PUBLIC INTEREST REVIEW FOR GROUNDWATER APPLICATIONS

TO: Water Rights Section Date **May 5, 2015**

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

SUBJECT: Application G- **17956** 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: **Paul Zehr** County: **Linn**

A1. Applicant(s) seek(s) **3.01** cfs from **3** well(s) in the **Willamette** Basin, **Upper Willamette** subbasin

A2. Proposed use **irrigation of 240.7 total 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	Proposed	1	Alluvium	1.958	T13S/R3W-S35 NW-SE	1460' N, 3360' E fr SW cor S 35
2	Proposed	2	Alluvium	1.958	T13S/R3W-S35 NW-SW	1550' N, 570' E fr SW cor S 35
3	Proposed	3	Alluvium	1.05	T14S/R4W-S11 SE-NE	1940' S, 70' W fr NE cor S 11

* 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	308 +/- 5		~5		80-100					**879**		
2	302 +/- 5		~5		80-100					**879**		
3	285 +/- 5		~10		80-100					**471**		

Use data from application for proposed wells.

A4. **Comments:** The proposed use is irrigation of two parcels which are separated by approximately five miles. The parcels are adjacent to different streams and located in different Water Availability Basins. The application has checked that for each parcel the water will be Diverted, Conveyed, and Used. Given the distance between the parcels and their location in different basins, for the purpose of this review it is assumed that water from wells 1 & 2 will be used on the parcel in which they are proposed, and that water from well 3 will be used on the parcel in which it is proposed. As the application does not distribute the rate between wells 1 & 2, this review analyzes the full rate for that parcel at either well. The estimated static water levels are based upon nearby well logs and published water table maps (Woodward et al., 1998).

Proposed wells 1 & 2 are located in tax lot 400, which is 156.7 acres in size. The maximum rate we will allow from wells 1 & 2 is 156.7 acres * 1/80 cfs per acres = 1.958 cfs (879 gpm).

Proposed well 3 is located on tax lot 202 which is 84 acres in size. The maximum rate we will allow from well 3 is 84 acres * 1/80 cfs per acres = 1.05 cfs (471 gpm).

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 proposed wells will be greater than ¼ mile from surface water sources, 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 proposed wells 1 & 2 is likely underlain by <10 feet of Willamette Silt which is underlain by a series of sand and gravel beds interbedded with silts and clays (Gannett and Caldwell, 1998). Well logs for nearby wells (LINN 11981 and LINN 13545) suggest that there are no continuous confining layers in the area. The gravely nature of the Calapooia River bed west of Brownsville (personal communication with watermaster Michael Mattick, 4/28/2015) also suggests that there is no extensive confining layer between the bed of the stream and the aquifer.

The area around proposed well 3 is underlain by approximately 10-20 feet of Willamette Silt which is underlain by a series of sand and gravel beds interbedded with silts and clays (Gannett and Caldwell, 1998). The water table occurs near land surface in the Willamette Silt which acts as an extensive confining unit.

Nearby observation wells, including LINN 13576 (~4 miles SW of proposed wells 1 &2, and ~2 miles SE of proposed well 3), suggest that groundwater levels are reasonably stable in this area. Due to uncertainties regarding the stability of the resource, annual water level measurements are recommended (permit condition 7C) to assess the health of the groundwater system over time.

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**	☒	☐
2	**Alluvium**	☒	☐
3	**Alluvium**	☒	☐
		☐	☐
		☐	☐

Basis for aquifer confinement evaluation: Regarding the area around wells 1 & 2, static water levels in nearby well logs (LINN 11981 and LINN 13545) are above the depth at which water was first encountered when constructing the well, indicating the aquifer is at least locally confined.

Regarding the area around well 3, published reports show the alluvial aquifer as being confined by the overlying Willamette Silt. Further, measured static water levels in nearby well logs (LINN 52584, LINN 59755, and LINN 13545) are above the depth at which water was first encountered when constructing the well, corroborating the confined nature of the aquifer.

