Oregon Water Resources Department

Memo

Date: March 20, 2008

To: Caseworkers, Water Rights Section

From: Doug Woodcock
Manager, Ground Water Section

Subject: Long-Term Interference in Klamath Basin

The water supply issues in Klamath basin are numerous and complex, as exemplified by the federal interest in resolving Klamath ESA and T&E concerns through the Klamath Water Bank. A very large uncertainty in future water allocation centers on the outcome of the Klamath adjudication. In addition to the current water conflicts in the basin, there will be users whose surface water claims are denied in the adjudication process and, absent a supplemental supply, will be without a water source to continue their historical farming practice and livelihood.

A cooperative ground water investigation of the Upper Klamath Basin (Ground-Water Hydrology of the Upper Klamath Basin, Oregon and California, USGS, 2007) has determined that much of the inflow to Upper Klamath Lake can be attributed to ground water discharge to streams and major spring complexes for some miles around the lake. Ground water wells that develop water from the local and regional flow systems that contribute to the lake and spring complexes will interfere with these over-appropriated surface water supplies and further exacerbate water supply problems in the basin.

Caseworkers: Not all ground water files that are determined to be hydraulically connected to surface water are assumed to have potential for substantial interference (PSI). Those files that do have PSI are then assessed for water availability. *Within the Klamath Basin* the Commission has provided direction on how non-supplemental uses are to be evaluated when the well(s) are hydraulically connected with Klamath Lake or surface waters that contribute to Klamath Lake or the Klamath River. Hydraulic connection with over-appropriated surface water is a sufficient circumstance for denial for uses other than supplemental, even in the absence of PSI.

Inserted in file: G 17278 Date: 11/23/09 Intials: KW

PUBLIC INTEREST REVIEW FOR GROUND WATER APPLICATIONS

TO: Water Rights Section Date **10 November 2009**

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

SUBJECT: Application G- **17278** 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: **Falcon Heights Water & Sewer District** County: **Klamath**

A1. Applicant(s) seek(s) (547 gpm) **1.22** cfs from **2** well(s) in the **Klamath River** Basin, **Lost River*** subbasin Quad Map: **Klamath Falls**

A2. Proposed use: **Municipal** Seasonality: **Year Round (365 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	**KLAM 12813**	**1**	**Basalt**	**0.71**	**39S/09E-sec 34 BCD**	**535' N, 654' W fr C-W 1/6 cor S 34**
2	**KLAM 12811**	**2**	**Basalt**	**0.51**	**39S/09E-sec 34 BCB**	**669' N, 965' W fr C-W 1/6 cor S 34**
3						
4						

* 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	**4215**	**135**	**236 ?**	**Oct 1956**	**500**	**0 - 417**	**0 - 417**	**None**	**None**	**240**	**1.17**	**P**
2	**4215**	**145**	**131**	**04/25/58**	**392**	**0 - 130**	**0 – 393**	**None**	**328 - 392**	**200**	**2.30**	**P**

Use data from application for proposed wells.

A4. **Comments:**

The wells are located in the Klamath River Basin, Lost River Sub-basin, Lake Ewauna-Klamath River watershed

Well KLAM 12813 (owner well 1) also has a duplicate water well report by the USGS KLAM 12812

Well KLAM 12811 (owner well 2) is sealed to a basalt flow within the predominant basin fill. The basin fill continues to 317 feet depth where the predominant basalt appears to begin at this site.

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 and 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 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:**

Recommend conditions 7B and 7N

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.

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 wells KLAM 12813 and KLAM 12811 are near an area that Gannett and others (2007) identifies as experiencing 10 to 20 feet of seasonal ground water level fluctuation.

OWRD ground water level measurements closest to the proposed wells were at well KLAM 12815 located less than 3,000 feet to the southeast. The data is from 1964 to 1998 before the USBOR water bank activity. The data shows seasonal fluctuations, an annual trend that appears climate controlled, and appears part of the ground water gradient that slopes away from the river (all consistent with Gannett and others (2007) observations for the basin).

The closest seasonal OWRD ground water level measurements that include the USBOR water bank activity period is at well KLAM 52797 located about 4.25 miles to the southeast. The data is primarily from after late 2002. There appears to be larger seasonal fluctuations and some annual decline when the water bank was most active and smaller seasonal fluctuation and a halt to the annual decline when the water bank was less or not active.

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 (based upon water well report)**	☐	☒
2	**Basalt (based upon water well report)**	☐	☒
		☐	☐
		☐	☐

Basis for aquifer confinement evaluation:

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.

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**	**Klamath River**	**?**	**4085**	**17,700**	☒	☐	☐	☐	☒
1	**2**	**Lost River**	**?**	**4075**	**17,100**	☒	☐	☐	☐	☒
						☐	☐	☐	☐	☐
2	**1**	**Klamath River**	**4084**	**4085**	**17,400**	☒	☐	☐	☐	☒
2	**2**	**Lost River**	**4084**	**4075**	**17,400**	☒	☐	☐	☐	☒
						☐	☐	☐	☐	☐

Basis for aquifer hydraulic connection evaluation:

Ground water elevation is based upon driller or other reported measurement at the wells. The measurement for KLAM 12813 (well 1) is suspect, very different from other area data. Note: 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 wells is hydraulically connected to both the Klamath River and the 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:

Both wells are more than 1.0 mile from the Klamath River and 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
		%	%	%	%	%	%	%	%	%	%	%	%
Well Q as CFS													
Interference CFS													

Distributed Wells													
Well	SW#	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	**1**	**0.3%**	**0.2%**	**0.2%**	**0.4%**	**0.7%**	**1.1%**	**1.7%**	**2.2%**	**2.9%**	**3.7%**	**4.6%**	**5.4%**
Well Q as CFS		**0.71**	**0.71**	**0.71**	**0.71**	**0.71**	**0.71**	**0.71**	**0.71**	**0.71**	**0.71**	**0.71**	**0.71**
Interference CFS		**0.002**	**0.001**	**0.002**	**0.003**	**0.005**	**0.008**	**0.012**	**0.016**	**0.021**	**0.026**	**0.032**	**0.038**
2	**1**	**0.3%**	**0.2%**	**0.3%**	**0.5%**	**0.7%**	**1.2%**	**1.8%**	**2.4%**	**3.1%**	**3.9%**	**4.9%**	**5.7%**
Well Q as CFS		**0.51**	**0.51**	**0.51**	**0.51**	**0.51**	**0.51**	**0.51**	**0.51**	**0.51**	**0.51**	**0.51**	**0.51**
Interference CFS		**0.001**	**0.001**	**0.001**	**0.002**	**0.004**	**0.006**	**0.009**	**0.012**	**0.016**	**0.020**	**0.025**	**0.029**
		%	%	%	%	%	%	%	%	%	%	%	%
Well Q as CFS													
Interference CFS													
		%	%	%	%	%	%	%	%	%	%	%	%
Well Q as CFS													
Interference CFS													
		%	%	%	%	%	%	%	%	%	%	%	%
Well Q as CFS													
Interference CFS													
(A) = Total Interf.		**0.003**	**0.002**	**0.003**	**0.005**	**0.009**	**0.014**	**0.021**	**0.028**	**0.037**	**0.046**	**0.057**	**0.067**
(B) = 80 % Nat. Q		**1470.**	**1530.**	**1710.**	**2240.**	**2110.**	**1670.**	**1180.**	**915.**	**831.**	**810.**	**955.**	**1240.**
(C) = 1 % Nat. Q		**14.70**	**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		**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.001**	**0.002**	**0.003**	**0.004**	**0.006**	**0.006**	**0.005**

(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:

Both proposed wells are more than 1.00 mile from the Klamath River.

