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Memorandum

To: Bassett Creek Watershed Management Commission
From: Barr Engineering Co.
Subject: Item 5B: Schaper Pond Effectiveness Monitoring Results and Consider Next Steps
BCWMC May 17, 2018 Meeting Agenda
Date: May 10, 2018

Recommendations:

1. Perform additional monitoring of Schaper Pond in 2018 including water quality monitoring longitudinally through the pond, a bathymetric survey, and a carp survey.
2. Authorize expenditures of Schaper Pond Diversion Project CIP funds up to $21,000 for the above monitoring. (Current CIP funds remaining are approximately $250,000.)

1.0 Background

Schaper Pond is classified by the Minnesota Department of Natural Resources as a public water wetland; it is located south of Sweeney Lake and north of Highway 55 in Golden Valley. The pond receives about 90% of its flow from the Sweeney Branch of Bassett Creek from the south (under Highway 55), and 10% of its flow from a storm water inlet (called the Railroad inlet) in the northwest lobe of the pond. The pond outlets directly to Sweeney Lake from the northeast lobe (Figure 1).

In 2011, the BCWMC completed the Sweeney Lake Total Phosphorous Total Maximum Daily Load Study (TMDL). The study's implementation program identified modifying the water flow through Schaper Pond as one of the options toward achieving the goal of reducing phosphorous loads to the lake. The BCWMC completed a feasibility report for the "Schaper Pond Improvement Project" in February 2012. The BCWMC added the Schaper Pond Diversion Project to their Capital Improvement Program through a watershed management plan amendment in 2013 and officially ordered the project in September 2013.

1.1 2011 monitoring and recommendations

In 2011, Schaper Pond was monitored as part of the Sweeney Lake TMDL Study. Equipment, including auto samplers, level sensors, and area velocity meters, was installed at the outlet of Schaper Pond, at the southern inlet under Highway 55, and at the Railroad inlet to collect enough data to evaluate the phosphorus removal performance of Schaper Pond and to develop a model to evaluate how removal could be enhanced through pond modifications. A total of six complete (e.g., samples collected simultaneously at both inlets and at the outlet) storm events were monitored from June 9 to August 13, 2011. For all events, samples were analyzed for total phosphorus, total dissolved phosphorus, total suspended solids, and volatile suspended solids. For two events, samples were also analyzed for particle size. Flow was measured continually from May 19 through August 14, 2011.

Figure 1

MONITORING & BAFFLE LOCATIONS
Schaper Pond Effectiveness Monitoring
Bassett Creek Watershed Management Comission

The monitoring results provided a good understanding of how Schaper Pond functioned at the time and the data were used to develop the Schaper Pond Improvement Project feasibility study. The results showed that approximately 90% of the phosphorus load to Schaper pond came from the Highway 55 inlet, but it was short-circuiting 65% of the pond volume that could otherwise be used to settle phosphorus from this source. Therefore, diversion of water within the pond to the northwest lobe of the pond was identified as a way to provide more time to settle phosphorus and improve overall phosphorus removal performance in Schaper Pond.

1.2 Implementation of floating barrier

The BCWMC selected the Schaper Pond Diversion Project alternative from the feasibility study. The City of Golden Valley constructed the project, which was designed to divert water, via a floating water baffle, within the pond to direct more of the water flows to the northwest part of the pond. Based on the 2011 monitoring data and modeling, it was believed that the diversion would allow the water to remain in the pond for a longer period of time, allowing a greater amount of sediment, phosphorous, and other suspended solids to settle out before the water exits the pond. The project included the installation of an approximately 380-foot-long floating water baffle extending out from the east side of the pond and the construction of two maintenance access areas. The project was expected to reduce the amount of phosphorus reaching Sweeney Lake by an estimated 81 - 156 pounds per year.

The city completed construction of the project in December 2015. Additional repairs and maintenance to the floating baffle, as well as vegetation management on the east side of the pond occurred in 2016. Also in 2016, the Commission approved the use of a portion of the remaining CIP funds to study the effectiveness of the project in 2017 by replicating the monitoring that occurred in 2011.

2.0 2017 effectiveness monitoring

The 2017 effectiveness monitoring was initiated a little more than two months after it was confirmed that the floating barrier was secured and working properly. Flow monitoring began in mid-August and continued into the first week of November. Twelve water quality samples were collected from the Highway 55 inlet and the Schaper Pond outlet during coincidental events between August 25th and October 25th, while eight water quality samples were collected from the Railroad Inlet during coincidental events in October. Figure 1 shows the sampling locations. The 2017 and 2011 sampling locations, equipment and methods were identical.

