Groundwater Review Summary Form

Application # G- 18428

GW Reviewer Aurora Bouchier **Date Review Completed:** 4/21/2017

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).

WATER RESOURCES DEPARTMENT

MEMO April 21, 2017

TO: **Application G-** 18428

FROM: **GW:** Aurora Bouchier
(Reviewer's Name)

SUBJECT: Scenic Waterway Interference Evaluation

☐ YES
The source of appropriation is within or above a Scenic Waterway
☒ NO

☐ YES
Use the Scenic Waterway condition (Condition 7J)
☒ NO

☐ Per ORS 390.835, the Groundwater Section is **able** to calculate ground water interference with surface water that contributes to a Scenic Waterway. The calculated interference is distributed below.

☐ Per ORS 390.835, the Groundwater Section is **unable** to calculate ground water 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 water flows necessary to maintain the free-flowing character of a scenic waterway.**

DISTRIBUTION OF INTERFERENCE

Calculate the percentage of consumptive use by month and fill in the table below. If interference cannot be calculated, per criteria in 390.835, do not fill in the table but check the "unable" option above, thus informing Water Rights that the Department is unable to make a Preponderance of Evidence finding.

Exercise of this permit is calculated to reduce monthly flows in _____ Scenic Waterway by the following amounts expressed as a proportion of the consumptive use by which surface water flow is reduced.

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

PUBLIC INTEREST REVIEW FOR GROUNDWATER APPLICATIONS

TO: Water Rights Section Date April 21, 2017

FROM: Groundwater Section Aurora C Bouchier
Reviewer's Name

SUBJECT: Application G- 18428 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: **KCK Partners LLC** County: **Polk**

A1. Applicant(s) seek(s) 0.50 cfs from 1 well(s) in the Willamette Basin, Middle Willamette subbasin (Mission Bottom quadrangle)

A2. Proposed use irrigation (107.4 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	0.5	6S/3W-17 SE-SW	250' N, 325' W fr S ¼ cor S 17
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	170				Est. 200	Est. 0-100	Est. 0-100		TBD	Est 250	--	--

Use data from application for proposed wells.

A4. **Comments:**

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 well location is greater than ¼-mile from a surface water source, therefore 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: The proposed well is located within the Eola Hills Groundwater Limited Area. However, this administrative restriction only applies to the basalt aquifers. The proposed well is intended to be constructed in the alluvial aquifer therefore the associated administrative rules do not apply.

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**;
   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 well is located in an area that contains fine-grained sediment (Willamette Silt) from land surface to a depth of approximately 60 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 40-60 feet locally (Gannett and Caldwell, 1998).

State Observation Well POLK 1070 is located approximately 0.5 miles to the east-southeast, and State Observation Well YAMH 7735 is located approximately 2.9 miles to the north-northeast. Water level measurements from the State Observation Wells and other nearby wells indicate relatively stable long-term trends for alluvial wells in the immediate area of the proposed well (see attached hydrograph). However, a thin aquifer and increased groundwater development in the area indicates a need for additional water-level monitoring.

Pumping Interference Estimates

The amount of interference due to pumping to the nearby well (POLK 1090) was estimated using the Theis Distance Drawdown Analytical Model. The model calculates drawdown in a well caused by pumping from another well at a specified distance. Model inputs include: total pumping time (t), radial distance from pumping well (r), pumping rate (Q), transmissivity (T), and storativity (S).

Values used for these parameters were t = 60 days (assumes a total of 60 days of pumping during the irrigation season), r = 550 feet (distance from POLK 1090), Q = 225 gpm, T = 5,500 ft^2/d - 10,300 ft^2/d (based on a pump test at a nearby well [POLK 1134] similarly located on the Willamette Silt terrace), and S = 0.05 to 0.001.

Calculated drawdowns range from 6.4 feet to 27 feet due to 60 days of pumping (see attached graph). The drawdowns calculated here are significant in an aquifer that is 45 - 55 feet thick. A pump test should be conducted to narrow down the range in drawdown and acceptable pumping rate.