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

Interference at the Klamath River was calculated using Hunt (2003) given the well obtains ground water predominantly from basalt below basin fill. The basin fill near the Klamath River is about 100 feet thick, but thickening toward the valley and thinning toward upland areas. The values used in the model were basalt transmissivity of 30,000 ft2/day (based upon specific capacity data for the wells and is within the range of values in Gannett and others (2007)), an intermediate storage coefficient of 0.001, basin fill thickness of 100 feet based on well log data for wells near the nearest reach of the Klamath River 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
		%	%	%	%	%	%	%	%	%	%	%	%
Well Q as CFS													
Interference CFS													
Distributed Wells													
Well	SW#	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	**2**	**0.0%**	**0.0%**	**0.0%**	**0.1%**	**0.1%**	**0.1%**	**0.1%**	**0.1%**	**0.2%**	**0.2%**	**0.2%**	**0.2%**
Well Q as CFS		**0.71**	**0.71**	**0.71**	**0.71**	**0.71**	**0.71**	**0.71**	**0.71**	**0.71**	**0.71**	**0.71**	**0.71**
Interference CFS		**0.000**	**0.000**	**0.000**	**0.000**	**0.001**	**0.001**	**0.001**	**0.001**	**0.001**	**0.001**	**0.002**	**0.002**
2	**2**	**0.0%**	**0.0%**	**0.0%**	**0.1%**	**0.1%**	**0.1%**	**0.1%**	**0.1%**	**0.2%**	**0.2%**	**0.2%**	**0.2%**
Well Q as CFS		**0.51**	**0.51**	**0.51**	**0.51**	**0.51**	**0.51**	**0.51**	**0.51**	**0.51**	**0.51**	**0.51**	**0.51**
Interference CFS		**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.001**	**0.001**	**0.001**	**0.001**	**0.001**	**0.001**
		%	%	%	%	%	%	%	%	%	%	%	%
Well Q as CFS													
Interference CFS													
		%	%	%	%	%	%	%	%	%	%	%	%
Well Q as CFS													
Interference CFS													
		%	%	%	%	%	%	%	%	%	%	%	%
Well Q as CFS													
Interference CFS													
(A) = Total Interf.		**0.000**	**0.000**	**0.000**	**0.000**	**0.001**	**0.001**	**0.002**	**0.002**	**0.002**	**0.002**	**0.003**	**0.003**
(B) = 80 % Nat. Q		**182.0**	**403.0**	**453.0**	**336.0**	**223.0**	**139.0**	**124.0**	**110.0**	**97.00**	**95.40**	**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**	**0.001**	**0.002**	**0.002**	**0.002**	**0.002**	**0.003**	**0.002**

(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:

Both proposed wells are more than 1.00 mile from the Lost River.

Given available data, it appears ground water at the proposed wells is hydraulically connected to the Lost River. The connection with the Lost River appears to be primarily at the nearest reach and northeast. Further south towards Merrill, it appears the ground water elevation drops below the Lost River.

Interference at the Lost River was calculated using Hunt (2003) given the well obtains ground water predominantly from basalt below basin fill. The basin fill in this vicinity near the Lost River likely exceeds 500 feet thickness, but thins to less than 100 feet near the upland areas. The values used in the model were basalt transmissivity of 30,000 ft2/day (based upon specific capacity data for the wells and is within the range of values in Gannett and others (2007)), an intermediate storage coefficient of 0.001, basin fill thickness of 1,000 based on well KLAM 52824 with a hydraulic conductivity of 2.09 ft/day based upon Upper Lost River sub-basin data.

The potential interference with distant springs to the northeast (west of Olene Gap) was not evaluated due conditions that exceed assumptions and capabilities of models currently available for analyses.

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**

Recommend conditions 7B and 7N

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 12815, KLAM 52797

Water well reports (well logs) for wells within 39S/09E-sec 34 and neighbor sections

USGS Klamath Falls quadrangle map (1:24,000 scale)

D. WELL CONSTRUCTION, OAR 690-200

D1. **Well #**: 1 **Logid**: KLAM 12813
Well #: 2 **Logid**: KLAM 12811

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 #1** 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.

THE WELL #2 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.

D6. ☐ **Route to the Enforcement Section.** I recommend withholding issuance of the permit until evidence of well reconstruction is filed with the Department and approved by the Enforcement Section and the Ground Water Section.

