Addendum to: Surface Water and Spring Flow Measurements for Upper Deer Creek in Smith Canyon, Bannock County ID

An Update by Mike and Lori Beer incorporating data from the LRPOA June 22nd response to the June 28, 2021 data request by James Cefalo of the IDWR

Summary

Both the Beers and the Lava Ranch Property Owners Association (LRPOA) have responded to the data request contained in the letter "RE: Request for Additional Information" from James Cefalo of the IDWR dated June 28th, 2021. That letter requested data concerning flows of the spring and Deer creek as well as information of power and water usage by the LRPOA well at the south end of Wolverine Pass Road. The most complete set of data is now available, which allows correlation of the two data sets. This addendum contains graphs created from the data and observations drawn from them.

Overview of Addendum

Two items of interest are presented:

1. A graph showing a general trend where each succeeding year the repurposed LRPOA stock well at the South end of Wolverine Pass Road has more power usage than the previous year. This collaborates the earlier observation of the year over year decline in the

flow in the Lot 182 spring.

2. A graph showing that monthly changes of well power use coincide with changes of the spring flow rate. In 2019, 2020, or 2021 there is evidence that the start of the spring flow decline begins at about the time that the LRPOA well on was turned on and that the decline in flow stopped about the time the well pump was turned off. The data on power usage confirms that the spring changes are in close synchronization with changes of power use levels.

Constraints

Although the amount known about the Deer Creek Aquifer, springs and wells has increased, there still is insufficient information to calculate water drawn by pumping from the aquifer. In particular, the length and diameter of the pipe running from the Wolverine Pass Road well is unknown, the power efficiency of the pump is unknown, as is the elevation change between the well's static head and the High Country tanks.

It should also be possible to empirically determine the relationship between power use and volume of water pumped, but this has not been done.

Despite not exactly knowing the relationship of power consumption and pumped volume, power consumption by the well may be used as a proxy for pumped volume. This relationship is believed to have remained constant since the well came into use as no changes to the system have been described.

Year to Year Well Power Trends 2016 to the Present

The power consumed for each year is summed, allowing comparison of the volume of water pumped by the well year to year.

Year to Year Well Power Trends Data Preparation:

The file "2021 ROCKY MTN POWER BILLING ANALYSIS.xlsx" from the zip files provided with the letter provided by Travis L Thompson on 22June, 2021 was used [1]. The data in this file shows the month to month power consumption of the LRPOA Wolverine Pass Well since use of this well began in 2016. The columns for Date and KWH (Upper Wolverine Well) were used to calculate total power used for each year. The results of this calculation are provided in the following table.

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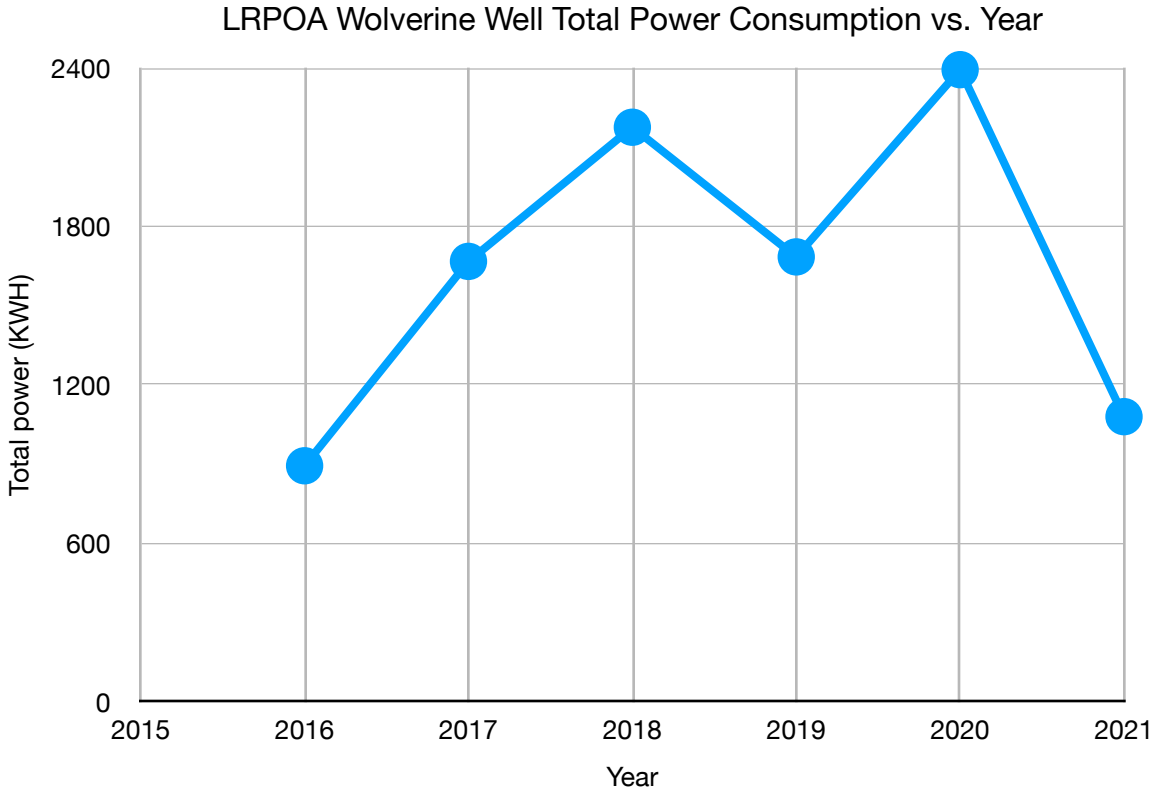
[1] Travis L. Thompson June 22, 2021 "Re: Lava Ranch Property Owners Assn / June 28, 2021 Letter" Law firm Barker Rosholt & Simpson LLP, 163 Second Ave. Wes, PO Box 63, Twin Falls, Idaho 83301

