memo

EOR water ecology community

Project Name	THPP Infiltration Monitoring	**Date**	12/14/2017
To / Contact info	BCWD Board of Managers		
Cc / Contact info	Karen Kill, District Administrator		
From / Contact info	Mike Majeski		
Regarding	THPP 2017 Monitoring Summary		

The objective of this memorandum is to report on the performance of the Trout Habitat Preservation Project (THPP) during the 2017 monitoring season and to report on the annual maintenance activities performed at this site. This was the ninth monitoring season since construction of the infiltration improvements were made in the winter of 2005-2006.

Background

The Trout Habitat Preservation Project was constructed in the winter of 1999. The District initiated the THPP Monitoring Program in the spring of 2000 to evaluate the performance of the infiltration basins. The infiltration rates measured in the early years of the THPP are provided in Table 1. These rates represent the infiltration capacity of Basins 1, 2 and 3 combined, assuming equal water levels and infiltration rates in all three basins.

Table 1. Infiltration Rates measured prior to Infiltration Recovery Project

Year	Basin 1-3 Complex Infiltration Rate [cfs]*
2000	0.018
2001	0.032
2002	0.081
2003	0.028
2004	0.017

* Based on an average infiltration rate measured for two separate suitable timeframes (no precipitation, and inflow or outflow from the basins occurred) per year.

In 2005, there was no level logger available to monitor infiltration rates in Basin 1. In 2006, a lack of basin inundation precluded monitoring of the infiltration system. Subsequently, no data exists for these years. Based on the decline in infiltration rates measured in 2003 and 2004, the District implemented the THPP Infiltration Recovery Project in the winter of 2006 to improve the infiltration capacity of the system. These improvements included the installation of an infiltration trench in Basin 1 and modifications to the Basin 1 outlet structure to allow water to flow from Basin 3 into Basin 1. The infiltration trench was installed to a depth where contact with a subsurface lens of coarse sand would augment infiltration performance.

The annual monitoring program continued until 2013 when lack of stormwater collecting in the THPP system prompted District Staff to recommend a reduction in the frequency of infiltration monitoring for this project. Instead of monitoring the infiltration basins annually, it was recommended that the BCWD monitor the BMP every three years to track the long-term performance of the system. The last monitoring effort occurred in the fall of 2016, and at that time it was decided that monitoring should continue in 2017 to determine if infiltration trench maintenance is needed to increase the infiltration performance of the system.

2017 Infiltration Event Summary

A warm weather pattern in mid-February resulted in early season snowmelt and subsequent basin inundation in late February. Following the snowmelt event, much of the water had infiltrated in Basin 1 by late April. A series of significant rain events beginning in mid-May caused water levels to rise with peak stage occurring in Basin 1 on May 22nd.

Infiltration monitoring equipment was installed on February 23rd. Water levels in Basin 1 were near the natural overflow elevation between Basin 1 and Basin 2 (elevation of 966.05 feet), but quickly dropped below the natural overflow elevation. Basin 1 operated independently from Basin 2 and Basin 3 for much of the monitoring season, with the exception from May 22nd to May 30th when water levels peaked approximately 0.5 feet above the natural overflow elevation. Water levels in Basin 3 did not reach the outlet structure (elevation 968.0); therefore, no water discharged to Brown's Creek in 2017. See Figure 1 for basin and wetland locations and flow paths.

