Vista Ridge LLC

POSGCD Well Monitoring Data Management Protocol

April 2021

Version 2.1

RULE 4.3. MONITORING REQUIREMENTS CHEKCLIST

_____ Monitoring equipment as reasonably required installed

(Badger turbine (8 inch model 3500 & 12 inch Model 6200) meter as specified by POSGCD in construction specifications)

_____ Wells capable for use as monitoring well

(Any GCD equipment will need to meet project design specifications to comply with equipment warranties and protocols)

_____ Well equipment has capability to measure water level and cumulative discharge rates.

Meters and transducers installed in wells measure water level and flow rates and report data to centralized SCADA system continuously. Data are reported to historian on an hourly basis.

_____ Monitoring equipment consists of transducer, a sonic water level, or equivalent technology capable of measuring within an accuracy of 0.1 ft and recording data at hourly intervals.

InSitu transducers measure water level within 0.1 ft while recording data at hourly intervals.

_____ Monitoring equipment consists of inline totalizing meter satisfying Rules 11.2.2, 11.2.3, 11.2.4 ft and recording data at hourly intervals.

(Badger turbine (8 inch model 3500 & 12 inch Model 6200) meter as specified by POSGCD in construction specifications) Data is recorded in SCADA and downloaded via historian into spreadsheet format. Network security does not allow external communication connection to SCADA system and download is via USB authorized download.

_____ Equipment and wells are available for GCD inspection upon 7 day notice.

First tour conducted February 2, 2021. Future site inspections are available upon notice from GCD.

_____ Monitoring data will be reported to the GCD electronically on a monthly basis using approved format.

The submission will be emailed to the GCD with a hyperlink to the data. Well monitoring data has been submitted to RW Harden for QA/QC and electronic submission to POSGCD.

_____ Statement that data has been checked using QA/QC protocols.

Statement documenting QA/QC protocols will be signed by P.E. or P.G. and submitted to GCD.

_____ Submission of data will be completed in a timely manner and by the 15th day of the following month.

Data submission has been delinquent due to Design Build Contract requirements not allowing EPCOR full programming access to SCADA system. All programming requests originally put into

system were in GCD compliance at time of construction and May 2020 rule changes require additional reprogramming. Historical and current data are now with POSGCD.

_____ Monitoring data is collected in at least 4-hour interval for each well.

SCADA historian is programmed to record monitoring data on an hourly interval.

_____ Wells allow access to collect water samples at well location.

Water sampling locations are located at each well site.

POSGCD WELL MONITORING DATA MANAGEMENT PROTOCOL

Per Post Oak Savannah Groundwater Conservation (POSGCD) Rule 4.3, all wells that produce more than 1,000 gallons per minute (gpm) and/or are included in an operating permit with an aggregate withdrawal of 10,000 acre-feet per year (ac-ft/yr) are required to be outfitted with monitoring equipment. The recorded wellbore water level, instantaneous flow rate, and cumulative production from each well are to be evaluated for accuracy and submitted to POSGCD on a monthly basis. This document describes the methods and equipment used to record raw data, perform quality assurance / quality control (QA/QC) checks, maintain and calibrate equipment, generate monthly reports, and provide reliable, long-term data storage.

Monitoring Equipment

The data monitoring equipment installed at each well site is listed in Table 1. As required, wellbore water levels are recorded by a transducer/data logger within an accuracy of at least 0.1 feet. Each well is equipped with an in-line flow meter capable of accurately recording instantaneous flow rates and cumulative production. All water level and flow sensors are equipped with software needed to record measurements at hourly intervals.