The water quality samples collected for each event were analyzed for total suspended solids (TSS), volatile suspended solids (VSS), total phosphorus (TP) and total dissolved phosphorus (TDP), consistent with the 2011 monitoring. Similar to 2011, two sets of samples (representing both high and low flow events) from the Highway 55 inlet and Schaper Pond outlet were analyzed for particle size distribution to aid in determining the likelihood that the solids (and phosphorus attached to solids) in the inflow could be settled in the pond.

2.1 Water quality comparison before/after project implementation

Because the water quality samples were collected over a range of flows for flow events of varying magnitudes, the sample results were flow-weighted (summing the product of average flow and constituent concentration for each sample and dividing by the total flow sampled) for direct comparison (shown in Table 1) between the 2011 and 2017 monitoring periods.

Table 1 Comparison of 2011 and 2017 Water Quality Effectiveness Monitoring

Flow-Weighted Event Mean Concentrations					
	Parameter (mg/L)				
2017 Monitoring Location	**TSS**	**VSS**	**TP**	**TDP**	**Average Flow (cfs)**
Highway 55 Inlet	22	6	0.090	0.018	20.8
Railroad Inlet	26	6	0.125	0.018	1.95
Pond Outlet	36	8	0.105	0.016	19.4
2011 Report					
Highway 55 Inlet	52	10	0.142	0.028	22.5
Railroad Inlet	14	5	0.118	0.055	2.5
Pond Outlet	26	7	0.098	0.034	25

When comparing the water quality in the pond and upstream of the pond between 2011 and 2017, the following observations were noted:

- Total phosphorus concentrations entering the pond under Hwy 55 was 37% lower in 2017 than in 2011.
- Total suspended solids concentrations entering the pond from the railroad inlet were nearly twice as high in 2017 as they were in 2011.
- Total phosphorus leaving the pond (and entering Sweeney Lake) was roughly similar between 2011 and 2017.
- All three monitoring locations had lower dissolved phosphorus concentrations than what was observed in 2011.
- Total suspended solids leaving the pond were 30% higher in 2017 than in 2011.
- Schaper Pond is not removing suspended solids or total phosphorus as well as it did in 2011, and during most of the monitored events, the flow-weighted constituent concentrations are higher at the pond outlet than the combined inflow.
- There was slightly less monitored flow during 2017 than in 2011 (i.e., the average flows were less in 2017 than in 2011).

Figure 2 shows the results of particle size distribution testing on four sets of samples, representing high- and low-flow events, collected from the Highway 55 inlet and Schaper Pond outlet during 2011 and 2017. The figure allows for comparisons based on flow through the pond, as well as differences between the two years of monitoring. The following observations were noted:

- In 2011, the particle size distributions were similar for the respective monitoring locations during low- and high-flow events.

- In 2017, the particle size distributions were similar for the Highway 55 inlet during low- and high-flow events, but the pond outlet showed a significantly finer particle size distribution under high flow compared to the Highway 55 inlet.
- The size of particles in the water were significantly finer in 2017 than in 2011 for all monitoring locations, including during low-flow events. During 2011, the particle size distribution of the pond inflows included significant fractions of solids that would more easily settle in detention ponds (i.e., larger-sized particles).
- Resuspension of particles in the pond may have played a role during high-flow events in 2017, but was not evident in 2011.

As previously discussed (and shown in Table 1), the flow-weighted concentrations of total suspended solids (TSS), volatile suspended solids (VSS), and total phosphorus (TP) are higher at the pond outlet than the combined inflows to Schaper Pond. As a result, Figure 3 was developed to evaluate the sample results for each of the 12 sampling events and consider whether flow or residence time (the amount of time it takes water to travel through the pond) could explain why Schaper Pond is not removing suspended solids or total phosphorus as well as expected or as well as it did in 2011. Figure 3 shows the relationship between 1) the ratio of the outlet sample concentration to the Highway 55 inlet sample concentration (y-axis), and 2) the Schaper outlet composite sample flow. The points shown in Figure 3 with a ratio of the outlet sample concentration to the Highway 55 inlet sample concentration greater than 1 indicate events where either TSS or TP are not being removed by the pond. Figure 3 shows only one event when the ratio was greater than 1; this occurred when the average flow was approximately 55 cubic feet/second. This is the only monitored event that resulted in some removal of TSS and TP. All of the other sampling events resulted in a net export of phosphorus and TSS from the pond, with greater levels of export coinciding with lower flow. Notably, Figure 3 shows that the net export of TSS from the pond is significantly higher than TP export for the corresponding events (i.e., the ratio is higher). This may be a byproduct of the higher TSS concentrations entering the pond from the railroad inlet, but at a minimum, would appear to rule out sediment phosphorus release as a source of phosphorus because the dissolved phosphorus levels observed at the Schaper outlet were quite low.