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	**Alluvial**	☒	☐
		☐	☐
		☐	☐

Basis for aquifer confinement evaluation: The coarse-grained sediments in the area are confined beneath approximately 60 feet of silt and clay (Gannett and Caldwell, 1998). Well logs for nearby wells (POLK list static water levels above the water-bearing zones at which water was first encountered, indicating 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? YES	NO	ASSUMED	Potential for Subst. Interfer. Assumed? YES	NO
1	**1**	**Spring Valley Cr**	**~125-135**	**115-145**	**1715**	☒	☐	☐	☐	☒
1	**2**	**Willamette River**	**~125-135**	**100**	**3345**	☒	☐	☐	☐	☒
						☐	☐	☐	☐	☐

Basis for aquifer hydraulic connection evaluation: The water level in nearby wells is greater than the elevation of the Willamette River and seasonally coincident with the elevation of Spring Valley Creek, indicating hydraulic connection with the groundwater contributing to the surface water bodies. This is corroborated by water table maps in the area (Woodward and others, 1998) indicating that the water table is at an elevation of about 120-130 feet in the area.
Water Availability Basin the well(s) are located within: 182 [WILLAMETTE R > COLUMBIA R – AB MOLLALA 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?
1	**1**	☐	☐	**na**	**na**	☐	**na**	☐	**<25%**	☐
1	**2**	☐	☐	**MR 182**	**1,500**	☐	**3,830**	☐	**<25%**	☐
		☐	☐			☐		☐		☐
		☐	☐			☐		☐		☐
		☐	☐			☐		☐		☐
		☐	☐			☐		☐		☐
		☐	☐			☐		☐		☐

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 Spring Valley Creek at 30 days was estimated using the Hunt 2003 model with an aquitard thickness below the stream of 11 feet. The thickness of the Willamette Silt beneath Spring Valley Creek results in an inefficient hydraulic connection with the groundwater.
Interference the Willamette River at 30 days was also estimated using the Hunt 2003 model to simulate confined aquifer - as is the case at the location of the well. Where the Willamette Silt has been eroded away (in the meander belt/flood plain of the Willamette River) it is likely the aquifer is not confined.

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:

n/a

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:**

Stream depletion will increase over time.

References Used:

Application file: G-18428.

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.

Theis, C.V., 1941, The effect of a well on the flow of a nearby stream: Am. Geophys. Union Trans., V. 22, pt. 3, p. 734-738.

Walton, W.C., 1984, Practical Aspects of Groundwater Modeling: National Water-Well Assoc., pp. 268-269 & 298-303.

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.

Nearby well logs and water level data, specifically: POLK 1070, POLK 1090, POLK 1095 and YAMH 7735.

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

WILLAMETTE R > COLUMBIA R - AB MOLALLA R

Watershed ID #: 182 Basin: WILLAMETTE Exceedance Level: 80
Time: 9:11 AM Date: 04/21/2017

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	7,470.00	15,700.00	0.00	1,500.00	14,200.00
MAR	22,400.00	7,250.00	15,200.00	0.00	1,500.00	13,700.00
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	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