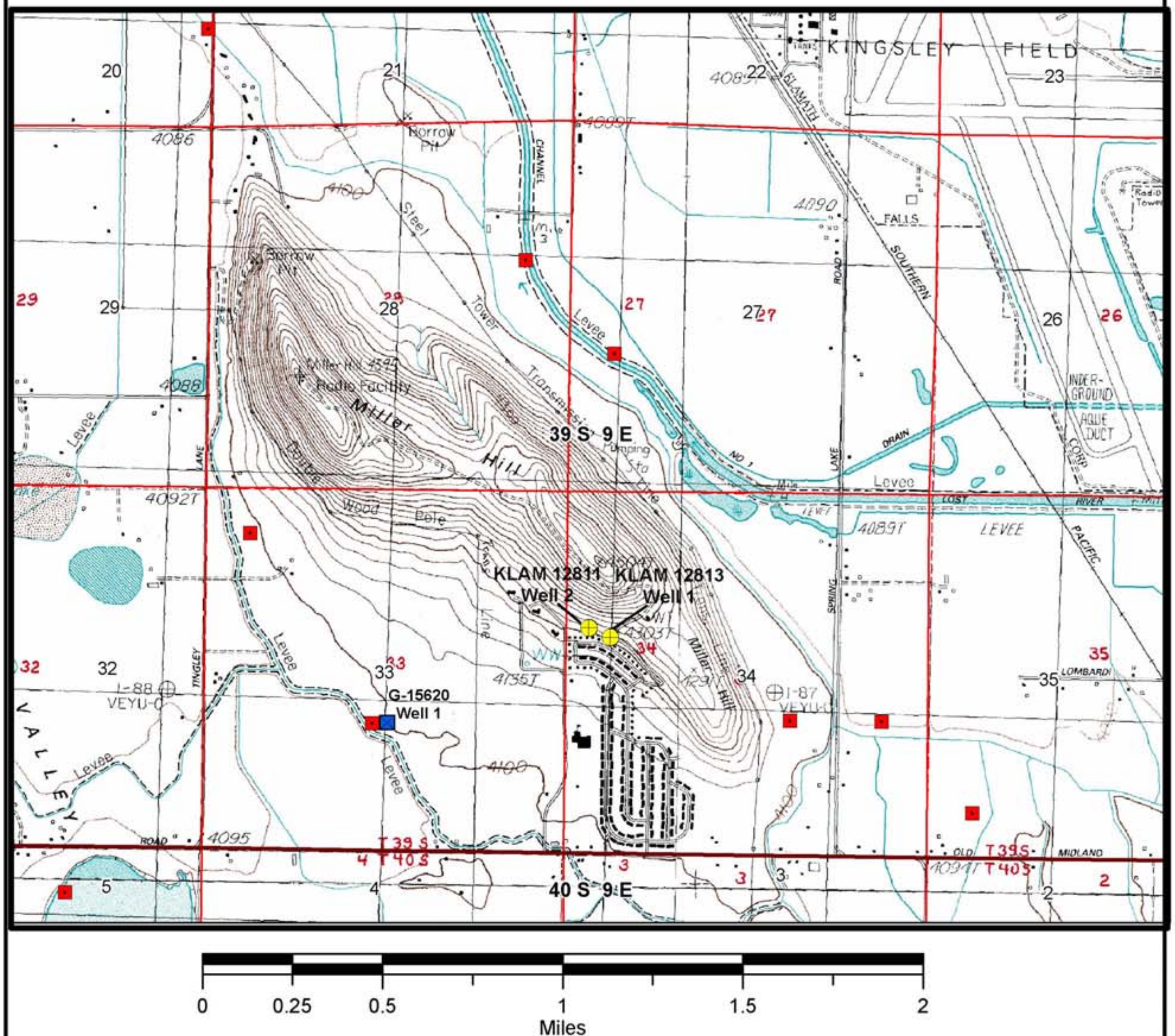
THIS SECTION TO BE COMPLETED BY ENFORCEMENT PERSONNEL

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).**

Water Right Application G-17278
Falcon Heights Water & Sewer District



Yellow = Proposed Wells
Red or Blue = Other Wells

Green = Surface Water Rights

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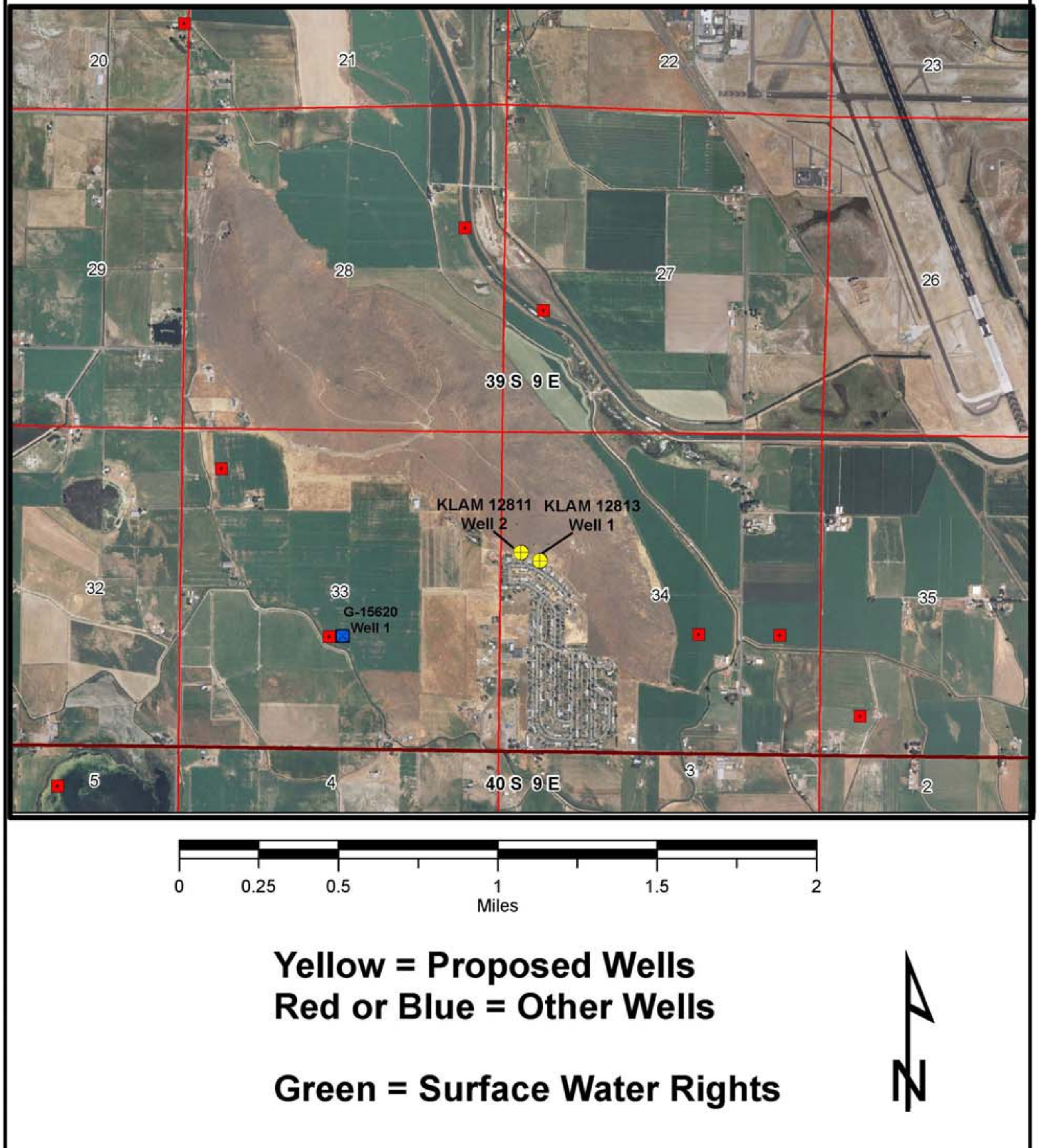
Falcon Heights Water & Sewer District



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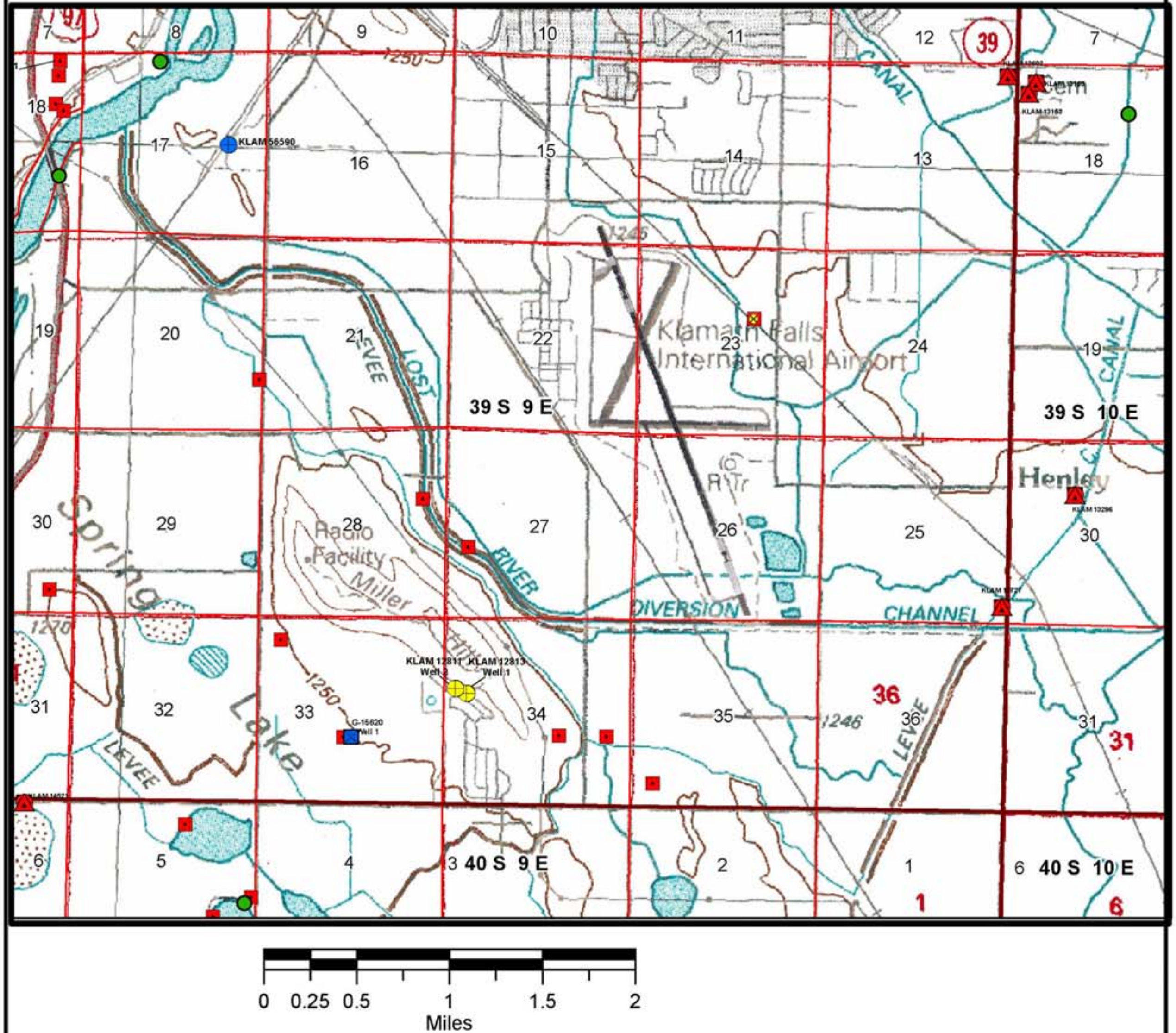

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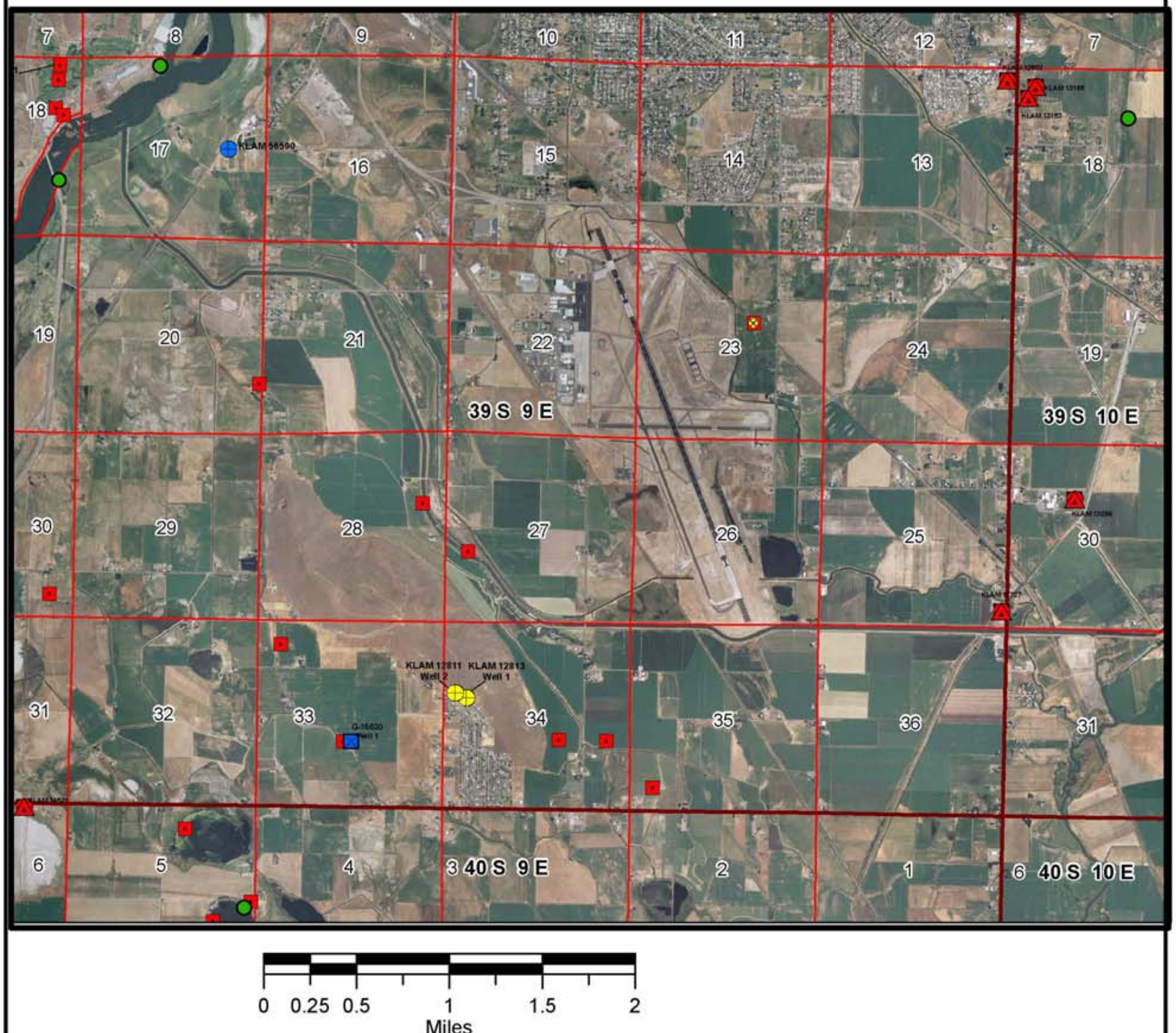