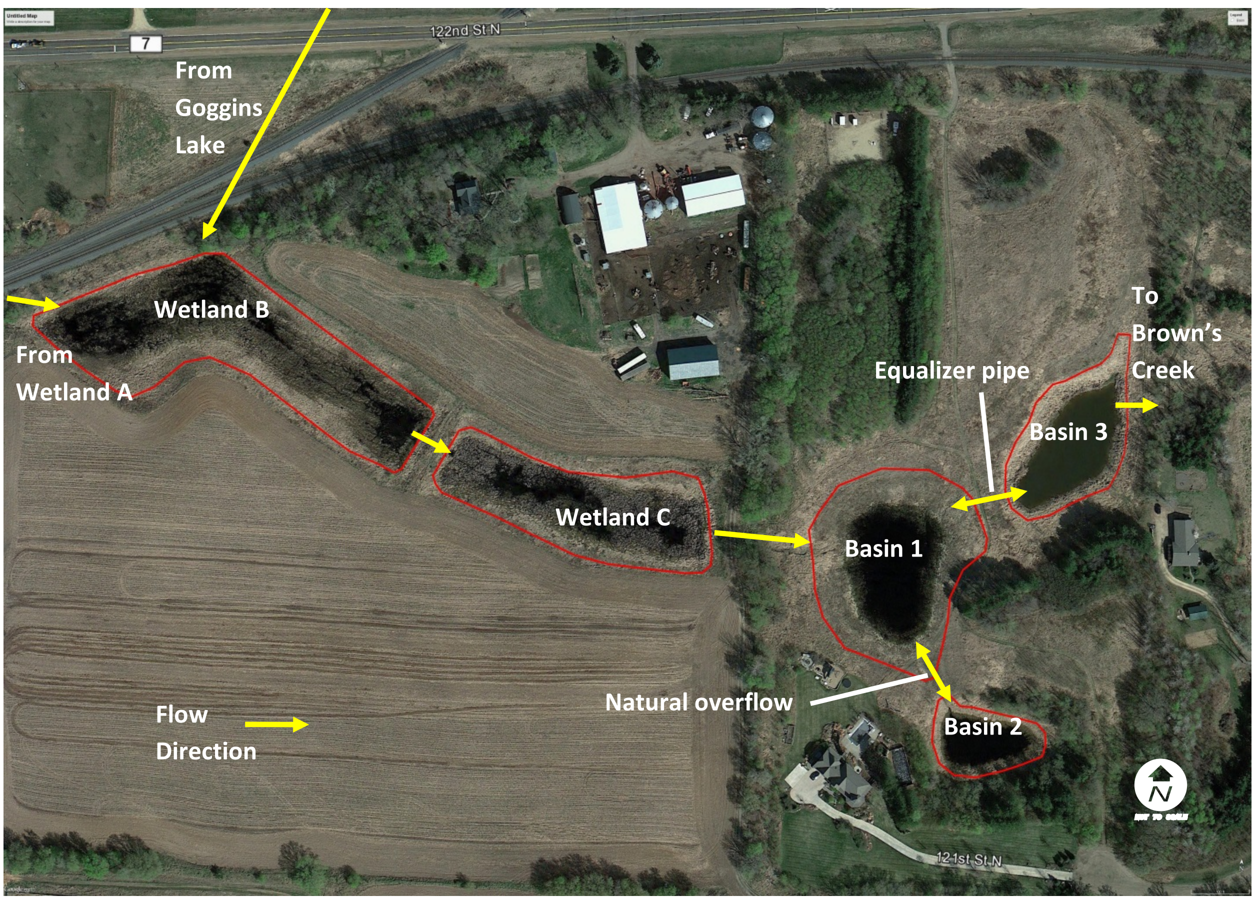

Figure 1. THPP Wetland and Infiltration Basin Flow Paths, the Infiltration Trench is Located on the East Side of Basin 1

Water levels in Goggins Lake approached the lake outlet elevation during the summer months, but no discharge occurred to the THPP system in 2017. The total volume of stormwater runoff collected in the THPP was the result of drainage generated from the surrounding 230-acre subwatershed west of the THPP.

Methodology

The slope evaluation method was used to measure volumetric infiltration rates by calculating the rate of water decline in the basin(s) and multiplying this rate by the average surface water area of the basin(s). The rate of water loss (infiltration) was derived from plotting the surface water elevation versus time. This methodology has been used to calculate the infiltration rates in the THPP since the establishment of this monitoring program.

To isolate the infiltration component from the other hydrological processes occurring in the system, timeframes of data were chosen when no inflow and/or outflow occurred within the basins. Pan evaporation rates were applied to infiltration rate equations for timeframes measured during the growing season. For timeframes when precipitation occurred, the depth of precipitation was added to the infiltration rate equations to compensate for the addition of rain water. This methodology is consistent with previous infiltration analyses allowing for comparison of datasets between years.

Analyses performed in 2000-2004 focused on the infiltration rates measured in the combined Basin 1-3 complex. The analysis for this complex assumed equal surface water elevations and infiltration rates in Basins 1, 2, & 3 combined. However, after modifications to the Basin 1 outlet structure were completed (2007), this assumption is only valid when water levels are above 966.42 feet (the drop outlet/equalizer pipe elevation in Basin 1) since Basins 1, 2, & 3 are hydraulically connected above this elevation. As water levels decrease, Basin 1 and Basin 3 operate independently below 966.42 feet. Similarly, Basin 1 and Basin 2 operate independently below the natural overflow elevation of 966.05 feet.

