

PUBLIC INTEREST REVIEW FOR GROUND WATER APPLICATIONS

TO: Water Rights Section Date 16 March 2012

FROM: Ground Water/Hydrology Section Gerald H. Grondin

Reviewer's Name

SUBJECT: Application G-17512 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: Crystal Clear Energy, LLC County: Lake

A1. Applicant(s) seek(s) 3.34 (1500 gpm) cfs from 4 well(s) in the Goose and Summer Lakes Basin, Thomas Creek sub basin Quad Map Lakeview NE

A2. Proposed use: Heating & Power Generation 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 1	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	LAKE 2326	Well 1	Tuff Breccia	3.34	39S/20E-sec 03 BDB	1506' S, 1631' E fr NW cor S 03
2	Not drilled	Well2	Basalt	-3.34	39S/20E-sec 04 ADA	1400' S, 80' W fr NW cor S 03
3	Not drilled	Well 3	Basalt	-3.34	39S/20E-sec 03 CCA	4545' S, 1065' E fr NW cor S 03
4	Not drilled	Well 4	Basalt	-3.34	39S/20E-sec 10 BDA	1390' S, 2020' E fr SW cor S 03

* 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	4950	120	109	03/19/81	685	0-140	+1-140	None	None	900	7	P
2	4840	?	?	?	500	?	?	?	150-500	?	?	?
3	4860	?	?	?	500	?	?	?	150-500	?	?	?
4	4920	?	?	?	500	?	?	?	150-500	?	?	?

Use data from application for proposed wells.

A4. Comments: _____

The application proposes to pump geothermal groundwater from well LAKE 2326 located in Hammersley Canyon adjacent to Hammersley Creek for heating and power generation use and re-inject the groundwater at three injection wells yet to be constructed.

The proposed annual groundwater use is 2420 acre-feet. That converts to 1500 gpm of continuous pumping for 365 days. How the re-injection will be distributed among the three proposed injection wells was not specified.

The proposed aquifer at the production well is identified as volcanic deposits. Walker (1963) mapped the site as tuff (Ttf). Brown and others (1980) mapped the site as tuffs (Tmt). Both describe the unit as being of rhyolitic and dacitic composition, tuffaceous sedimentary rocks, and aerially restricted rhyodacitic and andesitic flows.

The proposed aquifer identified on the application for the proposed injection wells is igneous rock basalt.

Proposed Well 2 (injection) is located on or near the boundary between the tuff of the uplands mapped by Walker (1963) as Ttf and by Brown and others (1980) as Tmt and the valley sediments mapped by Walker (1963) as Qal and by Brown and others (1980) as Qal/Qs which is undifferentiated alluvium and sediments that includes lacustrine and fluvialite gravel, sand, and silt, and can include undifferentiated evaporate deposits.

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, 7L, 7N, 7T, and special conditions
 - 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: _____

Reports for the Goose and Summer Lakes Basin indicate ground water occurs in alluvium, basin fill sediments, and different basalt units. Generally in the valleys, a low transmissivity (low permeability) sediment unit (predominantly basin-fill from volcanic and sedimentary sources with occasional basalt flows) of varying thickness overlies a high transmissivity (high permeability) basalt unit (predominantly volcanic flows and sediments). Groundwater occurs in both the sediment unit and the basalt unit. Groundwater is vertically connected within each unit. Additionally, Ground water in the sediment unit and the basalt unit is hydraulically connected.

Morgan (1988) notes for the Goose Lake subbasin that ground water flow is generally from upland recharge areas to lowland discharge areas. However, local subsystems discharge to lakes, reservoirs, meadows, and streams. Large quantities of ground water move through complexly interbedded, discontinuous, unconsolidated sand, gravel, silt, and clay deposits. Morgan characterizes the upper portion of ground water as unconfined with confined-like conditions increasing with depth. This appears related to anisotropic hydraulic conductivities with horizontal hydraulic conductivity much greater than vertical hydraulic conductivity. For one site noted, the estimated ratios ranged from 2:1 to 179:1. There is no indication of shallower ground water being separated from deeper ground water by a confining layer.

The nearest state observation well with long term data is state observation well 381 (well LAKE 2424). It is located in Goose lake valley about 0.7 miles southwest of the Hammersley Canyon mouth. The 800 foot deep well is completed in the predominantly basin fill sediments that overlie the predominantly basalt unit. The ground water level data is from 1965 through 2010. Interestingly, the annual peak water level from 1965 to 1970 was between 35 to 40 feet below land surface, then there was a gradual decline in the annual water level from about 40 to 50 feet below land surface from 1970 to 1990, then the annual water level water level rose to about 20 feet below land surface and has fluctuated between 15 to 20 from 1990 to 2010. The cause of the rise is undetermined at this time.