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Green = Surface Water Rights

ORIGINAL
File Original, and Duplicate with the STATE ENGINEER, SALEM, OREGON

NOV 7 1956 STATE ENGINEER SALEM, OREGON

WATER WELL DRILLERS REPORT
STATE OF OREGON KLAM 12813

Do Not Fill In — State Well No. 39/9-34E
State Permit No.

(1) OWNER:
Name U.S.A.F. Housing Project Test Well
Address 408th Fighter Group, Klamath Falls, Municipal Airport, Klamath Falls, Ore.

(2) LOCATION OF WELL:
County Klamath Owner's number, if any— I
R. F. D. or Street No.
Bearing and distance from section or subdivision corner
N52°E 825' - from West 1/4 Corner
See attached schedule Sect. 34
T39S R9E

(3) TYPE OF WORK (check):
New well ☒ Deepening ☐ Reconditioning ☐ Abandon ☐
If abandonment, describe material and procedure in Item 11.

(4) PROPOSED USE (check):
Domestic ☐ Industrial ☐ Municipal ☐
Irrigation ☐ Test Well ☒ Other ☐

(5) EQUIPMENT:
Rotary ☐
Cable ☒
Dug Well ☐

(6) CASING INSTALLED: — If gravel packed
Threaded ☒ Welded ☒

FROM ft. to ft. Diam.	Gage or Wall	Diameter of Bore	from ft.	to ft.
0 ft." 214 "ft. 8"				
"8" Std. T.C.				
214 ft. 2" "to 416' 10"				
"8" I.D. x "1/4" Wall				

Type and size of shoe or well ring 5/8X 5" Size of gravel:
Describe joint Welded

(7) PERFORATIONS:
Type of perforator used None
SIZE of perforations in., length, by in.
FROM ft. to ft. perf per foot No. of rows

SCREENS:
Give Manufacturer's Name, Model No. and Size

(8) CONSTRUCTION:
Was a surface sanitary seal provided? ☒ Yes ☐ No To what depth ft.
Were any strata sealed against pollution? ☒ Yes ☐ No
If yes, note depth of strata cased
FROM 0 ft. to 417 ft.
METHOD OF SEALING 12 sacks of Cement

(9) WATER LEVELS:
Depth at which water was first found 135 ft.
Standing level before perforating ft.
Standing level after perforating ft.

Log Accepted by:
[Signed] [signature] Owner Dated 31 Oct, 1956

(10) WELL TESTS: Interstate Pump Co.
Was a pump test made? ☒ Yes ☐ No If yes, by whom Klamath Falls
Yield: 240 gal./min. with 14" ft. draw down after 24 hrs.
Artesian flow g.p.m.
Shut-in pressure lbs. per square inch.
Bailer test g.p.m. with ft. drawdown
Temperature of water 88° Was a chemical analysis made? ☐ Yes ☐ No
Was electric log made of well? ☐ Yes ☐ No

(11) WELL LOG:
Diameter of well, 8 inches. I.D.
Total depth 500 ft. Depth of completed well 500 ft.
Formation: *Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.*

ft. to	ft.	Formation
0	1	Top soil
1	52	Yellow Shale
52	94	Burnd Lava (cemented)
94	101	Black Lava (dense)
101	118	Red Lava
118	124	Basaltic Boulders
124	146	Burnt Lava
146	246	Bank Sand
246	291	Shale
291	303	Black Lava
303	332	Grey Shale (hard)
332	340	Blue Shale
340	386	Clay & Shale
386	410	Hard Grey Shale
410	447	Dense Black Lava
447	473	Very Hard Blue Basalt
473	488	Black Porous Lava (Water Bearing)
488	500	Red Cinders Lava

Ground elevation at well site 4200 feet above mean sea level.
Work started Aug 21 1956. Completed Oct 27 1956

Well Driller's Statement:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME Chas. E. & Kenneth L. Hartley (Person, firm, or corporation) (Typed or printed)
Address 4779 ½ South Sixth Street
Driller's well number
[Signed] [signatures] (Well Driller)
License No. 145 & 161 Dated Oct. 31, 1956.

STATE ENGINEER
Salem, Oregon

KLAM
12812

Well Record

STATE WELL NO. 39/9-34E1
COUNTY Klamath
APPLICATION NO.

OWNER: U. S. Air Force MAILING ADDRESS:

LOCATION OF WELL: Owner's No. CITY AND STATE:

¼ ¼ Sec. T. N. S., R. E. W., W.M.

Bearing and distance from section or subdivision corner

Altitude at well 4,300

TYPE OF WELL: Drilled Date Constructed

Depth drilled 500 Depth cased 416

Section

CASING RECORD:

8 inch

FINISH:

AQUIFERS:

Basalt

WATER LEVEL:
236 feet below land surface, October, 1956

PUMPING EQUIPMENT: Type None H.P.
Capacity G.P.M.

WELL TESTS:
Drawdown ft. after hours G.P.M.
Drawdown ft. after hours G.P.M.

USE OF WATER None Temp. °F. , 19
SOURCE OF INFORMATION USGS
DRILLER or DIGGER
ADDITIONAL DATA:
Log X Water Level Measurements Chemical Analysis X Aquifer Test

REMARKS:

Test pumped 240 gpm with 1.17 ft. of drawdown after 24 hrs.

State Printing 89316

STATE ENGINEER
Salem, Oregon

State Well No. 39/9-34E1
County Klamath
Application No.

Well Log

Owner: U. S. Air Force Owner's No.

Driller: K. Hartley Date Drilled 1956

CHARACTER OF MATERIAL	(Feet below land surface) From	To	Thickness (feet)
Soil and shale, yellow	0	52	52
Upper lava rocks:			
Lava, burned	52	94	42
Lava, black, dense	94	101	7
Lava, red	101	118	17
"Boulders," basaltic	118	124	6
Lava, burned	124	146	22
Yonna formation:			
Sand	146	246	100
Shale	246	291	45
Lava, black	291	303	12
Shale, gray, hard	303	332	29
Shale, blue	332	340	8
Clay and shale	340	386	46
Shale, gray, hard	386	410	24
Lower lava rocks:			
Lava, black, dense	410	447	37
Basalt, blue, very dense	447	473	26
Lava, porous, black (water)	473	488	15
Lava, red, cinders	488	500	12

ORIGINAL
File Original, and Duplicate with the STATE ENGINEER, SALEM, OREGON

RECEIVED APR 28 1958
KLAM 12811

WATER WELL DRILLERS REPORT
STATE OF OREGON

Do Not Fill In — State Well No. 39/9 - 34 E — State Permit No. ________

(1) OWNER:
Name U.S.A.F. Housing Project
Address Kingsley Field, Klamath Falls, Ore.

(2) LOCATION OF WELL:
County Klamath — Owner's number, if any— Well No. 2
R. F. D. or Street No.
Bearing and distance from section or subdivision corner
N. 27° 22" E, 728 ft. + from the W¼ Cor. to Sec. 33 and 34. T39S, R9E, WM, Klamath Co., State of Oregon.

(3) TYPE OF WORK (check):
New well ☒ Deepening ☐ Reconditioning ☐ Abandon ☐
If abandonment, describe material and procedure in Item 11.