Wolverine Pass Road Well Total Power Use (KWH)

Year	total Power Used (KWH)
2016	894
2017	1668
2018	2176
2019	1685
2020	2394
2021	1080

Year to Year Well Power Trends Graph:

The following graph has been prepared from the data:



From this graph it is possible to easily see that ***there has been a general trend of increasing power consumption from year to year*** with the exception of 2019. The reasons for 2019 being lower are not presently understood.

The year 2021 is also low, but 2021 is a little more than half over and total power consumption is almost half way to the level of power used in 2020. Not too much can yet be read into this. All extrapolation is fraught with difficulty, and in this case particularly so. The use per day of the well since mid June of 2021 has been constrained from previous years to a maximum of 2500 gallons per day. There was also a possibility of a spike of well water use in early June when property owners were made aware of the IDWR cease and desist order on LRPOA well pumping. The shutdown of the LRPOA May Pavilion Well as an alternate water source may also impact use of the Wolverine Pass Well.

It is too early to confidently comment about total power consumption for 2021.

Year to Year Well Power Trends Conclusions

The LRPOA Wolverine Pass Well's power use, and therefore amount of water pumped, has generally increased year to year since 2016. As water is a finite resource, the increased use of water by LRPOA impacts the amount of water available to other aquifer users. This collaborates the earlier observation for the Lot 182 Spring that ‘‘there has been a [spring flow] decrease year on year”[2] for the years 2016 to the present.

Comparison of Well Power Use and Spring Flow Measurements for 2019 to the Present

With time based measurements for both power consumption by the LRPOA Wolverine Pass well and Lot 182 Spring flow it is now possible to line up well power use to the spring's flow rate and test earlier hypotheses.

Well Power Use and Spring Flow Measurements Data Preparation:

The June 22nd letter from Travis L. Thompson[3] included a zip file that contained directories for 2019, 2020 and 2021. Each of these year directories contained .pdf files that were copies of the LRPOA well power bills for the year. From these bills the dates of the start of the billing period and power used during the period were obtained. The starting billing period date is for the previous month's use of electricity. Because of this, the dates for this data set do not correspond with the billing dates in the “Year to Year Power Trends” data.

The earlier report by Beer[4] provided the spring data flow measurements and is in an

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[2] 2021 Beer “Surface Water and Spring Flow Measurements for Upper Deer Creek in Smith Canyon, Bannock County ID”, Section “Lot 182 Spring photographic measurement values” p 8

[3] ibid Travis L. Thompson June 22, 2021

[4] 2021 Beer

acceptable form for plotting so no data preparation was necessary for this data set.

The numerical results of the data preparation are presented in the two following tables.