The proposed aquifer at the production well is identified as volcanic deposits. It is located above Goose Lake valley in Hammersley Canyon in the uplands on the east border of Goose Lake valley. Walker (1963) mapped the site as tuff (Ttf). Brown and others (1980) mapped the site as tuffs (Tmt). Both describe the unit as being of rhyolitic and dacitic composition, tuffaceous sedimentary rocks, and aerially restricted rhyodacitic and andesitic flows.

The proposed aquifer identified on the application for the proposed injection wells is igneous rock basalt. These wells are located on eastern edge of Goose Lake valley where the east uplands begin.

Proposed Well 2 (injection) is located on or near the boundary between the tuff of the uplands mapped by Walker (1963) as Ttf and by Brown and others (1980) as Tmt and the valley sediments mapped by Walker (1963) as Qal and by Brown and others (1980) as Qal/Qs which is undifferentiated alluvium and sediments that includes lacustrine and fluvial gravel, sand, and silt, and can include undifferentiated evaporate deposits.

Proposed Well 3 (injection) and Well 4 (injection) are located on or near the boundary between the tuff, tuff breccia of the uplands mapped by Walker (1963) as Taf and by Brown and others (1980) as Tmst which is tuffaceous sedimentary rocks, claystones, hornblende andesite flows, and basalt flows and the valley sediments mapped by Walker (1963) as Qal and by Brown and others (1980) as Qal/Qs which is undifferentiated alluvium and sediments that includes lacustrine and fluvial gravel, sand, and silt, and can include undifferentiated evaporate deposits.

If a permit is issued, the following conditions need to be included: 7B, 7F, 7L, 7N (modified), 7T, and special conditions (see below):

7N, the measurement condition modified (change part "A" from three to "one or more feet", merge "B" and "C" to read "Annual water-level measurements reveal a water-level decline of 5 or more feet:", and change part "D" from 25 to "10 or more feet", and add a part "E" to read "OWRD groundwater section staff approved static ground water level measurements at well LAKE 2424 (state observation well 381) is below 30 feet below land surface", and insert the following to the last paragraph after "no action is necessary because...": insert "...the use is not contributing to the decline or contributing to the groundwater level being below 30 feet below land surface at well LAKE 2424 (state observation well 381) or because...". Note: this is condition modification is needed to reduce the possibility of injury to surface water rights at the mouth of Hammersley Creek and to reduce the possibility of violating OAR 690-513-0030 2dE (Goose Lake Subbasin).

7T, the measuring tube condition modified (add "For existing wells with a pump installed, installation of the measuring tube shall occur when the pump is removed or replaced and/or when the well is deepened or reconstructed or altered.").

The "large" water use condition (require a flow meter at each well; each flow meter shall be located within 50 feet of the wellhead. Adjacent to every flow meter shall be a clearly visible monument with a sign noting the flow meter. Lastly, require for every flow meter the reading, recording (monthly at minimum), and annual reporting of the flow meter data, all flow meters).

Well construction condition ("All wells shall be constructed to extract or inject groundwater from and to the same or adjoining water-bearing zone within the basalt unit (this includes tuff breccia) below the basin sediments. To meet this criterion, each well shall have at minimum continuous casing and continuous seal from land surface, through the sediment to the productive portion of the basalt unit. ").

Injection well location condition ("The location of all injection wells shall be at a distance from a point near the mouth of Hammersley Canyon that is equal to or less than the distance of the production well from the same point near the mouth of Hammersley Canyon. Otherwise, the use is invalid and subject to regulation, including possible immediate cancellation of the permit. The point location is 400 feet east of the west quarter of section 3 in township 39 south, range 20 east."). Note: this is condition is needed to ensure no net groundwater level drawdown at Hammersley Creek which will prevent injury to surface water rights at the mouth of Hammersley Creek and to prevent violation of OAR 690-513-0030 2dE (Goose Lake Subbasin).

Special condition for no net groundwater use: "This permit is valid if and only if 100 percent of the groundwater extracted from the production well(s) is injected in the authorized injection well(s) which can be confirmed by flow meter data. Otherwise, the use is invalid and subject to regulation, including possible immediate cancellation of the permit."

