WATER RESOURCES DEPARTMENT

MEMO 16 December, ~~200~~ 2010

TO: **Application G-** 17397

FROM: **GW:** Gerald Grondin
(Reviewer's Name)

SUBJECT: **Scenic Waterway Interference Evaluation**

X YES
The source of appropriation is within or above a Scenic Waterway
___ NO

X YES
Use the Scenic Waterway condition (Condition 7J)
___ NO

X Per ORS 390.835, the Ground Water 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 Ground Water 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
0.013	0.011	0.009	0.056	0.107	0.146	0.217	0.200	0.149	0.056	0.022	0.014

PUBLIC INTEREST REVIEW FOR GROUND WATER APPLICATIONS

TO: Water Rights Section **Date** **16 December 2010**

FROM: Ground Water/Hydrology Section **Gerald H. Grondin**
Reviewer's Name

SUBJECT: Application **G-17397** Supersedes review of **N.A.**
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 ground water 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: **Carland Family Trust** County: **Klamath**

A1. Applicant(s) seek(s) **4.52 (2029 gpm)** cfs from **1** well(s) in the **Klamath** Basin, **Lake Ewauna- Klamath River watershed in the Lost River** sub basin Quad Map: **Worden**

A2. Proposed use: **Irrigation (supplemental 361.9 acres** Seasonality: **1 April to 31 October (214 days)**

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	**Not Drilled**	**Well 1**	**Basin Fill?**	**4.52**	**40S/9E-sec 06 CBD**	**80' N, 835' E fr SW cor of NW of SW, S 6**

* 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	**4110**	**?**	**35?**	**N.A.**	**>400?**	**>100?**	**>100?**	**?**	**?**	**?**	**?**	**?**

Use data from application for proposed wells.

A4. **Comments:**

The application requests a groundwater permit for supplemental irrigation of 361.9 acres from a well allowing a maximum pumping rate of 4.52 cfs (2029 gpm) and a total volume of 1085.7 ac-ft per irrigation season. The requested pumping rate and total volume is typically allowed for 361.9 acres.

The well has not been drilled yet. The example water well reports submitted with the application are for wells completed in the predominantly basin fill deposits that overly the predominantly basalt unit. The reported yields are generally less than 100 gpm. So, a well completed in the basin fill deposits will not likely allow the maximum pumping rate requested by the application. Water well reports for vicinity wells completed in the basalt (KLAM 51231, KLAM 14521, KLAM 52970, KLAM 53940, and KLAM 52916) generally have reported yields exceeding 1,000 gpm.

Given the above paragraph, this review will assume and require the well to be completed in the predominantly basalt unit below the predominantly basin fill deposits.

The static water level in the table above is based upon the land surface elevation and reported static water levels for wells KLAM 51231, KLAM 14521, KLAM 52970, KLAM 53940, and KLAM 52916. This yields a static water level of about 4075 ft above mean sea level which is consistent with what Gannett and others (2007) show for the area.

Gannett and others (2007) indicate the ground water elevation north and west of the Klamath River is above the river elevation, but drops relatively steeply toward the river to the river elevation. Then, the ground water elevation in the valley south and east of the river slopes away from the river toward the southeast at a shallower gradient. Additionally, Gannett and others (2007) show the area of the proposed well location as experiencing 10 to 20 feet of seasonal ground water level fluctuation.

The total well depth, casing interval, and seal interval are based upon the example water well reports submitted with the groundwater permit application.

A5. ☐ **Provisions of the ______N.A.______** Basin rules relative to the development, classification and/or management of ground water hydraulically connected to surface water ☐ **are**, *or* ☐ **are not**, activated by this application. (Not all basin rules contain such provisions.)
Comments: **No basin rule applies. Only the Klamath River Compact ORS 542.610 to 542.630 applies to the Klamath Basin. However, that compact applies to surface water only, not ground water**

A6. ☐ **Well(s) # ___N.A.___** , _____ , _______ , _______ , _______ , tap(s) an aquifer limited by an administrative restriction.
Name of administrative area: ____________
Comments: **Currently, no administrative area.**

B. GROUND WATER AVAILABILITY CONSIDERATIONS, OAR 690-310-130, 400-010, 410-0070

B1. **Based upon available data**, I have determined that ground water* 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 ground water 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 ground water 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 ground water resource; or

d. ☒ **will, if properly conditioned**, avoid injury to existing ground water rights or to the ground water resource:
   i. ☒ The permit should contain condition #(s) **7B, 7F, 7N, and 7T**
   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 ground water production from no deeper than ________ ft. below land surface;

b. ☐ **Condition** to allow ground water production from no shallower than ________ ft. below land surface;

c. ☐ **Condition** to allow ground water production only from the ____________________ ground water 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 Ground Water 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. **Ground water availability remarks:**

If a permit is issued:

Recommend conditions 7B, 7F, 7N, 7T and the following special condition:

"The well shall be constructed to allow groundwater production from the lavas only. Continuous casing and seal shall extend down from above land surface through the basin fill sediments and 5 feet minimum into the lavas."

Data from the eastern Lost River sub-basin ground water investigation (Grondin, 2004) and the USGS-OWRD cooperative Upper Klamath Basin ground water investigation (Gannett and others, 2007) indicate basin long-term ground water levels are generally controlled by climate and short-term (seasonal) ground water levels are controlled by ground water use.

Additionally, the USGS (2005) has documented annual ground water level declines in the basin south of Upper Klamath Lake since 2001. The declines are greater than typically observed during drought periods. Gannett and others (2007) noted annual declines from 2001 to 2004 of 10 to 15 feet in areas south and east of the Klamath River. They appear related to the USBOR Klamath Project Water Bank. At this time, future ground water use for the USBOR water bank is uncertain, and it is uncertain whether the post-1999 ground water level declines will continue, stabilize at a lower level, or recover.

