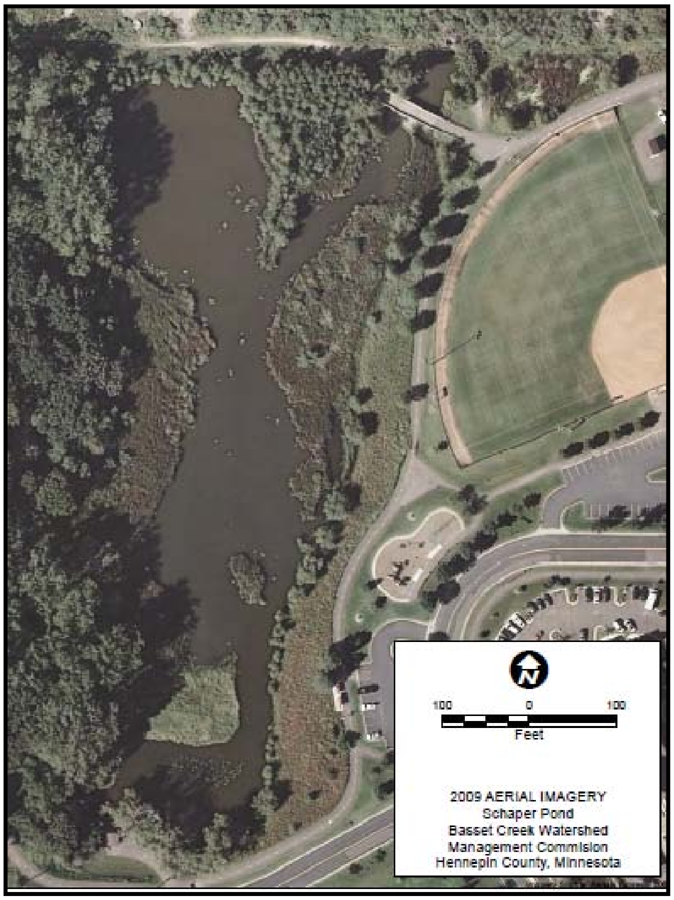
Item 5D.
BCWMC 8-21-14

Feasibility Report for the Schaper Pond Improvement Project



Prepared by the Bassett Creek Watershed Management Commission

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February 2012

Feasibility Report for the Schaper Pond Improvement Project

Golden Valley, Minnesota

Prepared by the
Bassett Creek Watershed Management Commission

February 2012

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Feasibility Report for the Schaper Pond Improvements Project
February 2012

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1.0 Executive Summary

The Implementation Plan for the Sweeney Lake TMDL includes several options for reducing phosphorus loads to Sweeney Lake. One option in the plan was modification of Schaper Pond to improve phosphorus removal performance. Modifications originally considered for Schaper Pond included: (1) dredging to increase pond depth, (2) expansion of the overall pond size (area and volume), and (3) installation of a filtration barrier to remove smaller-sized and largely unsettleable phosphorus particles.

Monitoring data collected at the two inlets to Schaper (identified as the Highway 55 Inlet at the south end of Schaper Pond and the Rail Road Inlet, which is on the north end of the pond) provided two important insights into the functioning of Schaper Pond: (1) Only 9 percent of the total phosphorus load to Schaper Pond comes from the Rail Road Inlet, however, 65 percent of the Schaper Pond volume is exclusively provided to settle phosphorus from the Rail Road Inlet, and (2) particles coming into Schaper Pond are large and settleable. These findings pointed to two viable and least cost pond modification options: (1) dredging (see Figure 7 in the main body of the report) to increase the depth and residence time of Schaper Pond to improve particle settling, and (2) diversion of water from the Highway 55 inlet to the large north west (see Figure 8 in the main body of the report) lobe of Schaper Pond to make use of the settling capacity of this part of the pond.

Dredging as well as diversion are both viable methods to improve the performance of Schaper Pond to begin complying with the phosphorus removal requirements (99 pounds during the June through September period) of the Sweeney Lake TMDL. Dredging will remove an estimated 59 to 114 pounds of phosphorus while diversion will remove an estimated 81 to 156 pounds. Diversion of flow from the Highway 55 Inlet to the north-west lobe of the pond was identified as the most cost-effective means to achieve the Sweeney Lake TMDL phosphorus removal requirement of 99 pounds of external load reduction for the June through September period (see Table 1 for phosphorus reduction with flow diversion). Diversion also potentially provides a larger margin of safety since it is estimated that as high as 50 percent more phosphorus may be removed (under normal flow conditions) compared to the TMDL requirement. Because dissolved phosphorus was only 23 percent of total phosphorus load entering the pond, filtration or other enhanced filtration methods such as iron sand filters would not be necessary to achieve the phosphorus reduction requirements of the Sweeney Lake TMDL (these filtration techniques take out colloidal and dissolved phosphorus).

Filtration methods are also not as practical as it is estimated that filtration media would need to be replaced frequently.

The recommended improvement alternative is diversion only. Two options are provided below, both provide the estimated treatment improvement, but the first option includes installation of a dock (walkway) or pier structure, made of wood and metal, which would include a diversion structure. This structure would also provide public access to the pond for viewing. The pier could be built with one section below the walkway with a diverter to stop water from flowing to the outlet, and another section with a walkway and subsurface structure open to water flow. The pier would connect to existing trails in Schaper Park. Hence the first option provides some recreation benefit as well as the intended treatment.

The second option would be to install the diversion structure only. This would require driving posts into the sediment and installing a timber diversion structure. This structure would serve only as a flow diverter. It would not provide public access but would provide the same treatment enhancement as the pier option.

The expected performance and cost of the diversion alternatives is provided in Table 1 and Table 2 below. No dredging is recommended at this time, however, it is recommended that the depth of Schaper Pond (e.g., a bathymetric survey) be evaluated again in 5 years to determine if dredging should be conducted.

It should also be noted that construction of the flow diversion structure will only address the needed external load reduction requirements of the Sweeney Lake TMDL and internal load reduction will be needed to achieve the summer average total phosphorus goal of 0.038 mg/L for Sweeney Lake.

Table 1 Phosphorus Reduction with Flow Diversion

Expected annual (365 days), summer (June through September-122 days), and daily phosphorus removal improvement with construction of a diversion structure in Schaper Pond. Phosphorus removal is based upon data collected and modeling performed for 2011. Phosphorus removal improvement estimates are provided using monitoring and modeling data and the 2004 loading estimates to Schaper Pond which were developed for the Sweeney Lake TMDL (July, 2011).

