Groundwater Application Review Summary Form

Application # G- 18748

GW Reviewer Michael Thoma **Date Review Completed:** 06/15/2020

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 **06/15/2020**

TO: **Application G- 18748**

FROM: **GW: Michael Thoma**
(Reviewer's Name)

SUBJECT: Scenic Waterway Interference Evaluation

☒ **YES**
☐ **NO**

The source of appropriation is hydraulically connected to a State Scenic Waterway or its tributaries

☒ **YES**
☐ **NO**

Use the Scenic Waterway Condition (Condition 7J)

☒ 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
See attached memo "Analysis of Groundwater Pumping Impacts on Scenic Waterway Flows" dated: February 19, 2013

☐ 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 **Klamath** 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
See attached memo "Analysis of Groundwater Pumping Impacts on Scenic Waterway Flows" dated: February 19, 2013											

PUBLIC INTEREST REVIEW FOR GROUNDWATER APPLICATIONS

TO: Water Rights Section Date 06/15/2020

FROM: Groundwater Section Michael Thoma
Reviewer's Name

SUBJECT: Application G- 18748 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: **Michael LaGrande** County: **Klamath**

A1. Applicant(s) seek(s) 6.27 cfs from 1 well(s) in the Klamath Basin, Wood River subbasin

A2. Proposed use Supplemental Irrigation (501.89 ac) Seasonality: Apr 1 – Oct 31 (214 d)

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	Bedrock	6.27	33S/7.5E-33 NENW	78'S, 1319'E of NW cor S 33
2						

* 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	4163	*	Artes.	*	690	0-510	+2-650		520-650	*		

Use data from application for proposed wells.

A4. **Comments:** *The well is proposed with proposed well construction listed on the application; SWL is likely to be flowing-artesian based on well logs in the area of similar depths (few wells are as deep as what is proposed).

A5. ☐ **Provisions of the** _____ 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: There are no Klamath Basin rules

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) **7J (Scenic); 7N (Annual SWL); 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 **510** 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:** There are very few wells in the Wood River basin near the proposed POA that have water level data so groundwater over-appropriation cannot be determined using water-level trends and the conditions in B1(d) are recommended. There are also only a few existing groundwater rights in the area and the nearest is approx. 2 miles north of the proposed well. However, transmissivity in this part of the Wood River basin aquifer system is generally high and storativity is generally low so injury at 2 miles is possible but cannot be determined within a reasonable uncertainty to make a positive finding of injury, so in addition to static water level reporting, the Large Water-Use condition, and the special condition described below are recommended.

B1(d)-iii Special Condition:
The well shall be equipped with an access port at the well head that is at least 1 in diameter and allows direct access to the water column. The permit holder shall allow Department staff access to the well for the purposes of obtaining water-level measurements and recording water use.

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	**Pliocene Volcanic Deposits**	☒	☐
		☐	☐

Basis for aquifer confinement evaluation: Deeper wells in the Wood River subbasin typically encounter confined aquifer conditions and often report flowing-artesian 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**	**Wood River**	**4163**	**4160-4165**	**5490**	☒	☐	☐	☐	☒
1	**2**	**Sevenmile Creek**	**4163**	**4150**	**14,760**	☒	☐	☐	☐	☒
						☐	☐	☐	☐	☐

Basis for aquifer hydraulic connection evaluation: Groundwater elevations are estimated to be above or near surface water elevations implying that water is flowing between surface water and groundwater. The number of artesian wells in the area further implies that the deeper aquifer zones have sufficient pressure to drive water up to the land surface where is contributes to surface water flows; Conceptual hydrogeologic models and physically-based numerical groundwater flow models produced by USGS reports (Gannett et al., 2007; Gannett et al., 2012) concluded connection between deep aquifer systems in the Wood River Basin and surface water.

Water Availability Basin the well(s) are located within: LINK R > KLAMATR – AB UNN STR (ID# 31420305) **and also hydraulically connected to** WOOD R > UPPER KLAMATH L – AT MOUTH (ID# 70829)