Further, the current USGS-OWRD cooperative Upper Klamath Basin ground water investigation (Gannett and others, 2007) has also found an exception to the basin-wide ground water level trends at wells in the vicinity of Upper Klamath Lake. Ground water levels at these wells are highly influenced by lake levels.

Gannett and others (2007) indicate the ground water elevation north and west of the Klamath River is above the river elevation, but drops relatively steeply toward the river to the river elevation. Then, the ground water elevation in the valley south and east of the river slopes away from the river toward the southeast at a shallower gradient.

The proposed well site is near an area that Gannett and others (2007) identifies as experiencing 10 to 20 feet of seasonal ground water level fluctuation.

In the vicinity of the proposed well site, OWRD and/or USGS staff have been measuring groundwater levels at well KLAM 10013, KLAM 11211, KLAM 51231, KLAM, 52970, and KLAM 53940 from about 2000 to present. The data show seasonal groundwater level fluctuations from 10 to 15 feet during "increased" groundwater use years (drought and water bank years) and less than 5 feet during other years. The data generally shows a total annual decline of about 5 feet from 2000 to 2005 and near full recovery to the 2000 level during a 2008 to 2009 recovery period. "Increased" groundwater use occurred again in 2010 due to a drought limiting available surface water.

The Klamath River may have contributed to 2008 and 2009 recovery observed in the vicinity of the proposed well site. Data for other wells in areas further away from the Klamath River generally do not show the 2008 and 2009 recovery.

C. GROUND WATER/SURFACE WATER CONSIDERATIONS, OAR 690-09-040

C1. **690-09-040 (1):** Evaluation of aquifer confinement:

Well	Aquifer or Proposed Aquifer	Confined	Unconfined
1	**Basalt**	☐	☒
2		☐	☐
3		☐	☐

Basis for aquifer confinement evaluation:

This review assumes and requires the well to be completed in the predominantly basalt unit below the predominantly basin fill deposits.

The groundwater system is identified as generally unconfined with discontinuous low permeability layers causing local (discontinuous, limited) confinement. Generally, low transmissivity (low permeability) sediment of varying thickness overlies high transmissivity (high permeability) basalt. Ground water occurs in both the sediment and basalt.

Water well reports (well logs) for wells in the vicinity of the proposed well site indicate the sediment thickness varies from less than 50 feet to more than 850 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?			Potential for Subst. Interfer. Assumed?	
						YES	**NO**	**ASSUMED**	**YES**	**NO**
1	**1**	**Klamath River**	**4075**	**4085**	**7400**	☒	☐	☐	☐	☒
1	**2**	**Lost River**	**4075**	**4073**	**32200**	☒	☐	☐	☐	☒
						☐	☐	☐	☐	☐

Basis for aquifer hydraulic connection evaluation:

The static water level in the table above is based upon the land surface elevation and reported static water levels for wells KLAM 51231, KLAM 14521, KLAM 52970, KLAM 53940, and KLAM 52916. This yields a static water level of about 4075 ft above mean sea level which is consistent with what Gannett and others (2007) show for the area.

Gannett and others (2007) indicate the ground water elevation north and west of the Klamath River is above the river elevation, but drops relatively steeply toward the river to the river elevation. Then, the ground water elevation in the valley south and east of the river slopes away from the river toward the southeast at a shallower gradient.

Given available data, it appears ground water at the proposed well (KLAM 52824) is hydraulically connected to the Klamath River and Lost River.

Water Availability Basin the well(s) are located within:

KLAMATH R > PACIFIC OCEAN - AB JOHN C BOYLE RES
LOST R > TULE L – AT STATE LINE

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:

The proposed well site is more than 1.00 mile from the Klamath River and the Lost River.

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	**22.7%**	**20.9%**	**18.9%**	**2.3%**	**5.6 %**	**9.6%**	**13.6%**	**17.4%**	**20.8%**	**24.0%**	**24.9%**	**24.3%**
Well Q as CFS		**0.00**	**0.00**	**0.00**	**2.56**	**2.56**	**2.56**	**2.56**	**2.56**	**2.56**	**2.56**	**0.00**	**0.00**
Interference CFS		**0.582**	**0.536**	**0.485**	**0.058**	**0.143**	**0.246**	**0.349**	**0.446**	**0.533**	**0.615**	**0.639**	**0.623**
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													
(A) = Total Interf.		**0.582**	**0.536**	**0.485**	**0.058**	**0.143**	**0.246**	**0.349**	**0.446**	**0.533**	**0.615**	**0.639**	**0.623**
(B) = 80 % Nat. Q		**1400**	**1530**	**1710**	**2240**	**2110**	**1670**	**1180**	**915**	**831**	**810**	**955**	**1240**
(C) = 1 % Nat. Q		**14.00**	**15.30**	**17.10**	**22.40**	**21.10**	**16.70**	**11.80**	**9.15**	**8.31**	**8.10**	**9.55**	**12.40**
(D) = (A) > (C)		**No**	**No**	**No**	**No**	**No**	**No**	**No**	**No**	**No**	**No**	**No**	**No**
(E) = (A / B) x 100		**0.042**	**0.035**	**0.028**	**0.003**	**0.007**	**0.015**	**0.030**	**0.049**	**0.064**	**0.076**	**0.067**	**0.050**

(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:

The proposed well site is more than 1.00 mile from the Klamath River.

Given available data, it appears ground water at the proposed well site is hydraulically connected to the Klamath River.

Interference at the Klamath River was calculated using Hunt (2003) given the well will likely be required to obtain ground water predominantly from basalt below basin fill. The values used in the model were basalt transmissivity of 31,100 ft2/day (based upon specific capacity data for nearby wells KLAM 51231; it is within the range of values in Gannett and others (2007)), an intermediate storage coefficient of 0.001, and a basin fill thickness of 100 feet (basin fill near the Klamath River varies) with a hydraulic conductivity of 2.09 ft/day based upon Upper Lost River sub-basin data.