Condition	Period (days)	Total Phosphorus	
		Pounds	Kilograms
Additional Total Phosphorus Removal with Diversion (Removal Modeled with Diversion - Removal Monitored in 2011)	365	181-347	82-157
% Removal, Original P8 model for TMDL = 6.6%	122	81-156	37-71
% Removal Monitored in 2011 = 31 %	1	0.67-1.28	0.3-0.6

Total external loading to Sweeney 122 days=667 pounds total phosphorus
Total external loading to Sweeney 365 days=1,470 pounds total phosphorus
The phosphorus reduction range is provided to account for reduced phosphorus treatment assumed to occur with high flow events (events greater than 25 cubic feet per second) which account for 48 percent of total flow through Schaper Pond.
From Sweeney Lake TMDL, the ratio of 365 days of load to 122 days of load 2.22

Table 2 Estimated Capital and Engineering and Design Cost for Two Options for Diverting Flow within Schaper Pond

Option	Total for Walkway or Diverter ($)	Maintenance Dredging for 20 Years ($)	Total Life Cost over 20 years ($)	Phosphorus Removal Cost Over 20 Years ($/lb.)
Pier Walkway	$244,000	$992,000	$1,639,000	$236
Diverter Only	$184,500	$992,000	$1,481,000	$213

Annual phosphorus removal with the diversion (lbs.): 347

Note: Interest rate of 5% used in per-pound phosphorus removal cost calculations
Note: Estimates of cost per pound removed are based upon normal flow conditions and do not include the effect of high flows on reduced phosphorus removal performance

2.0 Background and Objectives

2.1 Sweeney Lake TMDL Implementation

The Sweeney Lake Total Phosphorus TMDL (Basset Creek Watershed Management Organization and MPCA, 2011), includes an implementation plan identifying several phosphorus reduction measures to comply with the TMDL requirement of 99 pounds (for the June through September period for average flow and water quality conditions) of external phosphorus load reduction. Modification of Shaper Pond to improve phosphorus removal was one of the options. Because it was expected that modifications may not be very effective, the addition of a filtration barrier was also identified as an alternative or supplement to pond modification. This current feasibility study was designed to determine whether and what kind of pond modification could enhance phosphorus removal, what the cost of this modification may be, and the permitting requirements and hurdles.

It should also be point out that most storm water treatment devices are designed to perform under average flow conditions. In addition, the TMDL for Sweeney Lake was developed using a year of flow and water quality data which can be considered average. Hence, the design alternatives provided in this report are based upon the average flow conditions which were used to develop the TMDL. High flows may affect performance by causing scouring or short circuiting of intended flow direction. If performance greater than that required by the TMDL (e.g., high flow events) is desired for some other purpose such as protection of a future in-lake alum treatment, then additional alternative measures may need to be considered.

This feasibility study, including monitoring, modeling, conceptual design, planning level construction cost estimates, and an outline of expected permitting needs, is required as part of the BCWMC implementation process. The feasibility study must be completed prior to the BCWMC holding a public hearing and ordering the project.

2.1.1 Schaper Pond Background

Schaper Pond is identified on the Minnesota Department of Natural Resources Protected Waters and Wetlands Map for Hennepin County as a public water wetland (the map, which is difficult to read, appears to indicate that Shaper Pond is public water 649W). Aerial photographs prior to 1999 indicate that Schaper Pond was a small natural wetland with storm water inputs from the north and south of the pond. The Schaper Park recreation area and water quality facility were completed during 1999. The project included excavation of a large ponding area at the north end of the site and excavation of sediment traps out of stream channel (these traps now constitute the southern end of the pond) to improve the water quality of Sweeney Lake (see Figure 2). A floating peninsula was built by MnDOT as part of TH 100 and 394 projects to prevent short circuiting of water from the Rail Road inlet to the north arm of Schaper Pond. A skimming structure was constructed in 2002 by the Minnesota Department of Transportation as part of its agreement with the BCWMC for approval of Highway 100 and Interstate 394 upgrades. The skimming structure reduces floating debris and trash from entering Sweeney Lake.

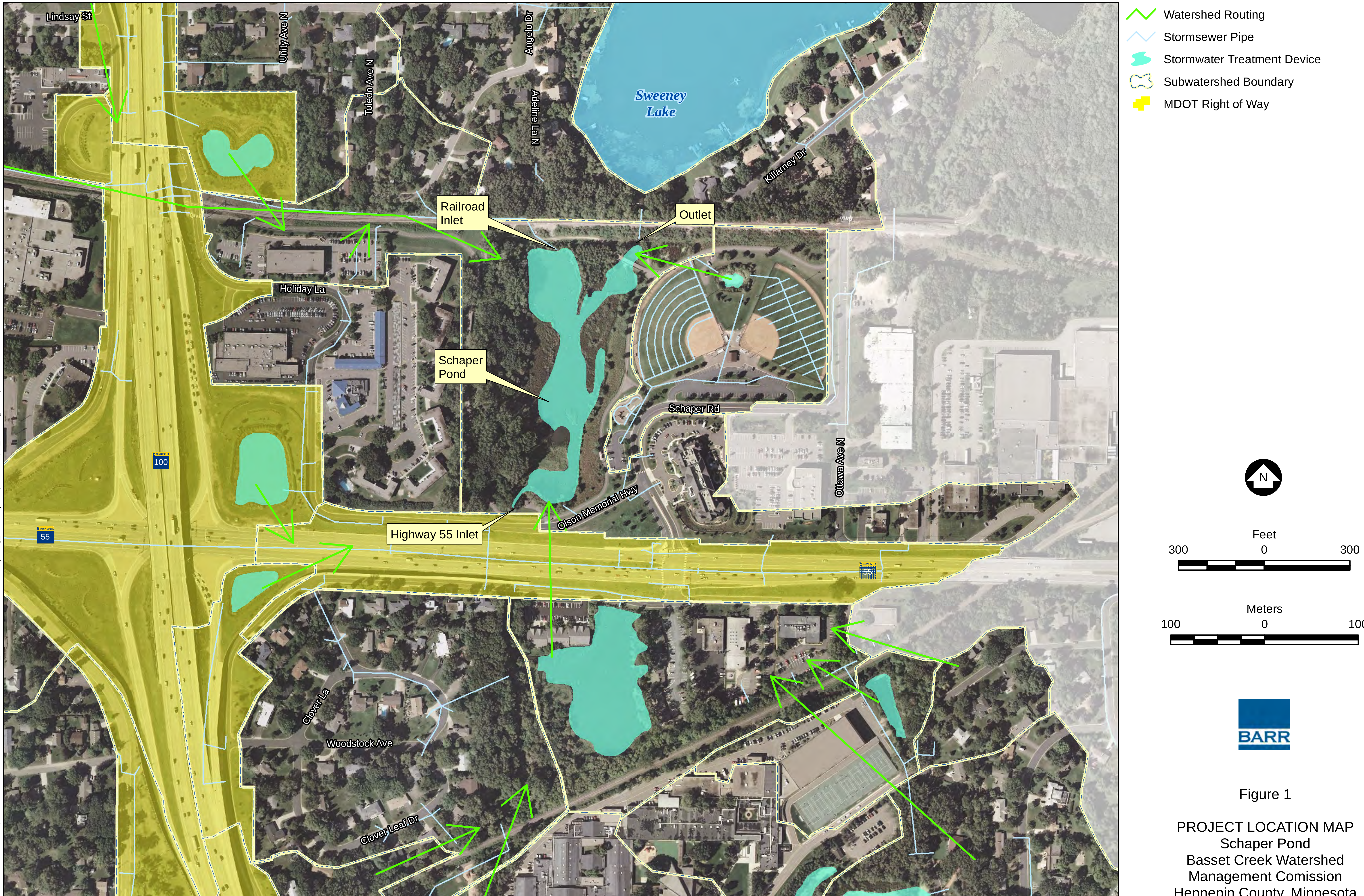


Figure 1

PROJECT LOCATION MAP
Schaper Pond
Basset Creek Watershed
Management Comission
Hennepin County, Minnesota