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

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

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

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

Comments: No surface water sources were evaluated less than one mile

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
1	**1**	**25**	**22**	**19**	**4**	**11**	**17**	**22**	**27**	**31**	**34**	**34**	**29**
Well Q as CFS		**0**	**0**	**0**	**6.27**	**6.27**	**6.27**	**6.27**	**6.27**	**6.27**	**6.27**	**0**	**0**
Interference CFS		**1.58**	**1.35**	**1.18**	**0.23**	**0.67**	**1.07**	**1.41**	**1.69**	**1.92**	**2.12**	**2.13**	**1.84**
Distributed Wells													
Well	SW#	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
		%	%	%	%	%	%	%	%	%	%	%	%
Well Q as CFS													
Interference CFS													
(A) = Total Interf.		**1.58**	**1.35**	**1.18**	**0.23**	**0.67**	**1.07**	**1.41**	**1.69**	**1.92**	**2.12**	**2.13**	**1.84**
(B) = 80 % Nat. Q		**314**	**309**	**315**	**334**	**379**	**375**	**371**	**347**	**334**	**335**	**328**	**312**
(C) = 1 % Nat. Q		**3.14**	**3.09**	**3.15**	**3.34**	**3.79**	**3.75**	**3.71**	**3.47**	**3.34**	**3.35**	**3.28**	**3.12**
(D) = (A) > (C)		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
(E) = (A / B) x 100		**0.5**	**0.44**	**0.37**	**0.07**	**0.18**	**0.29**	**0.38**	**0.49**	**0.57**	**0.63**	**0.65**	**0.59**

(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:
Stream-depletion was estimated using the Hunt (2003) stream-depletion model with parameter values informed by Gannett et al. (2012) and using methods previously used by the Department for estimating stream-depletion in the Klamath Basin.

Evaluation to Sevenmile Creek was not performed because the distance between the well and Sevenmile Creek is farther than to the Wood River so stream-depletion estimates would be lower. Additionally, the 80%-Exceedance flows for the WAB that Sevenmile Creek is in are higher than in the Wood River so PSI would be less likely.

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 applicant's proposed POA would be producing from an aquifer that has been found to be hydraulically connected to surface water in the Klamath Basin, Wood River Subbasin, at a distance of greater than 1 mile. However, the proposed rate and estimated stream-depletion does not lead to an automatic assumption of PSI per OAR 690-009.

References Used:

Gannett, M. W., B. J. Wagner, and K. E. Lite. 2012. *Groundwater Simulation and Management Models for the Upper Klamath Basin, Oregon and California*. USGS Scientific Investigations report 2012-5062.

Gannett, M. W., K. E. Lite, J. L. LaMarche, B. J. Fisher, and D. J. Polette. 2007. *Ground-water Hydrology of the Upper Klamath Basin, Oregon and California*. USGS Scientific Investigations Report 2007-5050

Hunt, B. 2003. *Unsteady Stream Depletion when Pumping from a Semiconfined Aquifer*. Journal of Hydrologic Engineering. Vol 8(1), pp 12-19

Sherrod, D. R., and L. B. G. Pickthorn. 1992. *Geologic Map of the West Half of the Klamath Falls 1° by 2° Quadrangle, South-Central Oregon*. USGS Miscellaneous Investigations Series Map I-2182.

OWRD Well Log Database – Accessed 08/05/2019

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

Water Availability Analysis
Detailed Reports

WOOD R > UPPER KLAMATH L - AT MOUTH
KLAMATH BASIN

Water Availability as of 8/5/2019

Watershed ID #: 70829 (Map)
Date: 8/5/2019

Exceedance Level: 80%
Time: 10:43 AM

Water Availability Calculation | Consumptive Uses and Storages | Instream Flow Requirements | Reservations | Water Rights | Watershed Characteristics

Water Availability Calculation

Monthly Streamflow in Cubic Feet per Second
Annual Volume at 50% Exceedance in Acre-Feet

Month	Natural Stream Flow	Consumptive Uses and Storages	Expected Stream Flow	Reserved Stream Flow	Instream Flow Requirement	Net Water Available
JAN	314.00	0.34	314.00	0.00	125.00	189.00
FEB	309.00	0.34	309.00	0.00	125.00	184.00
MAR	315.00	36.30	279.00	0.00	270.00	8.73
APR	334.00	80.30	254.00	0.00	286.00	-32.30
MAY	379.00	192.00	187.00	0.00	323.00	-136.00
JUN	375.00	249.00	126.00	0.00	352.00	-226.00
JUL	371.00	161.00	210.00	0.00	312.00	-102.00
AUG	347.00	95.80	251.00	0.00	277.00	-25.80
SEP	334.00	85.20	249.00	0.00	254.00	-5.23
OCT	335.00	60.90	274.00	0.00	255.00	19.10
NOV	328.00	0.34	328.00	0.00	263.00	64.70
DEC	312.00	0.34	312.00	0.00	125.00	187.00
ANN	281,000.00	58,300.00	222,000.00	0.00	179,000.00	57,100.00