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**	**Calapooia River**	**~300**	**290-307**	**2,650**	☒	☐	☐	☐	☒
2	**1**	**Calapooia River**	**~295**	**290-307**	**4,580**	☒	☐	☐	☐	☒
3	**2**	**Muddy Creek**	**~270**	**260-270**	**1,950**	☒	☐	☐	☐	☒
						☐	☐	☐	☐	☐

Basis for aquifer hydraulic connection evaluation: Published water table maps show that groundwater flows towards, and discharges into, perennial streams and their tributaries (Woodward et al., 1998).

Water Availability Basin the well(s) are located within: 76 (Calapooia R> Willamette R – ab mouth) for proposed wells 1 & 2, and 30200303 (Muddy Cr> E channel – at mouth) for well 3.

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**	☐	☐	**MF76A**	**20.0**	☒	**22.70**	☒	**20%**	☒
2	**1**	☐	☐	**MF76A**	**20.0**	☒	**22.70**	☒	**4%**	☒
3	**2**	☐	☐	**na**	**na**	☐	**14.90**	☒	**4%**	☒
		☐	☐			☐		☐		☐

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: For wells 1 & 2, the stream depletion at 30 days was estimated using the Hunt 1999 model. The discontinuous nature of any potential confining beds likely results in an efficient hydraulic connection between the aquifer and the Calapooia River.

For well 3, the stream depletion at 30 days was estimated using the Hunt 2003 model. The presence of low permeability Willamette Silt between the aquifer and the beds of the streams result in an inefficient connection between the aquifer and the streams. Therefore, the stream depletion at 30 days is < 25%.

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													

(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:**

References Used:

Conlon, T. D., Wozniak, K. C., Woodcock, D., Herrera, N.B., Fischer, 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.

Herra, 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. Geologcal Survey Scientific Investigations Report 2014-5136, 152 p., http//dx.doi.org/10.3133/sir20155136.

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

Hunt, B., 1999, Unsteady stream depletion from ground water pumping: Ground Water, v. 37, no. 1, p. 98-102.

Woodward, Dennis G., 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.

Nearby well logs and water level data, especially LINN 11981, LINN 13545, LINN 59755, LINN 52584, LINN 13760, LINN 13530 and LINN 13576.

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

CALAPOOIA R > WILLAMETTE R - AB MOUTH

Watershed ID #: 76 Basin: WILLAMETTE Exceedance Level: 80
Time: 2:01 PM Date: 04/27/2015

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	592.00	2.90	589.00	0.00	20.00	569.00
FEB	650.00	2.85	647.00	0.00	20.00	627.00
MAR	575.00	2.16	573.00	0.00	20.00	553.00
APR	423.00	1.84	421.00	0.00	20.00	401.00
MAY	234.00	6.84	227.00	0.00	20.00	207.00
JUN	111.00	12.50	98.50	0.00	20.00	78.50
JUL	49.00	19.30	29.70	0.00	20.00	9.69
AUG	26.00	13.80	12.20	0.00	20.00	-7.82
SEP	22.70	7.25	15.40	0.00	20.00	-4.55
OCT	29.60	1.38	28.20	0.00	20.00	8.22
NOV	133.00	1.89	131.00	0.00	20.00	111.00
DEC	499.00	2.86	496.00	0.00	20.00	476.00
ANN	404,000	4,580	399,000	0	14,500	385,000