(4) PROPOSED USE (check):
Domestic ☐ Industrial ☐ Municipal ☒
Irrigation ☐ Test Well ☐ Other ☐

(5) EQUIPMENT:
Rotary ☐
Cable ☒
Dug Well ☐

(6) CASING INSTALLED:
Threaded ☒ Welded ☐
FROM 0 ft. to 393 ft. Diam. 8" Gage or Wall: Std.

If gravel packed
Diameter of Bore 328 from ft. 392 to ft.
Size of gravel: Pea Gr

Type and size of shoe or well ring C. 8"
Describe joint: Threaded & Coupled

(7) PERFORATIONS:
Type of perforator used: Torch Ace.
SIZE of perforations 3/8 in., length, by 6 in.
FROM 328 ft. to 392 ft. 7 perf per foot 5 No. of rows

SCREENS:
Give Manufacturer's Name, Model No. and Size

(8) CONSTRUCTION:
Was a surface sanitary seal provided? ☒ Yes ☐ No To what depth 130 ft.
Were any strata sealed against pollution? ☒ Yes ☐ No
If yes, note depth of strata 0 to 130 ft. cemented
FROM 0 ft. to 130 ft.
METHOD OF SEALING: cemented

(9) WATER LEVELS:
Depth at which water was first found 145 ft.
Standing level before perforating ft.
Standing level after perforating 131 ft.

Log Accepted by:
[Signed] Ben V. Thompson Dated 25 APR, 1958
Owner

(10) WELL TESTS:
Was a pump test made? ☒ Yes ☐ No If yes, by whom? by driller
Yield: 200 gal./min. with 2 3/10 draw down after 24 hrs.
Artesian flow ________ g.p.m.
Shut-in pressure ________ lbs. per square inch.
Bailer test ________ g.p.m. with ________ ft. drawdown
Temperature of water 88° Was a chemical analysis made? ☐ Yes ☐ No
Was electric log made of well? ☐ Yes ☒ No

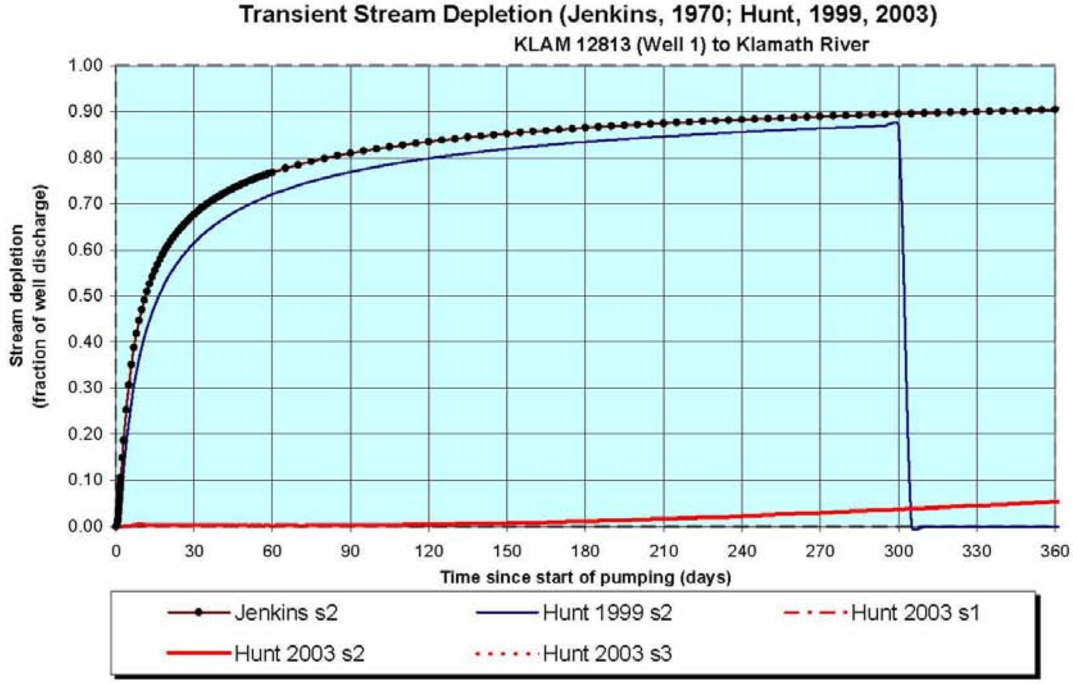
(11) WELL LOG:
Diameter of well, 8" 12" inches.
Total depth 392 ft. Depth of completed well 392 ft.
Formation: *Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.*

From (ft.)	To (ft.)	Formation
0	6	Top soil & boulders
6	63	Hillside lava imbedded in brown sand & sandstone
63	134	Yellow Shale
134	162	Lava Rock
162	174	Basalt Boulders
174	198	Black Sand
198	206	Rock
206	227	Sand Stone
227	317	Grey brown Shale streaked with Lava
317	348	Black Volcanic Formation
348	356	Dense Lava
356	392	*Porous Lava

Ground elevation at well site ________ feet above mean sea level.
Work started Dec. 20 1957. Completed Mar 15 1958

Well Driller's Statement:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME Chas. & Ken Hartley Well-drilling (Person, firm, or corporation) (Typed or printed)
Address 4779½ So. 6th St.
Driller's well number 145
[Signed] Charles E Hartley (Well Driller)
License No. 145 Dated Apr. 15, 1958



Output for Stream Depletion, Scenerio 2 (s2):					Time pump on (pumping duration) = 365 days							
Days	30	60	90	120	150	180	210	240	270	300	330	360
J SD	67.7%	76.8%	81.0%	83.5%	85.2%	86.5%	87.5%	88.3%	88.9%	89.5%	90.0%	90.4%
H SD 1999	61.5%	72.0%	76.9%	79.9%	81.9%	83.4%	84.6%	85.6%	86.4%	87.1%	#NUM!	#NUM!
H SD 2003	0.3%	0.2%	0.2%	0.4%	0.7%	1.1%	1.7%	2.2%	2.9%	3.7%	4.6%	5.4%
Qw, cfs	0.710	0.710	0.710	0.710	0.710	0.710	0.710	0.710	0.710	0.710	0.710	0.710
H SD 99, cfs	0.437	0.512	0.546	0.567	0.582	0.592	0.601	0.608	0.613	0.618	#NUM!	#NUM!
H SD 03, cfs	0.002	0.001	0.002	0.003	0.005	0.008	0.012	0.016	0.021	0.026	0.032	0.038

Parameters:		Scenario 1	Scenario 2	Scenario 3	Units
Net steady pumping rate of well	Qw	0.71	0.71	0.71	cfs
Time pump on (pumping duration)	tpon	365	365	365	days
Perpendicular from well to stream	a	17700	17700	17700	ft
Well depth	d	500	500	500	ft
Aquifer hydraulic conductivity	K	60	60	60	ft/day
Aquifer saturated thickness	b	500	500	500	ft
Aquifer transmissivity	T	30000	30000	30000	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	600	600	600	ft
Streambed conductance (lambda)	sbc	16.720000	16.720000	16.720000	ft/day
Stream depletion factor	sdf	10.443000	10.443000	10.443000	days
Streambed factor	sbf	9.864800	9.864800	9.864800	
input #1 for Hunt's Q_4 function	t'	0.095758	0.095758	0.095758	
input #2 for Hunt's Q_4 function	K'	218.258700	218.258700	218.258700	
input #3 for Hunt's Q_4 function	epsilon'	0.005000	0.005000	0.005000	
input #4 for Hunt's Q_4 function	lamda'	9.864800	9.864800	9.864800	