Results

Figure 2 shows the surface water elevations measured in Basin 1 in 2017. Table 2 identifies the timeframes selected for calculating the volumetric infiltration rates and the starting and ending surface water elevations and surface areas used in the 2017 analysis.

In order to compare the infiltration rates measured in 2017 with previous evaluations, infiltration timeframes were selected based on the amount of data available to comparable surface water elevation periods with previous analyses. After reviewing the data, 7 timeframes could be compared (see Table 3). It should be noted that several of the rates calculated in 2008 and 2013 were influenced by discharge from Wetland C; however, it was decided the data should still be used since it represented the best available data to compare between years. Although inflow from Wetland C was minimal, the inflow likely had a negative impact on the rates calculated during those timeframes. Wetland C did not outlet during the timeframes chosen for all other years, including 2017.

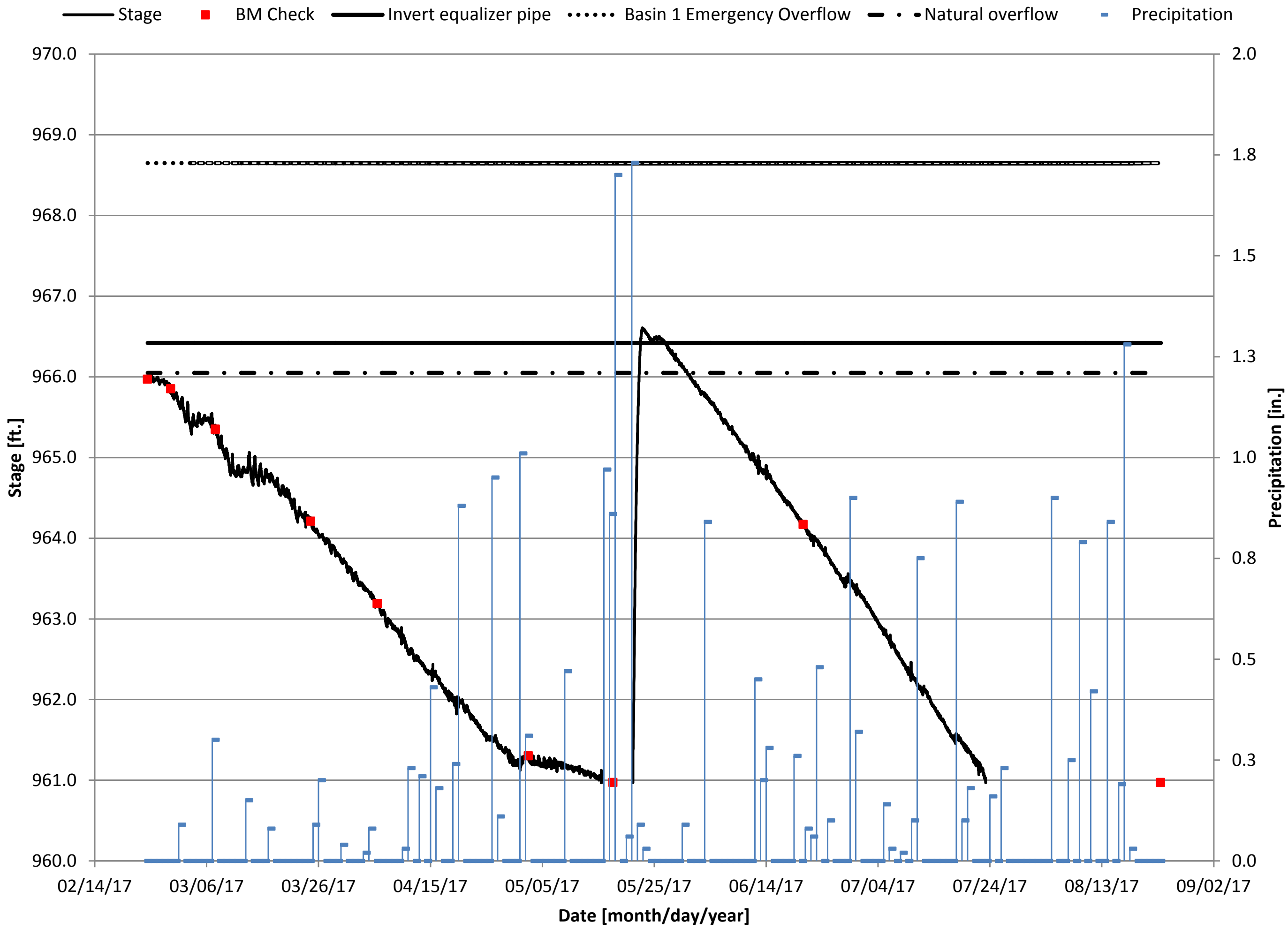

Figure 2. Basin 1 Surface Water Elevations, 2017

Table 2. Surface Water Elevations, Surface Areas, and Infiltration Rates Measured in 2017

Timeframe 1	Elevation [ft.]	Surface Area [sq. ft.]	Infiltration Rate [cfs]
03/16/17 (15:04) to	964.84	26,888.7	0.027
03/21/17 (6:19)	964.40	22,330.5	
Timeframe 2			
04/13/17 (10:19) to	962.45	13,381.7	0.015
04/18/17 (3:34)	962.03	12,079.7	
Timeframe 3			
05/29/17 (23:34) to	966.14	40,638.7	0.032
06/03/17 (5:49)	965.75	36,315.9	
Timeframe 4			
06/04/17 (21:04) to	965.62	34,969.1	0.029
06/09/17 (22:04)	965.13	29,893.0	
Timeframe 5			