Water Availability Analysis
Detailed Reports

LINK R > KLAMATH R - AB UNN STR
KLAMATH BASIN

Water Availability as of 8/5/2019

Watershed ID #: 31420305 (Map)
Date: 8/5/2019

Exceedance Level: 80%
Time: 10:43 AM

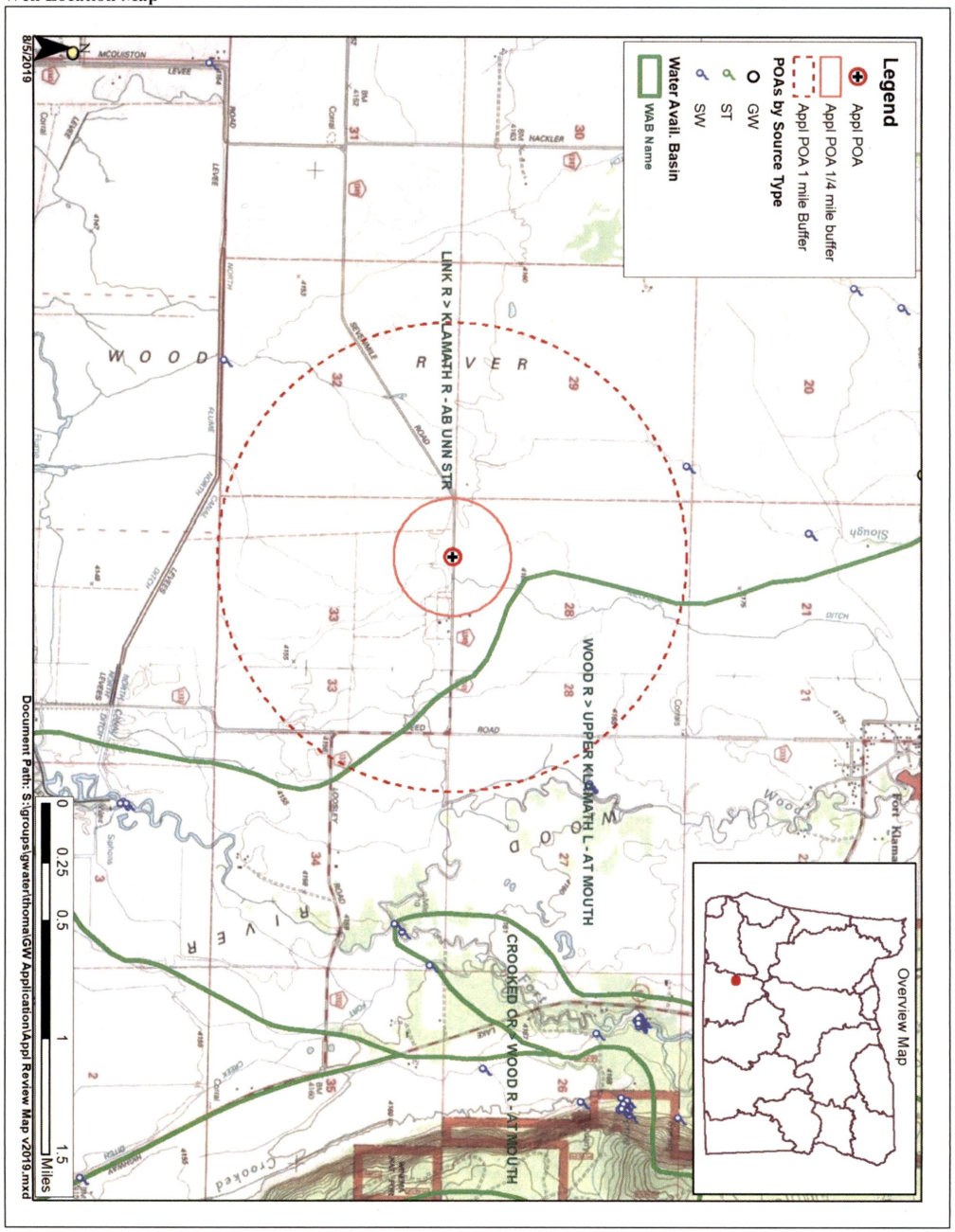
Water Availability Calculation | Consumptive Uses and Storages | Instream Flow Requirements | Reservations | Water Rights | Watershed Characteristics

Water Availability Calculation

Monthly Streamflow in Cubic Feet per Second
Annual Volume at 50% Exceedance in Acre-Feet

