SPARE ENGINEERING

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May 5, 2026

RE: 2026-ITI-46 / GMD5 / Southwestern College - 22076

Southwestern College, c/o Matt Foos
FNC, P.O. Box 454
Spearville, KS 67876

Mr Foos,

You have given me the opportunity to test and evaluate the irrigation system located on the **Southwestern College - 22076** field located at **NW 5-27-14W**. The field work was completed today, assisted by Mr Duane Miller and his son, Darian Miller.

Three primary systems need to work together properly for an efficient system operation. First, the well needs to produce a sustained flowrate. Secondly the pump transports the water from the well into the irrigation system with reasonable friction (pressure) loss. Thirdly, the irrigation system's sprinkler package (sprinklers, nozzles, regulators, end sprinklers) uniformly distributes the pumped water onto the ground or crop. Each of the three systems works together and must be individually optimized in order for the full operation to provide economical results.

WELL PERFORMANCE is most often measured as Specific Capacity (gpm per net ft of drawdown (DD)). Having access to the water level during pumping allows one to assess Specific Capacity (SC).

This replacement well (original had a priority date of 1981) was completed in 2015 to a depth of 146 ft, and the static water level (SWL) was 48 ft.

We measured the SWL at 53.5 ft. After 25 minutes the Pumping Water Level (PWL) was measured at 74.5 ft. The resulting calculation of Specific Capacity (SC) was 40 gpm/ft of Drawdown (DD) which indicates a very good water yield in this well.

PUMPING PLANT. For evaluations of irrigation pumping plants, we use the Nebraska Performance Standards for Irrigation Pumping Plants (NPPPC) as targets. The target Pumping Plant Efficiency for diesel powered pumping plants is 14.5, measured as Water Horsepower (WHP) per gal/hr of diesel consumption.

The installed pump is a 3-stage turbine pump of an unknown model. It has 90 ft of column pipe.

The right angle gear drive has a 6:5 ratio. The pump produced 833 gpm at 61 psi (measured at the pump). This flowrate was determined over 20 minutes via the McCrometer flowmeter register; the flowmeter needle indicated 1010 gpm. The pump was turning at 1836 rpm.

A buried pipeline of approximately 210 ft length transports water from the pump to the center pivot. Pressure at the pivot point at 4 ft below the well pad was 57 psi.

Total dynamic head (TDH) was calculated at 221 ft. Power being generated by the pump was 47 WHP.

Diesel fuel consumption was measured at 4.1 gal/hr. The pivot was not running during the test and the P85 sprinkler was not operating.

The pumping plant performance was calculated to be 11.4 WHP/gal/hr which is 78% of the NPPPC standard and is OK.

SPRINKLER PACKAGE. The center pivot irrigation machine and sprinkler package is the third sub-system that must be analyzed—the required flowrate and pressure from the well and pumping plant must be conveyed efficiently from end to end of the system and distributed uniformly via each of the sprinklers. The industry standard rule-of-thumb is that the pressure on the upstream side of pressure regulators needs to be at least 5 psi above the rated pressure, thus a 15 psi regulator needs 20 psi going into its upstream side.

Your system has a sprinkler chart dated May, 2026 representing the installed Senninger LDN sprayer with flat plate grooves and with 10 psi pressure regulators on an old Zimmatic center pivot machine with side outlets. Also installed are 1/2" galvanized drop pipes with the sprinklers at about 8 ft ground height. There were several plugged nozzles and one broken drop. Based on the reported water meter acre-feet of water used, we estimate that this sprinkler package has operated over 40,000 hrs. So, even though the sprinkler chart is recently made, it actually appears to have been created to represent the installed sprinkler package, though that set of sprinkler hardware was installed decades ago.

The sprinkler chart indicates 700 gpm at 39 psi for top of the pivot. As noted above we determined the existing flowrate to be 833 gpm with the pivot position at about 270 degrees from North. The high point of the field is about 10 ft higher than at this position. The end tower (ET) pressure (ascertained by a pressure gage attached to a drop near end tower at 9 ft above the ground) was greater than 35 psi (pressure gage pegged out).