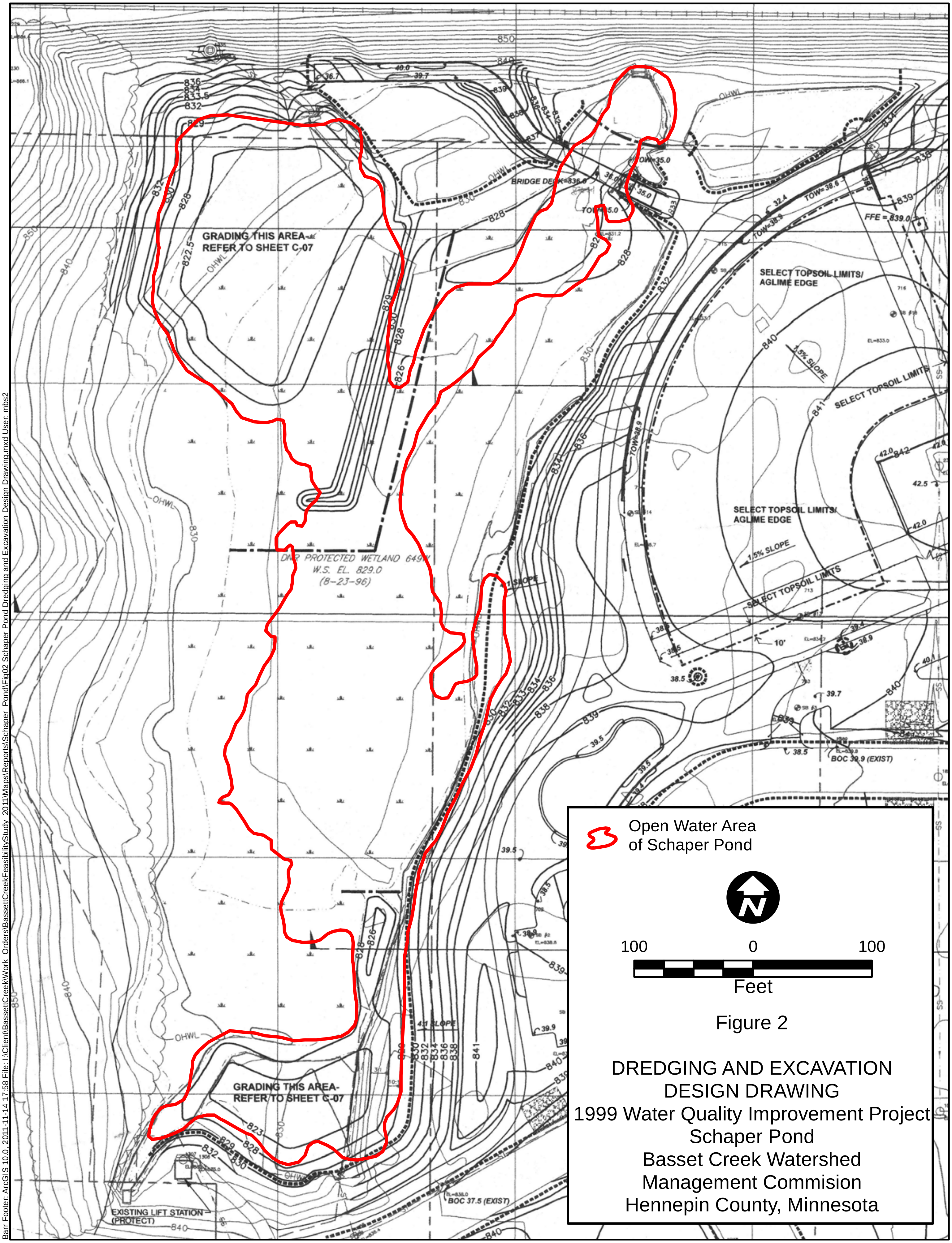


Figure 2

DREDGING AND EXCAVATION DESIGN DRAWING
1999 Water Quality Improvement Project
Schaper Pond
Basset Creek Watershed Management Commision
Hennepin County, Minnesota

Barr Footer: ArcGIS 10.0, 2011-11-14 17:58 File: I:\Client\BassettCreek\Work_Orders\BassettCreekFeasibilityStudy_2011\Maps\Reports\Schaper_Pond\Fig02 Schaper Pond Dredging and Excavation Design Drawing.mxd User: mbs2

2.2 Goals and Objective

The primary goal of this study was to identify the most cost effective modification to Schaper Pond to partially or fully meet external phosphorus loading reduction requirements of the Sweeney Lake TMDL. Because Shaper Pond is a Minnesota Department of Natural Resources (MDNR) public water wetland, another goal was to identify an improvement approach that could be permitted by the MDNR and other wetland permitting agencies.

3.0 Alternatives Analysis

3.1 Storm Water Monitoring

Auto samplers, level sensors, and area velocity meters were installed at the outlet of Schaper Pond, at the southern inlet (called Highway 55 inlet in this report), and the northern inlet (called Rail Road inlet in this report) to collect enough data to evaluate the phosphorus removal performance of Schaper Pond and to develop a model to evaluate how removal can 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 analyzed for particle size. Flow was measured continually from May 19 through August 14, 2011.

Storm water monitoring results are provided in Table 3 and Figures 3, 4, and 5. These data, which are discussed here, provide a good understanding of how Schaper Pond functions and how it can be modified to improve performance. Figure 3 shows the relative contribution of flow to Schaper Pond from the Highway 55 inlet and the Rail Road inlet. The Rail Road inlet provides on average 10 percent and the Highway 55 inlet provides on average 90 percent of the storm event flow to Schaper Pond. Because total phosphorus is about 20 percent lower at the Rail Road inlet compared to the Highway 55 inlet (see Table 3), phosphorus loading from the Rail Road inlet is less than 10 percent of the total load to Schaper Pond (Figure 4). However, 65 percent of the Schaper Pond volume is provided to exclusively settle phosphorus from the Rail Road inlet.

Another important monitoring program finding was that total dissolved phosphorus is low at the Highway 55 inlet (total dissolved phosphorus was 18 percent of total phosphorus), the primary source of phosphorus loading to Schaper Pond is in the particulate form. Because most of the phosphorus is bound to particles (particulate phosphorus = total phosphorus – total dissolved phosphorus), improved phosphorus removal can be had with improved particle settling performance.

