

MEMORANDUM

Date: January 30, 2013
To: Water Right File 47-7578
From: Michele Edl
Re: field exam and draft license review

I was asked to review the field examiner's report, and the heating volume recommendations for this permit. This memo documents my recommendations.

Space heating

The heated spaces consist of a small (15 ft x 36 ft) finished living area, and an adjoining (85 ft x 36 ft) shop area. Both are contained within a 3600 square foot cinderblock building that was constructed in 1982. Space heating is accomplished through direct use of low-temperature, geothermal water in a radiant floor heating system. The system is an open-loop configuration. There is no isolation heat exchanger and no pump. The only control appears to be a valve on the main supply line to the building. A shared artesian well is the water source and a pond on the Thompson property accepts the heating system's discharge.

The examiner made a flow measurement but no temperatures were recorded during his June 2012 site visit. The system appears to have been built robust enough to hold water so many years after it was constructed. But without temperature readings it is difficult to confirm that a heating use occurred.

The design or peak heating load provided by the examiner is 197,640 BTU/hr. This heating load appears to have been calculated from a derivative of IDWR's method for estimating the likely flow rate for an undeveloped heating use project. This method is useful at the application stage of our water right processes but should not be the only technique employed by a field examiner. A heating load calculation does not confirm beneficial use. It only estimates the potential requirement for the heating use. In this case, the examiner doesn't provide measurements or calculations which demonstrate that the installed heating system could meet his estimate for the heating load.

Although this heating system is not likely built to current building codes, the physics of radiant floor systems have not changed. I used contemporary limits on radiant floor design to determine whether the radiant flooring system in this building could satisfy the estimated peak heating load. I found that this system could not comfortably deliver the heat required to meet that peak load. It could provide adequate heat for much of the heating season but it could not satisfy the heating requirements for the coldest days.

ANSI/ASHRAE Standard 55-2004 puts an upper limit of 84 °F on floor surface temperatures for radiant floor heating systems. Flooring heated above 84 °F is too uncomfortable for prolonged contact even when buffered by footwear. In this case, the radiant floor could be heated no more than the temperature of the geothermal water which is assumed to be 88 °F. As a floor temperature, 88 °F is warmer than would be acceptable by current standards. If a floor heated to 88 °F could be tolerated, then the design inside air temperature, given by the examiner as 72 °F, could be maintained. But this would only be true for a building with an energy flow rate of 30 BTU/hr/ft² or less. (see attached figure). The examiner estimated that the building required approximately 54.9 BTU/hr/ft². (The calculation is: 197,640 BTU/hr ÷ 3600 ft² = 54.9 BTU/hr/ft²). Therefore, a significant portion of the annual heating requirement must be provided by a supplemental heat source. The examiner mentioned that a wood stove was available and used by the resident for those times.

Recreational pond heating

The same piping appears to provide geothermal water for the radiant floor heating system and for the pond. This design cascades water from the high priority, space heating use to a lower priority, recreational use. There does not appear to be any piping dedicated to conveying water directly to the pond. If the geothermal water can be used directly in the pond by somehow bypassing the heat transfer from the radiant flooring, then some additional volume could be attributed to recreational use. There is no evidence that such a bypass exists. I believe that the pond was constructed solely for the purposes of capturing spent water from the heating system.

Any recreational use is incidental to the heating use. Therefore, I recommend no additional rate or volume for recreation use.

Volume Recommendations

The volume of water beneficially used through this system is not available from measurements. Both the examiner and I rely on mathematical calculations to estimate a volume for the license.

The examiner calculated and recommended a licensing volume based on the continuous diversion of the geothermal water for the duration of the heating season. He recommended a volume based on a water flow rate, not on a heat transfer rate.