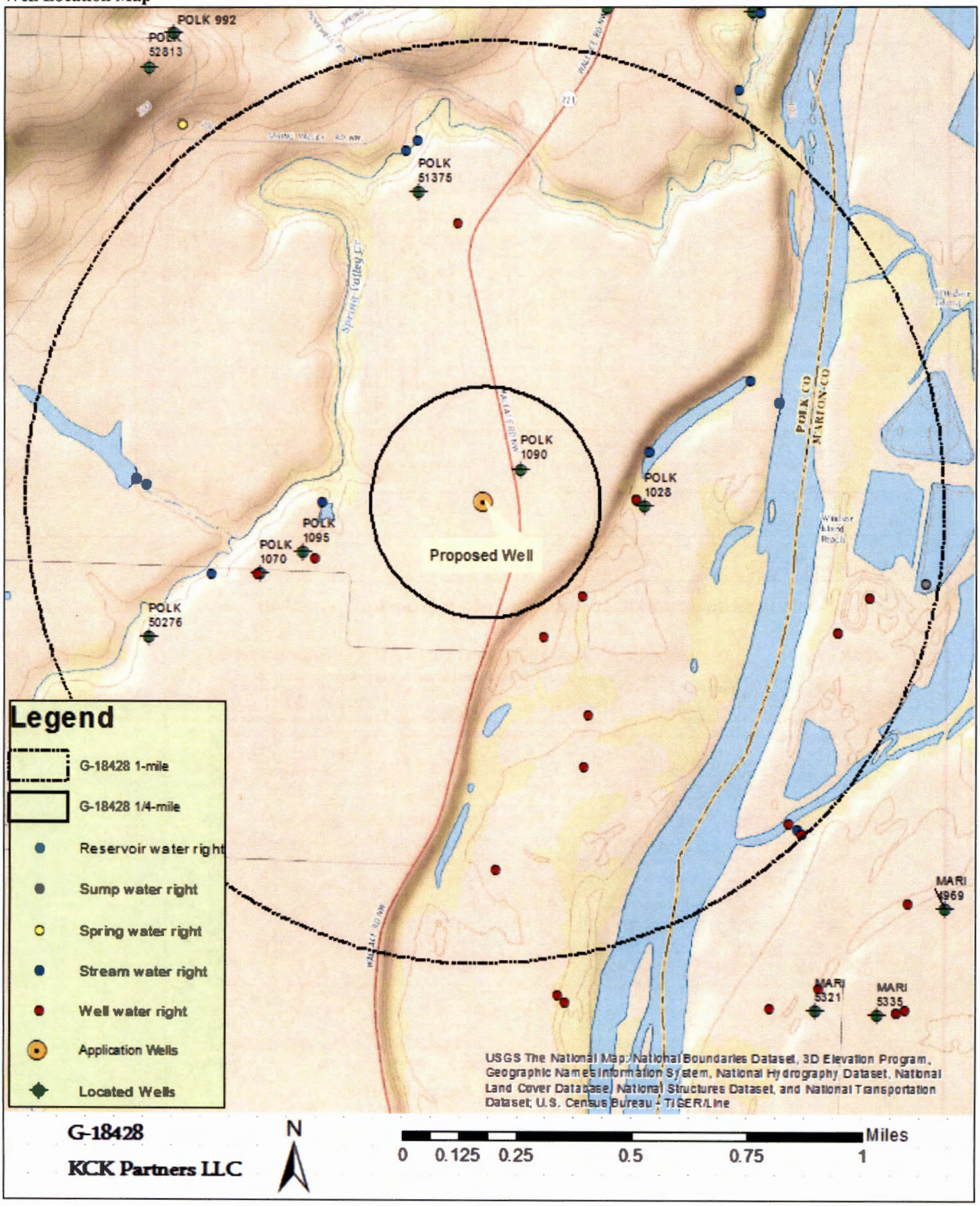
DETAILED REPORT OF INSTREAM REQUIREMENTS