From the particle settling data (Figure 5) also collected as part of this monitoring program it can be seen that particles entering Schaper Pond are large and settleable. Particles currently being removed by Schaper Pond are greater than 150 μm in diameter, hence, any additional performance improvements will need to be achieved by removing particles less than 150 μm in diameter.

3.2 Pond Modeling

A two-dimensional particle settling model was developed for Schaper Pond to evaluate two pond modifications: (1) selective dredging of a portion of Schaper Pond, and (2) diversion of water from the south end of the pond through the north end and then to the outlet. The model was developed and calibrated using the flow, phosphorus, solids, and particle size data collected at the two inlets and the outlet of Schaper Pond.

Table 3 Stormwater Monitoring Results

Average solids, phosphorus, flows and loads monitored at the Schaper Pond inlets and outlet in 2011. Note that daily loads appear high because they are for storm events with high flows which averaged 25 cubic feet per second.

Parameter	Units	Location		
		Pond Outlet	Highway 55 Inlet	Rail Road Inlet
Total Suspended Solids	mg/L	25	45	14
Volatile (organic) Suspended Solids	mg/L	7	9	5
Inorganic Suspended Solids	mg/L	17	36	9
Total Phosphorus	mg/L	0.093	0.136	0.109
Total Dissolved Phosphorus	mg/L	0.031	0.025	0.050
Particulate Phosphorus	mg/L	0.062	0.111	0.059
Average Flow During Monitoring Events	cfs	25	22.5	2.5
Total Suspended Solids	kg/day	1502	2472	87
Volatile (organic) Suspended Solids	kg/day	437	488	31
Inorganic Suspended Solids	kg/day	1065	1984	55
Total Phosphorus	kg/day	5.7	7.5	0.7
Total Dissolved Phosphorus	kg/day	1.9	1.4	0.3
Particulate Phosphorus	kg/day	3.8	6.1	0.4

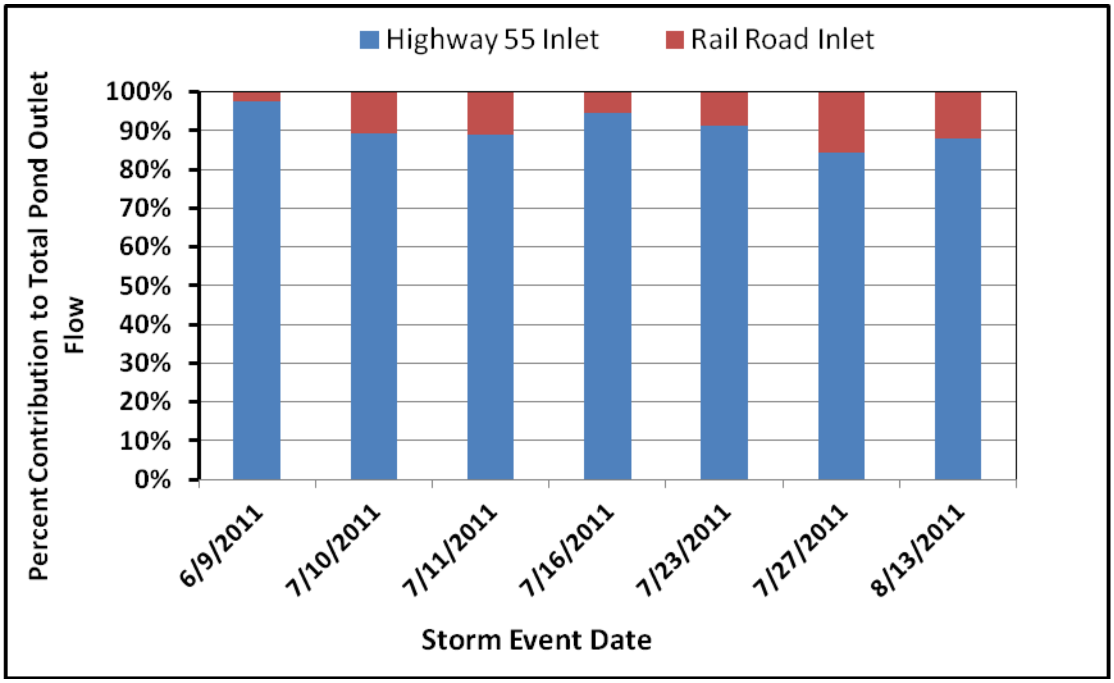


Figure 3 The relative contribution of flow to Schaper Pond from the Highway 55 inlet and the Rail Road inlet.

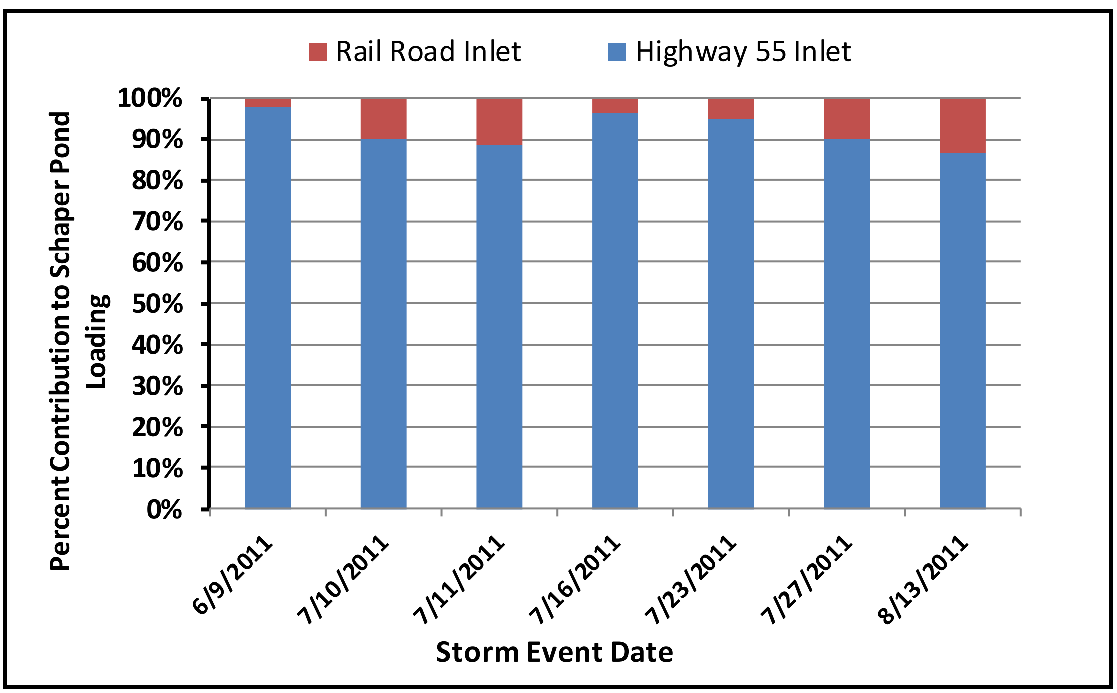


Figure 4 The relative contribution of phosphorus load to Schaper Pond from the Highway 55 inlet and the Rail Road inlet.

