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Date: November 18, 2021
Our Ref: 30015296
Subject: Revised Appendix B: Ditch B Flow Monitoring and Reporting Methods
Tyco Fire Technology Center
BRRTS #: 02-38-580694

Dear Ms. Sellwood,

Arcadis U.S., Inc. (Arcadis) has prepared the attached revision to Appendix B of the Operation, Maintenance, and Long-Term Monitoring Plan (OM&M Plan) for the Ditch B treatment system on behalf of Tyco Fire Products LP (Tyco). The original OM&M Plan was submitted to the Wisconsin Department of Natural Resources (WDNR) on July 19, 2021. Revisions to Appendix B: Ditch B Flow Monitoring and Reporting Methods were requested by the WDNR in a letter dated October 29, 2021 and are addressed in this submittal. The revisions made to Appendix B are outlined below.

Background

- Revised to include a summary paragraph detailing the timeline of the original submittal and requested revisions.

Ditch B Treatment System Flow Rate

- Equation 1 was simplified to describe the daily flow volume of the Ditch B treatment system as the sum of the daily flow volumes for the two treatment trains.

Ditch B Stream Flow Rate

- Clarified that the rating curve is a best fit line and represents an estimate of the depth vs. flow relationship in Ditch B.

- Clarified that reported flow rates and volumes will include notes indicating that they are estimates based on the rating curve and could fall within a range.

- Revised to include statement indicating that the rating curve may be updated periodically to increase accuracy. Any future modifications to the rating curve and/or flow estimating procedures will be discussed in the Semi-Annual Operation, Maintenance, and Optimization Progress Reports.
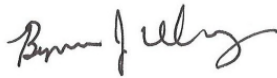
Alyssa Sellwood
WDNR
November 18, 2021

Closing

This submittal supersedes all previous versions of Appendix B: Ditch B Flow Monitoring and Reporting Methods in the Ditch B treatment system OM&M Plan.

Please contact me with any comments or questions.

Sincerely,
Arcadis U.S., Inc.

Ben Verburg, PE
Principal Engineer

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CC.   Jeff Danko (Tyco)
        Scott Wahl (Tyco)
        Denice Nelson (Tyco)
        Mike Bedard (Arcadis)
        Scott Potter (Arcadis)

Enclosures:
        Attachment 1. Appendix B: Ditch B Flow Monitoring and Reporting Methods – Revised November 2021
        Figure B1. Ditch B Rating Curve

Attachment 1

Appendix B: Ditch B Flow Monitoring and Reporting Methods – Revised November 2021

Appendix B: Ditch B Flow Monitoring and Reporting Methods – Revised November 2021

Background

Per the Wisconsin Department of Natural Resources' (WDNR's) request in a letter dated April 20, 2021, Tyco Fire Products LP (Tyco) will collect the data outlined below as part of the Operation, Maintenance, and Long-Term Monitoring Plan (OM&M Plan). Calculation methods for each parameter are provided in this appendix.

- Record stream flow in Ditch B during each weekly monitoring event;
- Record or estimate weekly volume of water moving past the treatment system that goes untreated (e.g., downtimes for maintenance, high flow events, or seepage not captured by the system);
- Collect a per- and polyfluoroalkyl substances (PFAS) sample from the surface water in Ditch B at a location downstream of the treatment system at least once per month and analyze the sample for the 36 PFAS analyte list; and
- Calculate or estimate perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS) mass migrating downstream of the Ditch B treatment system for each month during the reporting period.

Tyco submitted the OM&M Plan for the Ditch B treatment system on July 19, 2021. Revisions to Appendix B: Ditch B Flow Monitoring and Reporting Methods were requested by WDNR in a letter dated October 29, 2021. The requested revisions are incorporated into this revised Appendix B.

Ditch B Treatment System Flow Rate

Electromagnetic flow meters FIT-301 and FIT-401 are installed immediately upstream of the two granular activated carbon (GAC) treatment trains (herein referred to as the 300-train and 400-train, respectively) that serve as the primary method of PFAS removal in the Ditch B System. The flow rates and totalizer readings from these flow meters are recorded by the supervisory control and data acquisition (SCADA) system on an hourly basis. The Ditch B treatment system flow rate calculation is described by Equation 1, where V_{System} is the total daily volume processed by the Ditch B treatment system in gallons, V_{300} is the daily totalized volume recorded by FIT-301 in gallons, and V_{400} is the daily totalized volume recorded by FIT-401 in gallons. The daily values will be summed and reported on a weekly basis in the Semi-Annual Operation, Maintenance, and Optimization Progress Reports. The flow rate will be reported on a daily basis in the monthly electronic discharge monitoring reports (eDMRs).