DETAILED REPORT ON THE WATER AVAILABILITY CALCULATION

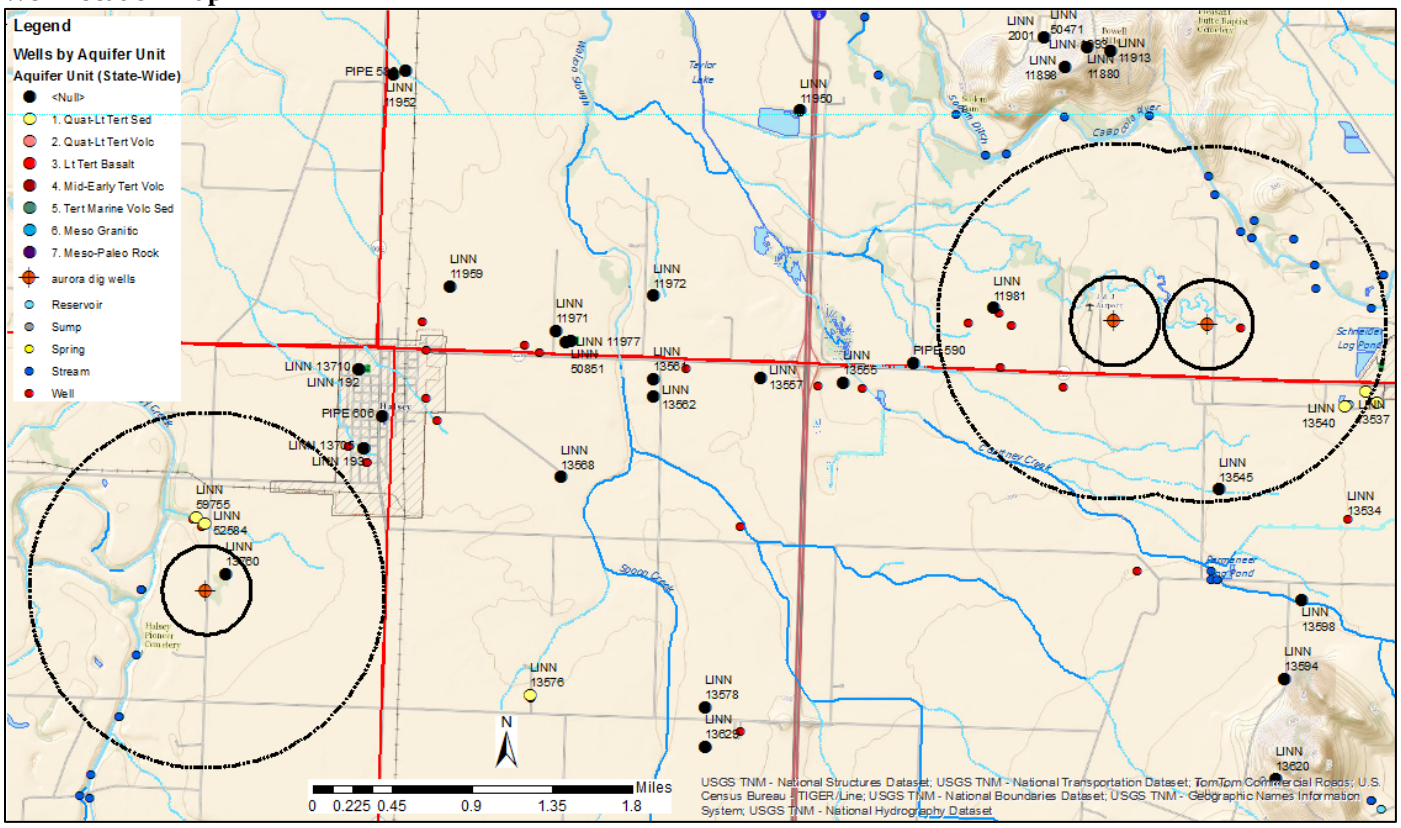
MUDDY CR > E CHANNEL - AT MOUTH

Watershed ID #: 30200303 Basin: WILLAMETTE Exceedance Level: 80
Time: 2:03 PM Date: 04/27/2015