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	**2**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**
Well Q as CFS		**0.00**	**0.00**	**0.00**	**2.56**	**2.56**	**2.56**	**2.56**	**2.56**	**2.56**	**2.56**	**0.00**	**0.00**
Interference CFS		**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**

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													

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(A) = Total Interf.	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
(B) = 80 % Nat. Q	**182.0**	**403.0**	**453.0**	**336.0**	**223.0**	**139.0**	**124.0**	**110.0**	**97.0**	**95.4**	**104.0**	**151.0**
(C) = 1 % Nat. Q	**1.820**	**4.030**	**4.530**	**3.360**	**2.230**	**1.390**	**1.240**	**1.100**	**0.970**	**0.954**	**1.040**	**1.510**
(D) = (A) > (C)	**No**	**No**	**No**	**No**	**No**	**No**	**No**	**No**	**No**	**No**	**No**	**No**
(E) = (A / B) x 100	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**

(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:

The proposed well site is more than 1.00 mile from the Lost River.

Given available data, it appears ground water at the proposed well site is hydraulically connected to the Lost River.

Interference at the Lost River was calculated using Hunt (2003) given the well will likely be required to obtain ground water predominantly from basalt below basin fill. The values used in the model were basalt transmissivity of 31,100 ft2/day (based upon specific capacity data for nearby wells KLAM 51231; it is within the range of values in Gannett and others (2007)), an intermediate storage coefficient of 0.001, and a basin fill thickness of 1000 feet (basin fill near the Lost River varies) with a hydraulic conductivity of 2.09 ft/day based upon Upper Lost River sub-basin data.

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 ground water 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**

If a permit is issued:

Recommend conditions 7B, 7F, 7N, 7T and the following special condition:

"The well shall be constructed to allow groundwater production from the lavas only. Continuous casing and seal shall extend down from above land surface through the basin fill sediments and 5 feet minimum into the lavas."

The proposed well site is near an area that Gannett and others (2007) identifies as experiencing 10 to 20 feet of seasonal ground water level fluctuation.

In the vicinity of the proposed well site, OWRD and/or USGS staff have been measuring groundwater levels at well KLAM 10013, KLAM 11211, KLAM 51231, KLAM, 52970, and KLAM 53940 from about 2000 to present. The data show seasonal groundwater level fluctuations from 10 to 15 feet during "increased" groundwater use years (drought and water bank years) and less than 5 feet during other years. The data generally shows a total annual decline of about 5 feet from 2000 to 2005 and near full recovery to the 2000 level during a 2008 to 2009 recovery period. "Increased" groundwater use occurred again in 2010 due to a drought limiting available surface water.

The Klamath River may have contributed to 2008 and 2009 recovery observed in the vicinity of the proposed well site. Data for other wells in areas further away from the Klamath River generally do not show the 2008 and 2009 recovery.

References Used:

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

USGS, 2005. Assessment of the Klamath Project pilot water bank: a review from a hydrologic perspective. Prepared by the U.S. Geological Survey Oregon Water Science Center, Portland, Oregon for the U.S. Bureau of Reclamation Klamath Basin Area Office, Klamath Falls, Oregon, May 3, 2005.

Grondin, G.H., 2004. Ground Water in the Eastern Lost River Sub-Basin, Langell, Yonna, Swan Lake, and Poe Valleys of Southeastern Klamath County, Oregon. Ground Water Report 41, Oregon Water Resources Department, Salem, Oregon.

Leonard, A.R. and Harris, A.B. 1974. Ground water in selected areas in the Klamath Basin, Oregon. OWRD Ground Water Report No. 21, 104 pgs.

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

Theis, C.V. 1935. The relation between the lowering of the piezometric surface and the rate and duration of discharge of a well using ground water storage. American Geophysical Union Transactions, 16 annual meeting, vol. 16, pg. 519-524.

Hydrographs and ground water level data for wells KLAM 10013, KLAM 11211, KLAM 51231, KLAM 52970, KLAM 53940

USGS Worden and Klamath Falls quadrangle maps (1:24,000 scale)

D. WELL CONSTRUCTION, OAR 690-200

D1. **Well #:** ______________________ **Logid:** ______________________

D2. **THE WELL does not 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**:
- a. ☐ constitutes a health threat under Division 200 rules;
- b. ☐ commingles water from more than one ground water reservoir;
- c. ☐ permits the loss of artesian head;
- d. ☐ permits the de-watering of one or more ground water reservoirs;
- e. ☐ other: (specify) ______________________

D4. **THE WELL construction deficiency is described as follows:** ______________________

D5. **THE WELL** a. ☐ **was**, *or* ☐ **was not** constructed according to the standards in effect at the time of original construction or most recent modification.

b. ☐ I don't know if it met standards at the time of construction.