LRPO Wolverine Pass Well

LRPOA Use month	LRPOA Power
Apr 9, 2019	7
May 8, 2019	106
Jun 6, 2019	680
Jul 9, 2019	361
Aug 8, 2019	389
Sep 9, 2019	141
Oct 9, 2019	8
May 7, 2020	416
Jun 8, 2020	479
Jul 8, 2020	567
Aug 7, 2020	725
Sep 8, 2020	207
Apr 8, 2021	380
May 7, 2021	12
Jun 9, 2021	682

Lot 182 Spring Flow

Date	Spring Flow gallons/min
Aug 10, 2019	0.1458
Aug 17, 2019	0.1250
Sep 1, 2019	0.0938
Sep 7, 2019	0.1042
Sep 14, 2019	0.1042
Sep 21, 2019	0.1250
Sep 29, 2019	0.1250
Oct 5, 2019	0.1042
Oct 13, 2019	0.1146
Oct 20, 2019	0.1042
Oct 26, 2019	0.1042
Nov 2, 2019	0.1172
Nov 9, 2019	0.1146
Nov 24, 2019	0.1042
Feb 29, 2020	0.2344
Jun 2, 2020	0.2708
Jun 6, 2020	0.2708

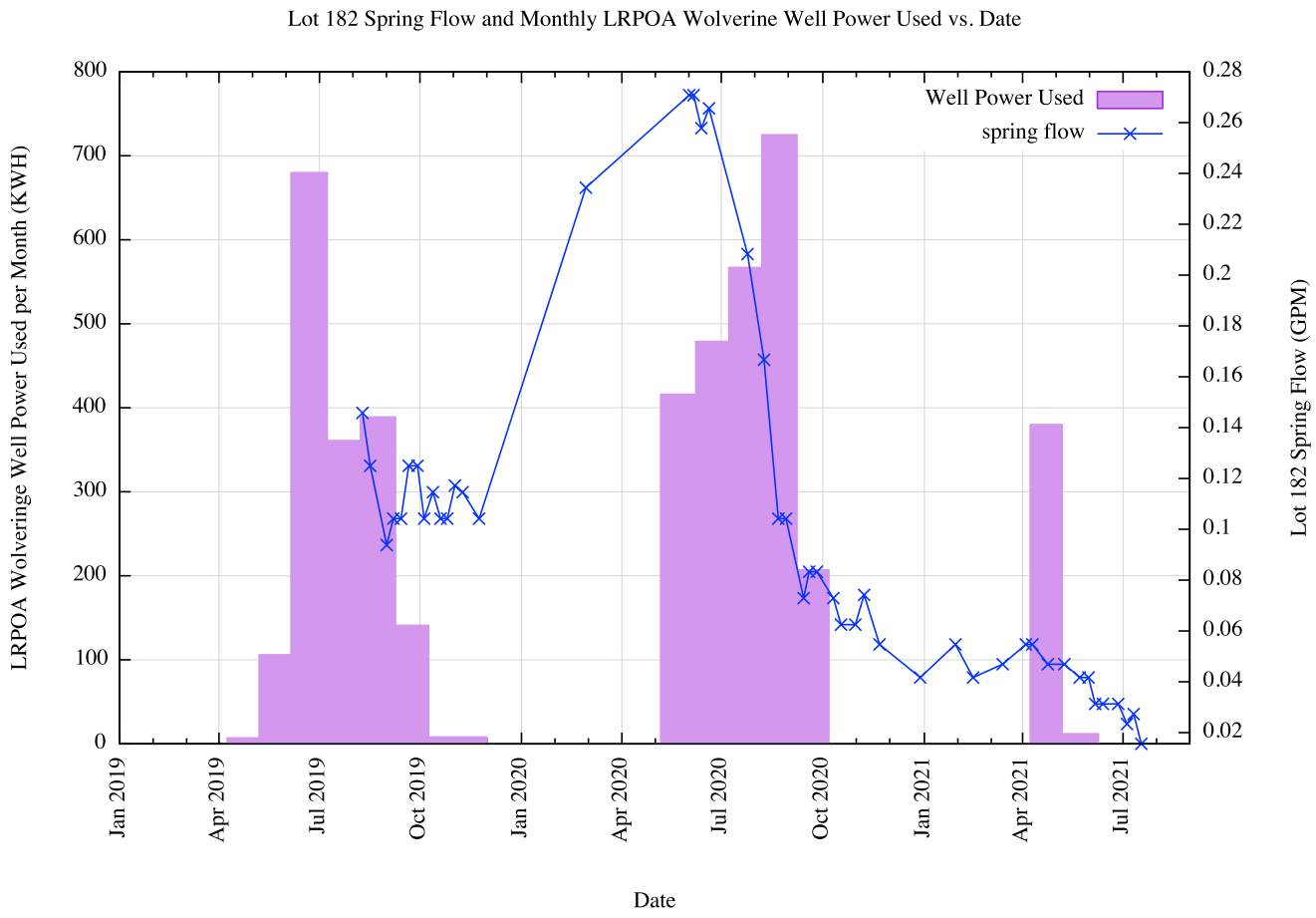
Jun 13, 2020	0.2578
Jun 20, 2020	0.2656
Jul 25, 2020	0.2083
Aug 9, 2020	0.1667
Aug 22, 2020	0.1042
Aug 29, 2020	0.1042
Sep 14, 2020	0.0729
Sep 19, 2020	0.0833
Sep 26, 2020	0.0833
Oct 11, 2020	0.0729
Oct 18, 2020	0.0625
Oct 31, 2020	0.0625
Nov 8, 2020	0.0742
Nov 22, 2020	0.0547
Dec 29, 2020	0.0417
Jan 30, 2021	0.0547
Feb 15, 2021	0.0417
Mar 14, 2021	0.0469
Apr 4, 2021	0.0547
Apr 10, 2021	0.0547
Apr 24, 2021	0.0469
May 9, 2021	0.0469
May 23, 2021	0.0417
May 31, 2021	0.0417
Jun 6, 2021	0.0313
Jun 13, 2021	0.0313
Jun 27, 2021	0.0313
Jul 5, 2021	0.0234
Jul 11, 2021	0.0273
Jul 18, 2021	0.0156