Continues on next page

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 < 1/4 mile?	Qw > 5 cfs?	Instream Water Right ID	Instream Water Right Q (cfs)	Qw > 1% ISWR?	80% Natural Flow (cfs)	Qw > 1% of 80% Natural Flow?	Interference @ 30 days (%)	Potential for Subst. Interfer. Assumed?
1	1	<input type="checkbox"/>	<input type="checkbox"/>	N.A.	N.A.	<input type="checkbox"/>	8.24	<input type="checkbox"/>		<input type="checkbox"/>
2	1	<input type="checkbox"/>	<input type="checkbox"/>	N.A.	N.A.	<input type="checkbox"/>	8.24	<input type="checkbox"/>		<input type="checkbox"/>
3	1	<input type="checkbox"/>	<input type="checkbox"/>	N.A.	N.A.	<input type="checkbox"/>	8.24	<input type="checkbox"/>		<input type="checkbox"/>
4	1	<input type="checkbox"/>	<input type="checkbox"/>	N.A.	N.A.	<input type="checkbox"/>	8.24	<input type="checkbox"/>		<input type="checkbox"/>

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?
	<input type="checkbox"/>			<input type="checkbox"/>		<input type="checkbox"/>		<input type="checkbox"/>
	<input type="checkbox"/>			<input type="checkbox"/>		<input type="checkbox"/>		<input type="checkbox"/>
	<input type="checkbox"/>			<input type="checkbox"/>		<input type="checkbox"/>		<input type="checkbox"/>
	<input type="checkbox"/>			<input type="checkbox"/>		<input type="checkbox"/>		<input type="checkbox"/>

Comments: _____

The proposed production well (LAKE 2326) site and all the injection well sites are less than 1-mile from Hammersley Creek.

The natural flow rate is for Thomas Creek to which Hammersley Creek is tributary.

No Analysis. The application proposes and this review is based upon no net use of groundwater (net use = 0.0 gpm) where 100 percent of the groundwater extracted is injected back to the same source. So no calculation was conducted. If less than 100 percent of the groundwater extracted is injected to the same source and/or if any injection well is located at a distance from a point near the mouth of Hammersley Canyon that is greater than the distance of the production well from the same point near the mouth of Hammersley Canyon (the location of the point at the canyon mouth is 400 feet east of the west quarter of section 3 in township 39 south, range 20 east) this review is invalid and the permit should not be issued.

Note: the injection wells location previously noted is important (critical) to ensure no net groundwater level drawdown at Hammersley Creek which will prevent injury to surface water rights at the mouth of Hammersley Creek, to prevent violation of OAR 690-513-0030 2dE (Goose Lake Subbasin), and to prevent triggering a potential for substantial interference.

C4a. **690-09-040 (5):** Estimated impacts on **hydraulically connected surface water sources greater than one mile** as a percentage of the proposed pumping rate. Limit evaluation to the effects that will occur up to one year after pumping begins. This table encompasses the considerations required by 09-040 (5)(a), (b), (c) and (d), which are not included on this form. Use additional sheets if calculated flows from more than one WAB are required.

Non-Distributed Wells													
Well	SW#	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
		%	%	%	%	%	%	%	%	%	%	%	%
Well Q as CFS													
Interference CFS													
Distributed Wells													
Well	SW#	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
		%	%	%	%	%	%	%	%	%	%	%	%
Well Q as CFS													
Interference CFS													
		%	%	%	%	%	%	%	%	%	%	%	%
Well Q as CFS													
Interference CFS													
		%	%	%	%	%	%	%	%	%	%	%	%
Well Q as CFS													
Interference CFS													
(A) = Total Interf.													
(B) = 80 % Nat. Q													
(C) = 1 % Nat. Q													
(D) = (A) > (C)													
(E) = (A / B) x 100													

(A) = total interference as CFS; (B) = WAB calculated natural flow at 80% exceed. as CFS; (C) = 1% of calculated natural flow at 80% exceed. as CFS; (D) = highlight the checkmark for each month where (A) is greater than (C); (E) = total interference divided by 80% flow as percentage.

Basis for impact evaluation: _____

The proposed production well (LAKE 2326) site and all the injection well sites are less than 1-mile from Hammersley Creek.

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 _____

The application proposes and this review is based upon no net use of groundwater (net use = 0.0 gpm) where 100 percent of the groundwater extracted is injected back to the same source. If less than 100 percent of the groundwater extracted is injected to the same source and/or if any injection well is located at a distance from a point near the mouth of Hammersley Canyon that is greater than the distance of the production well from the same point near the mouth of Hammersley Canyon (the location of the point at the canyon mouth is 400 feet east of the west quarter of section 3 in township 39 south, range 20 east) this review is invalid and the permit should not be issued.

Note: the injection wells' location noted in the condition below is important (critical) to ensure no net groundwater level drawdown at Hammersley Creek which will prevent injury to surface water rights at the mouth of Hammersley Creek, to prevent violation of OAR 690-513-0030 2dE (Goose Lake Subbasin), and to prevent triggering a potential for substantial interference. If the location condition is not met, this review is invalid and the permit should not be issued. If the permit is issued and the condition is not met, the use needs to be considered invalid and subject to regulation, including possible immediate cancellation of the permit.