Comment: ______________________

D6. ☐ **Route to the Enforcement Section.**

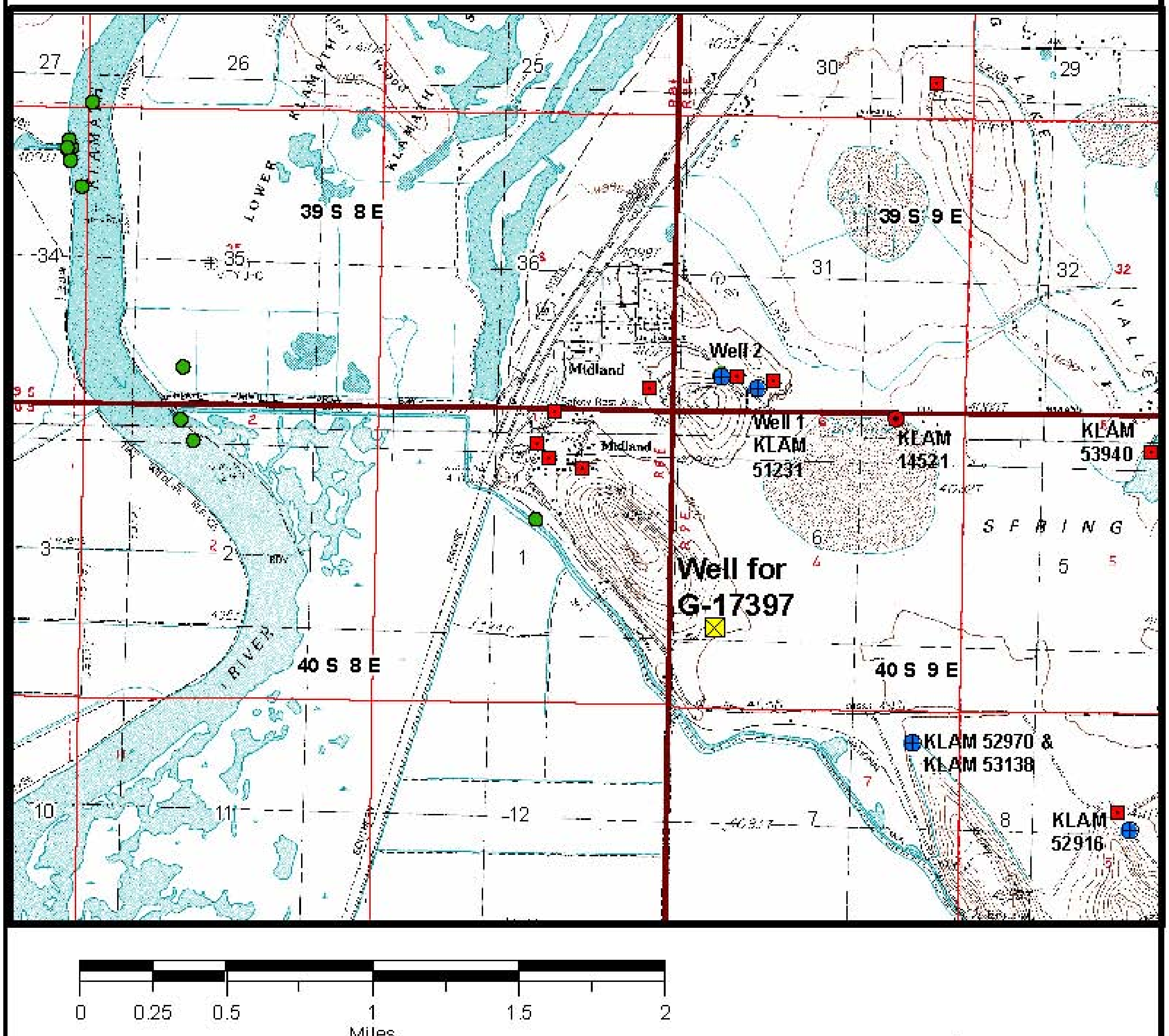
THIS SECTION TO BE COMPLETED BY ENFORCEMENT PERSONNEL

D7. ☐ Well construction deficiency has been corrected by the following actions: ______________________

______________________ ______________________, 200____.
(Enforcement Section Signature)

D8. ☐ **Route to Water Rights Section (attach well reconstruction logs to this page).**