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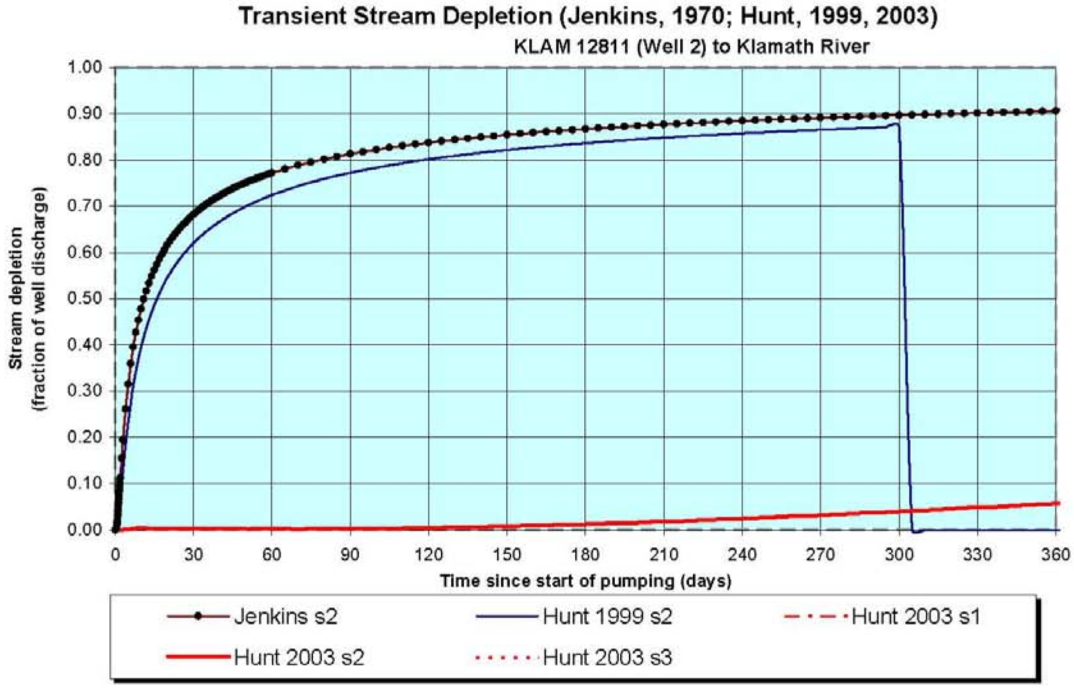

Output for Stream Depletion, Scenerio 2 (s2):						Time pump on (pumping duration) = 365 days						
Days	30	60	90	120	150	180	210	240	270	300	330	360
J SD	68.2%	77.2%	81.3%	83.8%	85.4%	86.7%	87.7%	88.5%	89.1%	89.7%	90.2%	90.6%
H SD 1999	62.0%	72.4%	77.2%	80.2%	82.2%	83.7%	84.8%	85.8%	86.6%	87.2%	#NUM!	#NUM!
H SD 2003	0.3%	0.2%	0.3%	0.5%	0.7%	1.2%	1.8%	2.4%	3.1%	3.9%	4.9%	5.7%
Qw, cfs	0.510	0.510	0.510	0.510	0.510	0.510	0.510	0.510	0.510	0.510	0.510	0.510
H SD 99, cfs	0.316	0.369	0.394	0.409	0.419	0.427	0.433	0.437	0.441	0.445	#NUM!	#NUM!
H SD 03, cfs	0.001	0.001	0.001	0.002	0.004	0.006	0.009	0.012	0.016	0.020	0.025	0.029

Parameters:		Scenario 1	Scenario 2	Scenario 3	Units
Net steady pumping rate of well	Qw	0.51	0.51	0.51	cfs
Time pump on (pumping duration)	tpon	365	365	365	days
Perpendicular from well to stream	a	17400	17400	17400	ft
Well depth	d	392	392	392	ft
Aquifer hydraulic conductivity	K	60	60	60	ft/day
Aquifer saturated thickness	b	500	500	500	ft
Aquifer transmissivity	T	30000	30000	30000	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	600	600	600	ft
Streambed conductance (lambda)	sbc	16.720000	16.720000	16.720000	ft/day
Stream depletion factor	sdf	10.092000	10.092000	10.092000	days
Streambed factor	sbf	9.697600	9.697600	9.697600	
input #1 for Hunt's Q_4 function	t'	0.099088	0.099088	0.099088	
input #2 for Hunt's Q_4 function	K'	210.922800	210.922800	210.922800	
input #3 for Hunt's Q_4 function	epsilon'	0.005000	0.005000	0.005000	
input #4 for Hunt's Q_4 function	lamda'	9.697600	9.697600	9.697600	

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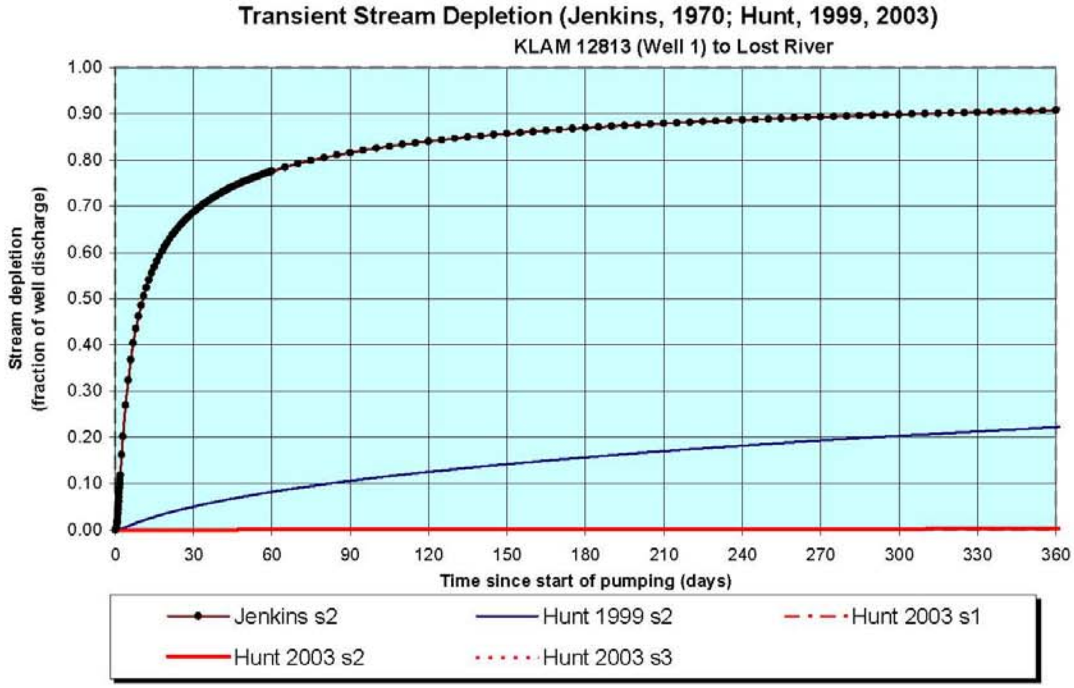

Output for Stream Depletion, Scenerio 2 (s2):						Time pump on (pumping duration) = 365 days						
Days	30	60	90	120	150	180	210	240	270	300	330	360
J SD	68.7%	77.6%	81.6%	84.0%	85.7%	86.9%	87.9%	88.7%	89.3%	89.9%	90.3%	90.7%
H SD 1999	5.0%	8.2%	10.6%	12.5%	14.2%	15.7%	17.0%	18.2%	19.3%	20.3%	21.3%	22.2%
H SD 2003	0.0%	0.0%	0.0%	0.1%	0.1%	0.1%	0.1%	0.1%	0.2%	0.2%	0.2%	0.2%
Qw, cfs	0.710	0.710	0.710	0.710	0.710	0.710	0.710	0.710	0.710	0.710	0.710	0.710
H SD 99, cfs	0.036	0.058	0.075	0.089	0.101	0.111	0.121	0.129	0.137	0.144	0.151	0.158
H SD 03, cfs	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.002

Parameters:		Scenario 1	Scenario 2	Scenario 3	Units
Net steady pumping rate of well	Qw	0.71	0.71	0.71	cfs
Time pump on (pumping duration)	tpon	365	365	365	days
Perpendicular from well to stream	a	17100	17100	17100	ft
Well depth	d	500	500	500	ft
Aquifer hydraulic conductivity	K	60	60	60	ft/day
Aquifer saturated thickness	b	500	500	500	ft
Aquifer transmissivity	T	30000	30000	30000	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	9.747000	9.747000	9.747000	days
Streambed factor	sbf	0.094050	0.094050	0.094050	
input #1 for Hunt's Q_4 function	t'	0.102596	0.102596	0.102596	
input #2 for Hunt's Q_4 function	K'	20.371230	20.371230	20.371230	
input #3 for Hunt's Q_4 function	epsilon'	0.005000	0.005000	0.005000	
input #4 for Hunt's Q_4 function	lamda'	0.094050	0.094050	0.094050	