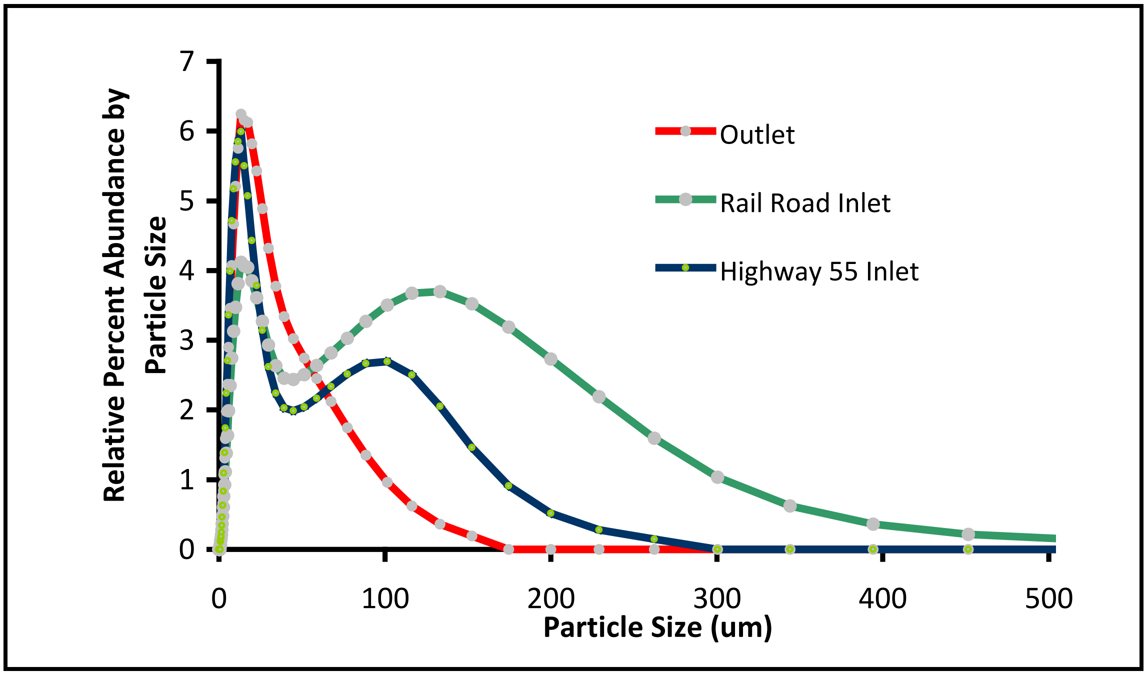
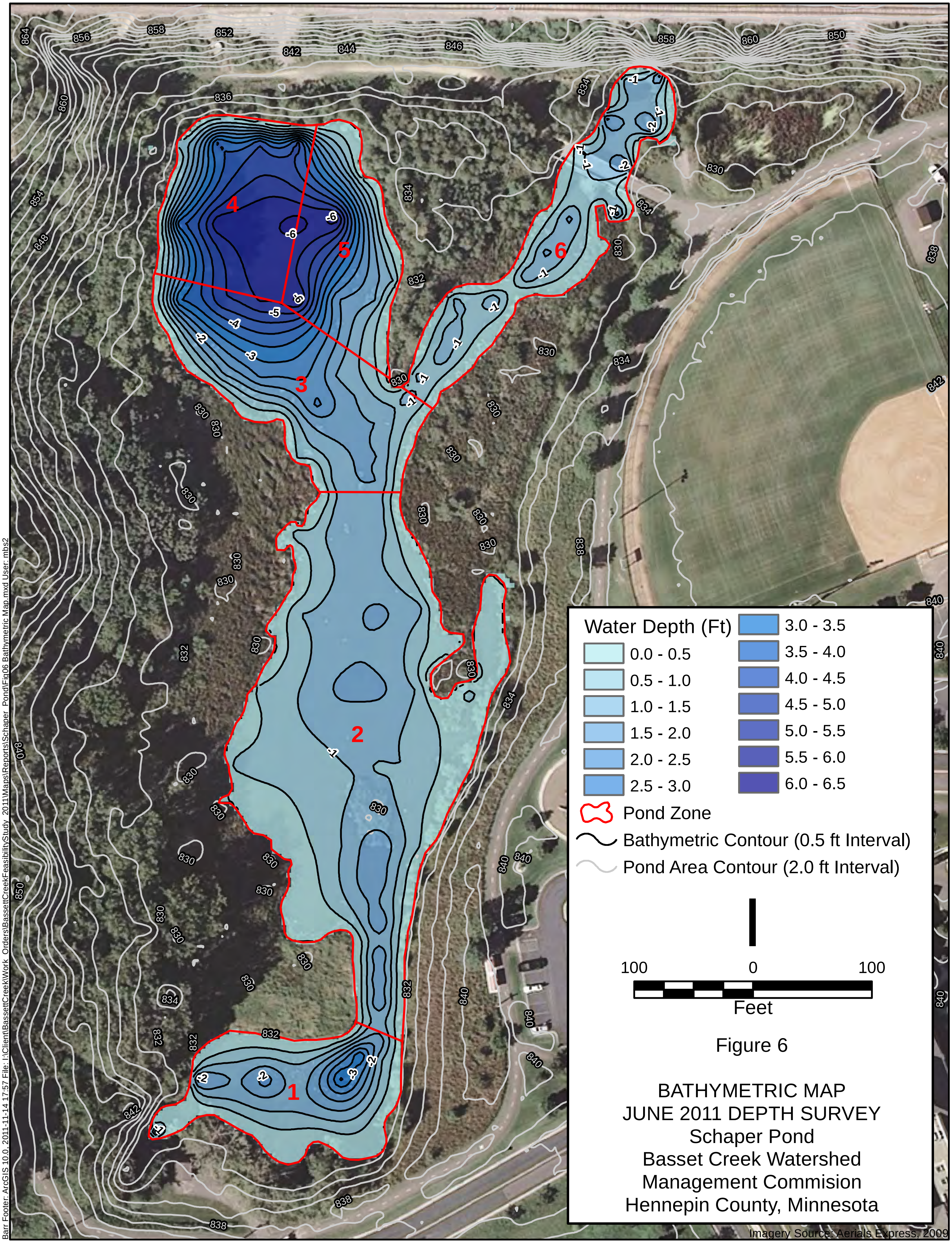


Figure 5 Distribution of suspended sediment particles sizes at the two inlets and the outlet of Schaper Pond.