Pressure at the pivot point was 52 psi, thus a pressure loss of 13 psi with the flowrate of 833 gpm.

Discussion and Recommendations

Your well appeared to be providing water with a very good water yield as the SC is 44 gpm per ft of DD.

The pumping plant efficiency was determined to be 11.4 WHP/(gal/hr) which is considered OK.

We noted that the pump was operating at a speed of 1836 rpm, thus the engine would have been operating at 2203 rpm (6:5 ratio). The generator voltage was 500 for the test.

Had the P85 sprinkler been operating, the flowrate would have been 887 gpm.

As we discussed during the day, a useful target for change of flowrate would be 750 gpm at 33 psi for top-of-pivot pressure. You may also wish to change out the P85 end sprinkler for a R65 end sprinkler and mount that at about 7 ft above the ground to expose the water to lower wind velocity.

I also recommend that a new sprinkler package be installed. The current installation includes worn out pressure regulators, and sprinklers. If you install the A3030 sprinklers with 10 psi pressure regulators, and place the sprinklers at about 6 ft above the ground (a height that makes possible the cleaning of the nozzles when plugged), you should still be able to achieve a good radius of throw that will be less likely to create runoff in comparison to the spray nozzles that have been in use on this machine. But also, try to transition to ¾" drop hoses, immediately downstream of the ½" galvanized side-outlet elbows, as this will reduce friction losses in the drop pipes.

As you make these changes, you will likely find it helpful to have a pressure gage at the pump site where you can make your adjustments of engine speed. It may be that you can lower the pump speed closer to 1770 rpm. I believe that you should be able to achieve the 33 psi at the top of the pivot if you have 42 psi at the pump outflow (where we measured pressure). With lower engine speed and thus lower pressure you should find a significant energy savings.

I note also that from your crop yield imagery that you shared with us, the high places of your field showed significantly lower crop yields than the lower areas. By having correctly functioning new pressure regulators you should be able to achieve more uniform yields across your field as a result of uniform water application.

If you can manage it, I suggest that you place a pressure transducer at the ET (mounted on top of the span pipe) so that you can track pressure across the season. If, with 10 psi regulators in your sprinkler package, you see the ET pressure lower than 15 psi, then you will need to adjust the pump speed up somewhat.

I realize that you also need to keep the generated voltage up to around 500V for optimum pivot operation. If the above changes make it difficult to reach your target voltage, then you may need to change the generator sheave diameter to make the voltage adjustment while maintaining the required pressure and pump speed.

I also noted that on top of the surge tank immediately downstream of the flowmeter there is a vacuum vent. I recommend that this be replaced with a continuous acting air vent (CAV) which makes it possible to discharge any air accumulations in the surge tank. This can be especially useful if the air bubble in that section of piping has been preventing full pipe flow through the flowmeter. This CAV will also allow for the necessary influx of air when the pump stops, thus preventing collapse of downstream pipe.

In the chart, **FUTURE – With Improvements**, you can see some estimated savings resulting from reducing the flowrate and from operating at a correct pressure. The amount of annual energy cost savings that appears there appears to be about $8000 for a 750 gpm flowrate. This is due partly to the advantage of less friction loss in the span pipes, but more importantly due to lower pressure requirements, and fewer acre-feet of water needed to be pumped.

You should find yourself able to achieve good crop yields with less than the average of 18 applied inches, due to the uniform application across this field.

You may wish to explore the use of commercially available soil moisture probes to assist in management of water applications.

If you use cost share funds from GMD5 then you should be able to cover the costs of nozzle changes and the other changes mentioned above. I suggest that you be in contact with the GMD5 Manager, Orrin Feril, to explore your options.

If you have questions about the above information, or would like to discuss, feel free to contact me.