WILLAMETTE R > COLUMBIA R - AB MOLALLA R

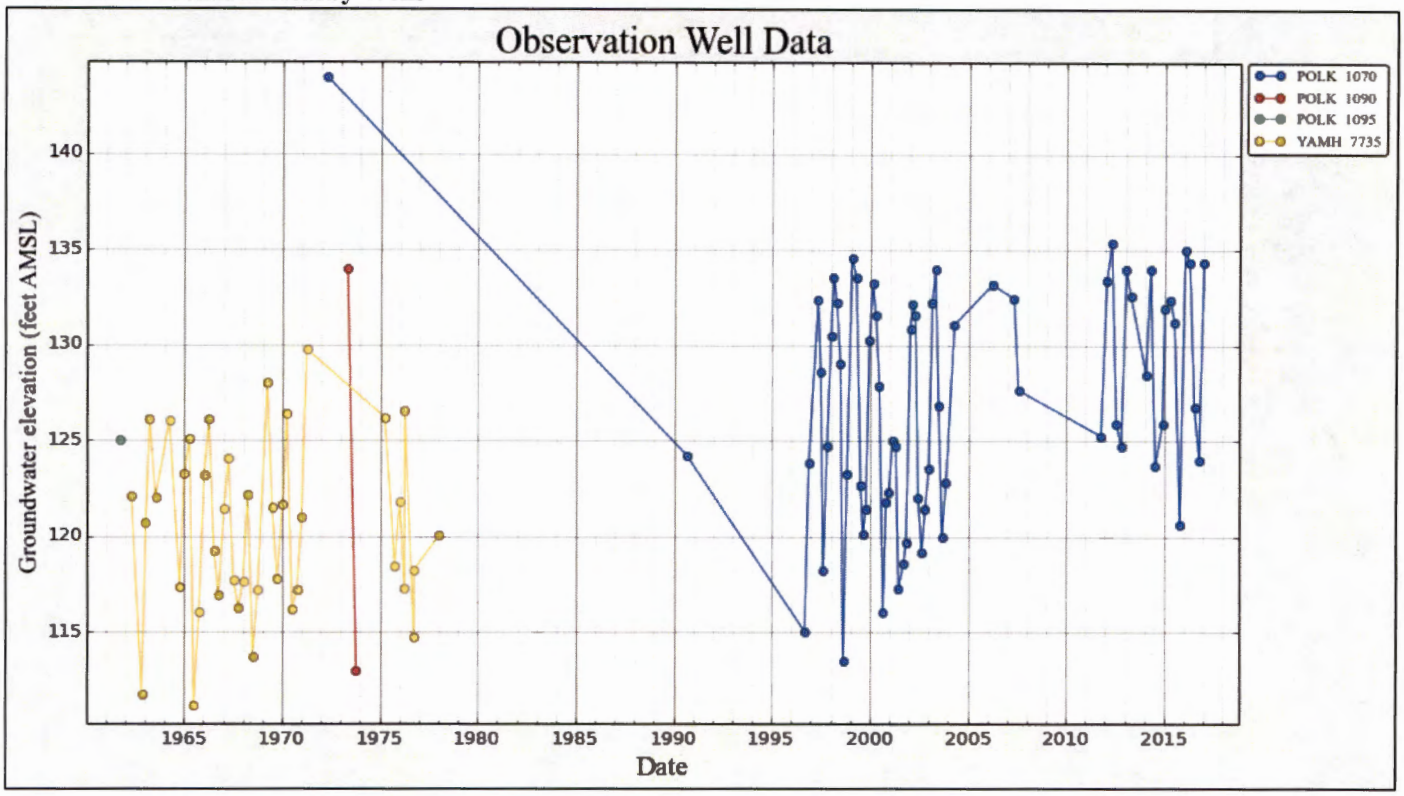
Watershed ID #: 182 Basin: WILLAMETTE
Time: 9:15 AM Date: 04/21/2017

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	1500.00	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