3.2.1 Dredging

For purposes of modeling and modification evaluation, Schaper Pond was divided into 6 sections or cells which include areas of the pond that may be modified and areas with inlets (Figure 6). From a bathymetric (e.g., measurement of pond depth across the entire pond) survey conducted in 2011, the volume, area and average depth of each cell was calculated (see table in Figure 6). It can be seen that Cell 2 is fairly large and shallow and hence dredging this cell was identified as a potential means to improve phosphorus removal. By dredging to a final depth of 3 feet and an average depth of 1.67 feet (see Figure 7), the total excavated volume is expected to be 1,953 cubic yards.

Dredging Cell 2 to an average depth of 1.67 feet is expected to improve the phosphorus removal performance of Schaper Pond from 31 to 50 percent total phosphorus removal under normal flow conditions. This will likely lead to 59 to 114 pounds (the low end of the estimate considers the effect of high flows on reduced phosphorus treatment) of additional phosphorus removal during the June through September period. Under average flow conditions, the load reduction with dredging will be able to achieve 99 pounds of phosphorus removal required by the Sweeney Lake TMDL.


Water Depth (Ft)
0.0 - 0.5
0.5 - 1.0
1.0 - 1.5
1.5 - 2.0
2.0 - 2.5
2.5 - 3.0
3.0 - 3.5
3.5 - 4.0
4.0 - 4.5
4.5 - 5.0
5.0 - 5.5
5.5 - 6.0
6.0 - 6.5
Pond Zone
Bathymetric Contour (0.5 ft Interval)
Pond Area Contour (2.0 ft Interval)
100 0 100
Feet
Figure 6
BATHYMETRIC MAP
JUNE 2011 DEPTH SURVEY
Schaper Pond
Basset Creek Watershed
Management Commision
Hennepin County, Minnesota
Imagery Source: Aerials Express, 2009

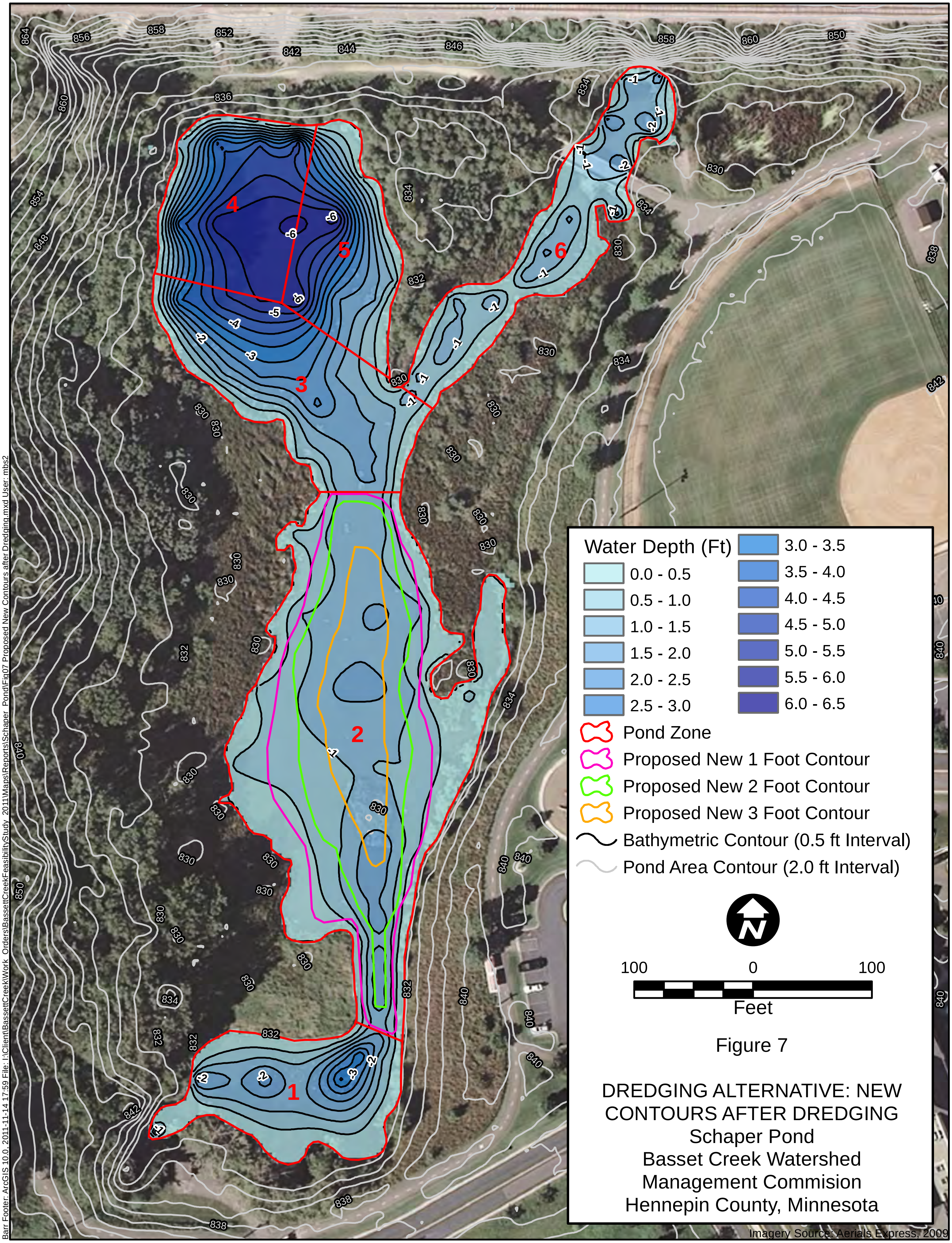


Figure 7

DREDGING ALTERNATIVE: NEW CONTOURS AFTER DREDGING
Schaper Pond
Basset Creek Watershed Management Commision
Hennepin County, Minnesota

Barr Footer: ArcGIS 10.0, 2011-11-14 17:59 File: I:\Client\BassettCreek\Work_Orders\BassettCreekFeasibilityStudy_2011\Maps\Reports\Schaper_Pond\Fig07 Proposed New Contours after Dredging.mxd User: mbs2

It should be noted that the calculated phosphorus removals provided in Table 4 are consistent with the load allocations reported in the Sweeney Lake TMDL. The modeling work and percent removal estimates provided in this feasibility study were applied to the TMDL loading values. For example, from the monitoring work conducted in 2011, it was shown that 31 percent of the phosphorus load was removed by Schaper Pond. This equates to 408 pound of phosphorus reduction for the TMDL model year of 2004. With dredging, phosphorus removal was modeled at 50 percent or 661 pounds per year for 2004 (under normal flow conditions). The difference of the phosphorus removal estimates for the unmodified and the dredged pond was the estimated annual phosphorus removal improvement expected with dredging.

Table 4 Phosphorus Removal with Dredging

Expected annual, summer (June through September), and daily phosphorus removal improvement with dredging in Schaper Pond. Phosphorus removal is based upon data collected and modeling performed for 2011. Additional phosphorus removal estimates are provided using the 2004 loading estimates to Schaper Pond used for the Sweeney Lake TMDL (July, 2011).