Table 1. Monitoring Equipment

Well Field	*Well*	*Water Level Sensor*	*Flow Rate Sensor*
Vista Ridge	CW1	In-Situ Level Troll 400	Badger 8” 3500
Vista Ridge	CW2	In-Situ Level Troll 400	Badger 8” 3500
Vista Ridge	CW3	In-Situ Level Troll 400	Badger 8” 3500
Vista Ridge	CW4	In-Situ Level Troll 400	Badger 8” 3500
Vista Ridge	CW5	In-Situ Level Troll 400	Badger 8” 3500
Vista Ridge	CW6	In-Situ Level Troll 400	Badger 8” 3500
Vista Ridge	CW7	In-Situ Level Troll 400	Badger 8” 3500
Vista Ridge	CW8	In-Situ Level Troll 400	Badger 8” 3500
Vista Ridge	CW9	In-Situ Level Troll 400	Badger 8” 3499
Vista Ridge	PW9	In-Situ Level Troll 400	Badger 12” 6200
Vista Ridge	PW10	In-Situ Level Troll 400	Badger 12” 6200
Vista Ridge	PW11	In-Situ Level Troll 400	Badger 12” 6200
Vista Ridge	PW12	In-Situ Level Troll 400	Badger 12” 6200
Vista Ridge	PW13	In-Situ Level Troll 400	Badger 12” 6200
Vista Ridge	PW14	In-Situ Level Troll 400	Badger 12” 6200
Vista Ridge	PW15	In-Situ Level Troll 400	Badger 12” 6200
Vista Ridge	PW16	In-Situ Level Troll 400	Badger 12” 6200
Vista Ridge	PW17	In-Situ Level Troll 400	Badger 12” 6200

Data Collection Methods

On a monthly basis, raw water level and flow rate data will be compiled either through direct download from the individual sensor/datalogger memory or from data repositories maintained by the well field control systems (SCADA). In addition, field staff conducts monthly inspections and data retrieval from all well monitoring and data collection equipment. The centralized SCADA system is isolated from a network connection and data must be manually downloaded. The SCADA system is programmed to download well data to GCD requirements.

Data Quality Control Methods

Raw monitoring data recorded by well field control systems typically include inaccurate data that must be corrected or removed prior to submittal of the monthly report required by POSGCD. The steps that will be taken to investigate and correct/exclude erroneous data from the monthly report are:

Multiple raw data files that include records of measured well bore water levels and production rates will be extracted from applicable well field control systems and will be appended to available historic data to generate continuous datasets for each production well. These raw data files will be reviewed using appropriate QA/QC protocols.

Plots depicting each well's production rate and wellbore depth to water through time will be generated. Production rate data used for plotting will be processed to enhance the legibility of the data set by discarding instantaneous well production rate records measured within a few minutes of the points in time when wells were turned on/off.

Each plot will be inspected for irregularities (potential errors) in the data collected through time. Each identified data irregularity will be investigated to determine its consistency with other information. For example, records of uncharacteristic well production rates will be compared to water level data; if there are no changes in water levels corresponding to changes in well production rates, it likely that the well production rate records are in error and should be removed. As applicable, production rate and water level records may also be compared to manufacturer's pumping equipment performance curves and other documentation to identify data that are inconsistent with the physical specifications of each well's pump/motor.

Cumulative production through time will be calculated for each well from instantaneous flow (gpm) records and compared to the monthly flow meter totalizer readings recorded in the field. Any significant discrepancies between measured and calculated cumulative production records will be investigated to determine whether the SCADA measurements and/or field totalizer readings are in error.

A spreadsheet log of all identified inaccurate raw data records will be maintained, which identifies the well name, data type, interval of affected data, and description of the error.

Monitoring Equipment Maintenance and Calibration Protocols

As stated in Rule 11.2.2, all flow meters shall be installed in accordance with the manufacturer's specifications and meet the accuracy requirements set forth in the American Water Works Association standards for cold-water meters. Per Rule 11.4, all flow meters shall be recalibrated to a flow volume accuracy within 2% at intervals of three years or less. Records documenting monitoring equipment replacement, repair, and calibration shall be maintained and provided to POSGCD, on request. All meters are calibrated by manufacturer's representative on a quarterly basis according to project requirements.