Well Power Use and Spring Flow Measurements Comparison Graph:

The above data was graphed with the spring data as a line with points and the well data as bars beginning at the date of the power use period. Bar height corresponds to power use and bar width corresponds to of the number of days in the billing month.

From this graph it is apparent that ***larger pump power consumption results in a faster decline in spring flow***. ***When the pump power consumption decreases, the spring flow rate either stabilizes at a reduced level or reduces its rate of decline.*** These changes may require a month from the change in power use to stabilize.

One of the curious things in the spring flow data set was that sometimes succeeding measurements jump up and down. This was perplexing as the variation was well outside the precision of the measurements. The well power data shows that this variation usually occurs ***after*** an abrupt change in power use. This is particularly apparent at the higher spring flow rates.



This type of behavior is a common response to an abrupt change in systems that can be modeled using differential equations. When there are parts of the system that can be modeled as inertia (water flow), resistance to water flow and water flow storage, it should be expected that this type of behavior occurs [5]. This behavior is often referred to as ringing. Ringing is a possible response of the of the aquifer to the abrupt change in the amount of water withdrawn.

Seeing this ringing in the Lot 182 Spring Flow data in response to changes in the well pumping re-enforeces the belief that the two are interrelated.

In this case, the sampling interval of the Lot 182 Spring flow was not short enough to faithfully capture the shape of the expected ringing wave form. [6]

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[5] Marion, Jerry 1970, “Classical Dynamics of Particles and Systems”, second edition, Academic Press, Inc., 111 Fifth Avenue, New your, New York, Chapter 4.6 “The Response of Linear Oscillators to Impulsive Forcing Functions”

[6] Shannon, Claude E. (January 1949). "Communication in the presence of noise". *Proceedings of the Institute of Radio Engineers*. **37** (1): 10–21. doi:10.1109/jrproc.1949.232969. S2CID 52873253. Reprint as classic paper in: *Proc. IEEE*, Vol. 86, No. 2, (Feb 1998)

Well Power Use and Spring Flow Measurements Conclusions

The Lot 182 Spring flow is observed to rapidly decline coincident with increases in the power use and accompanying increases in the pumping rate of the LRPOA Wolverine Pass Well. The Lot 182 Spring flow is seen to either level off or not drop as rapidly after the Wolverine Pass well power use declines.

An interesting observation is that the spring flow rate appears to “ring” in response to abrupt changes to pumping power. This provides further evidence that the LPROA Wolverine Pass Road Well and the Lot 182 Spring are interconnected.

Addendum Conclusions

Power consumption by the LRPOA well on Wolverine Pass Road is believed to be directly related to volume of water pumped from the well. Insufficient information is available to calculate the relationship and no empirical calibration has been provided. Because of this power consumption by the well is used as a proxy for pumped volume.

A general trend was previously observed for the span of 2016 to the present that the flow of the Lot 128 Spring has declined each succeeding year. Over this same span the total power consumed and therefore volume pumped by the LRPOA well on Wolverine Pass Road has generally increased each succeeding year. The new yearly power use data shows that the year on year decline in spring flow is consistent with increasing pumped volume

The monthly changes of the LRPOA Wolverine Pass Road Well's power use coincide with changes in the spring flow rate. In the earlier Beer report, it was known that the start of the spring flow decline began at about the time that the LRPOA well on was turned on and that the decline in flow stopped about the time the well pump was turned off. The data on power usage confirms that these changes are in synchronization with actual power use levels. The flow response of the spring to abrupt changes is also highly suggestive of interconnection.