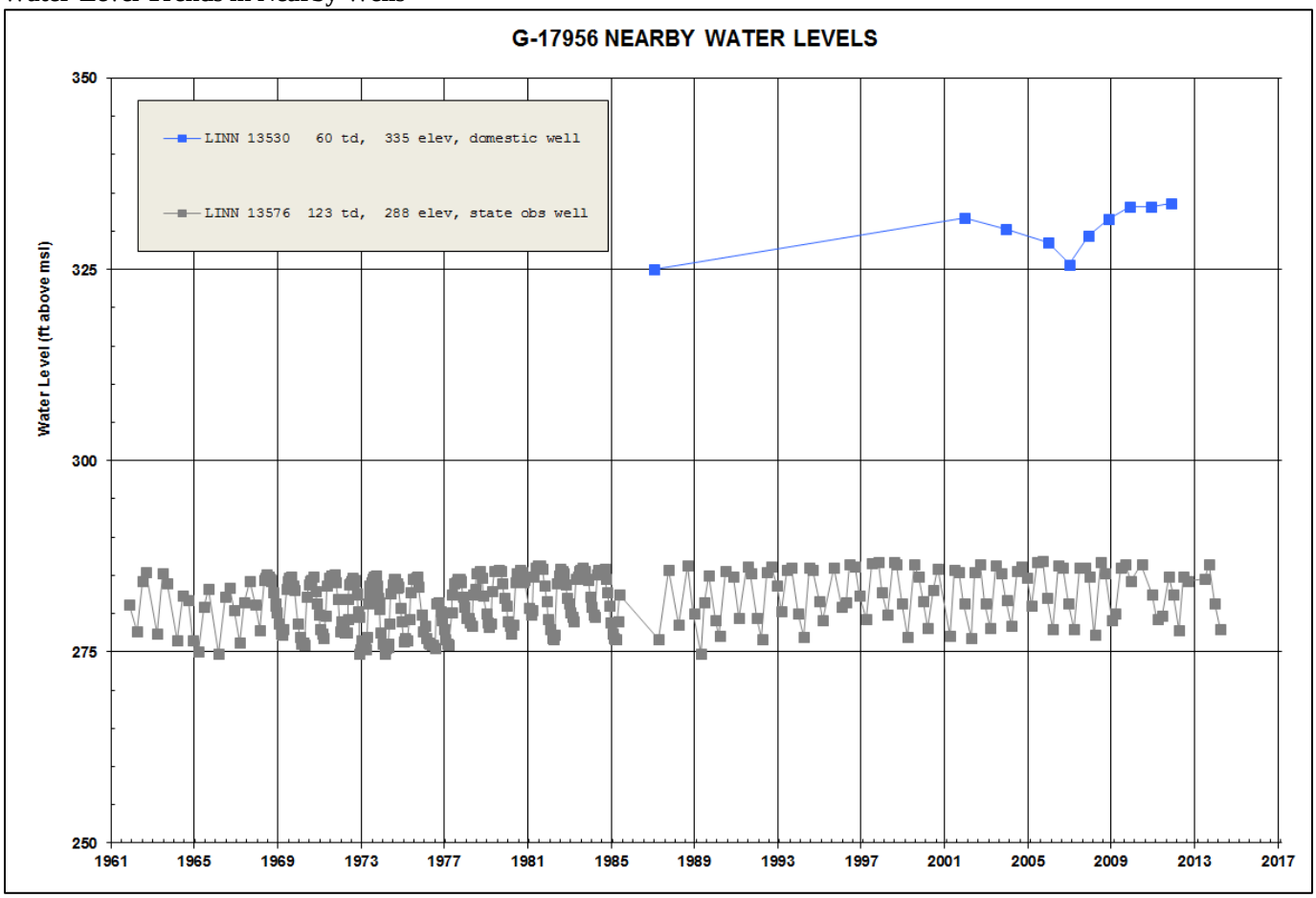
Monthly values are in cfs.
Storage is the annual amount at 50% exceedance in ac-ft.