If a permit is issued, the following conditions need to be included: 7B, 7F, 7L, 7N (modified), 7T, and special conditions (see below):

7N, the measurement condition modified (change part "A" from three to "one or more feet", merge "B" and "C" to read "Annual water-level measurements reveal a water-level decline of 5 or more feet.", and change part "D" from 25 to "10 or more feet", and add a part "E" to read "OWRD groundwater section staff approved static ground water level measurements at well LAKE 2424 (state observation well 381) is below 30 feet below land surface", and insert the following to the last paragraph after "no action is necessary because...": insert "...the use is not contributing to the decline or contributing to the groundwater level being below 30 feet below land surface at well LAKE 2424 (state observation well 381) or because..."). Note: this is condition modification is needed to reduce the possibility of injury to surface water rights at the mouth of Hammersley Creek and to reduce the possibility of violating OAR 690-513-0030 2dE (Goose Lake Subbasin).

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The "large" water use condition (require a flow meter at each well; each flow meter shall be located within 50 feet of the wellhead. Adjacent to every flow meter shall be a clearly visible monument with a sign noting the flow meter. Lastly, require for every flow meter the reading, recording (monthly at minimum), and annual reporting of the flow meter data, all flow meters).

Well construction condition ("All wells shall be constructed to extract or inject groundwater from and to the same or adjoining water-bearing zone within the basalt unit (this includes tuff breccia) below the basin sediments. To meet this criterion, each well shall have at minimum continuous casing and continuous seal from land surface, through the sediment to the productive portion of the basalt unit. ").

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Continues on next page

Special condition for no net groundwater use: "This permit is valid if and only if 100 percent of the groundwater extracted from the production well(s) is injected in the authorized injection well(s) which can be confirmed by flow meter data. Otherwise, the use is invalid and subject to regulation, including possible immediate cancellation of the permit."

Special condition for low temperature geothermal wells used for heating: "All water produced under this permit shall be injected into the authorized well(s). Prior to receiving a certificate of water right, the permit holder shall submit documentation affirming that any applicable additional requirements of the Department's Division 230 rules have been met."

Special Condition for groundwater production: "Groundwater production shall occur from the predominant basalt unit (this includes tuff breccia) below the predominant basin fill unit by casing and sealing through the basin fill unit into the basalt unit."

Reports for the Goose and Summer Lakes Basin indicate ground water occurs in alluvium, basin fill sediments, and different basalt units. Generally in the valleys, a low transmissivity (low permeability) sediment unit (predominantly basin-fill from volcanic and sedimentary sources with occasional basalt flows) of varying thickness overlies a high transmissivity (high permeability) basalt unit (predominantly volcanic flows and sediments). Groundwater occurs in both the sediment unit and the basalt unit. Groundwater is vertically connected within each unit. Additionally, Ground water in the sediment unit and the basalt unit is hydraulically connected.

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Multiple horizontal lines for additional text or notes.

References Used:

Brown, D.E., Peterson, N.V., and McLean, G.D., 1980, Preliminary geology and geothermal resource potential of the Lakeview area, Oregon: DOGAMI Open-File Report O-80-09, 57 p., 1:62,500 maps.

Gonthier, J.B. 1985, A description of aquifer units in eastern Oregon: USGS Water Resources Investigations Report 84-4095, 39 p., 4 plates.

Morgan, D.S., 1988, Geohydrology and numerical model analysis of ground-water flow in the Goose Lake Basin, Oregon and California: USGS Water Resources Investigations Report 87-4058, 92 p.

Oregon Water Resources Department, 1989, Goose and Summer Lakes Basin report: OWRD Basin Report, 112 p.

Peterson, N.V. and McIntyre, J.R., 1970, The reconnaissance geology and mineral resources of eastern Klamath County and western Lake County, Oregon: DOGAMI Bulletin 66, 70 p.

Phillips, K.N. and VanDenburgh, A.S., 1971, Hydrology and geochemistry of Abert, Summer, and Goose Lakes, and other closed-basin lakes in south-central Oregon: USGS Professional Paper 502-B, 86p.

Walker, G.W., 1963, Reconnaissance geologic map of the eastern half of the Klamath Falls (AMS) quadrangle, Lake and Klamath Counties, Oregon: USGS Mineral Investigations Field Studies Map MF-260.

Walker, G.W. and Reppening, C.A., 1965, Reconnaissance geologic map of the Adel quadrangle, Lake, Harney, and Malheur Counties, Oregon: USGS Miscellaneous Geologic Investigations Map I-446.

Waring, G.A., 1908, Geology and water resources of a portion of south-central Oregon: USGS Water Supply Paper 220, 85 p.

Goose and Summer Lakes Basin Program rules (OAR 690-513).

State Observation Well SOW 381 (well LAKE 2424).

Water well reports for well LAKE 2326 (proposed production well).