I calculated the volume based on an adaptation of an ASHRAE heating degree day, (HDD) energy estimation method. I used the HDD from the nearest station, Buhl 2, Idaho (Co-op #101220) for 1993, the coolest year in the period-of-record. I calculated the volume of water beneficially used for space heating using the following equation:

$$\text{Vol} = (\text{HL} \times \text{HDD} \times 24 \times \text{Cd}) / (\text{deltaT1} \times k \times C \times \text{deltaT2}), \text{ where}$$

- HL = 30 BTU/hr/ft² rate based on max possible radiant floor temperature
- HDD = 7438.5 (1993 data, Base 65 F from Buhl 2 station)
- 24 = 24 hr/day
- Cd = 0.6 (factor to account for the construction standard)
- deltaT1 = 61 F (design indoor temperature minus design outdoor temperature)
- k = 0.9 (factor to account for losses)
- C = 2.72 x10⁶ BTU/AF- F (constant to correct for units)
- deltaT2 = 16 F (temperature of incoming geothermal water, assumed to be 88 F, minus temperature of outgoing water, assumed to be 72 F)

My recommended space heating volume is: 4.84 AF. See attached spreadsheet

My total volume recommendation for space heating use and recreational use is 4.84 AF.

Appendix C

Radiant Surface Temperature Charts

Radiant Floor

Surface Temperatures

$$\text{Floor Surface Temperature} = (\text{BTU/h/ft}^2 \div 2) + \text{Room Setpoint}$$

Room setpoint	75°F	80.0	82.5	85.0	87.5	90.0	92.5	95.0	97.5	100.0	102.5
	72°F	77.0	79.5	82.0	84.5	87.0	89.5	92.0	94.5	97.0	99.5
	70°F	75.0	77.5	80.0	82.5	85.0	87.5	90.0	92.5	95.0	97.5
	68°F	73.0	75.5	78.0	80.5	83.0	85.5	88.0	90.5	93.0	95.5
	65°F	70.0	72.5	75.0	77.5	80.0	82.5	85.0	87.5	90.0	92.5
	60°F	65.0	67.5	70.0	72.5	75.0	77.5	80.0	82.5	85.0	87.5
		10.0	15.0	20.0	25.0	30.0	35.0	40.0	45.0	50.0	55.0
BTU/h/ft ²											



Exceeds the maximum recommended surface temperature for hardwood floors



Exceeds the maximum recommended surface temperature for all floors

Radiant Ceiling

Surface Temperatures

$$\text{Ceiling Surface Temperature} = (\text{BTU/h/ft}^2 \div 1.1) + \text{Room Setpoint}$$

Room setpoint	75°F	84.1	88.6	93.2	97.7	100.0	102.3	106.8	114.4
	72°F	81.1	85.6	90.2	94.7	97.0	99.3	103.8	108.4
	70°F	79.1	83.6	88.2	92.7	95.0	97.3	101.8	106.4
	68°F	77.1	81.6	86.2	90.7	93.0	95.3	99.8	104.4
	65°F	74.1	78.6	83.2	87.7	90.0	92.3	96.8	101.4
	60°F	69.1	73.6	78.2	82.7	85.0	87.3	91.8	96.4
		10.0	15.0	20.0	25.0	27.5	30.0	35.0	40.0
BTU/h/ft ²									



Exceeds the maximum recommended surface temperature for 8-foot ceilings
Maximum is 110°F for ceilings higher than 8 feet, but lower than 12 feet.