Sincerely yours,

Daniel P Spare

Daniel Spare, P.E. (Kansas 23540)
Agricultural Engineer

AS-IS

Southwestern College c/o Matt Foos	Diesel-Powered	
ITI Energy and Water Use Audit	2026-ITI-46	
Date	5/5/2026	
Legal	NW 5-27-14W	
Field #	**Southwestern College - 22076**	
McCrometer Timed Test gpm	833	EG OFF
McCrometer Needle reading gpm	1010	
Ultrasonic Meter		
Pressure at pump, psi	61	at 1' ht
Pressure at pivot base	57	
Press on top of pivot	52	calc'd
Nozzling Package Design GPM	646	subtracted 54 for EG
PSI on top of pivot	39	
Pressure REG setting	10	
Installed Sprinklers	LDN flat grooved	
Measured Pressure at end Tower	39	unsure; pegged out; 270deg
Lowest ET Pressure (hi point)	34	ET 10 ft higher
Req'd ET Pressure Minimum(Hi Point)	31	
Static Water Level, ft	53.5	
Pumping Water Level, ft	74.5	
Well's Specific Capacity		
gpm/ft of DD	40	
Total Dynamic Head, ft (TDH)	221	
Water HP	46.6	
Adjusted WHP for GenSet/HydT&L	46.6	pivot not running
Diesel Fuel Consumption gal/hr	4.10	
Gearhead Ratio	6:5	
PUMP shaft RPM	1836	
Engine RPM	2203	
Engine Tach Reading	n/a	
GENSET	500.00	operation voltage
Volts		
amps		
Pfactor		
Estimated Motor HP	n/a	
Estimated Water HP equivalent		
WHP/gal/hr Diesel	11.4	
NPPPC standard	14.5	
% of NPPPC standard	78%	
	OK	
Permit number	35004	
Allotted Acres	160	
Maximum Flow rate	1050	
Alloted AF	195	
Actual acres irrigated	130	
WELL Depth WIZARD KGS		
SWL at Drilling	48	2015
Operating Hours Calculations		
Max Inches applied per acre	18.00	
OP Hours in a drier year	1,273	
Elevation at Pivot	2006	
Elevation at Well	2010	
Elevation at Highest pt in field	2016	
spr pkg age, yrs	40?	very old, estimated
Estim. Operating Hrs	43984	
Age of pump, yrs	11	Overhauled June, 2015

FUTURE - WITH IMPROVEMENTS

New Sprinkler Package; Contin Air Vent

Field Number	Southwestern College - 22076	
Flow Rate, gpm		750
per acre flowrate		5.8
Press at end tower		15.0
HF pivot friction loss psi		13.7
Psi loss to highest pt in field		4.3
Measured Hf to pivot base psi		4.0
(adjusted to design flow rate		
Required Press at Pump		42.2
Required Press at Pivot on Top		33.0
Design Total Dynamic Head, TDH		175.9
PWL-Includes 5 future GW decline		77
Water HP		33.3
Press at Pivot Base using Pump psi		39.1
Mainline to Pivot Hydraulics Pipe ID		7.8
Length ft		212
Hf friction loss psi		3.1
Cost per gallon of Diesel ($)		$3.50
Energy Use Comparison		
AS IS gallons Diesel		5,214
Energy Cost AS IS ($)		$18,248
OP Hours at Design Flow Rate		1,272
New Pump Water HP		33.32
Brake HP 82% pump efficiency		40.64
Motor Size, HP		
Pump KWDemand		34.45
Total New Diesel gal/hr		2.30
New gallons Diesel		2923
NEW annual cost of Diesel		$10,232
Savings in Energy Cost		$8,016
Combined BTU As Is		723,083,724
Combined BTU Future		405,440,274
Savings in BTU per year		317,643,450
% Energy Savings		43.93%
IMPROVEMENT COSTS		
Replacement Sprinkler Package	$10,000	
CAV	$250	
NET TOTAL COSTS	$10,250	
Payback Years		1