Groundwater Application G-17397
Carland Family Trust

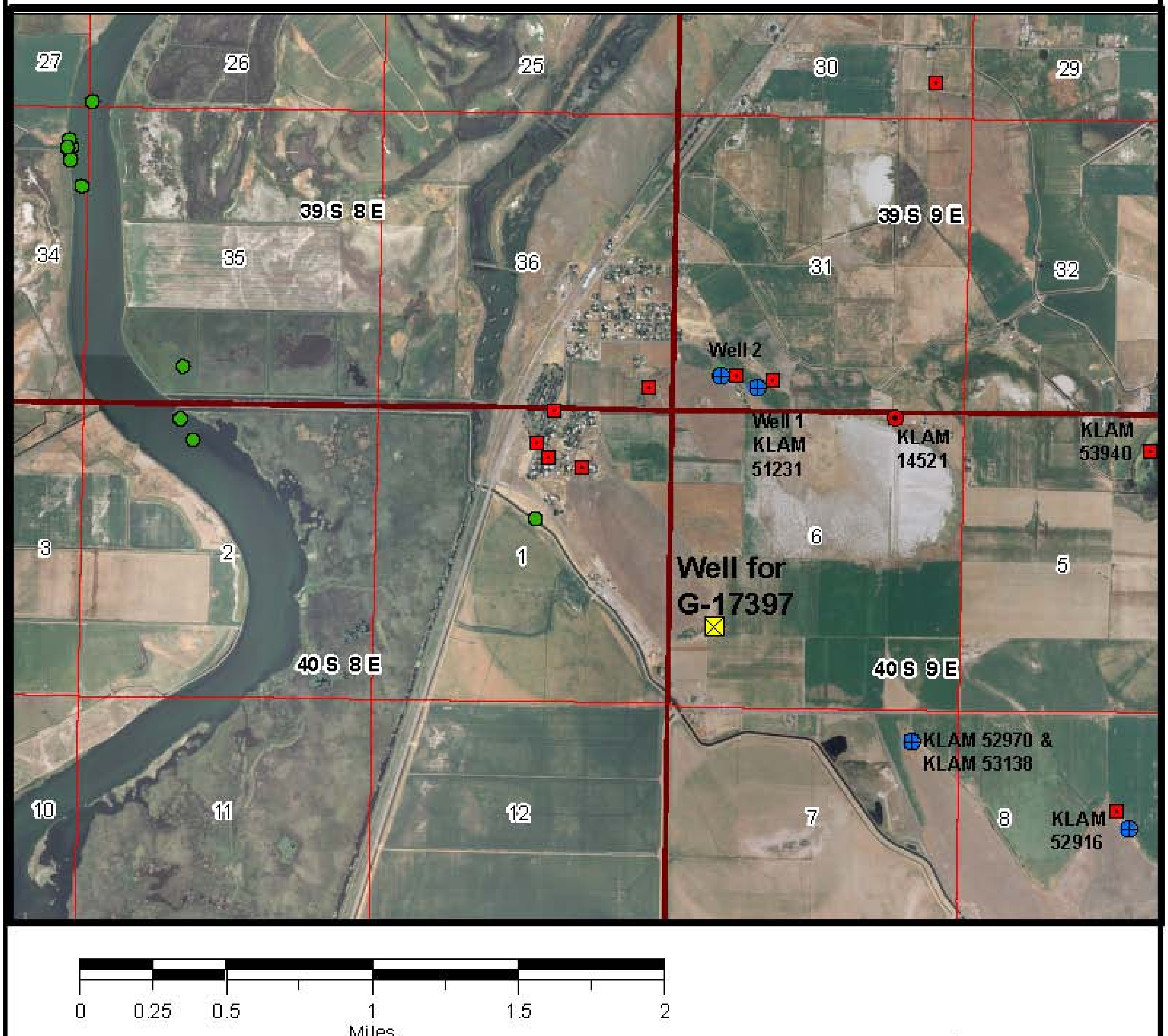


Yellow = Existing & Proposed Wells
Red or Blue = Other Wells

Green = Surface Water Rights

N

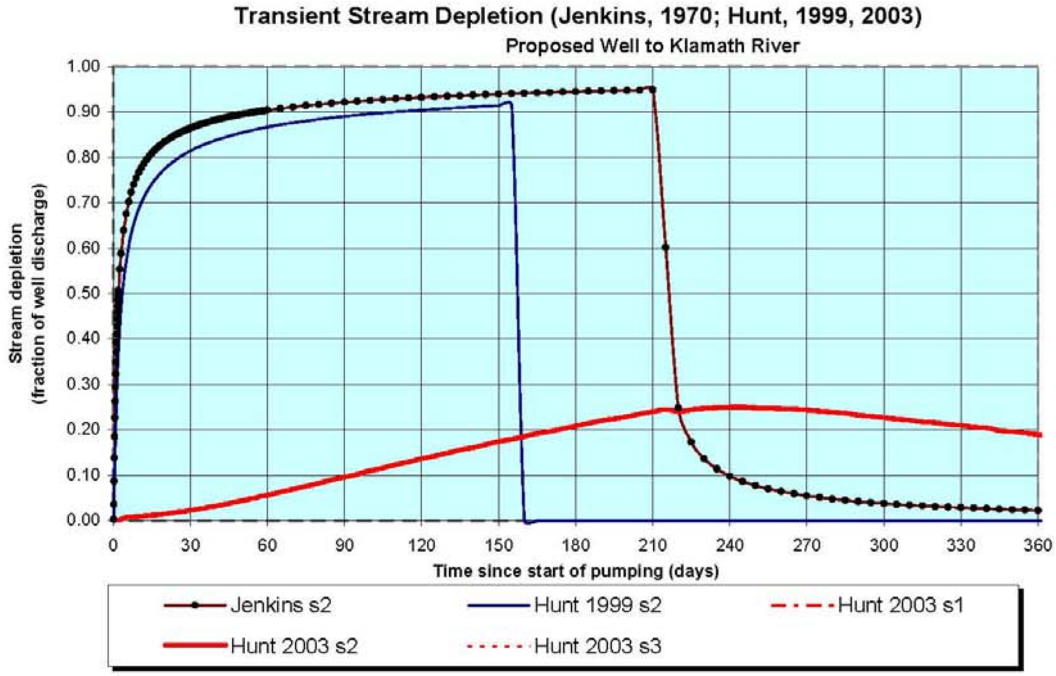
Groundwater Application G-17397
Carland Family Trust