Month	Natural Stream Flow	Consumptive Uses and Storages	Expected Stream Flow	Reserved Stream Flow	Instream Flow Requirement	Net Water Available
JAN	1,470.00	576.00	894.00	0.00	60.00	834.00
FEB	1,520.00	972.00	548.00	0.00	60.00	488.00
MAR	1,690.00	1,040.00	652.00	0.00	80.00	572.00
APR	2,220.00	1,110.00	1,110.00	0.00	80.00	1,030.00
MAY	2,100.00	1,280.00	816.00	0.00	83.00	733.00
JUN	1,670.00	1,510.00	161.00	0.00	74.00	87.40
JUL	1,180.00	1,370.00	-186.00	0.00	20.00	-206.00
AUG	914.00	1,060.00	-146.00	0.00	40.00	-186.00
SEP	830.00	826.00	4.08	0.00	30.00	-25.90
OCT	808.00	325.00	483.00	0.00	30.00	453.00
NOV	952.00	333.00	619.00	0.00	30.00	589.00
DEC	1,240.00	569.00	671.00	0.00	50.00	621.00
ANN	1,500,000.00	662,000.00	839,000.00	0.00	38,400.00	800,000.00

Well Location Map



Stream-Depletion Model Results

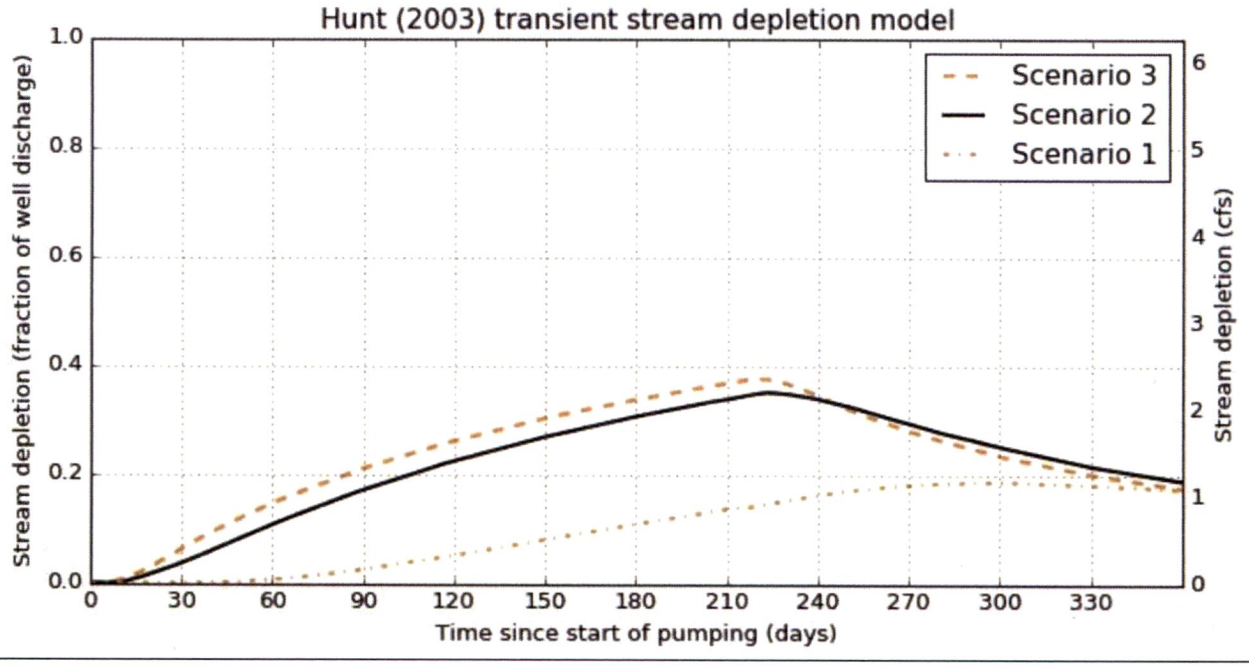
PyHunt stream depletion analysis tool

Application type:	G
Application number:	18748
Well number:	1
Stream Number:	1
Pumping rate (cfs):	6.27
Pumping duration (days):	214
Pumping start month number (3=March)	4

Parameter	Symbol	Scenario 1	Scenario 2	Scenario 3	Units
Distance from well to stream	a	5490	5490	5490	ft
Aquifer transmissivity	T	4250	20000	35825	ft2/day
Aquifer storativity	S	0.001	0.001	0.001	-
Aquitard vertical hydraulic conductivity	Kva	28.5	28.5	28.5	ft/day
Aquitard saturated thickness	ba	60	60	60	ft
Aquitard thickness below stream	babs	57	57	57	ft
Aquitard specific yield	Sya	0.1	0.1	0.1	-
Stream width	ws	20	20	20	ft