Condition	Period (days)	Total Phosphorus	
		Lbs	kg
a. 2004 Loading to Schaper Pond Modeled for TMDL	365	1329	603
b. % Removal, Original P8 model for TMDL=6.64%	365	88	40
c. % Removal Monitored in 2011= 31 %	365	408	185
d. % Removal Modeled with Dredging= 50 %	365	661	300
Additional Total Phosphorus Removal with Dredging (calculated from rows d - c above)	365	131-252	60-115
	122	59-114	27-52
	1	0.48-0.93	0.2-0.4

Total external loading to Sweeney 122 days=667 pounds total phosphorus

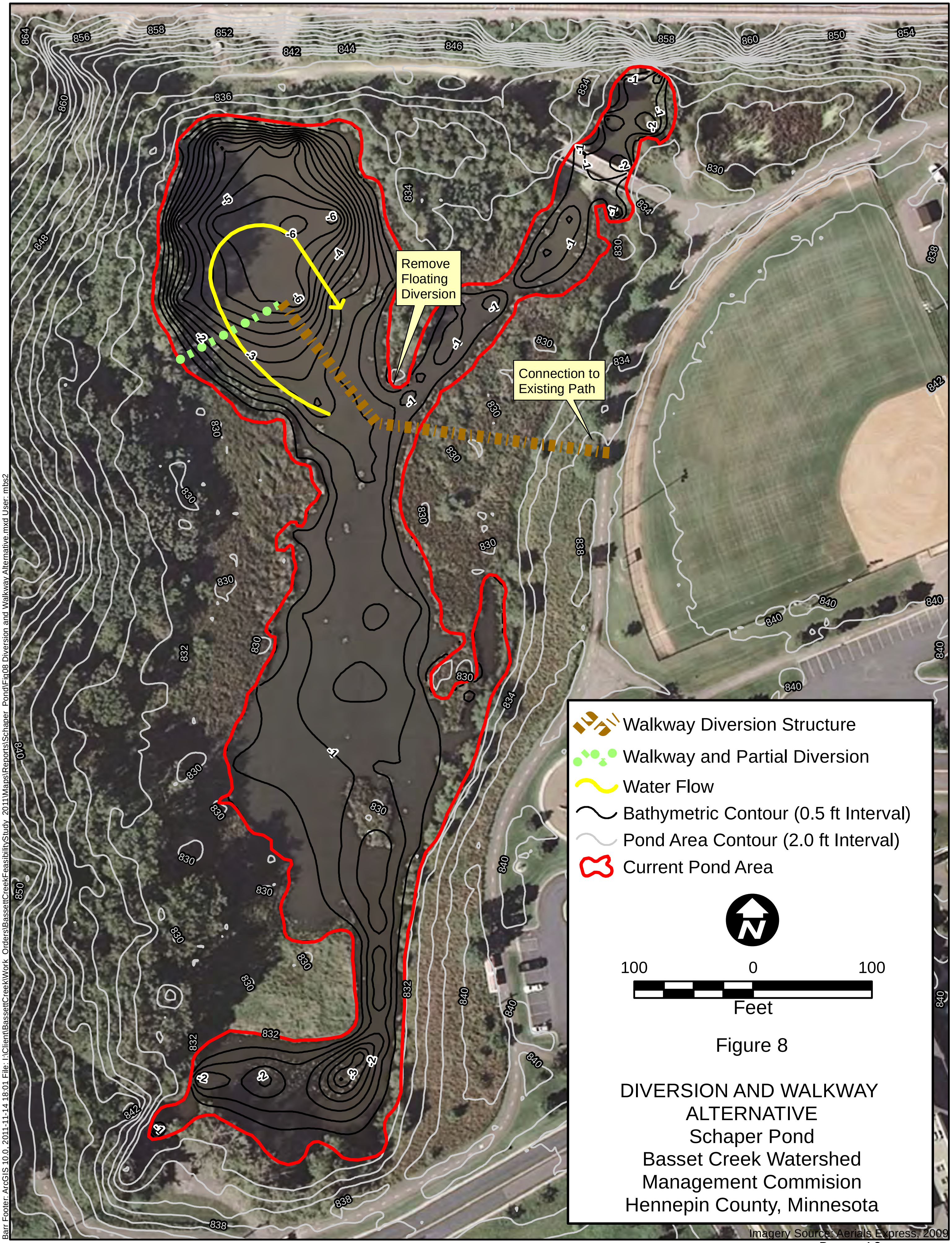
Total external loading to Sweeney 365 days=1,470 pounds total phosphorus

The phosphorus reduction range is provided to account for reduced phosphorus treatment assumed to occur with high flow events (events greater than 25 cubic feet per second) which account for 48 percent of total flow through Schaper Pond.

Ratio of 365 days of load to 122 days of load 2.22

3.2.2 Diversion

Since approximately 90 percent of the phosphorus load to Schaper pond comes from the Highway 55 inlet, and only 35 percent of the pond volume is provided to settle phosphorus from this source, diversion of water to the north west lobe of the pond was identified as a way to provide more time to settle phosphorus and improve overall phosphorus removal performance in Shaper Pond (see Figure 8). Flow would be diverted from Cell 2 to Cell 3, 4, 5 and then to Cell 6. The large volume of water and surface area of Cell 3, 4, and 5 provides additional volume and time for particle settling. There would be minimal treatment performance loss for phosphorus originating at the Rail Road inlet, partly because 50 percent of the phosphorus from this source is dissolved and unsettleable.



Remove Floating Diversion
Connection to Existing Path
Walkway Diversion Structure
Walkway and Partial Diversion
Water Flow
Bathymetric Contour (0.5 ft Interval)
Pond Area Contour (2.0 ft Interval)
Current Pond Area
N
100 0 100
Feet
Figure 8
DIVERSION AND WALKWAY ALTERNATIVE
Schaper Pond
Basset Creek Watershed Management Commision
Hennepin County, Minnesota
Imagery Source: Aerials Express, 2009

Diversion of water from Cell 2 to Cell 3, 4, and 5 is expected to improve the phosphorus removal performance of Schaper Pond from 31 to 57 percent total phosphorus removal. This will likely lead to 156 pounds of additional phosphorus removal during the June through September period. This additional load reduction is greater than the 99 pounds of phosphorus removal required by the Sweeney Lake TMDL.

It should be noted that the calculated phosphorus removals provided in Table 5 are consistent with the load allocations reported in the Sweeney Lake TMDL. The modeling work and percent removal estimates provided in this feasibility study were applied to the TMDL loading values. For example, from the monitoring work conducted in 2011, it was shown that 31 percent of the phosphorus load was removed by Schaper Pond. This equates to 408 pounds of phosphorus reduction for the TMDL model year of 2004. With diversion, phosphorus removal was modeled at 57% or 755 pounds per year for 2004. The difference of the phosphorus removal estimates for the unmodified pond and with the diversion was the estimated annual phosphorus removal improvement.