USGS Lakeview NW quadrangle map (1:24,000)

D. WELL CONSTRUCTION, OAR 690-200

D1.	Well #:	<u>Well 1</u>	Logid:	<u>LAKE 2326</u>
	Well #:	<u>Well 2</u>	Logid:	<u>not drilled yet</u>
	Well #:	<u>Well 3</u>	Logid:	<u>not drilled yet</u>
	Well #:	<u>Well 4</u>	Logid:	<u>not drilled yet</u>

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** Well #: 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.

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

THIS SECTION TO BE COMPLETED BY ENFORCEMENT PERSONNEL

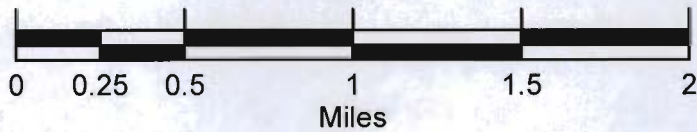
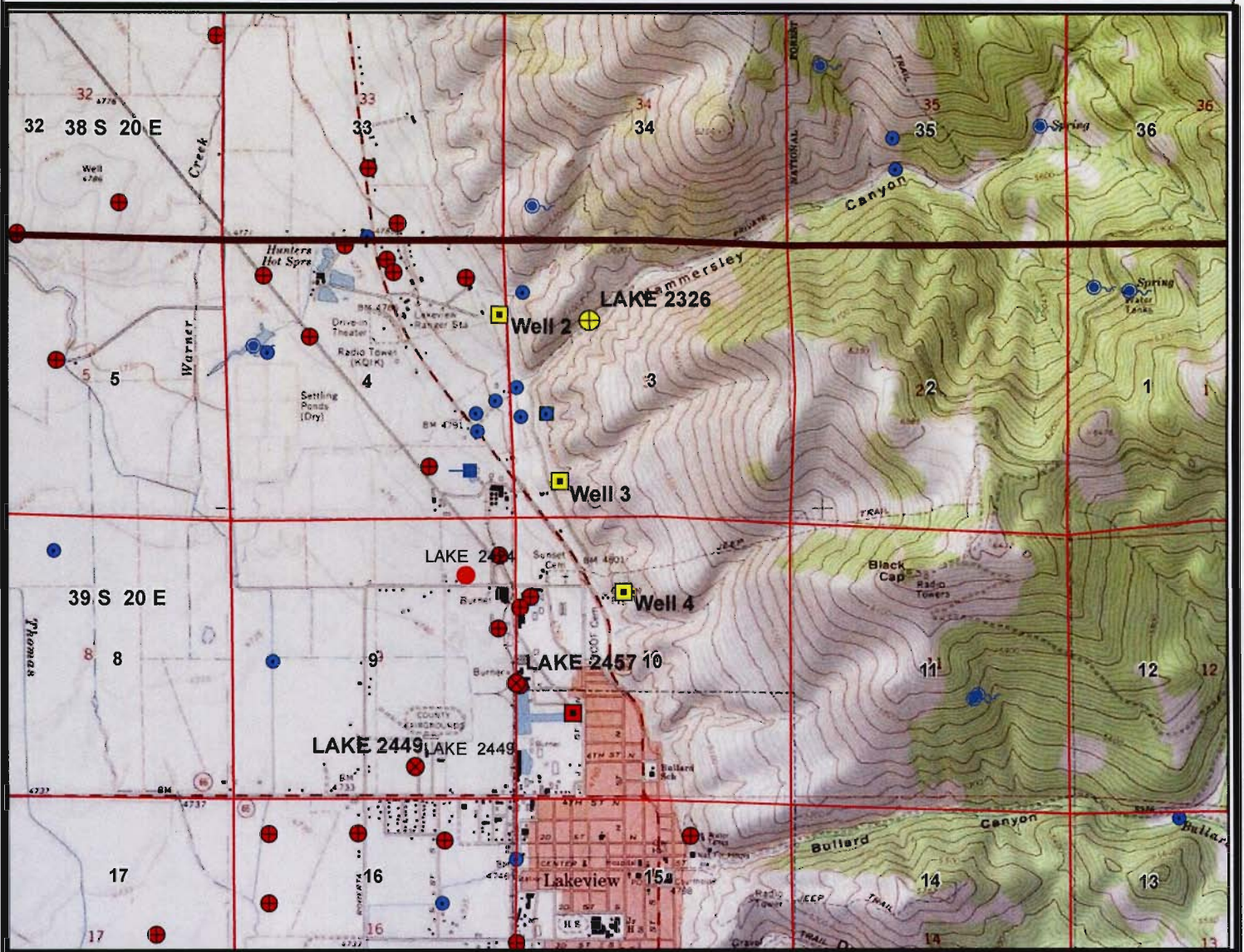
D7. Well construction deficiency has been corrected by the following actions: _____

_____, 200____.

(Enforcement Section Signature)