Stream depletion for Scenario 2:

Days	10	300	330	360	30	60	90	120	150	180	210	240	270
Depletion (%)	0	25	22	19	4	11	17	22	27	31	34	34	29
Depletion (cfs)	0.01	1.58	1.35	1.18	0.23	0.67	1.07	1.41	1.69	1.92	2.12	2.13	1.84



Appendix Memo: Analysis of Groundwater Pumping Impacts on Scenic Waterway Flows

State of Oregon
Water Resources Department

Memorandum

To: Barry Norris – Administrator, Technical Services Division
Dwight French – Administrator, Waterrights Division
Tom Paul – Deputy Director
Doug Woodcock – Administrator, Field Services Division

From: Ivan Gall – Manager, Groundwater Section

Date: February 19, 2013

Subject: Analysis of Groundwater Pumping Impacts on Klamath Scenic Waterway Flows

In 1971 the Oregon Legislature created the Scenic Waterway Act, codified by Oregon Revised Statutes 390.805 to 390.925, to preserve for the benefit of the public Waldo Lake and selected parts of the state's free-flowing rivers. The Klamath Scenic Waterway was part of the Act and includes the Klamath River from the John Boyle Dam powerhouse downstream to the Oregon-California border. Under the Act, the Water Resources Commission is allowed to allocate small amounts of surface water for human consumption and livestock watering, as long as issuing the water right does not significantly impair the free-flowing character of these waters in quantities necessary for recreation, fish and wildlife, and the amount allocated may not exceed a cumulative total of one percent of the average daily flow or one cubic foot per second (cfs), whichever is less.

In 1995 the Scenic Waterway Act was modified to address the impact of groundwater uses that, based upon a preponderance of evidence, would measurably reduce the surface water flows within a scenic waterway. "Measurably reduce" means that the use authorized will individually or cumulatively reduce surface water flows within the scenic waterway in excess of a combined cumulative total of one percent of the average daily flow or one cfs, whichever is less.

In 2012 the United States Geological Survey (USGS), in cooperation with OWRD and the US Bureau of Reclamation, completed groundwater flow and management models for the Upper Klamath Basin. The 2012 groundwater flow model uses generally accepted hydrogeologic methods and the relevant field data to model the cumulative effects of groundwater pumping within the Klamath Scenic Waterway, and provides a comprehensive methodology for analyzing the relevant field data necessary to determine whether the cumulative use of groundwater in the Klamath Basin will measurably reduce the surface water flow necessary to maintain the free-flowing character of the Klamath Scenic Waterway.

In September 2012 the OWRD Groundwater Section conducted two model simulations. The two simulations used the 2012 USGS flow model, incorporating groundwater permits issued (61.96 cfs) since adoption of the 1995 Scenic Waterway Act amendment up through 2004. Each simulation was run to steady-state, where inflows and outflows for that model run balanced. An evaluation of the water budgets showed that groundwater discharge to the Klamath Scenic Waterway decreased by 5.88 cfs as a result of the 61.96 cfs of groundwater uses issued between 1995 and 2004. These results indicate to the OWRD that a preponderance of evidence exists to establish that groundwater development occurring in the Upper Klamath Basin in Oregon since 1995 has "measurably reduced" surface water flows within the Klamath Scenic Waterway.

In January 2013 the OWRD Groundwater Section conducted flow model simulations to evaluate impacts to streams from pumping groundwater within the Lost River subbasin. Groundwater pumping was simulated by placing wells in the model that correspond to the center of 39 townships in the southeast part of the Klamath Basin in Oregon. Each of the simulations was run to steady-state, where inflows and outflows for that model run balanced. These results indicate that the scenic waterway is impacted by pumping groundwater in all of the townships evaluated in Oregon in the Lost River subbasin. In summary, a preponderance of evidence exists to establish that groundwater development occurring in Oregon since 1995 in the Upper Klamath Basin and Lost River subbasin has "measurably reduced" surface water flows within the Klamath Scenic Waterway.

References:

Gannett, M.W., Lite, K.E., Jr., La Marche, J.L., Fisher, B.J., and Polette, D.J., 2007. Ground-water hydrology of the upper Klamath Basin, Oregon and California: U.S. Geological Survey Scientific Investigations Report 2007-5050, 84p.

Gannett, M.W., Wagner, B.J., and Lite, K.E., Jr., 2012. Groundwater simulation and management models for the upper Klamath Basin, Oregon and California: U.S. Geological Survey Scientific Investigations Report 2012-5062, 92p.