memo

Project Name |	Weather Station Monitoring Program	**Date** |	1/07/2020
To / Contact info |	BCWD Board of Managers		
Cc / Contact info |	Karen Kill, District Administrator		
From / Contact info |	Mike Majeski		
Regarding |	2019 Weather Station QA/QC Summary		

Background

The Weather Station Monitoring Program was initiated in the spring of 2011. Each season the weather station is installed on top of the vegetated berm at the Stillwater Public Works Facility and collects the following data: precipitation, air temperature, relative humidity, solar radiation, wind speed, gust speed, and wind direction. The weather station is programmed to collect data from spring through fall of each season. This information is being collected to support a variety of District projects and programs including hydrologic and hydraulic model upgrades and calibration (which required 15-minute precipitation data), thermal modeling efforts, and more recently assessing the Settlers Glen iron-enhanced sand filter project and sediment loading to Lake McKusick. The weather station data is routinely shared with the Washington Conservation District and University of Minnesota (Bill Herb). During the 2019 monitoring season, the weather station data was evaluated for quality assurance purposes by comparing data on a monthly basis to local weather stations. This memorandum summarizes the results of this quality assurance/quality control (QA/QC) process.

QA/QC Summary

The Brown's Creek weather station was installed at the Stillwater Public Works Facility (latitude: 45°03'49.86", longitude: 92°51'21.05") on April 2, 2019 and was removed on October 15, 2019. For quality assurance and quality control of the dataset, 9 individual time periods were analyzed by comparing the data to the nearest weather stations reporting similar data parameters. A review of weather station locations provided by WeatherUnderground.com indicated a personal weather station located 2.5 miles southeast (KMNOAKPA4) and another station located 2.0 miles northwest (KMNSTILL18) of the Brown's Creek weather station. These two weather stations were chosen for comparison because they were the nearest weather stations reporting hourly temperature, relative humidity, precipitation, and wind speed data. It should be noted that weather stations KMNSTILL8 and KMNSTILL 36 that were used for comparison in 2018 were not available in 2019, and no close weather stations existed in 2019 that recorded solar radiation.

Beginning in April, individual time periods in each month were compared to the Weather Underground personal weather stations for the same time period. For example, the time period reviewed in April was April 10 at 4:30 for the Brown's Creek station, April 10 at 4:29 for the KMNSTILL18 station, and April 10 at 4:29 for the KMNOAKPA4 station. It should be noted that the weather stations did not report at the exact same time, resulting in slightly different timestamps for data comparison. In addition, time periods were selected at different times of the day (early morning, late morning, early afternoon, evening, and night) to compare the data against temperature and relative humidity extremes. Nine time periods were analyzed from April-October (Table 1).