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

Water Right Application G-17512 Crystal Clear Energy, LLC

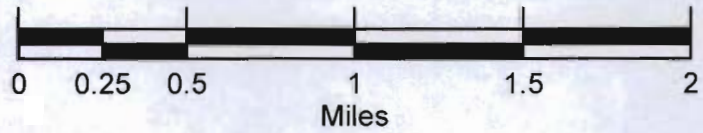
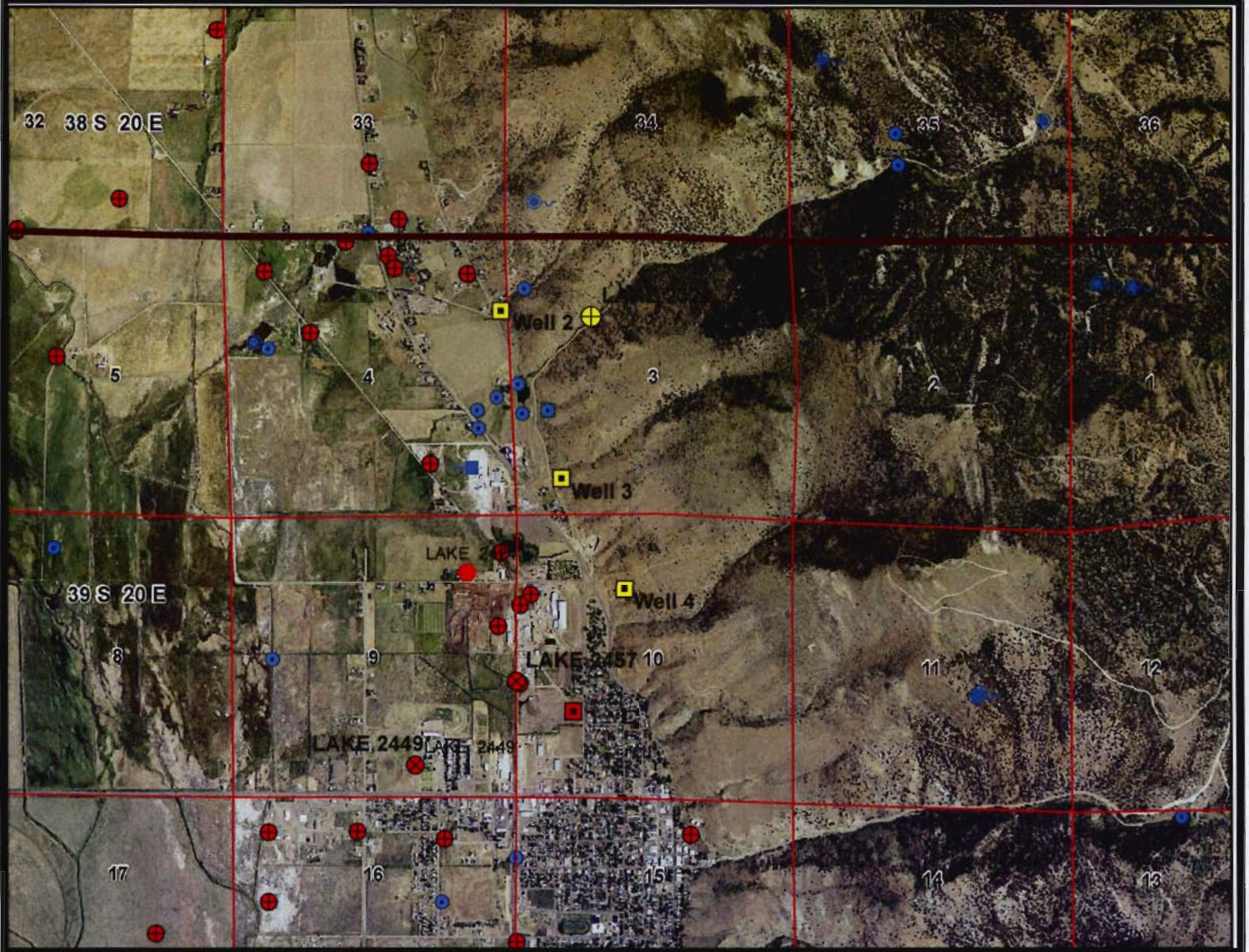


Yellow = Proposed Well(s)
Red = Other Wells

Blue and Other = surface water rights



Water Right Application G-17512 Crystal Clear Energy, LLC



Yellow = Proposed Well(s)
Red = Other Wells

Blue and Other = surface water rights



Ground Water



Oregon Water Resources Department
(503)778-8455 • 158 12th St. NE, Salem, OR 97310



Oregon Water Resources Department Hydrograph for State Well LAKE 2424, State Observation Well # 381