Figure 2 Comparison of 2011 and 2017 Particle Size Distributions for Low and High Flow Events

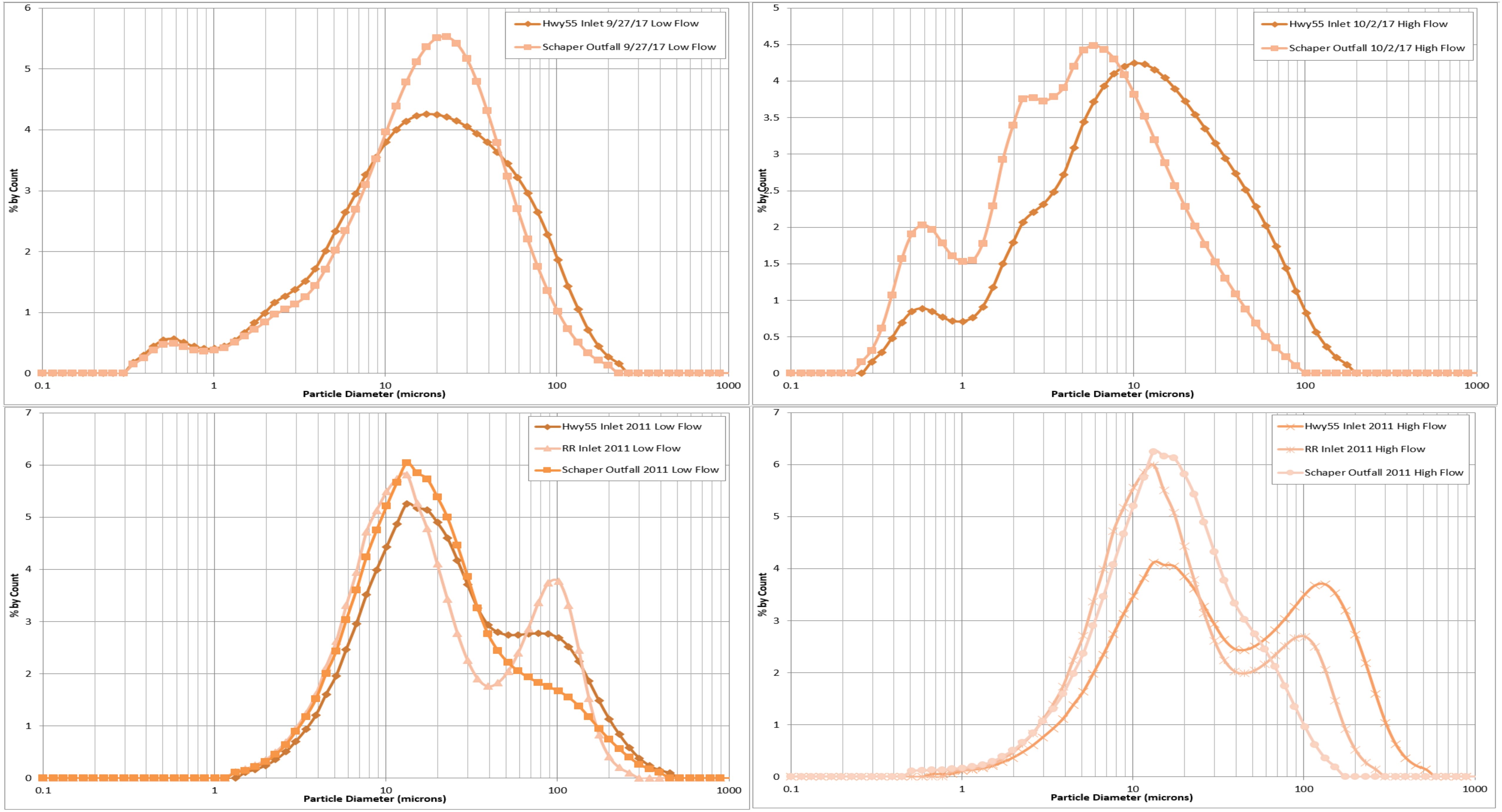
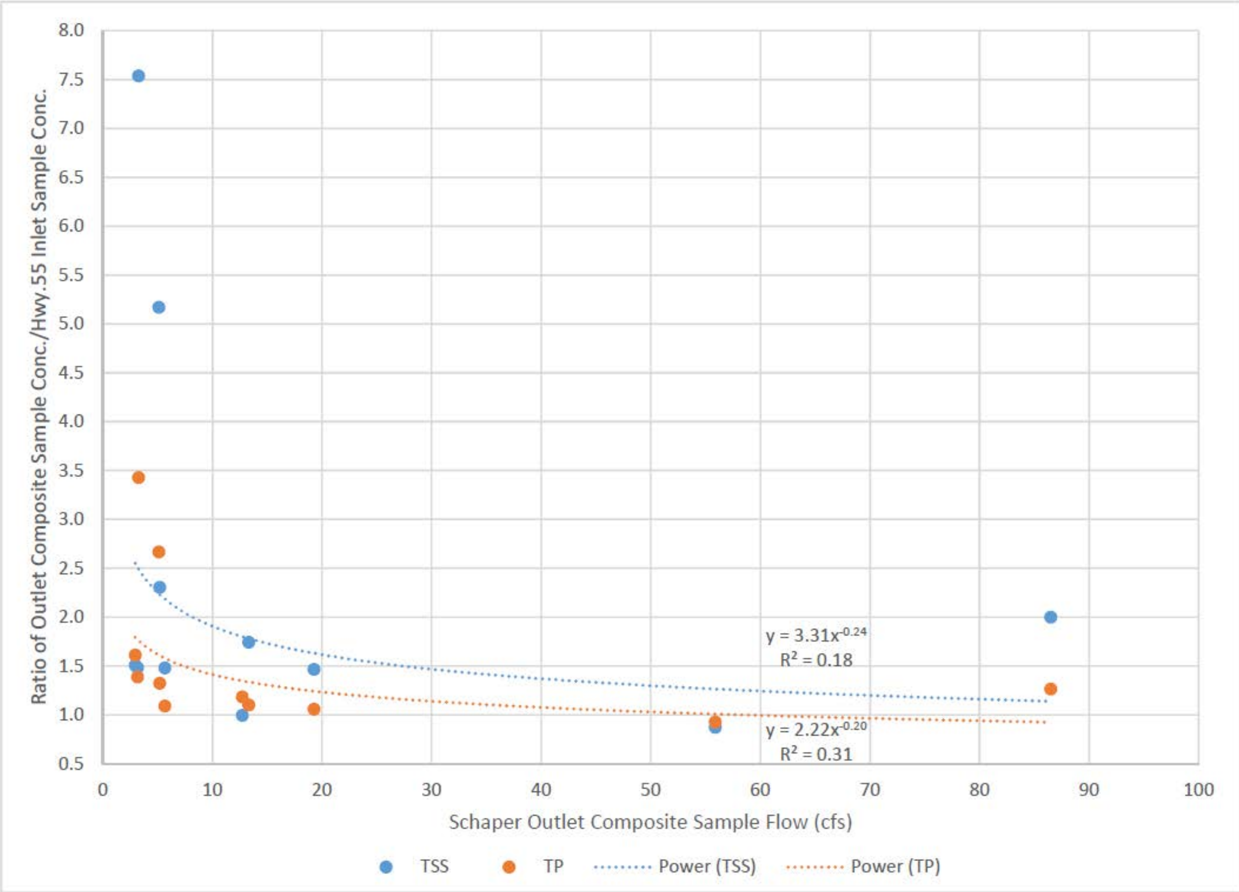


Figure 3 Effect of Flow on Inflow/Outflow Concentrations during 2017 Monitoring Events



As the preliminary results of the laboratory sample analysis began to indicate that the TSS and TP concentrations were higher at the Schaper Pond outlet than the Highway 55 inlet, Barr scheduled a longitudinal monitoring event to evaluate where the constituent concentrations might become elevated within the pond system. Figure 1 shows the four sampling locations in the pond that were used for the longitudinal monitoring event and Table 2 shows the results of the analyses. The sampling occurred on November 17th, during low flow (less than 2 cfs). The sample results shown in Table 2 confirm that phosphorus and chlorophyll become elevated as the flow moves from the Highway 55 inlet through the pond to the Schaper outlet.