Yellow = Existing & Proposed Wells
Red or Blue = Other Wells

Green = Surface Water Rights

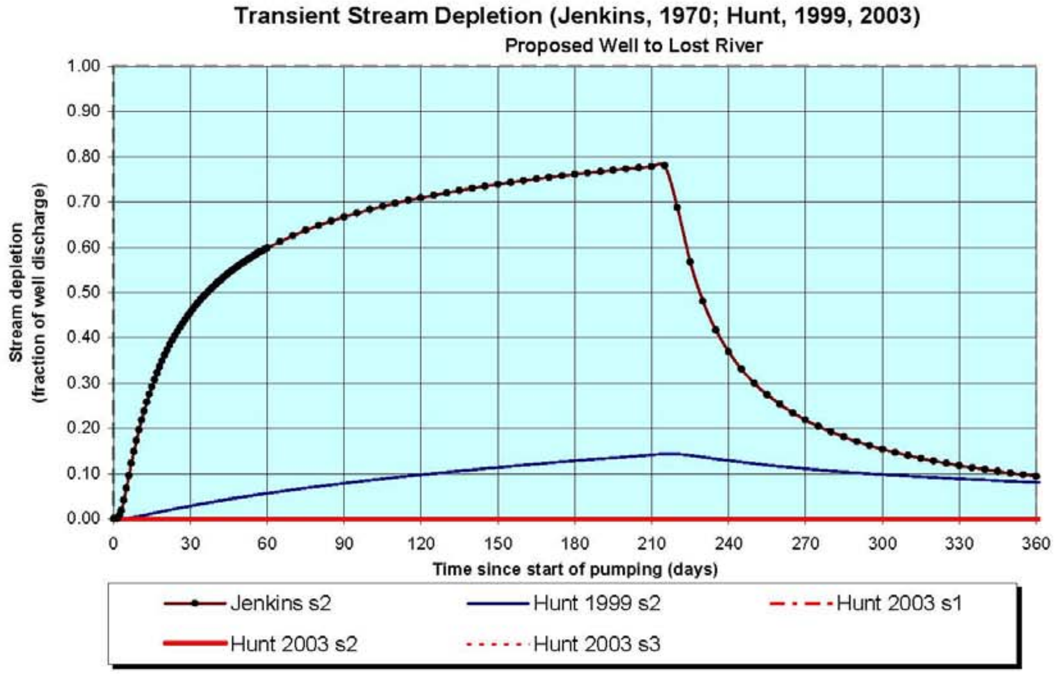
N



Output for Stream Depletion, Scenerio 2 (s2):						Time pump on (pumping duration) = 214 days						
Days	30	60	90	120	150	180	210	240	270	300	330	360
J SD	86.4%	90.4%	92.1%	93.2%	93.9%	94.4%	94.8%	9.8%	5.4%	3.7%	2.8%	2.2%
H SD 1999	81.4%	86.6%	89.0%	90.4%	91.4%	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!
H SD 2003	2.3%	5.6%	9.6%	13.6%	17.4%	20.8%	24.0%	24.9%	24.3%	22.7%	20.9%	18.9%
Qw, cfs	2.560	2.560	2.560	2.560	2.560	2.560	2.560	2.560	2.560	2.560	2.560	2.560
H SD 99, cfs	2.084	2.218	2.278	2.315	2.340	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!
H SD 03, cfs	0.058	0.143	0.246	0.349	0.446	0.533	0.615	0.639	0.623	0.582	0.536	0.485

Parameters:		Scenario 1	Scenario 2	Scenario 3	Units
Net steady pumping rate of well	Qw	2.56	2.56	2.56	cfs
Time pump on (pumping duration)	tpon	214	214	214	days
Perpendicular from well to stream	a	7400	7400	7400	ft
Well depth	d	500	500	500	ft
Aquifer hydraulic conductivity	K	62.2	62.2	62.2	ft/day
Aquifer saturated thickness	b	500	500	500	ft
Aquifer transmissivity	T	31100	31100	31100	ft*ft/day
Aquifer storativity or specific yield	S	0.001	0.001	0.001	
Aquitard vertical hydraulic conductivity	Kva	2.09	2.09	2.09	ft/day
Aquitard saturated thickness	ba	100	100	100	ft
Aquitard thickness below stream	babs	75	75	75	ft
Aquitard porosity	n	0.2	0.2	0.2	
Stream width	ws	850	850	850	ft
Streambed conductance (lambda)	sbc	23.686667	23.686667	23.686667	ft/day
Stream depletion factor	sdf	1.760772	1.760772	1.760772	days
Streambed factor	sbf	5.636056	5.636056	5.636056	
input #1 for Hunt's Q_4 function	t'	0.567933	0.567933	0.567933	
input #2 for Hunt's Q_4 function	K'	36.800129	36.800129	36.800129	
input #3 for Hunt's Q_4 function	epsilon'	0.005000	0.005000	0.005000	
input #4 for Hunt's Q_4 function	lamda'	5.636056	5.636056	5.636056	