$$V_{System} = V_{300} + V_{400} \qquad (1)$$

Ditch B Stream Flow Rate

A SonTek-IQ Plus acoustic doppler velocity and depth instrument was installed for the purposes of quantifying the stream flow discharge rate to develop a stage rating curve. Measurements from November 2020 through April 2021 were collected and evaluated. Ditch B is a dynamic surface water body/drainage feature and during this evaluation period, variability was observed in the measured staged and discharge rates due to natural fluctuations

within the channel, high turbidity events affecting instrument performance, rim ice due to freezing weather conditions, erosion, whether the channel is filling or draining, and low flow events. During periods when backflow occurred between the system intake and outfall in Ditch B, the system was operated at various flow rates to calibrate the SonTek flow meter data. Several manual measurements were also collected for purposes of independently confirming the measured stream flow rates. This information was used to develop a stream flow rating curve for Ditch B. The rating curve is shown in **Figure B1** described by Equation 2, where D is the upstream stilling well depth in feet and Q is stream flow rate in GPM. The empirical data presented in **Figure B1** show a range of observed flow rates associated with depth. The scatter observed in the dataset is representative of the dynamic flow conditions observed in Ditch B. The rating curve is a best fit line through the data set and represents an estimate of the depth vs. flow relationship in Ditch B.

$$Q = \left(\frac{D}{0.0003362}\right) - 2073.56 \tag{2}$$

The upstream stilling well depth is recorded by the SCADA system on an hourly basis and is converted to a stream flow rate using Equation 2. The daily stream flow volume will be calculated using Equation 3, where V_{Stream} flow volume in gallons and $\bar{Q}$ is the daily average stream flow rate in GPM. The daily values will be summed and reported on a weekly basis in the Semi-Annual Operation, Maintenance, and Optimization Progress Reports. The reported flow rates and volumes will be indicated as estimates based on the rating curve and noted that they could fall within a range.

$$V_{Stream} = \bar{Q} * 1440 \tag{3}$$

As part of the daily operation, maintenance, and monitoring (OMM) checklist, when the estimated stream flow rate is below 700 GPM, the operator will conduct a visual observation of the flow direction in the channel between the intake and the outfall. Organic debris or a float (aka bobber test) will be used by the system operator to visually assess the stream flow direction. If the channel flow direction between the intake and the outfall is reversed (i.e., flowing upstream), the stream flow rate will be recorded as less than or equal to the system operating flow rate. However, the system operating flow rate will be used as a conservative estimate for calculation purposes.

The rating curve that was developed and corresponding equation (Equation 2) that is used for the flow estimate, may be updated periodically to increase the accuracy of the rating curve based on data from the SonTek-IQ flow meter and visual flow observations. If modifications of the rating curve and/or flow estimating procedures change, the changes will be discussed in semi-annual operation reports.

Estimate of Untreated Water Volume Moving Past the Ditch B Treatment System

When the flow in Ditch B is above 700 GPM, a portion of the daily flow is not treated. The daily volume of untreated water moving past the Ditch B treatment system will be calculated using Equation 4, where V_U is the daily volume of untreated water moving past the Ditch B treatment system in gallons, V_{Stream} is the estimated daily stream flow volume based on the methodology described herein, and V_{System} is the daily volume of water treated by the Ditch B system. The daily values will be summed and reported on a weekly basis in the Semi-Annual Operation, Maintenance, and Optimization Progress Reports.

$$V_U = V_{Stream} - V_{System} \tag{4}$$

PFOA and PFOS Mass Migration Downstream of Ditch B Treatment System

The mass of PFOA and PFOS migrating downstream of the Ditch B treatment system will be calculated by Equation 5, where m is the estimated monthly mass of PFOA or PFOS migrating downstream of the Ditch B treatment system, $\overline{C_{in}}$ is the average weekly influent concentration of PFOA or PFOS, $\overline{C_{out}}$ is the average weekly system effluent concentration of PFOA or PFOS, n is the number of weeks for a given month, $V_{Stream,Weekly}$ is the weekly Ditch B flow volume, and $V_{System,Weekly}$ is the weekly treatment system flow volume.

$$m = \sum_1^n \overline{C_{in,n}}\left(V_{Stream,Weekly,n} - V_{System,Weekly,n}\right) + \sum_1^n \overline{C_{out,n}}\left(V_{System,Weekly,n}\right) \tag{5}$$