Table 2 Longitudinal Water Quality Monitoring Results

Pond Location	TP (μg/L)	Chlorophyll-a (μg/L)
South	28	4.3
Center	--[1]	--
Northwest	40	--
Northeast	35	9.2

[1]—not reported due to disturbance of bottom sediment during sampling.

2.2 Potential factors limiting treatment effectiveness

As a result of preliminary discussions with Golden Valley and watershed staff it was determined that there are several potential factors that could have limited the 2017 treatment effectiveness of Schaper Pond with the floating barrier in-place:

- Start-up conditions—the 2017 monitoring began approximately two months after the final floating barrier anchors had been replaced. The 2017 monitoring results may have captured conditions in which the typical flow patterns through the pond were adjusting to a new equilibrium following the final implementation of the barrier.
- High water—the floating barrier design ensures that there will be enough of the curtain to divert the flow in the intended direction at pond inundation levels that correspond with flows up to 25 cfs. There were five days during 2017 where the flow exceeded 25 cfs, resulting in inundation levels that would have raised the curtain off the bottom of the pond. Figure 2 indicates that the high flow (approximately 90 cfs) event may have resulted in resuspension of finer particulates, which could have occurred when the bottom of the curtain was above the bottom of the pond. This would have temporarily allowed for short-circuiting of the flow, similar to the flow pattern that would have existed before the barrier was installed.
- Carp—several observers have noticed the presence of carp during field visits to Schaper Pond in the past. Anecdotally, field observations have usually mentioned the northwest corner of the pond as the primary location where carp were seen. It is plausible that if a significant carp population is present, and is more often concentrated in the northwest corner of the pond, then the flow patterns established after implementation of the floating barrier would be more likely to resuspend the solids (and associated phosphorus) that are typically stirred up by carp. The flow patterns through the pond in 2011 had a lower likelihood of resuspending sediment from the northwest corner of the pond.
- Watershed construction—city staff noted that Douglas Drive was under construction during 2017, which may have contributed to the elevated TSS concentrations observed at the railroad inlet. Because the flow from the railroad inlet enters the pond downstream from the floating barrier, this source of flow may not have received the same level of treatment that would have occurred in 2011.

- Water quality changes to the Highway 55 inflow—city staff noted that several upstream water quality improvement projects were recently implemented, which could explain why the primary source of inflow to Schaper Pond is not as "treatable" as it was in 2011.
- Changes to bathymetry—during the longitudinal water quality monitoring event, it was noted that the center of the pond was approximately 1 to 1.5 feet deep, which is between 0.5 and 1 foot shallower than indicated in the previous bathymetric map. An updated bathymetric survey would be used to determine whether there is adequate volume for sediment accumulation in the pond and/or whether there are areas of the pond that are subject to sediment scour or resuspension.

3.0 Recommendations for 2018

The 2017 monitoring indicated that there were unexpected factors contributing to the results which had not previously been assessed (carp) or might require updated information (such as the bathymetry). In addition, the single longitudinal monitoring event appeared to provide a better understanding about where within the pond system the treatment effectiveness is being compromised. Consequently, it is recommended that during the remainder of 2018, the BCWMC collectively monitor the gaps in the available data and distinguish the source(s) or factors that are limiting the treatment capacity of the pond. We recommend performing longitudinal water quality monitoring during 2018, along with surveys of the carp and bathymetry.

3.1 Water quality monitoring

Our recommended longitudinal water quality monitoring includes collecting grab samples at the four locations shown in Figure 1, twice per season, under low flow and storm flow conditions. Our preliminary estimate of the longitudinal water quality monitoring costs is $10,000, based on six sampling events.

3.2 Carp and bathymetric surveys

We recommend conducting a single bathymetric survey this summer and comparing the survey results to the pre-construction survey from 2011. We also recommend conducting a carp survey, which would involve performing individual electrofishing surveys seasonally throughout the pond. The carp survey results would include a report on the population estimates of carp during 2018. A preliminary estimate of the carp survey costs is $3,000, and the bathymetric survey is estimated to cost $3,000.

3.3 Reporting on 2018 monitoring

We would compile the results of the 2018 monitoring and compare them with past monitoring data in a technical memorandum, which would include conclusions and recommendations for improving water quality treatment in Schaper Pond/next steps. Our estimated cost to report on the results of the 2018 monitoring is $5,000.