Sterling Method		$V=(HL*DD*24*Cd)/(deltaT1*k*C*deltaT2)$									
Parameter	Explanation										
V	heat value of the fuel ASHRAE or annual volume Sterling										
HL	peak heating load in BTU/hr										
DD	annual heating degree days										
24	24 hrs/day										
Cd	correction factor; for standard construction choose from ASHRAE fig 1										
deltaT1	design indoor temp minus design outdoor temp										
k	correction factor to account for losses. Use .90										
C	constant to correct for units										
deltaT2	temp of incoming geothermal water minus temp of outgoing										
Area of floor space	liveable floor space in square ft given by assessor										
Geo-Heat Center gives 5-20 BTU/hr per square ft of floor space											
Admin memo 23 suggests range 25-75 BTU/hr per square ft of floor space											
Flux (BTU/hr-ft^2)	HL(BTU/hr) design or peak heating load	DD	hr/day	Cd	delta t1	k	C	delta t2			
5	18,000	7438.5	24	0.6	61	0.9	2720000	16			
10	36,000	7438.5	24	0.6	61	0.9	2720000	16			
15	54,000	7438.5	24	0.6	61	0.9	2720000	16			
20	72,000	7438.5	24	0.6	61	0.9	2720000	16			
25	90,000	7438.5	24	0.6	61	0.9	2720000	16			
30	108,000	7438.5	24	0.6	61	0.9	2720000	16	estimated using radiant floor design		
35	126,000	7438.5	24	0.6	61	0.9	2720000	16			
36	129,600	7438.5	24	0.6	61	0.9	2720000	16	estimated based on R Sterling graph for 'normal' home		
40	144,000	7438.5	24	0.6	61	0.9	2720000	16			
45	162,000	7438.5	24	0.6	61	0.9	2720000	16			
50	180,000	7438.5	24	0.6	61	0.9	2720000	16	estimated based on S Kavanaugh tables		
55	198,000	7438.5	24	0.6	61	0.9	2720000	16			
54.90	197,640	7438.5	24	0.6	61	0.9	2720000	16	estimated using admin memo 23 spreadsheet		
60	216,000	7438.5	24	0.6	61	0.9	2720000	16			
Range of calculated results											
V (AF)/yr	$V= (HL \times DD \times 24 \times Cd)/(delt1 \times k \times C \times delt2)$										
0.81											
1.61											
2.42											
3.23											
4.03											
	8.860566176										
4.84											
5.65											
	5.810207329										
6.46											
7.26											
	8.069732401										
8.88											
Admin memo 23 derived spreadsheet											
Required data											
Brockway inputs											
A	Area of liveable space ft squared			3600							
	2 story (N=1, Y=2)****			1							
e	House efficiency factor			0.9							
Ti	Inside design tempeature in deg F			72							
To	Average outside design temperature in deg F			11							
S	Source temperature in deg F			88							
D	Heating or cooling degree days per season										
H	Hours/day system operates										
Calculations											
Ts = (0.6 x S) - Ti	Temperature drop across the system			4.8							
E = [e x (Ti-To)] x A	Design heat load, BTU/hr			197640.00							
Q = E / ((500 x Ts) x 448.8)	Flow rate required at given source temperture, cfs			0.1834893							
Q = E / ((500 x Ts)	Flow rate required at given source temperature, gpm			82.35							
measured	.09 cfs =			40.4 gpm							

BUHL 2, IDAHO

Monthly Total Heating Degree Days

(101220)

Base Temperature = 65 F

File last updated on Oct 29, 2012

*** Note *** Provisional Data *** After Year/Month 201210

a = 1 day missing, b = 2 days missing, c = 3 days, ..etc.,

z = 26 or more days missing, A = Accumulations present

Long-term means based on columns; thus, the monthly row may not sum (or average) to the long-term annual value.

Months with 5 missing days or less use mean for missing day(s)

Individual Months not used for annual or monthly statistics if more than 5 days are missing.

Individual Years not used for annual statistics if any month in that year has more than 5 days missing.