The influent and effluent PFOA and PFOS samples will be collected from the Ditch B system influent sampling port (SC-203) and effluent sampling port (SC-503), respectively. In the event that weekly system flow rate exceeds the weekly estimated stream flow rate, the untreated flow volume ($V_{Stream,Weekly,n} - V_{System,Weekly,n}$) will be recorded as 0 in Equation 5.
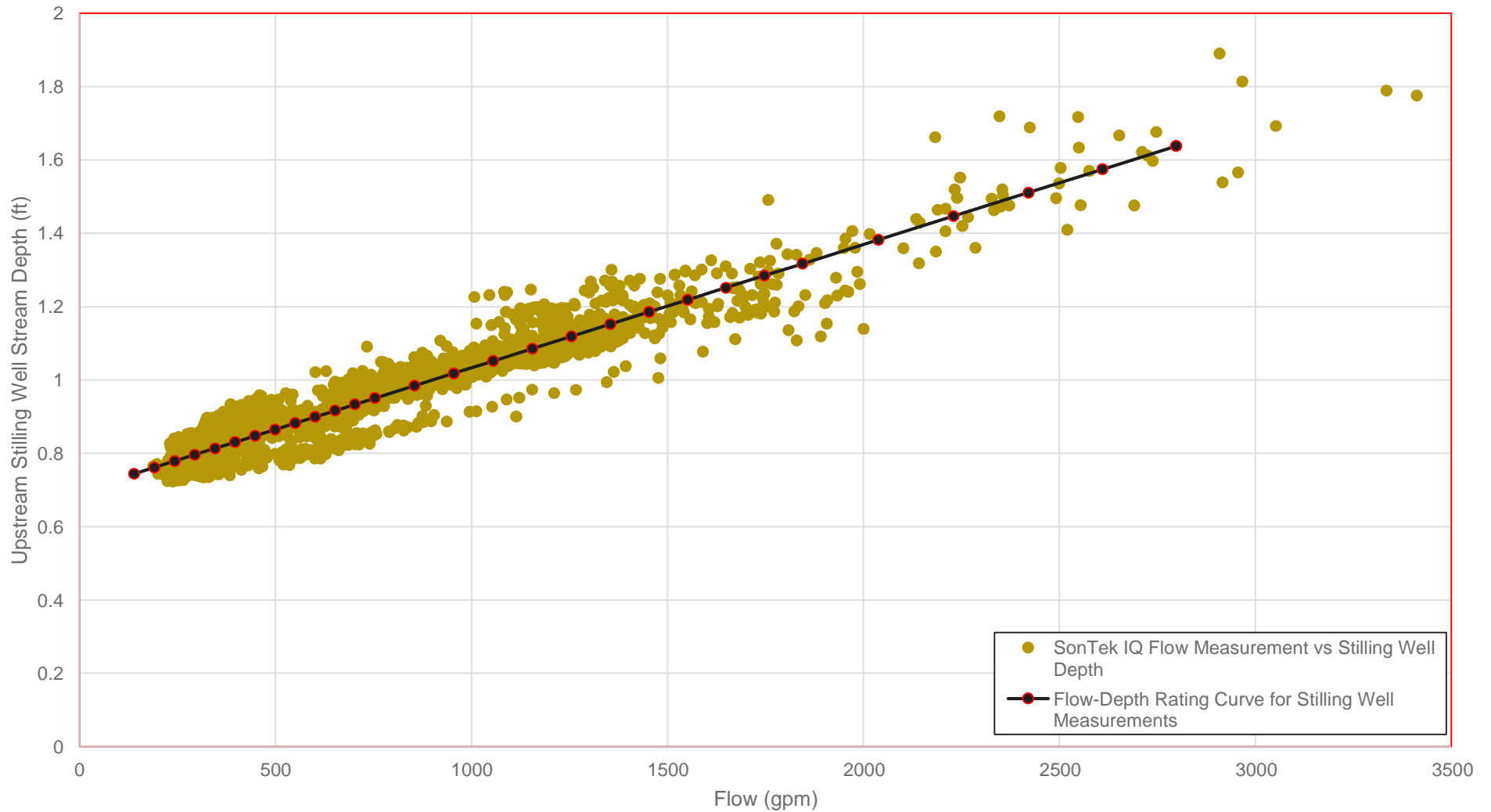
Low Flow Adjustments

As discussed during the permit review process prior to construction and during review of the approved permit modifications for increasing the system capacity to 700 GPM, WDNR had questions regarding the portion of the channel between the intake and the outfall becoming completely dewatered during low flow conditions. The treatment system flow rate will be decreased as necessary during low flow conditions to maintain continuous operations of the treatment system and capture of the base flow. For example, when the wet well pumps are observed to be cycling on/off and a reversal of flow direction in the channel between the intake and outfall. As described above, the reversal in the channel flow direction during low flow conditions conforms with this request, and daily visual monitoring by the system operator will be used to adjust the treatment system flow rate to keep the system operating as continuously as possible.

Another factor during low flow conditions is that the intake wet well pumps could dewater the wet well if the flow rate set point is too high, which would result in the system cycling off for short durations until the water level recovers in the wet well. Therefore, the system operator will conduct daily monitoring of the wet well water levels and pump operations to ensure the system is running as continuously as possible and will reduce the system flow rate as necessary in the event the pumps cycle off due to low flow conditions.

Figure B1

Ditch B Rating Curve

Y-axis: Upstream Stilling Well Stream Depth (ft)

X-axis: Flow (gpm)

Legend:
- SonTek IQ Flow Measurement vs Stilling Well Depth
- Flow-Depth Rating Curve for Stilling Well Measurements

Abbreviations:

ft = feet

gpm = gallons per minute

Rating Curve Equation:

Stream Flow Rate = (Depth / 0.0003362) – 2073.56

TYCO FIRE PRODUCTS LP
813 PINE BEACH ROAD
MARINETTE, WISCONSIN

DITCH B RATING CURVE

ARCADIS

FIGURE
B1