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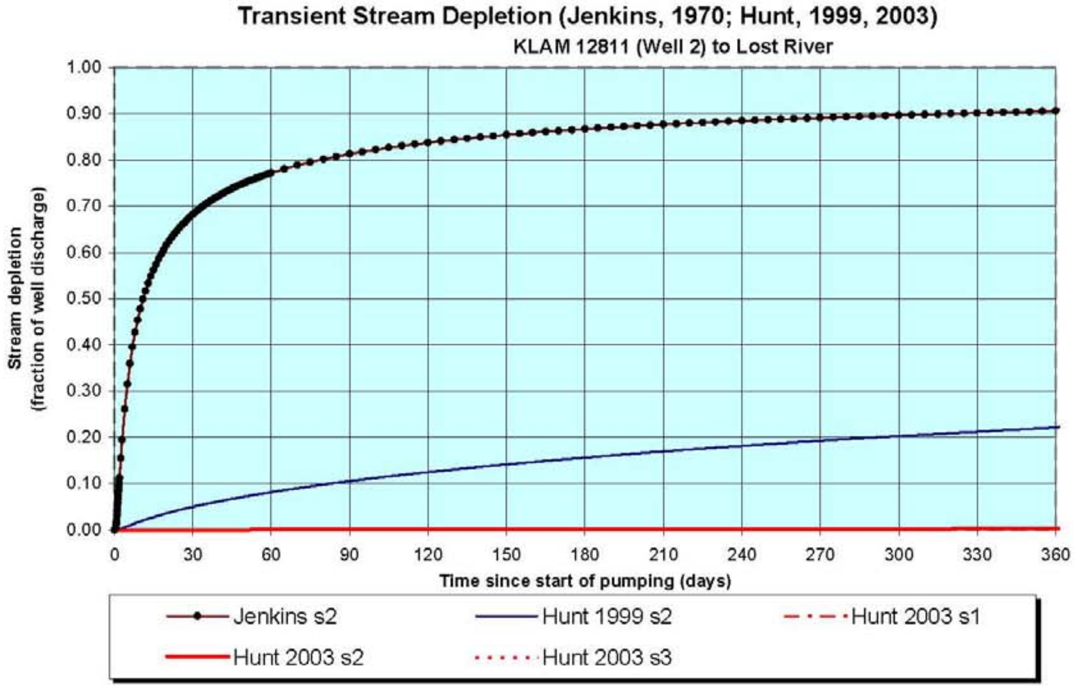

Output for Stream Depletion, Scenerio 2 (s2):					Time pump on (pumping duration) = 365 days							
Days	30	60	90	120	150	180	210	240	270	300	330	360
J SD	68.2%	77.2%	81.3%	83.8%	85.4%	86.7%	87.7%	88.5%	89.1%	89.7%	90.2%	90.6%
H SD 1999	5.0%	8.2%	10.5%	12.5%	14.2%	15.6%	17.0%	18.2%	19.3%	20.3%	21.2%	22.1%
H SD 2003	0.0%	0.0%	0.0%	0.1%	0.1%	0.1%	0.1%	0.1%	0.2%	0.2%	0.2%	0.2%
Qw, cfs	0.510	0.510	0.510	0.510	0.510	0.510	0.510	0.510	0.510	0.510	0.510	0.510
H SD 99, cfs	0.025	0.042	0.054	0.064	0.072	0.080	0.086	0.093	0.098	0.103	0.108	0.113
H SD 03, cfs	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.001	0.001	0.001

Parameters:		Scenario 1	Scenario 2	Scenario 3	Units
Net steady pumping rate of well	Qw	0.51	0.51	0.51	cfs
Time pump on (pumping duration)	tpon	365	365	365	days
Perpendicular from well to stream	a	17400	17400	17400	ft
Well depth	d	392	392	392	ft
Aquifer hydraulic conductivity	K	60	60	60	ft/day
Aquifer saturated thickness	b	500	500	500	ft
Aquifer transmissivity	T	30000	30000	30000	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	10.092000	10.092000	10.092000	days
Streambed factor	sbf	0.095700	0.095700	0.095700	
input #1 for Hunt's Q_4 function	t'	0.099088	0.099088	0.099088	
input #2 for Hunt's Q_4 function	K'	21.092280	21.092280	21.092280	
input #3 for Hunt's Q_4 function	epsilon'	0.005000	0.005000	0.005000	
input #4 for Hunt's Q_4 function	lamda'	0.095700	0.095700	0.095700	

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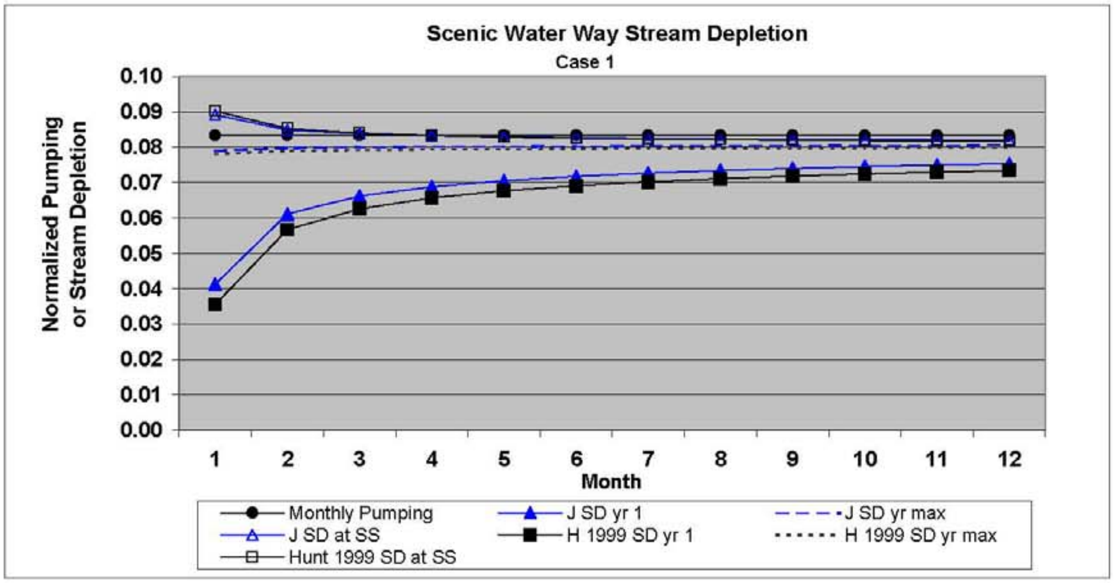
Oregon Water Resources Department



Region	28	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	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.00
Jenkins SD													
yr1	0.041	0.061	0.066	0.069	0.071	0.072	0.073	0.073	0.074	0.074	0.075	0.075	0.176
yrmax-1	0.079	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.081	0.081	0.081	0.037
yrmax	0.079	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.081	0.081	0.081	0.037
yrmax-yr1	0.038	0.019	0.014	0.011	0.010	0.009	0.008	0.007	0.006	0.006	0.006	0.005	0.138
J SD SS	**0.089**	**0.085**	**0.084**	**0.083**	**0.083**	**0.083**	**0.082**	**0.082**	**0.082**	**0.082**	**0.082**	**0.082**	**0.000**
Hunt SD 1999													
yr 1	0.036	0.057	0.063	0.066	0.068	0.069	0.070	0.071	0.072	0.072	0.073	0.073	0.211
yr max-1	0.078	0.079	0.079	0.079	0.079	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.047
yr max	0.078	0.079	0.079	0.079	0.079	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.047
yrmax-yr1	0.043	0.022	0.017	0.014	0.012	0.010	0.009	0.009	0.008	0.007	0.007	0.006	0.164
H99 SD SS	**0.090**	**0.085**	**0.084**	**0.083**	**0.083**	**0.083**	**0.082**	**0.082**	**0.082**	**0.082**	**0.082**	**0.082**	**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	17550	ft	
Well depth	d	500 & 392	ft	
Aquifer hydraulic conductivity	K	60	ft/day	
Aquifer saturated thickness	b	500	ft	
Aquifer transmissivity	T_ft	30,000	ft*ft/day	= K*b
Aquifer transmissivity	T_gal	224,400	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	600	ft	
Streambed conductance (lambda)	sbc	16.7200	ft/day	= Ks*ws/bs
Stream depletion factor	sdf	10.2668	days	= (a^2*S)/(T)
Streambed factor	sbf	9.7812		= sbc*a/T

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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 12813	
Pumping Rate (gpm) = Q =	240.00	(gpm)
Drawdown (feet) = s =	1.17	(feet)
Time (hours) = t =	24.0000	(hours)
Storage Coefficient = S =	0.001000	(dimensionless)
Well Diameter (inches) = d =	8.0000 Press F9 to Calculate	(inches)