G_17397_Carland_Midland_Klamath_River_sd_hunt_2003_1.01.xls

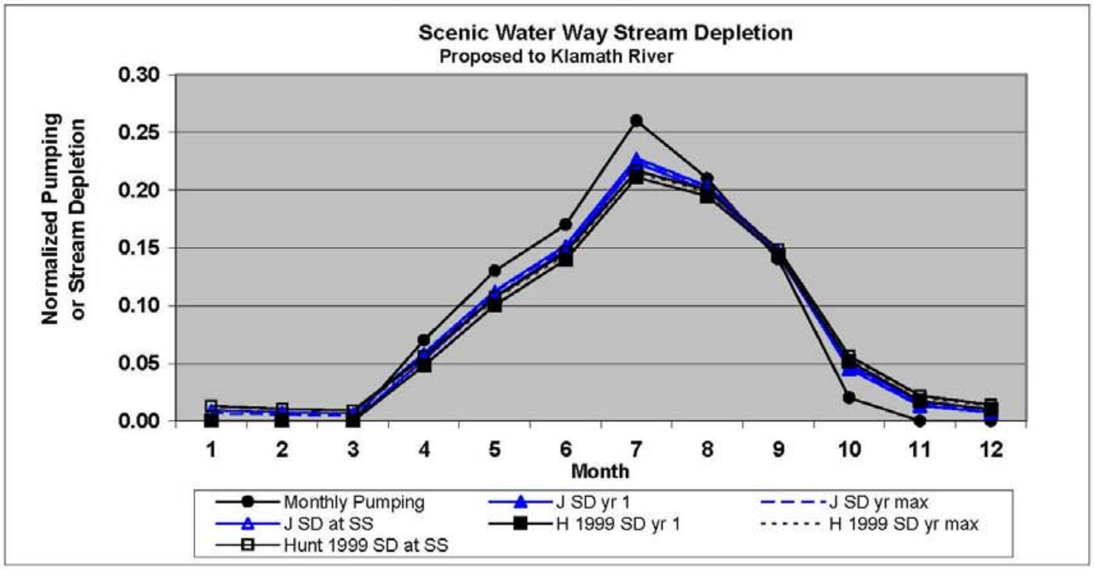


Output for Stream Depletion, Scenerio 2 (s2):					Time pump on (pumping duration) = 214 days							
Days	30	60	90	120	150	180	210	240	270	300	330	360
J SD	45.6%	59.8%	66.7%	70.9%	73.9%	76.1%	77.8%	36.9%	21.8%	15.4%	11.8%	9.4%
H SD 1999	2.9%	5.7%	7.9%	9.7%	11.4%	12.8%	14.1%	12.9%	11.1%	9.8%	8.9%	8.1%
H SD 2003	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Qw, cfs	2.560	2.560	2.560	2.560	2.560	2.560	2.560	2.560	2.560	2.560	2.560	2.560
H SD 99, cfs	0.073	0.145	0.202	0.249	0.291	0.328	0.361	0.329	0.284	0.251	0.227	0.208
H SD 03, cfs	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Parameters:		Scenario 1	Scenario 2	Scenario 3	Units
Net steady pumping rate of well	Qw	2.56	2.56	2.56	cfs
Time pump on (pumping duration)	tpon	214	214	214	days
Perpendicular from well to stream	a	32200	32200	32200	ft
Well depth	d	500	500	500	ft
Aquifer hydraulic conductivity	K	62.2	62.2	62.2	ft/day
Aquifer saturated thickness	b	500	500	500	ft
Aquifer transmissivity	T	31100	31100	31100	ft*ft/day
Aquifer storativity or specific yield	S	0.001	0.001	0.001	
Aquitard vertical hydraulic conductivity	Kva	2.09	2.09	2.09	ft/day
Aquitard saturated thickness	ba	1000	1000	1000	ft
Aquitard thickness below stream	babs	950	950	950	ft
Aquitard porosity	n	0.2	0.2	0.2	
Stream width	ws	75	75	75	ft
Streambed conductance (lambda)	sbc	0.165000	0.165000	0.165000	ft/day
Stream depletion factor	sdf	33.338907	33.338907	33.338907	days
Streambed factor	sbf	0.170836	0.170836	0.170836	
input #1 for Hunt's Q_4 function	t'	0.029995	0.029995	0.029995	
input #2 for Hunt's Q_4 function	K'	69.678315	69.678315	69.678315	
input #3 for Hunt's Q_4 function	epsilon'	0.005000	0.005000	0.005000	
input #4 for Hunt's Q_4 function	lamda'	0.170836	0.170836	0.170836	

G_17397_Carland_Midland_Klamath_River_sd_hunt_2003_1.01.xls

Oregon Water Resources Department



Region	18	Steady state stream depletion as a fraction of pumping normalized to crop water use consumption.											
Month	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec	Resid
Qw	0.00	0.00	0.00	0.07	0.13	0.17	0.26	0.21	0.14	0.02	0.00	0.00	0.00
Jenkins SD													
yr1	0.000	0.000	0.000	0.053	0.108	0.148	0.223	0.200	0.144	0.045	0.013	0.007	0.059
yrmax-1	0.007	0.006	0.005	0.057	0.111	0.151	0.226	0.203	0.147	0.047	0.016	0.009	0.015
yrmax	0.007	0.006	0.005	0.057	0.111	0.151	0.226	0.203	0.147	0.047	0.016	0.009	0.015
yrmax-yr1	0.007	0.006	0.005	0.004	0.004	0.003	0.003	0.003	0.003	0.002	0.002	0.002	0.044
J SD SS	**0.009**	**0.008**	**0.006**	**0.059**	**0.113**	**0.152**	**0.228**	**0.204**	**0.148**	**0.048**	**0.016**	**0.010**	**0.000**
Hunt SD 1999													
yr 1	0.000	0.000	0.000	0.048	0.100	0.140	0.211	0.195	0.144	0.052	0.017	0.010	0.083
yr max-1	0.010	0.008	0.007	0.054	0.105	0.144	0.215	0.199	0.148	0.055	0.021	0.013	0.022
yr max	0.010	0.008	0.007	0.054	0.105	0.144	0.215	0.199	0.148	0.055	0.021	0.013	0.022
yrmax-yr1	0.010	0.008	0.007	0.006	0.005	0.005	0.004	0.004	0.004	0.003	0.003	0.003	0.062
H99 SD SS	**0.013**	**0.011**	**0.009**	**0.056**	**0.107**	**0.146**	**0.217**	**0.200**	**0.149**	**0.056**	**0.022**	**0.014**	**0.000**

Parameters:		Values	Units	
Maximum number of years pumped	yrmax	25	years	
Days pumped each month	tpoff	30.4375	days/month	
Perpendicular from well to stream	a	7400	ft	
Well depth	d	500	ft	
Aquifer hydraulic conductivity	K	62.2	ft/day	
Aquifer saturated thickness	b	500	ft	
Aquifer transmissivity	T_ft	31,100	ft*ft/day	= K*b
Aquifer transmissivity	T_gal	232,628	gpd/ft	= K*b
Aquifer storativity or specific yield	S	0.001		
Streambed conductivity (Hunt 1999)	Ks	2.09	ft/day	
Streambed thickness, Hunt 1999	bs	75	ft	
Stream width (Hunt 1999)	ws	850	ft	
Streambed conductance (lambda)	sbc	23.6867	ft/day	= Ks*ws/bs
Stream depletion factor	sdf	1.7608	days	= (a^2*S)/(T)
Streambed factor	sbf	5.6361		= sbc*a/T

S:\groups\gwater\grondin\areas\klamath\water_rights\Applications_GW\G_17397_Carland_Midland_Klamath_River_scenic_stream_depletion_sd_1033_3_30.xls

Transmissivity from Specific Capacity using the Theis Equation

Adapted from Vorhis (1979)

Theis Equation: T = [Q/(4*s*pi)][W(u)]
u = (r*r*S)/(4*T*t)
W(u) = (-ln u)-(0.5772157)+(u/1*1!)-(u*u/2*2!)+(u*u*u/3*3!)-(u*u*u*u/4*4!)+...

T = transmissivity (L*L/T)
s = drawdown (L)
S = storage coefficient (dimensionless)
pi = 3.141592654
r = radial distance (L)
t = time (T)
u = dimensionless
W(u) = well function

Note: Transmissivity is derived using an iterative process
The calculations use a known or assumed Storage Coeficient (S) provided by the user
Specific Capacity (Q/s) is used to first approximate the Transmissivity (T) used to calculate u in the first Theis equation iteration
The Transmissivity of the previous iteration is used to calculate u in a given Theis equation iteration
Total Theis Equation iterations = 25 iterations
Can accept answer if difference in calculated Transmissivity for the last 2 iterations is < 0.0001
Can accept answer if u in the last iteration is < 7.1

Note: Well efficiency is not included in the calculations

References:

Theis, C.V. 1935. The relation between the lowering of the piezometric surface and the rate and duration of discharge of a well using ground water storage. American Geophysical Union Transactions, 16 annual meeting, vol. 16, pg. 519-524.