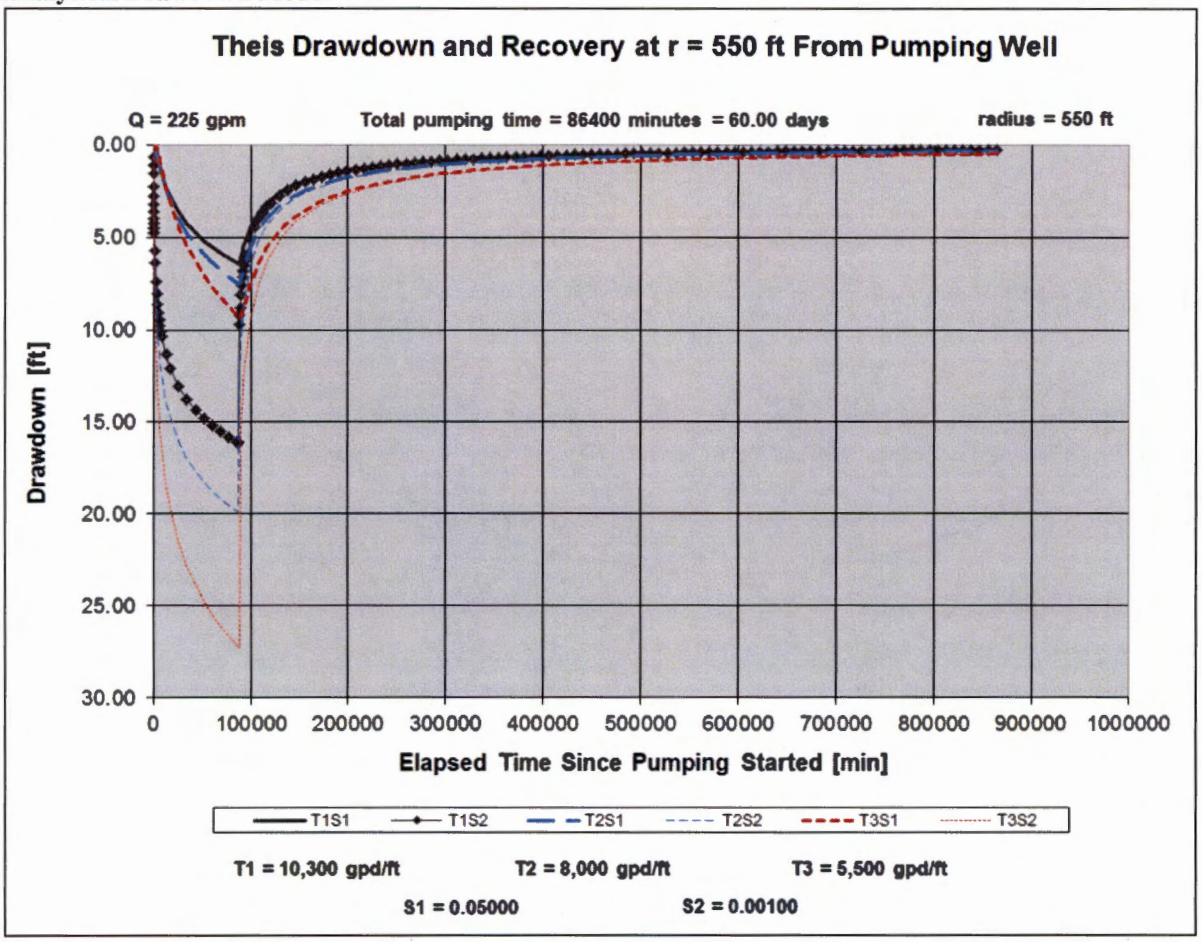
Well Location Map



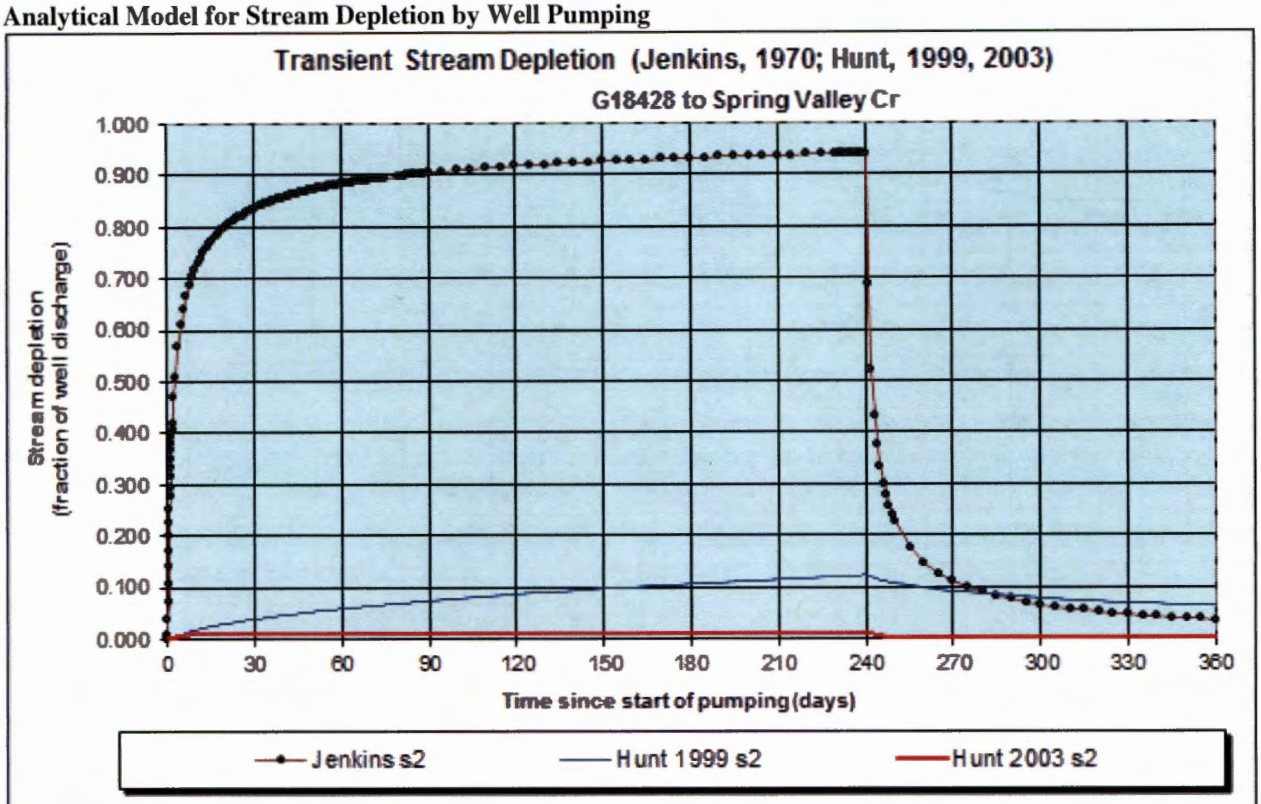
Water-Level Trends in Nearby Wells



Analytical Drawdown Model

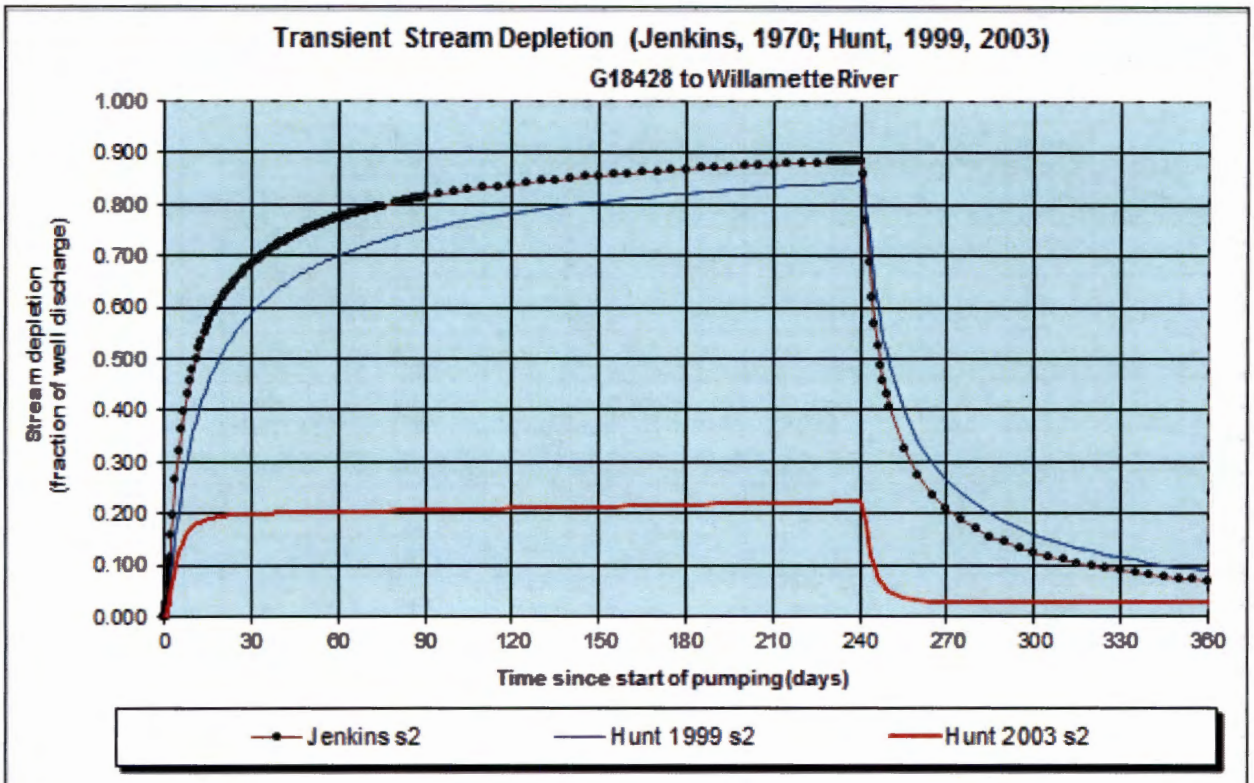


Analytical Model for Stream Depletion by Well Pumping



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	83.5%	88.3%	90.4%	91.7%	92.6%	93.2%	93.7%	94.1%	11.0%	6.5%	4.6%	3.5%
H SD 1999	3.9%	5.9%	7.3%	8.6%	9.6%	10.6%	11.4%	12.2%	9.1%	7.8%	6.9%	6.3%
H SD 2003	1.07%	1.10%	1.12%	1.14%	1.16%	1.18%	1.21%	1.23%	0.17%	0.17%	0.17%	0.17%
Qw, cfs	0.501	0.501	0.501	0.501	0.501	0.501	0.501	0.501	0.501	0.501	0.501	0.501
H SD 99, cfs	0.019	0.029	0.037	0.043	0.048	0.053	0.057	0.061	0.045	0.039	0.035	0.032
H SD 03, cfs	0.005	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.001	0.001	0.001	0.001

Parameters:		Scenario 1	Scenario 2	Scenario 3	Units
Net steady pumping rate of well	Qw	225.00	225.00	225.00	gpm
Time pump on (pumping duration)	tpon	240	240	240	days
Perpendicular from well to stream	a	1715	1715	1715	ft
Well depth	d	100	100	100	ft
Aquifer hydraulic conductivity	K	20	25	50	ft/day
Aquifer saturated thickness	b	45	45	45	ft