Calculated Results	Calculated Results	
Transmissivity (ft2/day) = T =	66,025.33	(ft2/day)
Transmissivity (gpd/ft) = T =	493,903.77	(gpd/ft)
Transmissivity Difference = (last 2 iterations)	0.0000E+00 okay to use T if diff < 0.0001	(ft2/day)
u = (last iteration)	4.2071E-10 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	
1.17	0.00100	240.00	0.53	1.00	0.33			39,487.18		T = Q/s	
1.17	0.00100	240.00	0.53	1.00	0.33	7.0346E-10	20.4978	64,409.99	2.4923E+04	T = Theis Equation	1.00
1.17	0.00100	240.00	0.53	1.00	0.33	4.3127E-10	20.9871	65,947.49	1.5375E+03	T = Theis Equation	2.00
1.17	0.00100	240.00	0.53	1.00	0.33	4.2121E-10	21.0107	66,021.62	7.4127E+01	T = Theis Equation	3.00
1.17	0.00100	240.00	0.53	1.00	0.33	4.2074E-10	21.0118	66,025.15	3.5300E+00	T = Theis Equation	4.00
1.17	0.00100	240.00	0.53	1.00	0.33	4.2072E-10	21.0118	66,025.32	1.6801E-01	T = Theis Equation	5.00
1.17	0.00100	240.00	0.53	1.00	0.33	4.2071E-10	21.0119	66,025.33	7.9958E-03	T = Theis Equation	6.00
1.17	0.00100	240.00	0.53	1.00	0.33	4.2071E-10	21.0119	66,025.33	3.8054E-04	T = Theis Equation	7.00
1.17	0.00100	240.00	0.53	1.00	0.33	4.2071E-10	21.0119	66,025.33	1.8111E-05	T = Theis Equation	8.00
1.17	0.00100	240.00	0.53	1.00	0.33	4.2071E-10	21.0119	66,025.33	8.6192E-07	T = Theis Equation	9.00
1.17	0.00100	240.00	0.53	1.00	0.33	4.2071E-10	21.0119	66,025.33	4.1022E-08	T = Theis Equation	10.00
1.17	0.00100	240.00	0.53	1.00	0.33	4.2071E-10	21.0119	66,025.33	1.9500E-09	T = Theis Equation	11.00
1.17	0.00100	240.00	0.53	1.00	0.33	4.2071E-10	21.0119	66,025.33	0.0000E+00	T = Theis Equation	12.00
1.17	0.00100	240.00	0.53	1.00	0.33	4.2071E-10	21.0119	66,025.33	0.0000E+00	T = Theis Equation	13.00
1.17	0.00100	240.00	0.53	1.00	0.33	4.2071E-10	21.0119	66,025.33	0.0000E+00	T = Theis Equation	14.00
1.17	0.00100	240.00	0.53	1.00	0.33	4.2071E-10	21.0119	66,025.33	0.0000E+00	T = Theis Equation	15.00
1.17	0.00100	240.00	0.53	1.00	0.33	4.2071E-10	21.0119	66,025.33	0.0000E+00	T = Theis Equation	16.00
1.17	0.00100	240.00	0.53	1.00	0.33	4.2071E-10	21.0119	66,025.33	0.0000E+00	T = Theis Equation	17.00
1.17	0.00100	240.00	0.53	1.00	0.33	4.2071E-10	21.0119	66,025.33	0.0000E+00	T = Theis Equation	18.00
1.17	0.00100	240.00	0.53	1.00	0.33	4.2071E-10	21.0119	66,025.33	0.0000E+00	T = Theis Equation	19.00
1.17	0.00100	240.00	0.53	1.00	0.33	4.2071E-10	21.0119	66,025.33	0.0000E+00	T = Theis Equation	20.00
1.17	0.00100	240.00	0.53	1.00	0.33	4.2071E-10	21.0119	66,025.33	0.0000E+00	T = Theis Equation	21.00
1.17	0.00100	240.00	0.53	1.00	0.33	4.2071E-10	21.0119	66,025.33	0.0000E+00	T = Theis Equation	22.00
1.17	0.00100	240.00	0.53	1.00	0.33	4.2071E-10	21.0119	66,025.33	0.0000E+00	T = Theis Equation	23.00
1.17	0.00100	240.00	0.53	1.00	0.33	4.2071E-10	21.0119	66,025.33	0.0000E+00	T = Theis Equation	24.00
1.17	0.00100	240.00	0.53	1.00	0.33	4.2071E-10	21.0119	66,025.33	0.0000E+00	T = Theis Equation	25.00

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 12813	
Pumping Rate (gpm) = Q =	240.00	(gpm)
Drawdown (feet) = s =	1.17	(feet)
Time (hours) = t =	24.0000	(hours)
Storage Coefficient = S =	0.001000	(dimensionless)
Well Diameter (inches) = d =	8.0000 Press F9 to Calculate	(inches)
Calculated Results	**Calculated Results**	
Transmissivity (ft2/day) = T =	66,025.33	(ft2/day)
Transmissivity (gpd/ft) = T =	493,903.77	(gpd/ft)
Transmissivity Difference = (last 2 iterations)	0.0000E+00 okay to use T if diff < 0.0001	(ft2/day)
u = (last iteration)	4.2071E-10 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	
1.17	0.00100	240.00	0.53	1.00	0.33			39,487.18		T = Q/s	
1.17	0.00100	240.00	0.53	1.00	0.33	7.0346E-10	20.4978	64,409.99	2.4923E+04	T = Theis Equation	1.00
1.17	0.00100	240.00	0.53	1.00	0.33	4.3127E-10	20.9871	65,947.49	1.5375E+03	T = Theis Equation	2.00
1.17	0.00100	240.00	0.53	1.00	0.33	4.2121E-10	21.0107	66,021.62	7.4127E+01	T = Theis Equation	3.00
1.17	0.00100	240.00	0.53	1.00	0.33	4.2074E-10	21.0118	66,025.15	3.5300E+00	T = Theis Equation	4.00
1.17	0.00100	240.00	0.53	1.00	0.33	4.2072E-10	21.0118	66,025.32	1.6801E-01	T = Theis Equation	5.00
1.17	0.00100	240.00	0.53	1.00	0.33	4.2071E-10	21.0119	66,025.33	7.9958E-03	T = Theis Equation	6.00
1.17	0.00100	240.00	0.53	1.00	0.33	4.2071E-10	21.0119	66,025.33	3.8054E-04	T = Theis Equation	7.00
1.17	0.00100	240.00	0.53	1.00	0.33	4.2071E-10	21.0119	66,025.33	1.8111E-05	T = Theis Equation	8.00
1.17	0.00100	240.00	0.53	1.00	0.33	4.2071E-10	21.0119	66,025.33	8.6192E-07	T = Theis Equation	9.00
1.17	0.00100	240.00	0.53	1.00	0.33	4.2071E-10	21.0119	66,025.33	4.1022E-08	T = Theis Equation	10.00
1.17	0.00100	240.00	0.53	1.00	0.33	4.2071E-10	21.0119	66,025.33	1.9500E-09	T = Theis Equation	11.00
1.17	0.00100	240.00	0.53	1.00	0.33	4.2071E-10	21.0119	66,025.33	0.0000E+00	T = Theis Equation	12.00
1.17	0.00100	240.00	0.53	1.00	0.33	4.2071E-10	21.0119	66,025.33	0.0000E+00	T = Theis Equation	13.00
1.17	0.00100	240.00	0.53	1.00	0.33	4.2071E-10	21.0119	66,025.33	0.0000E+00	T = Theis Equation	14.00
1.17	0.00100	240.00	0.53	1.00	0.33	4.2071E-10	21.0119	66,025.33	0.0000E+00	T = Theis Equation	15.00
1.17	0.00100	240.00	0.53	1.00	0.33	4.2071E-10	21.0119	66,025.33	0.0000E+00	T = Theis Equation	16.00
1.17	0.00100	240.00	0.53	1.00	0.33	4.2071E-10	21.0119	66,025.33	0.0000E+00	T = Theis Equation	17.00
1.17	0.00100	240.00	0.53	1.00	0.33	4.2071E-10	21.0119	66,025.33	0.0000E+00	T = Theis Equation	18.00
1.17	0.00100	240.00	0.53	1.00	0.33	4.2071E-10	21.0119	66,025.33	0.0000E+00	T = Theis Equation	19.00
1.17	0.00100	240.00	0.53	1.00	0.33	4.2071E-10	21.0119	66,025.33	0.0000E+00	T = Theis Equation	20.00
1.17	0.00100	240.00	0.53	1.00	0.33	4.2071E-10	21.0119	66,025.33	0.0000E+00	T = Theis Equation	21.00
1.17	0.00100	240.00	0.53	1.00	0.33	4.2071E-10	21.0119	66,025.33	0.0000E+00	T = Theis Equation	22.00
1.17	0.00100	240.00	0.53	1.00	0.33	4.2071E-10	21.0119	66,025.33	0.0000E+00	T = Theis Equation	23.00
1.17	0.00100	240.00	0.53	1.00	0.33	4.2071E-10	21.0119	66,025.33	0.0000E+00	T = Theis Equation	24.00
1.17	0.00100	240.00	0.53	1.00	0.33	4.2071E-10	21.0119	66,025.33	0.0000E+00	T = Theis Equation	25.00