YEAR (S)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	
1978	997.50	0.00z	664.00	589.50	440.50	143.50	22.00	83.00	273.00	457.50	928.00	12'
1979	1584.00	955.50	791.50	592.00	294.50	135.50	14.50	12.50	80.00	418.50	981.00	10'
1980	1257.50	880.50	872.00	488.50	384.00	185.00	9.00	51.00	173.00	486.00	841.50	10'
1981	1086.11 c	915.00	777.00	545.50	397.50	141.50	28.00	13.50	190.50	642.73 a	781.00	10'
1982	1339.50	1115.33 a	870.50	712.50	0.00z	117.00	47.50	5.50	236.00	580.50	953.00	11'
1983	985.00	816.50	752.00	656.00	376.00	94.50	67.50	5.50	158.00	443.00	752.50	12'
1984	1406.37 a	0.00z	794.50	590.00	363.50	191.00	0.00	1.00	213.50	559.50	828.00	12'
1985	1459.50	1194.50	971.50	428.00	233.00	67.00	1.50	40.50	334.50	539.50	1136.00	9'
1986	1173.50	771.00	600.00	578.50	350.82 a	48.50	38.50	2.00	333.00	484.00	851.00	11'
1987	1247.46 d	879.00	779.50	228.00	0.00z	84.50	62.50	35.00	129.00	401.00	826.00	11'
1988	1188.50	865.00	784.50	440.00	337.50	80.00	9.00	6.50	231.00	235.50	844.50	12'
1989	1299.00	1171.00	785.00	442.00	327.00	80.00	6.00	44.50	167.00	521.50	803.00	11'
1990	1120.00	1020.00	711.50	367.00	373.50	142.00	9.00	37.50	27.00	473.00	787.00	14'
1991	1263.00	729.00	798.50	613.50	428.00	155.00	4.00	4.00	155.50	453.00	935.50	11'
1992	1104.00	732.00	575.00	412.50	172.00	99.00	31.50	51.50	182.50	381.00	1009.00	13'
1993	1390.50	1167.00	858.00	601.50	203.00	224.50	113.50	76.50	198.00	462.50	1019.00	11'
1994	1021.50	1007.00	689.00	472.50	222.50	121.50	15.50	7.50	93.50	539.00	1075.00	12'
1995	1065.50	738.50	797.00	575.50	394.00	207.50	16.50	32.50	130.00	550.50	706.00	10'
1996	1086.50	1024.00	765.50	0.00z	381.50	94.50	0.50	24.50	230.50	473.50	784.00	10'
1997	0.00z	911.50	736.00	613.50	238.50	100.50	53.00	0.00	105.50	476.50	772.50	11'
1998	904.00	808.50	777.00	546.50	342.00	158.00	0.00	0.00	87.50	471.00	744.00	11'
1999	1006.50	888.50	738.00	618.50	366.50	124.00	11.50	1.50	153.50	365.50	595.50	10'
2000	1058.50	770.50	747.00	378.50	208.50	66.50	1.50	0.00	184.00	457.00	1058.50	11'
2001	1236.50	979.00	641.50	538.50	209.50	96.50	2.50	0.00	65.50	393.00	674.00	12'
2002	1211.00	1090.50	836.50	452.50	293.50	106.00	0.00	19.00	132.50	584.50	800.50	9'
2003	862.00	863.00	632.00	554.00	324.50	49.50	0.00	2.50	117.50	328.00	903.50	9'
2004	1226.50	1051.00	553.50	426.50	293.00	73.50	2.00	20.00	157.50	423.50	872.50	9'

2005	1127.00	909.00	671.50	551.50	308.00	172.50	0.00	21.00	188.50	474.00	846.50	11'
2006	960.00	986.00	821.50	503.50	0.00z	37.00	0.00	13.50	192.00	514.50	781.50	11'
2007	1255.00	785.50	633.50	492.50	212.00	79.50	0.00	0.00	169.00	546.00	792.00	11'
2008	1277.00	968.00	848.50	678.50	309.50	136.50	0.00	15.00	148.00	503.50	683.00	11'
2009	1159.00	938.50	828.00	539.00	268.50	105.50	5.00	25.00	55.00	652.00	822.00	12'
2010	1028.00	870.00	750.50	559.00	469.00	122.50	13.00	37.50	97.50	378.50	865.00	10'
2011	1131.00	942.00	761.00	667.50	406.00	140.00	0.00	0.00	25.50	432.00	871.00	11'
2012	1022.00	900.00	662.50	388.00	274.00	95.00	0.00	0.00z	34.50	321.00h	0.00z	

Period of Record Statistics

MEAN	1162.91	928.56	750.71	524.74	318.81	116.43	16.71	20.28	155.69	473.57	850.68	11'
S.D.	162.02	128.22	92.30	104.28	78.22	45.33	25.28	22.08	75.89	86.11	119.82	1'
SKEW	0.45	0.37	-0.18	-0.58	-0.12	0.47	2.13	1.23	0.37	-0.26	0.40	
MAX	1584.00	1194.50	971.50	712.50	469.00	224.50	113.50	83.00	334.50	652.00	1136.00	14'
MIN	862.00	729.00	553.50	228.00	172.00	37.00	0.00	0.00	25.50	235.50	595.50	9'
NO YRS	34	33	35	34	32	35	35	34	35	34	34	