Table 1. Comparison of Weather Station Data for the 2019 Monitoring Season

Weather Station	Date/ Time	Temp (°F)	RH (%)	Solar Radiation (w/m2)	Wind Speed (mph)	Gust Speed (mph)	24 hr Precip (in)
Brown's Creek	4/10/2019 4:30	26.3	79.4	0.6	0.0	2.2	0.00
KMNSTILL18	4/10/2019 4:29	26.2	92.0	N/A	0.0	0.0	0.00
KMNOAKPA4	4/10/2019 4:29	27.2	76.0	N/A	1.2	3.8	0.00
Brown's Creek	5/6/2019 8:15	46.4	50.7	176.9	5.6	11.3	0.00
KMNSTILL18	5/6/2019 8:14	46.6	59.0	N/A	0.0	0.0	0.00
KMNOAKPA4	5/6/2019 8:14	47.2	50.0	N/A	1.0	2.2	0.00
Brown's Creek	5/27/2019 23:45	46.5	97.4	0.6	3.4	9.0	1.95
KMNSTILL18	5/27/2019 23:44	46.0	99.0	N/A	0.0	0.0	2.06
KMNOAKPA4	5/27/2019 23:44	46.7	98.0	N/A	1.4	4.3	0.00
Brown's Creek	6/24/2019 11:30	62.8	91.7	58.1	0.0	4.5	0.79
KMNSTILL18	6/24/2019 11:29	63.7	99.0	N/A	0.0	0.0	0.79
KMNOAKPA4	6/24/2019 11:29	63.3	91.0	N/A	0.3	2.0	0.61
Brown's Creek	7/15/2019 14:30	91.1	70.0	259.4	1.1	9.0	0.83
KMNSTILL18	7/15/2019 14:29	96.6	67.0	N/A	1.5	2.7	0.83
KMNOAKPA4	7/15/2019 14:29	89.1	67.0	N/A	2.1	4.8	0.79
Brown's Creek	8/18/2019 18:00	69.3	59.0	46.9	0.0	3.4	2.36
KMNSTILL18	8/18/2019 17:59	70.2	68.0	N/A	0.0	0.0	1.89
KMNOAKPA4	8/18/2019 17:59	71.5	54.0	N/A	0.4	2.1	1.19
Brown's Creek	9/16/2019 12:30	82.6	60.9	320.6	1.1	5.6	0.00
KMNSTILL18	9/16/2019 12:29	84.9	65.0	N/A	1.1	2.4	0.00
KMNOAKPA4	9/16/2019 12:29	80.4	62.0	N/A	1.3	4.8	0.00
Brown's Creek	10/1/2019 9:15	53.3	91.4	76.9	0.0	4.5	0.97
KMNSTILL18	10/1/2019 9:14	52.9	99.0	N/A	0.0	0.0	1.07
KMNOAKPA4	10/1/2019 9:14	52.9	91.0	N/A	0.9	2.6	0.94
Brown's Creek	10/14/19 1:00	33.5	95.2	0.6	0.0	4.5	0.01
KMNSTILL18	10/14/19 0:59	32.9	99.0	N/A	0.0	0.0	0.00
KMNOAKPA4	10/14/19 0:59	33.6	95.0	N/A	0.1	1.0	0.00

Similar values between the three weather stations were observed in the temperature, relative humidity, and precipitation data. Some variability in precipitation, relative humidity, wind speed, and gust speed data occurred, but this was expected based on the distances between the three weather stations. It is likely the 0.00 precipitation value recorded by station KMNOAKPA4 on 5/27/2019 was the result of a plugged precipitation funnel or data logger issue. This station appeared to be recording data in all other months checked. Differences in wind speed and gust speed can be influenced by differences in measuring equipment, location, age of the anemometer,

logging rate and time, and landscape obstructions such as buildings, trees, and topography. Differences in precipitation can be influenced by tree and building obstructions, type of measuring equipment, clogging of the precipitation funnel, differences in rainfall intensity and duration between weather stations, and logger calibrations (if performed).

Conclusion

The District's weather station performed as expected in 2019. The weather sensors were inspected after the weather station was removed in the fall of 2019, and all sensors appeared to be in good working condition. The oldest sensor is the pyranometer (solar radiation sensor) but based on the color of the filter window(white), the sensor is still functional. Should the filter window fade to a dull yellow color or darker, the sensor will need to be replaced.

Recommendations

In late summer 2019, Stillwater Public Works staff cut down the box elder trees that were growing along the berm where the weather station is located. It is unknown if the cut stumps were treated with a herbicide, but if sucker growth is observed in 2020, EOR will contact Stillwater Public Works staff to have the stumps treated.

Based on the age of some of the weather station sensors, it is recommended the temperature/ relative humidity and pyranometer sensors be sent to the manufacturer to check calibrations. The sensors will be replaced if they are out of calibration.

2020 Scope of Services

The following scope identifies the costs associated with the collection and review of weather station data for the 2020 monitoring season (March to November). This scope includes the cost to replace the temperature/ relative humidity and pyranometer sensors, if needed, and prepare a memo describing the quality control used to evaluate data integrity. All data collected in 2020 will be forwarded to the Washington Conservation District, University of Minnesota, and other entities if requested.

Task	**Hours**	**Estimated Cost**
Equipment Prep and Installation of Weather Station	5	$755
Monthly Download of Data	7	$1,057
End of Season Equipment Removal	4	$604
Data Storage, Quality Control memo, and Distribution to the WCD	8	$1,208
Expenses	N/A	$490*
TOTALS	**25**	**$4,114**

* includes cost to replace temperature/relative humidity and pyranometer sensors, if needed

Action Item

1. Authorize EOR to implement the weather station monitoring program in the spring of 2020 per the costs identified in this scope. This work will be completed by December 31, 2020.