

Cefalo, James

From: Kristin Moore <kristin.rmea@gmail.com>
Sent: Monday, April 11, 2022 3:32 PM
To: Cefalo, James
Subject: RE: Transfer application 85706 (Steel)
Attachments: PCC_memo_20220411.pdf

Categories: ASAP

James,

After careful review of your analysis, and a little bit of our own, we have come to the conclusion that Nef's can operate with the remaining rate of 4.96 cfs. The VFD was installed about 4 years ago. Since installing it, they have not required the use of the booster. There is one year in the WMIS data that represents the current water usage. 2019 records show that the VFD was installed and no booster was running. The calculated cfs is 5.05 cfs. All of the calculations make some assumptions and include a margin of error. A reduced rate of 4.96 cfs is within a margin of error (5%) of what they are already pumping.

Dave Nef has indicated that they already have a flow meter on the system with a data logger. It is his preference to accept your flow meter requirement rather than the volume limitation. As a side note, the system changes they have made, including changing to a VFD pump, converting wheel lines and hand lines to pivots, etc., were for the sole purpose of reducing power costs, becoming more efficient, and staying within their water right.

I've attached a brief summary from Bryce's review of the historical data and the current operating practices.

Thanks,

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From: Cefalo, James [<mailto:James.Cefalo@idwr.idaho.gov>]
Sent: Thursday, March 24, 2022 5:44 PM
To: Kristin Moore <kristin.rmea@gmail.com>
Subject: Re: Transfer application 85706 (Steel)

Memorandum
PCC Data for WMIS Site No. 200114
Dave Nef

To: Project File 21-0104
Fr: Bryce Contor
Date: April 11, 2022

Re: Review of PCC Data

At the request of Kristin Moore, RMEA, I have reviewed Power Consumption Coefficient data from a *.pdf file that Moore indicates was provided by IDWR for WMIS site 200114. I also have reviewed water-right backfile 35-7443 for the same location, which I recently downloaded from the IDWR website. My background for this review is based on many years of experience and having performed hundreds of flow measurements, PCC calculations and flowmeter calibrations, using similar instruments, and having performed annual volume calculations for over 700 wells for a three-year period in the North Water Measurement District, as well as assisting with calculations in the East Water Measurement District.

Because the system has been operated without the booster for the past three years and likely the booster will be removed, I considered only the three measurements where the booster was not running. I excluded the WMIS data for some events where the booster flag was set to "no," because the "notes" field clearly indicated that the booster was on, or because the kilowatt field indicated an input horsepower over 900, which would be extremely unlikely with only the 600-horsepower main pump running. With these qualifications, the three measurements of the booster-off condition are presented in Table 1. Columns and rows with yellow-highlighted titles in italics I calculated from the other data, which all came from the WMIS reports. A blank entry indicates that the data item was not provided in the WMIS report. The "CFS/Mean" column divides the calculated CFS from the mean of calculated CFS readings, and likewise the "PCC/Mean" column divides the calculated PCC by the mean of calculated PCCs.

Table 1. PCC Data for Booster-off Condition								
Date	KW	GPM	<i>CFS fr. GPM</i>	<i>CFS/ Mean</i>	<i>CFS/ 5.07</i>	<i>CFS/ 4.96</i>	<i>Calc. PCC</i>	<i>PCC/ Mean</i>
6/11/2002	507	1969	4.39	91%	86.6%	88.5%	1398	106%
6/11/2002	534	2283	5.09	105%	100.4%	102.6%	1271	97%
6/1/2019	530	2268	5.05	104%	99.6%	101.8%	1269	97%
<i>Max</i>	534	2283	5.09				1398	
<i>Min</i>	507	1969	4.39				1269	
<i>Median</i>	530	2268	5.05				1271	
<i>Mean</i>	524	2173	4.84				1313	

Water Right Implications

The field instruments likely used to collect the data in Table 1 are nominally accurate to plus or minus five percent in laboratory conditions and will be less in field conditions. Nevertheless, even at a plus or minus five percent assumption, none of the measured booster-off flows can be shown with confidence to exceed either the current 5.07 cfs rate or a potential reduced rate of 4.96 cfs.

Implications of Variable Frequency Drive

The 2019 measurement notes confirm the owner's indication of a "Variable Frequency Drive" now installed on the system. At the most basic level, the determinants of the PCC are:

$$\text{PCC} = \frac{(\text{Total Dynamic Head})}{(\text{Pumping Plant Efficiency})} \times 1.02 \quad (1)$$

where:

PCC = power consumption coefficient, kilowatt hours per acre foot

Total Dynamic Head = the pressure or "head" that must be generated to lift, deliver and pressurize the flow of water, expressed in feet.

Pumping Plant Efficiency = the combined electrical and mechanical efficiency, expressed as a decimal.

1.02 = units-conversion multiplier

Table 2 provides theoretical calculations informed by available data and reasonable assumptions.

Table 2. Theoretical PCC Calculation			
Variable	Value - High PCC	Value - Low PCC	Notes
Static water level	700 feet	685 feet	Well log in WR backfile gives static WL at 685 feet.
Drawdown	40 feet	20 feet	Assumed values
Column Friction	30 feet	20 feet	Assumed values
Pressure Head	139 feet	104 feet	60 psi or 45 psi times 2.31 ft/psi
Total Dynamic Head	909 feet	829 feet	Sum of sub entries
Pumping-plant efficiency	50%	70%	Assumed values
Calculated PCC	1,854	1,207	Per Equation (1)

All the reported PCCs are within the theoretically-calculated range.

The VFD PCC is nearly equal to one of the prior booster-off PCCs and is 97% of the average PCC for all booster-off measurements. All booster-off PCCs are within six percent of the mean booster-off PCC. These are point measurements, and though the data are very consistent they are sparse. Theoretically, because of the moderating effect of a VFD on discharge pressure and therefore total dynamic head, A VFD would be expected to stabilize PCC across operating conditions by stabilizing the discharge-pressure component of Total Dynamic Head (TDH). If the pump is designed with a wide range of discharge rates, which would have been the design choice for a well pump intended to supply a booster, and if the VFD drive itself has electrical efficiency more or less constant across its operating range, then Pumping Plant Efficiency also will be reasonably stable across a range of flows. Finally, given the low diversion rate per acre of this right, the system is likely to be operated near the water-right limit most of the time and so operating conditions usually would be very similar to conditions that prevailed when the PCCs were measured.

It is my professional opinion that as a practical manner, PCC data will be adequate for future use. In fact, there are anecdotal reports that some electronic flowmeters can be influenced by the operation of a VFD, and if so at this site, PCC data would be superior to flowmeter data. Another factor is that in my experience, kilowatt-hour meters are much less trouble prone than water-flow meters.

Dwight A. Contor