Monthly Data Reports and Storage

On a monthly basis, a spreadsheet report will be generated that includes a tab for each well listing all accurate water level and well production data averaged over 1-hour intervals. Intervals during which there were no accurate data will be identified by a representative numeral such as "-999.99" in the value portion of each affected record. Each monthly report shall be accompanied with a statement sealed by a licensed professional geologist or engineer verifying that the data have been compiled and checked using methods described herein. Any changes to previously submitted monthly data sets will be accompanied by a letter explaining the reason for the resubmission. The transmission of data to POSGCD will be consistent with the formats described in Attachment A

All monitoring data will be redundantly stored in at least two locations such that loss of one data storage system will have no effect on the integrity of the data stored in the other location. All stored data will be periodically recompiled and evaluated to verify that no significant data loss or corruption occurs over time.

Attachment A

The data will be transmitted to the District using an Excel spreadsheet. Each tab will contain hourly data for only one well and the tab will be labeled using the well name.

Each tab will provide hourly data for the production rate, the cumulative production, the depth to water level. The hourly data will be submitted using the format shown in Table 7-1. Table 7-1 contain six columns which are:

- Col A, Date & Time: date of measurement (mm/dd/yyyy); ending hourly interval (hh:mm) using 24 hour clock
- Col B, Production Rate: averaged production rate (gpm) for the specified hour
- Col C, Cumulative Production: total cumulative production (gallons) from the well at the date and time provided in column A
- Col D, Depth to Water: depth to water (ft) measured from a fixed datum at the date and time provided in column A
- Col E, Production Flags: quality control code associated with production in columns B or C
- Col F, Water Level Flags: quality control code with depth to water in column D

Table 7-1 Example of formatted hourly data from Well CW2

A	B	C	D	E	F
Date & Time	***CW2 Production Rate (GPM) [1 Hr Avg]***	***CW2 Cumulative Production (gallons)***	***CW2 Depth_to_Water (ft) [1 Hr Avg]***	***Production Flags***	***Depth_to_Water Flags***
7/24/2020 14:59	1150.88	397744128.0	438.07	0	0
7/24/2020 15:59	1149	397745277.0	438.07	0	0
7/24/2020 16:59	1152.49	397746429.5	438.07	0	0
7/24/2020 17:59	1148.53	397747578.0	438.07	0	0
7/24/2020 18:59	1144.5	397748722.5	438.07	0	0
7/24/2020 19:59	1145.65	397749868.2	438.07	0	0
7/24/2020 20:59	1147.43	397751015.6	438.07	0	0
7/24/2020 21:59	1146.4	397752162.0	438.07	0	0
7/24/2020 22:59	1145.06	397753307.1	438.07	0	0
7/24/2020 23:59	1141.03	397754448.1	438.07	0	0
7/25/2020 0:59	1146.05	397755594.1	438.07	0	0
7/25/2020 1:59	1144.83	397756739.0	438.55	0	0
7/25/2020 2:59	1144.45	397757883.4	439.52	0	0
7/25/2020 3:59	1142.13	397759025.6	439.52	0	0

The hourly production rate is determined by averaging 12 instantaneous pumping rates that are spaced at 5-minute intervals and reported hourly. The cumulative production will be determined by accumulating the estimated hourly average production rates. At the end of the month, the cumulative monthly production will be compared to the cumulative production determined from manual readings from the cumulative productions provided the excel sheet in a tab named “Manual Readings.” Table 7-2 provides the format for the data entered into the “Manual Readings” tab. Table 7-2 requires that that