Oregon Water Resources Department Well Location
 Oregon Water Resources Department Logid
 Oregon Water Resources Department Well Tag (Well ID)
 Oregon Water Resources Department State Observation Well Number
 Total well depth (feet below land surface)
 Land surface elevation (feet above mean sea level)
 Primary use of well
 Primary aquifer system

39 .00S/20 .00E-944X
 LAKE 2424
 --- 381
 --- 800

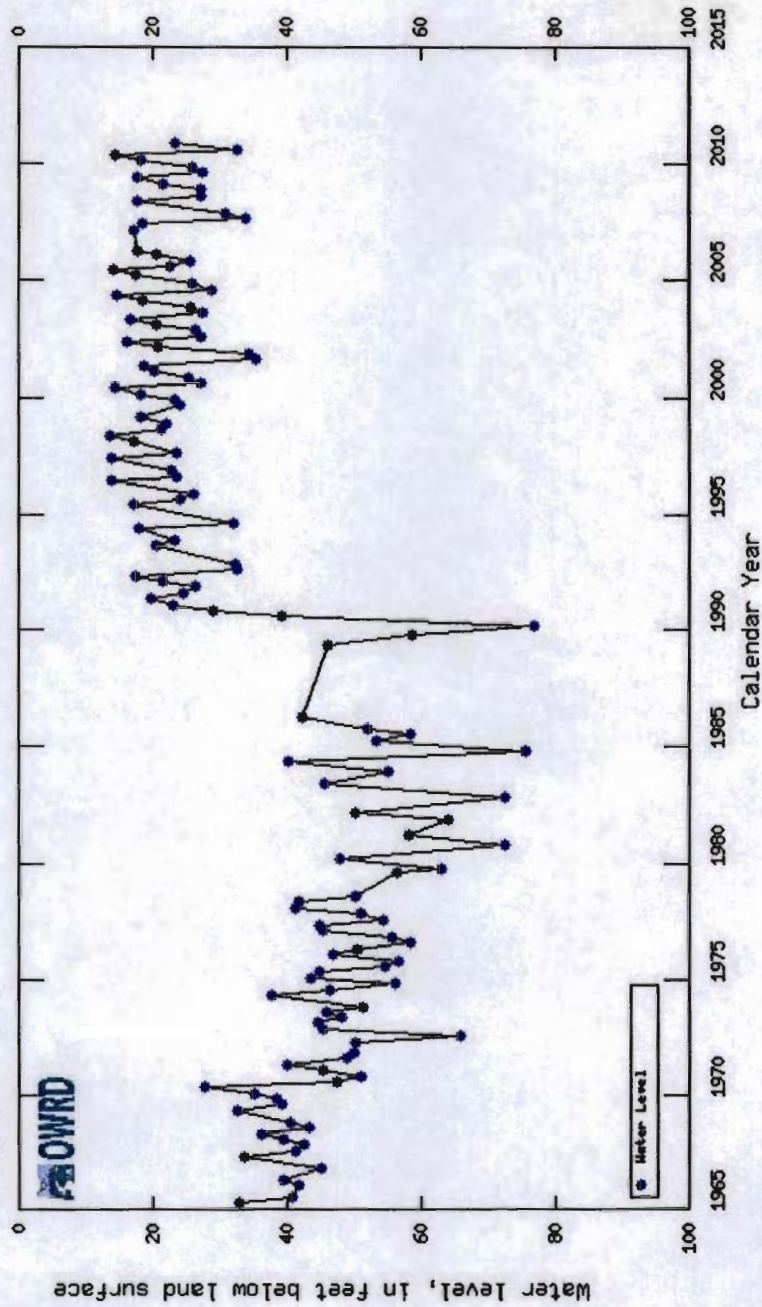


Table showing water-level data for State Well LAKE 2424, State Observation Well # 381

Drawdown Calculations Using Theis Equation

Theis Equation: $s = [Q/(4 \cdot T \cdot pi)] W(u)$
 $u = (r^2 \cdot S)/(4 \cdot T \cdot t)$
 $W(u) = (-\ln u) - 0.5772157 + (u/1^1) - (u^2/2^2) + (u^3/3^3) - (u^4/4^4) + \dots$

s = drawdown (L)
 T = transmissivity (L²/T)
 S = storage coefficient (dimensionless)
 pi = 3.141592654