Vorhis, R.C. 1979. Transmissivity from pumped well data. Well Log, National Water Well Association newsletter, vol. 10, no. 11, Dec. 1979, pg. 50-52.

Data Entry	Enter Data Below (yellow boxes only)	
Well Log ID or Comment for Records	KLAM 51231	
Pumping Rate (gpm) = Q =	1,100.00	(gpm)
Drawdown (feet) = s =	10.00	(feet)
Time (hours) = t =	4.0000	(hours)
Storage Coefficient = S =	0.001000	(dimensionless)
Well Diameter (inches) = d =	8.0000	(inches)
	Press F9 to Calculate	

Calculated Results	Calculated Results	
Transmissivity (ft2/day) = T =	31,119.36	(ft2/day)
Transmissivity (gpd/ft) = T =	232,789.00	(gpd/ft)
Transmissivity Difference = (last 2 iterations)	0.0000E+00 okay to use T if diff < 0.0001	(ft2/day)
u = (last iteration)	5.3557E-09 okay to use T if u <7.1	

Drawdown s (feet)	Storage Coefficient S	Pumping Rate Q (gal/min)	Pumping Rate Q (ft3/sec)	Time t (days)	Distance r = d/2 (feet)	u	W(u)	Transmissivity T (ft2/day)	Transmissivity difference from previous	Comments	Theis Equation Iteration
Note:	yellow grid areas are where values are calculated					Note : W(u) calculation valid when u < 7.1					
						7.0000	1.1545E-04			W(u) calculation test	
10.00	0.00100	1,100.00	2.45	0.17	0.33			21,175.00		T = Q/s	
10.00	0.00100	1,100.00	2.45	0.17	0.33	7.8709E-09	18.0829	30,470.60	9.2956E+03	T = Theis Equation	1.00
10.00	0.00100	1,100.00	2.45	0.17	0.33	5.4698E-09	18.4468	31,083.86	6.1326E+02	T = Theis Equation	2.00
10.00	0.00100	1,100.00	2.45	0.17	0.33	5.3618E-09	18.4667	31,117.44	3.3577E+01	T = Theis Equation	3.00
10.00	0.00100	1,100.00	2.45	0.17	0.33	5.3561E-09	18.4678	31,119.26	1.8192E+00	T = Theis Equation	4.00
10.00	0.00100	1,100.00	2.45	0.17	0.33	5.3557E-09	18.4679	31,119.36	9.8511E-02	T = Theis Equation	5.00
10.00	0.00100	1,100.00	2.45	0.17	0.33	5.3557E-09	18.4679	31,119.36	5.3342E-03	T = Theis Equation	6.00
10.00	0.00100	1,100.00	2.45	0.17	0.33	5.3557E-09	18.4679	31,119.36	2.8884E-04	T = Theis Equation	7.00
10.00	0.00100	1,100.00	2.45	0.17	0.33	5.3557E-09	18.4679	31,119.36	1.5640E-05	T = Theis Equation	8.00
10.00	0.00100	1,100.00	2.45	0.17	0.33	5.3557E-09	18.4679	31,119.36	8.4687E-07	T = Theis Equation	9.00
10.00	0.00100	1,100.00	2.45	0.17	0.33	5.3557E-09	18.4679	31,119.36	4.5857E-08	T = Theis Equation	10.00
10.00	0.00100	1,100.00	2.45	0.17	0.33	5.3557E-09	18.4679	31,119.36	2.4847E-09	T = Theis Equation	11.00
10.00	0.00100	1,100.00	2.45	0.17	0.33	5.3557E-09	18.4679	31,119.36	1.3461E-10	T = Theis Equation	12.00
10.00	0.00100	1,100.00	2.45	0.17	0.33	5.3557E-09	18.4679	31,119.36	0.0000E+00	T = Theis Equation	13.00
10.00	0.00100	1,100.00	2.45	0.17	0.33	5.3557E-09	18.4679	31,119.36	0.0000E+00	T = Theis Equation	14.00
10.00	0.00100	1,100.00	2.45	0.17	0.33	5.3557E-09	18.4679	31,119.36	0.0000E+00	T = Theis Equation	15.00
10.00	0.00100	1,100.00	2.45	0.17	0.33	5.3557E-09	18.4679	31,119.36	0.0000E+00	T = Theis Equation	16.00
10.00	0.00100	1,100.00	2.45	0.17	0.33	5.3557E-09	18.4679	31,119.36	0.0000E+00	T = Theis Equation	17.00
10.00	0.00100	1,100.00	2.45	0.17	0.33	5.3557E-09	18.4679	31,119.36	0.0000E+00	T = Theis Equation	18.00
10.00	0.00100	1,100.00	2.45	0.17	0.33	5.3557E-09	18.4679	31,119.36	0.0000E+00	T = Theis Equation	19.00
10.00	0.00100	1,100.00	2.45	0.17	0.33	5.3557E-09	18.4679	31,119.36	0.0000E+00	T = Theis Equation	20.00
10.00	0.00100	1,100.00	2.45	0.17	0.33	5.3557E-09	18.4679	31,119.36	0.0000E+00	T = Theis Equation	21.00
10.00	0.00100	1,100.00	2.45	0.17	0.33	5.3557E-09	18.4679	31,119.36	0.0000E+00	T = Theis Equation	22.00
10.00	0.00100	1,100.00	2.45	0.17	0.33	5.3557E-09	18.4679	31,119.36	0.0000E+00	T = Theis Equation	23.00
10.00	0.00100	1,100.00	2.45	0.17	0.33	5.3557E-09	18.4679	31,119.36	0.0000E+00	T = Theis Equation	24.00
10.00	0.00100	1,100.00	2.45	0.17	0.33	5.3557E-09	18.4679	31,119.36	0.0000E+00	T = Theis Equation	25.00