the manual readings for cumulative flow be entered at the start and end of each month so that the total monthly production from the totalizing discharge meter for each well can be calculated and compared to the total monthly production determined from the hourly production rates. If the difference between the two calculated total monthly productions for any well is greater than 5 percent then Vista Ridge LLC will conduct an investigation to determine whether the SCADA measurements or the totalizer readings are in error. If the difference of 10 percent are recorded for any three consecutive months in a calendar year, Vista Ridge LLC will prepare a corrective action plan to the District for approval. If the difference is greater than 10 percent for a well for any month, the well may be considered out of compliance, and a District fee may be considered. A corrective action plan will include actions and a schedule for identifying and correcting data collection or analysis protocols so that the two methods for calculating total monthly production will differ less than 5 percent. A corrective action plan will be due to the District no later than 15 days after the submittal of the monthly production report that triggers the requirement for a corrective action plan.

Table 7-2 Format for the Manual Readings of the Cumulative Flow

Well	Reading of Cumulative Production from Flow Meter				Total Production (gals)		Difference in Total Production (gals)
	Start of Month (mm/dd/yy, hh:mm)	Reading (gallons)	End of Month (mm/dd/yy, hh:mm)	Reading (gallons)	Based on Monthly Meter Reading	Based on Hourly Production Rates	
CW1	1/1/21 1:00	397744128	1/31/21 0:00	397775128	31000	29760	1240
CW2	1/1/21 1:00	357969715	1/31/21 0:00	357994515	24800	25296	-496
CW3	1/1/21 1:00	318195302	1/31/21 0:00	318218552	23250	22646	605
CW4	1/1/21 1:00	477292954	1/31/21 0:00	477320854	27900	26784	1116
CW5	1/1/21 1:00	437518541	1/31/21 0:00	437542721	24180	24664	-484
CW6	1/1/21 1:00	258533683	1/31/21 0:00	258560963	27280	26571	709
….,	1/1/21 1:00	346037391	1/31/21 0:00	346060021	22630	23083	-453

The depth to water is calculated from the transducer measurements water level sensor. Table 7-2 lists the elevation for each well that is used as the datum for measuring the depth to the water level in each well. Any change in the elevation datum for a well are documented in the monthly submittal to the District.

Table 7-3 Elevation of Well Datums for Measuring Depth to Water

Well	Elevation Datum (ft, msl)
CW1	383
CW2	369
CW3	363
CW4	347
CW5	375

CW6	314
CW7	317
CW8	343
CW9	347
PW9	383
PW10	369
PW11	363
PW12	347
PW13	343
PW14	317
PW15	314
PW16	375
PW17	347

One of the reasons to include quality control codes in Table 7-1 is to identify data that may not reflect actual field conditions. For instance, the values for instantaneous production rates at the start-up of a pump may be inaccurate as a result of unsteady flows, pump operation, and equipment maintenance and operation impacts. Also, inaccurate measurements of depth to water can occur if the transducers are vented and vented airline becomes partially clogged with condensate or other malfunction. As part of the quality checks on the measurement data, the field data will be graphed to identify any inconsistency between the measured production rates and measured depth to water. Apparent inconsistencies will be flagged with a quality control code. In addition, an exceedance of the maximum instantaneous production rate will be flagged. The time interval for determining exceedance will be any continuous 24-hour interval that produces an average production rate that is greater than the maximum instantaneous production rate allowable in the District permit. Table 7-4 provide example quality control codes will be used. Additional quality control codes may be added as needed.

Table 7-4 QA/QC codes for Production

Quality Control Codes for Production	
#	**Description**
1	no production occurred
2	graphical analysis indicates discrepancy between measured production and water level

3	magnetic flow meter may not be working properly,
4	possible inaccurate flow measurement as a result of recent pump start up
5	Maximum instantaneous production rate was exceeded
6	SCADA System Alarm response
7	Mechanical flow meter may not be working properly,
8	Mechanical failure of pumping system
9	System Operation Maintenance

Quality Control Codes for Water Levels	
#	**Description**
1	graphical analysis indicates discrepancy between measured production and water level
2	adjustments may be needed based on recent manually measured depth to water