06/04/17 (21:04) to	965.62	34,969.1	0.025
06/18/17 (8:49)	964.40	22,330.5	
Timeframe 6			
06/14/17 (3:49) to	964.84	26,888.7	0.024
06/18/17 (8:49)	964.40	22,330.5	
Timeframe 7			
07/08/17 (15:19) to	962.45	13381.7	0.014
07/12/17 (21:34)	962.03	12,079.7	

Table 3. Basin 1-3 Complex and Basin 1 Infiltration Rates by Slope Evaluation Method: 2007-2010, 2012-2013, 2016-2017 (rates achieved post improvements)

Year, Month, Timeframe Evaluated	Water Elevations used in Evaluation	Basin 1-3 Complex Infiltration Rate [cfs]	Basin 1 Infiltration Rate [cfs]	Approximate Water Depth [ft.]
2007 Mar Timeframe 1	967.97-967.64	0.108	---	8.7
2010 Mar Timeframe 1	967.83-967.61	0.211	---	8.6
2009 Mar Timeframe 1	967.83-967.61	0.141	---	8.6
2013 Apr Timeframe 1	967.83-967.61	0.120*	---	8.6
2010 Mar Timeframe 2	967.57-967.31	0.161	---	8.4
2009 Apr Timeframe 2	967.57-967.31	0.130	---	8.4
2013 Apr/May Timeframe 2	967.57-967.31	0.119	---	8.4
2010 Mar/Apr Timeframe 3	967.27-966.42	0.123	---	8.1
2009 Apr non-reported	967.27-966.42	0.103	---	8.1
2013 May Timeframe 3	967.27-966.42	0.096	---	8.1
2016 Oct Timeframe 1	967.27-966.42	0.090	---	8.1
2010 Mar Timeframe 4	967.08-966.67	0.122	---	7.9
2009 Apr Timeframe 3	967.08-966.67	0.103	---	7.9
2013 May Timeframe 4	967.08-966.67	0.091	---	7.9
2016 Oct Timeframe 2	967.08-966.67	0.084	---	7.9
2007 Apr Timeframe 2	967.08-966.67	0.082	---	7.9
2012 Mar Timeframe 1	966.14-965.75	---	0.073	6.9
2008 Apr Timeframe 1	966.14-965.75	---	0.066*	6.9
2007 Apr Timeframe 3	966.14-965.75	---	0.058	6.9
2013 May Timeframe 5	966.14-965.75	---	0.056	6.9
2016 Oct Timeframe 3	966.14-965.75	---	0.047	6.9
2017 May/Jun Timeframe 3	**966.14-965.75**	**---**	**0.032**	**6.9**