r = radial distance (L)
 t = time (T)
 u = dimensionless
 $W(u)$ = well function

Transmissivity T (gpd/ft)	Transmissivity T (ft ² /day)	Storage Coefficient S	Pumping Rate Q (gal/min)	Pumping Rate Q (ft ³ /sec)	Time t (days)	Distance r (feet)	pi	u	W(u)	Drawdown s (feet)	Comments	Net Drawdown (feet)
Note: yellow grid areas are where values are calculated												
Scenario 1: Injection evenly distributed among all 3 proposed injection wells												
LAKE 2326 to Surface Water Right at Hammersley Canyon mouth												
72,944.05	9,751.20	0.00124	1,500.00	3.34	30.00	1,570.00	3.14	0.0026	5.3754	12.6668	Continuous Pumping at Full Rate	1.7464
72,944.05	9,751.20	0.00124	1,500.00	3.34	365.00	1,570.00	3.14	0.0002	7.8717	18.5492	Continuous Pumping at Full Rate	2.6982
Well 2 to Surface Water Right at Hammersley Canyon mouth												
72,944.05	9,751.20	0.00124	-500.00	-1.11	30.00	1,350.00	3.14	0.0019	5.6767	-4.4569	Continuous Pumping at Full Rate	
72,944.05	9,751.20	0.00124	-500.00	-1.11	245.00	1,350.00	3.14	0.0002	7.7751	-6.1071	Continuous Pumping at Full Rate	
Well 3 to Surface Water Right at Hammersley Canyon mouth												
72,944.05	9,751.20	0.00124	-500.00	-1.11	30.00	2,010.00	3.14	0.0043	4.8630	-3.8355	Continuous Pumping at Full Rate	
72,944.05	9,751.20	0.00124	-500.00	-1.11	245.00	2,010.00	3.14	0.0005	6.9793	-5.4821	Continuous Pumping at Full Rate	
Well 4 to Surface Water Right at Hammersley Canyon mouth												
72,944.05	9,751.20	0.00124	-500.00	-1.11	30.00	4,375.00	3.14	0.0202	3.3433	-2.6261	Continuous Pumping at Full Rate	
72,944.05	9,751.20	0.00124	-500.00	-1.11	245.00	4,375.00	3.14	0.0025	5.4257	-4.2618	Continuous Pumping at Full Rate	

Drawdown Calculations Using Theis Equation

Theis Equation: $s = \frac{Q}{4\pi T} W(u)$

$u = \frac{r^2 S}{4 T t}$

$W(u) = (-\ln u) - 0.5772157 + (u/1) - (u^2/2!) + (u^3/3!) - (u^4/4!) + \dots$

s = drawdown (L)

T = transmissivity (L²/T)

S = storage coefficient (dimensionless)

pi = 3.141592654

r = radial distance (L)

t = time (T)

u = dimensionless

W(u) = well function

Transmissivity T (gpd/ft)	Transmissivity T (ft ² /day)	Storage Coefficient S	Pumping Rate Q (gal/min)	Pumping Rate Q (ft ³ /sec)	Time t (days)	Distance r (feet)	pi	u	W(u)	Drawdown s (feet)	Comments	Net Drawdown (feet)
Note: yellow grid areas are where values are calculated												
Scenario 2: Inject 100% at one injection well only												
LAKE 2326 to Surface Water Right at Hammersley Canyon mouth												
72,944.05	9,751.20	0.00124	1,500.00	3.34	30.00	1,570.00	3.14	0.0026	5.3754	12.6668	Continuous Pumping at Full Rate	
72,944.05	9,751.20	0.00124	1,500.00	3.34	365.00	1,570.00	3.14	0.0002	7.8717	18.5492	Continuous Pumping at Full Rate	
Well 2 to Surface Water Right at Hammersley Canyon mouth (assuming 100% re-injection occurs at this well)												
72,944.05	9,751.20	0.00124	-1,500.00	-3.34	30.00	1,350.00	3.14	0.0019	5.6767	-13.3767	Continuous Pumping at Full Rate	-0.7099
72,944.05	9,751.20	0.00124	-1,500.00	-3.34	245.00	1,350.00	3.14	0.0002	7.7751	-18.3214	Continuous Pumping at Full Rate	0.2278
Well 3 to Surface Water Right at Hammersley Canyon mouth (assuming 100% re-injection occurs at this well)												
72,944.05	9,751.20	0.00124	-1,500.00	-3.34	30.00	2,010.00	3.14	0.0043	4.8830	-11.5064	Continuous Pumping at Full Rate	1.1604
72,944.05	9,751.20	0.00124	-1,500.00	-3.34	245.00	2,010.00	3.14	0.0005	6.9793	-16.4462	Continuous Pumping at Full Rate	2.1030
Well 4 to Surface Water Right at Hammersley Canyon mouth (assuming 100% re-injection occurs at this well)												
72,944.05	9,751.20	0.00124	-1,500.00	-3.34	30.00	4,375.00	3.14	0.0202	3.3433	-7.8782	Continuous Pumping at Full Rate	4.7886
72,944.05	9,751.20	0.00124	-1,500.00	-3.34	245.00	4,375.00	3.14	0.0025	5.4257	-12.7853	Continuous Pumping at Full Rate	5.7639