Month	Natural Stream Flow	Consumptive Use and Storage	Expected Stream Flow	Reserved Stream Flow	Instream Requirements	Net Water Available
JAN	178.00	0.43	178.00	0.00	0.00	178.00
FEB	203.00	0.39	203.00	0.00	0.00	203.00
MAR	174.00	0.32	174.00	0.00	0.00	174.00
APR	91.30	0.32	91.00	0.00	0.00	91.00
MAY	52.50	1.14	51.40	0.00	0.00	51.40
JUN	35.30	2.13	33.20	0.00	0.00	33.20
JUL	26.10	2.20	23.90	0.00	0.00	23.90
AUG	20.30	1.76	18.50	0.00	0.00	18.50
SEP	14.90	1.24	13.70	0.00	0.00	13.70
OCT	15.20	0.21	15.00	0.00	0.00	15.00
NOV	29.00	0.14	28.90	0.00	0.00	28.90
DEC	113.00	0.39	113.00	0.00	0.00	113.00
ANN	114,000	647	113,000	0	0	113,000

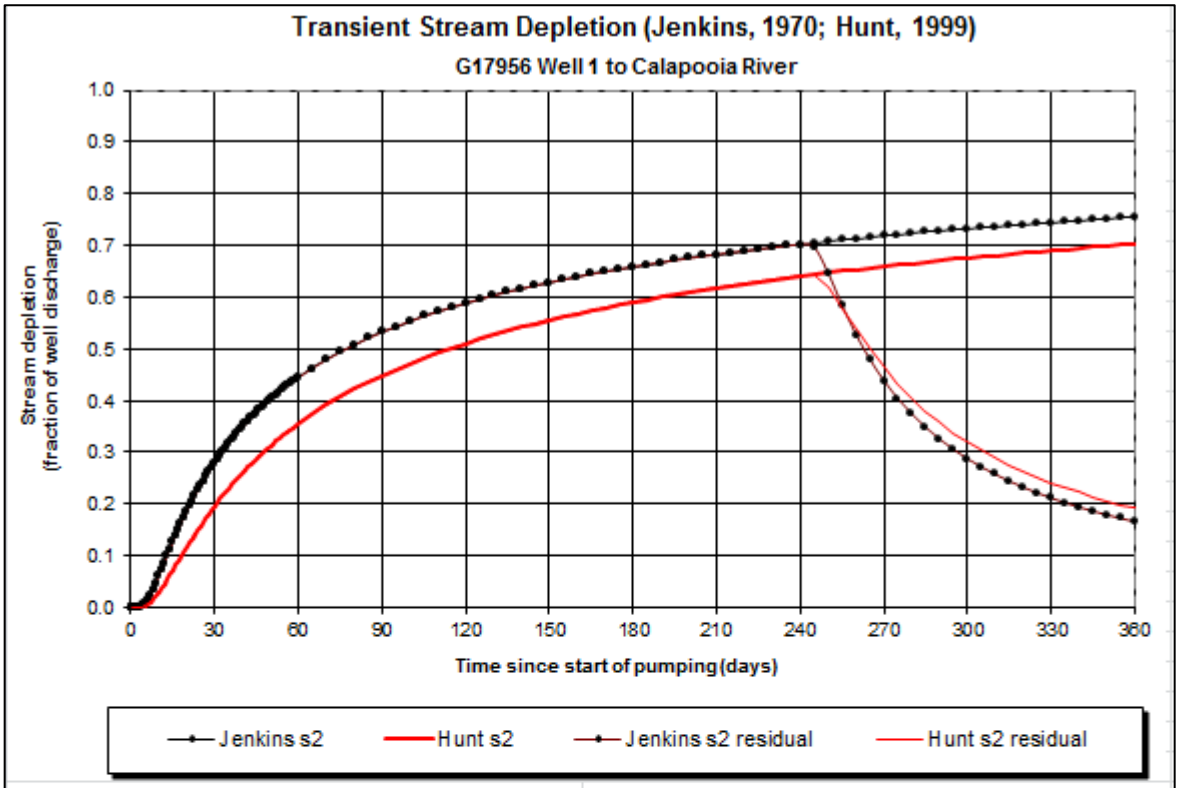
Well Location Map