Aquifer transmissivity	T	900	1125	2250	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	60	60	60	ft
Aquitard thickness below stream	babs	11	11	11	ft
Aquitard porosity	n	0.2	0.2	0.2	
Stream width	ws	20	20	20	ft
Streambed conductance (lambda)	sbc	0.018182	0.018182	0.018182	ft/day
Stream depletion factor	sdf	3.268028	2.614422	1.307211	days
Streambed factor	sbf	0.034646	0.027717	0.013859	
input #1 for Hunt's Q_4 function	t'	0.305995	0.382494	0.764987	
input #2 for Hunt's Q_4 function	K'	0.544671	0.435737	0.217869	
input #3 for Hunt's Q_4 function	epsilon'	0.005000	0.005000	0.005000	
input #4 for Hunt's Q_4 function	lamda'	0.034646	0.027717	0.013859	



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	68.4%	77.3%	81.4%	83.9%	85.6%	86.8%	87.8%	88.6%	20.8%	12.4%	8.8%	6.8%
H SD 1999	58.9%	70.0%	75.2%	78.4%	80.5%	82.2%	83.4%	84.4%	26.4%	16.0%	11.4%	8.8%
H SD 2003	19.99%	20.33%	20.65%	20.98%	21.31%	21.69%	22.02%	22.39%	2.73%	2.69%	2.75%	2.78%
Qw, cfs	0.501	0.501	0.501	0.501	0.501	0.501	0.501	0.501	0.501	0.501	0.501	0.501
H SD 99, cfs	0.295	0.351	0.377	0.393	0.404	0.412	0.418	0.423	0.132	0.080	0.057	0.044
