda'	0.117500	0.117500	0.117500	



Output for Stream Depletion, Scenerio 2 (s2):						Time pump on (pumping duration) = 180 days						
Days	30	60	90	120	150	180	210	240	270	300	330	360
J SD	82.1%	87.3%	89.6%	91.0%	92.0%	92.7%	11.1%	6.3%	4.4%	3.3%	2.6%	2.1%
H SD 1999	18.6%	26.5%	31.8%	35.8%	39.0%	41.7%	25.3%	19.4%	15.9%	13.5%	11.7%	10.3%
H SD 2003	4.68%	4.80%	4.91%	5.02%	5.14%	5.25%	0.68%	0.67%	0.67%	0.67%	0.66%	0.66%
Qw, cfs	1.700	1.700	1.700	1.700	1.700	1.700	1.700	1.700	1.700	1.700	1.700	1.700
H SD 99, cfs	0.317	0.451	0.541	0.608	0.663	0.708	0.430	0.330	0.270	0.229	0.199	0.176
H SD 03, cfs	0.080	0.082	0.083	0.085	0.087	0.089	0.012	0.011	0.011	0.011	0.011	0.011

Parameters:		Scenario 1	Scenario 2	Scenario 3	Units
Net steady pumping rate of well	Qw	1.70	1.70	1.70	cfs
Time pump on (pumping duration)	tpon	180	180	180	days
Perpendicular from well to stream	a	3500	3500	3500	ft
Well depth	d	215	215	215	ft
Aquifer hydraulic conductivity	K	50	50	50	ft/day
Aquifer saturated thickness	b	80	80	80	ft
Aquifer transmissivity	T	4000	4000	4000	ft*ft/day
Aquifer storativity or specific yield	S	0.001	0.001	0.001	
Aquitard vertical hydraulic conductivity	Kva	0.01	0.01	0.01	ft/day
Aquitard saturated thickness	ba	50	50	50	ft
Aquitard thickness below stream	babs	0.5	0.5	0.5	ft
Aquitard porosity	n	0.2	0.2	0.2	
Stream width	ws	10	10	10	ft
Streambed conductance (lambda)	sbc	0.200000	0.200000	0.200000	ft/day
Stream depletion factor	sdf	3.062500	3.062500	3.062500	days
Streambed factor	sbf	0.175000	0.175000	0.175000	
input #1 for Hunt's Q_4 function	t'	0.326531	0.326531	0.326531	
input #2 for Hunt's Q_4 function	K'	0.612500	0.612500	0.612500	
input #3 for Hunt's Q_4 function	epsilon'	0.005000	0.005000	0.005000	
input #4 for Hunt's Q_4 function	lamda'	0.175000	0.175000	0.175000	



Output for Stream Depletion, Scenerio 2 (s2):	Time pump on (pumping duration) = 180 days											
Days	30	60	90	120	150	180	210	240	270	300	330	360
J SD	81.1%	86.6%	89.0%	90.5%	91.5%	92.2%	11.7%	6.7%	4.6%	3.5%	2.8%	2.3%
H SD 1999	50.5%	62.0%	67.9%	71.7%	74.4%	76.4%	27.6%	17.4%	12.5%	9.7%	7.8%	6.5%
H SD 2003	15.94%	16.28%	16.62%	16.96%	17.31%	17.66%	2.09%	2.12%	2.17%	2.22%	2.29%	2.35%
Qw, cfs	1.700	1.700	1.700	1.700	1.700	1.700	1.700	1.700	1.700	1.700	1.700	1.700
H SD 99, cfs	0.858	1.054	1.155	1.219	1.265	1.299	0.469	0.295	0.213	0.165	0.133	0.110
H SD 03, cfs	0.271	0.277	0.283	0.288	0.294	0.300	0.036	0.036	0.037	0.038	0.039	0.040

Parameters:		Scenario 1	Scenario 2	Scenario 3	Units
Net steady pumping rate of well	Qw	1.70	1.70	1.70	cfs
Time pump on (pumping duration)	tpon	180	180	180	days
Perpendicular from well to stream	a	3700	3700	3700	ft
Well depth	d	215	215	215	ft
Aquifer hydraulic conductivity	K	50	50	50	ft/day
Aquifer saturated thickness	b	80	80	80	ft
Aquifer transmissivity	T	4000	4000	4000	ft*ft/day
Aquifer storativity or specific yield	S	0.001	0.001	0.001	
Aquitard vertical hydraulic conductivity	Kva	0.01	0.01	0.01	ft/day
Aquitard saturated thickness	ba	50	50	50	ft
Aquitard thickness below stream	babs	5	5	5	ft
Aquitard porosity	n	0.2	0.2	0.2	
Stream width	ws	500	500	500	ft
Streambed conductance (lambda)	sbc	1.000000	1.000000	1.000000	ft/day
Stream depletion factor	sdf	3.422500	3.422500	3.422500	days
Streambed factor	sbf	0.925000	0.925000	0.925000	
input #1 for Hunt's Q_4 function	t'	0.292184	0.292184	0.292184	
input #2 for Hunt's Q_4 function	K'	0.684500	0.684500	0.684500	
input #3 for Hunt's Q_4 function	epsilon'	0.005000	0.005000	0.005000	
input #4 for Hunt's Q_4 function	lamda'	0.925000	0.925000	0.925000	

Application Review Map