Water-Level Trends in Nearby Wells

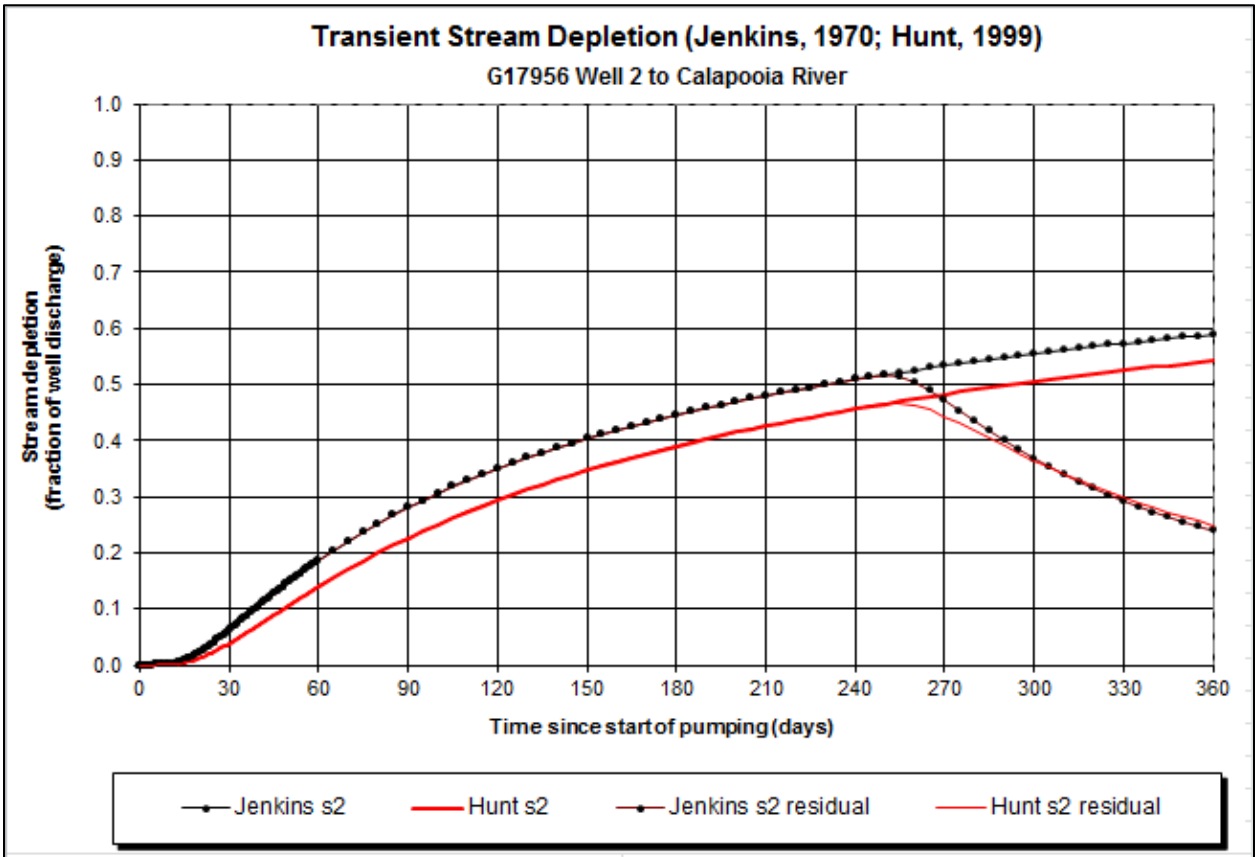


Transient Stream Depletion Model Results



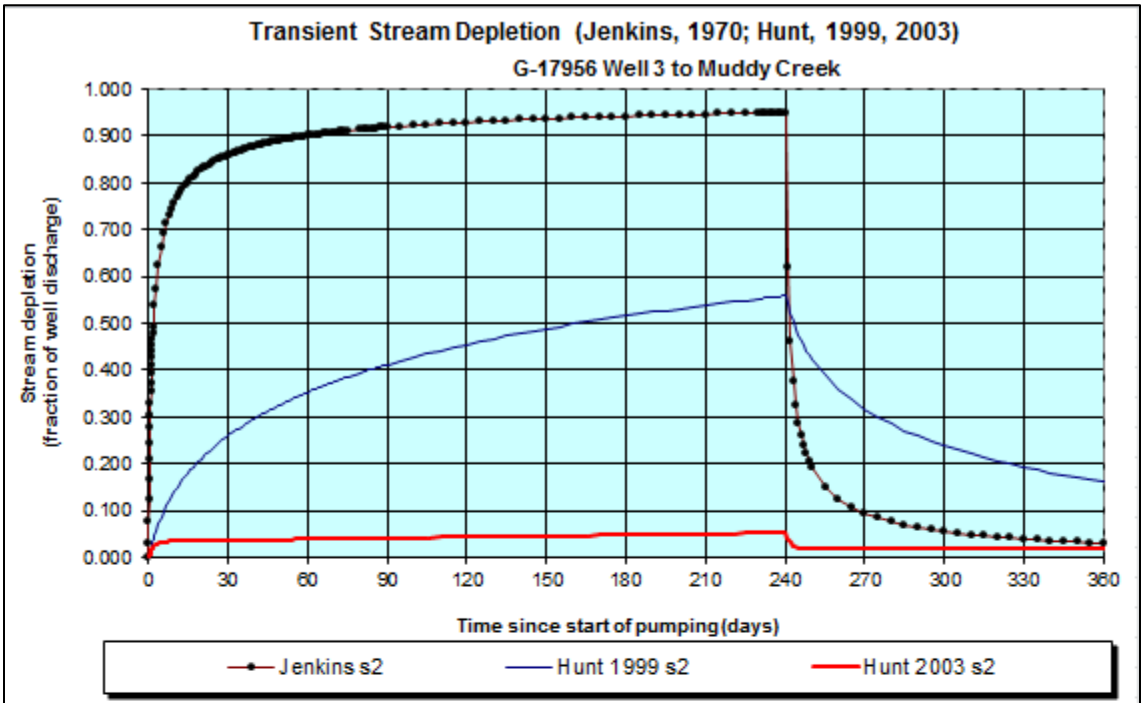
Output for Hunt Stream Depletion, Scenerio 2 (s2):	Time pump on = 240 days											
Days	**30**	60	90	120	150	180	210	240	270	300	330	360
Qw, cfs	1.958	1.958	1.958	1.958	1.958	1.958	1.958	1.958	1.958	1.958	1.958	1.958
Jenk SD s2 %	**27.93**	44.43	53.22	58.86	62.85	65.87	68.26	70.21	43.91	28.80	21.21	16.63
Jen SD s2 cfs	0.547	0.870	1.042	1.152	1.231	1.290	1.337	1.375	0.860	0.564	0.415	0.326
Hunt SD s2 %	**19.62**	35.52	44.83	51.04	55.55	59.00	61.77	64.04	46.33	32.06	24.17	19.21
Hunt SD s2 cfs	0.384	0.695	0.878	0.999	1.088	1.155	1.209	1.254	0.907	0.628	0.473	0.376

Parameters:		Scenario 1	Scenario 2	Scenario 3	Units
Net steady pumping rate	Qw	1.958	1.958	1.958	cfs
Distance to stream	a	2650	2650	2650	ft
Aquifer hydraulic conductivity	K	50	50	50	ft/day
Aquifer thickness	b	20	20	20	ft
Aquifer transmissivity	T	1000	1000	1000	ft*ft/day
Aquifer storage coefficient	S	0.01	0.01	0.01	
Stream width	ws	100	100	100	ft
Streambed hydraulic conductivity	Ks	0.1	0.1	0.1	ft/day
Streambed thickness	bs	3	3	3	ft
Streambed conductance	sbc	3.333333333	3.333333333	3.333333333	ft/day
Stream depletion factor (Jenkins)	sdf	70.225	70.225	70.225	days
Streambed factor (Hunt)	sbf	8.833333333	8.833333333	8.833333333	