H SD 03, cfs	0.100	0.102	0.104	0.105	0.107	0.109	0.110	0.112	0.014	0.013	0.014	0.014

Parameters:		Scenario 1	Scenario 2	Scenario 3	Units
Net steady pumping rate of well	Qw	225.00	225.00	225.00	gpm
Time pump on (pumping duration)	tpon	240	240	240	days
Perpendicular from well to stream	a	3345	3345	3345	ft
Well depth	d	100	100	100	ft
Aquifer hydraulic conductivity	K	20	25	50	ft/day
Aquifer saturated thickness	b	45	45	45	ft
Aquifer transmissivity	T	900	1125	2250	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	60	60	60	ft
Aquitard thickness below stream	babs	3	3	3	ft
Aquitard porosity	n	0.2	0.2	0.2	
Stream width	ws	600	600	600	ft
Streambed conductance (lambda)	sbc	2.000000	2.000000	2.000000	ft/day
Stream depletion factor	sdf	12.432250	9.945800	4.972900	days
Streambed factor	sbf	7.433333	5.946667	2.973333	
input #1 for Hunt's Q_4 function	t'	0.080436	0.100545	0.201090	
input #2 for Hunt's Q_4 function	K'	2.072042	1.657633	0.828817	
input #3 for Hunt's Q_4 function	epsilon'	0.005000	0.005000	0.005000	
input #4 for Hunt's Q_4 function	lamda'	7.433333	5.946667	2.973333	

Well Construction and Surface Water Sketch for Conceptual Models