2012 Mar Timeframe 2	965.62-965.13	---	0.064	6.4
2010 Apr Timeframe 5	965.62-965.13	---	0.057	6.4
2007 Apr Timeframe 5	965.62-965.13	---	0.052	6.4
2009 Apr Timeframe 4	965.62-965.13	---	0.042	6.4
2016 Oct/Nov Timeframe 4	965.62-965.13	---	0.031	6.4
2017 June Timeframe 4	**965.62-965.13**	**---**	**0.029**	**6.4**
2012 Mar Timeframe 3	965.62-964.40	---	0.055	6.4
2010 Apr Timeframe 6	965.62-964.40	---	0.047	6.4
2007 Apr Timeframe 4	965.62-964.40	---	0.043	6.4
2008 May Timeframe 2	965.62-964.40	---	0.042*	6.4
2016 Oct/Nov Timeframe 5	965.62-964.40	---	0.032	6.4
2017 June Timeframe 5	**965.62-964.40**	**---**	**0.025**	**6.4**
2012 Apr Timeframe 4	964.84-964.40	---	0.047	5.6
2007 Apr Timeframe 6	964.84-964.40	---	0.034	5.6
2009 Apr/May Timeframe 5	964.84-964.40	---	0.032	5.6
2016 Nov Timeframe 6	964.84-964.40	---	0.029	5.6
2017 Mar Timeframe 1	**964.84-964.40**	**---**	**0.027**	**5.6**
2017 June Timeframe 6	**964.84-964.40**	**---**	**0.024**	**5.6**
2012 Apr Timeframe 5	962.45-962.03	---	0.024	3.2
2010 Apr/May Timeframe 7	962.45-962.03	---	0.022	3.2
2009 May Timeframe 6	962.45-962.03	---	0.022	3.2
2008 June Timeframe 3	962.45-962.03	---	0.020	3.2
2017 Apr Timeframe 2	**962.45-962.03**	**---**	**0.015**	**3.2**
2017 July Timeframe 7	**962.45-962.03**	**---**	**0.014**	**3.2**

* Infiltration rates negatively influenced by discharge from Wetland C

Conclusions

The Basin 1-3 complex has infiltrated at the same rate or higher than what the system achieved from 2000 to 2004. However, the independent Basin 1 rates measured in 2017 continue to decline compared to other rates measured after the THPP Infiltration Recovery Project. A visual inspection of the infiltration trench was completed in the summer of 2017, but there was no indication of clogging of the surface substrate of the trench. Further site investigations will be needed to determine the cause of declining infiltration rates in Basin 1.

2017 Maintenance Activities

Prairie Restorations cut down the larger box elder trees growing around wetlands B and C and treated the cut stumps with herbicide on March 21. No other maintenance activities were conducted in 2017.

Recommendations

Based on the results of the 2017 analysis, it is recommended that the infiltration trench in Basin 1 be directly monitored to measure the performance of the trench independently from Basin 1. A level logger should be installed at the bottom of the infiltration trench pipe to measure infiltration rates within the trench. Measuring water levels at the bottom of the trench pipe will also determine if the groundwater table in the immediate vicinity of Basin 1 has increased to a point where the water table is influencing the infiltration rates in Basin 1. A piezometer was installed in the early 2000's near Basin 1 to measure groundwater levels near the site. If this piezometer can be located, a second level logger should be installed within the well to monitor groundwater elevations. A third level logger should be installed at the bottom of Basin 1. This monitoring approach will determine if the local groundwater table is influencing the infiltration rates measured in the trench and in the basin. This recommended monitoring effort will only occur if sufficient inundation occurs within Basin 1 in 2018. In addition to monitoring the infiltration capacity of the trench, EOR will inspect the filter fabric installed within the trench to determine if clogging of the filter and/or the trench aggregate has occurred. This fabric is located approximately 4 inches below the surface of the trench and is placed under a layer of washed gravel.

Recommended Scope of Services for 2018

EOR Tasks:

- EOR proposes to install one level logger inside the infiltration trench pipe, one logger at the bottom of Basin 1, and one logger inside the piezometer near Basin 1, if the piezometer can be located. EOR will also inspect the filter fabric inside the infiltration trench and provide written documentation summarizing our findings and recommendations for improving infiltration in Basin 1. If it's determined the performance of the infiltration trench has diminished due to clogging of the filter, EOR will submit a cost estimate to replace the filter fabric in the infiltration trench. The anticipated total cost for this task is $3,816.00.

Requested Action

1. Approve this scope of services for $3,816.00 to implement the monitoring approach as outlined above.