Output for Hunt Stream Depletion, Scenerio 2 (s2):						Time pump on = 240 days						
Days	**30**	60	90	120	150	180	210	240	270	300	330	360
Qw, cfs	1.958	1.958	1.958	1.958	1.958	1.958	1.958	1.958	1.958	1.958	1.958	1.958
Jenk SD s2 %	**6.15**	18.61	28.04	34.98	40.30	44.53	47.97	50.86	47.16	36.82	29.26	23.95
Jen SD s2 cfs	0.120	0.364	0.549	0.685	0.789	0.872	0.939	0.996	0.923	0.721	0.573	0.469
Hunt SD s2 %	**3.88**	14.01	22.65	29.39	34.72	39.03	42.61	45.64	44.36	36.49	29.84	24.87
Hunt SD s2 cfs	0.076	0.274	0.443	0.575	0.680	0.764	0.834	0.894	0.869	0.714	0.584	0.487

Parameters:		Scenario 1	Scenario 2	Scenario 3	Units
Net steady pumping rate	Qw	1.958	1.958	1.958	cfs
Distance to stream	a	4580	4580	4580	ft
Aquifer hydraulic conductivity	K	50	50	50	ft/day
Aquifer thickness	b	20	20	20	ft
Aquifer transmissivity	T	1000	1000	1000	ft*ft/day
Aquifer storage coefficient	S	0.01	0.01	0.01	
Stream width	ws	100	100	100	ft
Streambed hydraulic conductivity	Ks	0.1	0.1	0.1	ft/day
Streambed thickness	bs	3	3	3	ft
Streambed conductance	sbc	3.333333333	3.333333333	3.333333333	ft/day
Stream depletion factor (Jenkins)	sdf	209.764	209.764	209.764	days
Streambed factor (Hunt)	sbf	15.26666667	15.26666667	15.26666667	



Output for Stream Depletion, Scenerio 2 (s2):	Time pump on (pumping duration) = 240 days											
Days	30	60	90	120	150	180	210	240	270	300	330	360
J SD	85.9%	90.0%	91.8%	92.9%	93.7%	94.2%	94.6%	95.0%	9.4%	5.5%	3.9%	3.0%
H SD 1999	25.9%	35.2%	41.1%	45.5%	48.8%	51.6%	53.9%	55.8%	31.6%	23.8%	19.3%	16.2%
H SD 2003	3.64%	3.88%	4.11%	4.35%	4.57%	4.80%	5.02%	5.24%	1.82%	1.80%	1.77%	1.75%
Qw, cfs	1.049	1.049	1.049	1.049	1.049	1.049	1.049	1.049	1.049	1.049	1.049	1.049
H SD 99, cfs	0.272	0.370	0.432	0.477	0.512	0.541	0.565	0.586	0.332	0.250	0.203	0.170
H SD 03, cfs	0.038	0.041	0.043	0.046	0.048	0.050	0.053	0.055	0.019	0.019	0.019	0.018

Parameters:		Scenario 1	Scenario 2	Scenario 3	Units
Net steady pumping rate of well	Qw	471.00	471.00	471.00	gpm
Time pump on (pumping duration)	tpon	240	240	240	days
Perpendicular from well to stream	a	1950	1950	1950	ft
Well depth	d	100	100	100	ft
Aquifer hydraulic conductivity	K	50	50	50	ft/day
Aquifer saturated thickness	b	40	40	40	ft
Aquifer transmissivity	T	2000	2000	2000	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	20	20	20	ft
Aquitard thickness below stream	babs	5	5	5	ft
Aquitard porosity	n	0.2	0.2	0.2	
Stream width	ws	100	100	100	ft
Streambed conductance (lambda)	sbc	0.200000	0.200000	0.200000	ft/day
Stream depletion factor	sdf	1.901250	1.901250	1.901250	days
Streambed factor	sbf	0.195000	0.195000	0.195000	
input #1 for Hunt's Q_4 function	t'	0.525970	0.525970	0.525970	
input #2 for Hunt's Q_4 function	K'	0.950625	0.950625	0.950625	
input #3 for Hunt's Q_4 function	epsilon'	0.005000	0.005000	0.005000	
input #4 for Hunt's Q_4 function	lamda'	0.195000	0.195000	0.195000	