Table 5 Phosphorus Removal with Diversion

Expected annual, summer (June through September), and daily phosphorus removal improvement with construction of a diversion structure in Schaper Pond. Phosphorus removal is based upon data collected and modeling performed for 2011. Additional phosphorus removal estimates are provided using the 2004 loading estimates to Schaper Pond which were developed for the Sweeney Lake TMDL (July, 2011).

Condition	Period (days)	Total Phosphorus	
		Lbs	kg
a. 2004 Loading to Schaper Pond Modeled for TMDL	365	1329	603
b. % Removal, Original P8 model for TMDL = 6.6%	365	88	40
c. % Removal Monitored in 2011 = 31 %	365	408	185
d. % Removal Modeled with Diversion = 57 %	365	755	343
Additional Total Phosphorus Removal with Diversion (calculated from rows d - c above)	365	181-347	82-157
	122	81-156	37-71
	1	0.67-1.28	0.3-0.6

Total external loading to Sweeney 122 days=667 pounds total phosphorus

Total external loading to Sweeney 365 days=1,470 pounds total phosphorus

The phosphorus reduction range is provided to account for reduced phosphorus treatment assumed to occur with high flow events (events greater than 25 cubic feet per second) which account for 48 percent of total flow through Schaper Pond.

Ratio of 365 days of load to 122 days of load 2.22

3.3 Filtration Barrier

It is expected that a filtration barrier would be most effective when constructed in conjunction with the diversion approach in Section 3.2.2 or the dredging approach in Section 3.2.1. Hence, a filtration barrier would most likely be constructed downstream of the trash rack and upstream of the outlet of Schaper Pond. This area of the pond could accommodate a 50- by 50- by 2-foot deep cell. The cell would consist of a wooden weir structure at the front end to direct water to the top of the filtration cell, perforated drainage pipes in the cell and wooden weir at the outlet, and 1/8 to 1/16 cubic inch limestone filtration material placed in the cell. The limestone material would filter fine particulate matter that is not removed by settling in Shaper Pond. It is expected that solids loading to this structure could be significant and could fill the pore spaces of the barrier every year, hence from a maintenance perspective this approach is impractical. Another complication with this approach is that wetland area would need to be filled to accommodate a big enough barrier to be effective.

3.4 Alternatives Evaluation

3.4.1 Costs

The cost to construct, engineering and design, and the total cost to remove a pound of phosphorus was estimated for the dredging alternative and the diversion alternative but not for the filtration barrier because the application of this treatment approach is not expected to be practical for the high flows and loads at Schaper Pond.

Both dredging and flow diversion are estimated to be capable of removing enough phosphorus to meet the requirements of the Sweeney Lake TMDL, however, flow diversion removes approximately 38 percent more phosphorus. The cost to dredge Cell 2 (Table 6) is comparable to the cost to build a flow diversion structure (Table 7). On a cost per pound of phosphorus removed basis, the flow diversion approach is more cost effective (see Section 3.4.2 for maintenance dredging to maintain treatment performance). It should be noted that for the dredging option it is assumed that the dredged material can be land applied or disposed in a landfill. The disposal cost may increase by $40,000 if the material has to be placed in a Level 3 MPCA certified landfill if it were determined that the sediment is contaminated (e.g., high levels of poly aromatic hydrocarbons-PAHs and other contaminants).

3.4.2 Maintenance

Dredging of Cell 2

Based upon the monitoring data collected and the modeling performed, it is expected that enhanced solids removal of Cell 2 with dredging will lead to the accumulation of approximately 0.73 acre-feet (1200 cubic yards) of solids across the entire area of Schaper Pond every 10 years. With greater than 50 percent solids accumulation expected to occur in Cell 2, this cell will need to be dredged every 3 to 6 years to maintain the current depth of this cell (area of this cell is 1.4 acres and average depth is 0.8 feet) and to maintain the phosphors removal performance of Schaper Pond.

Diversion Structure

Based upon the monitoring data collected and the modeling performed, it is expected that approximately 1 acre-foot (1600 cubic yards) of solids will accumulate in Schaper Pond every 10 years. If the diversion structure is designed to force water to the bottom of Cell 3, 4, and 5, much of the additional solids removal and accumulation will occur in these cells, and dredging of the accumulated material in these cells will need to occur once every 10 to 20 years (total area of these cells is 1.2 acres and mean depth is 2.8 feet). If the diversion structure is <u>not</u> designed to force water to the bottom of Cell 3, 4, and 5, much of the additional solids removal and accumulation will occur in Cell 6—it is expected then that accumulated solids will need to be dredged every 3 to 5 years in Cell 6 (area is approximately 0.4 acres and the mean depth is 0.75 feet). It should also be noted that accumulated material in Cell 6 will be small and fine and mostly organic, and hence, has the greatest potential for resuspension during large storm events.

Greater than 50 percent of the solids removed in Schaper Pond are expected to settle in Cell 2, and hence this cell will need to be dredged every 5 to 10 years (note that this estimate is different from the estimate for Dredging of Cell 2 because dredging of Cell 2 will enhance solids removal) to maintain the current depth and phosphorus removal performance of this cell (area of this cell is 1.4 acres and average depth is 0.8 feet). It is recommended that the depth of Schaper Pond (e.g., a bathymetric survey) be evaluated again in 5 years to determine if dredging should be conducted.

Filtration Barrier

It is expected that this material may need to be excavated and the filtration media replaced every year.

Table 6 Opinion of cost to dredge and dispose of dredged material from Schaper Pond.

Option	Cell 2 Dredging Only								Maintenance Dredging (20 years)	Total Life (20 year) Cost ($)	Phosphorus removal cost over 20 years ($/lb)
	Dredge Volume (cy)	Mobilization, Site Restoration, and Erosion Control	Excavation and Removal ($)	Dewatering ($)	Landfill Disposal ($)	20% Contingency ($)	20% Engineering and Design ($)	Total ($)			
Dredging Cell 2	1,953	$15,000	$41,000	$74,000	$39,000	$34,000	$34,000	$236,000	$755,000	$1,382,000	$274

Annual phosphorus removal with the diversion (lbs): 347

Note: Interest rate of 5% used in total costs for life of project (20 years) and phosphorus removal cost calculations ($/lb.)

Table 7 Opinion of cost for capital and engineering and design for two options for diverting flow within Schaper Pond.

Option	**Costs for Pier or Diverter Structure Only**						Maintenance Dredging for 20 Years ($)	Total Life Cost (20 years)	Phosphorus Removal Cost Over 20 Years ($/lb)
	Length (ft)	Mobilization, Site Restoration, and Erosion Control	Pier Structure ($)	20% Contingency ($)	20% Engineering and Design ($)	Total for Walkway or Diverter ($)			
Pier Walkway	425	$15,000	$170,000	$37,000	$37,000	$244,000	$992,000	$1,639,000	$236
Diverter Only	425	$15,000	$127,500	$28,500	$28,500	$184,500	$992,000	$1,481,000	$213

Annual phosphorus removal with the diversion: 347 lbs.

Note: Interest rate of 5% used in phosphorus removal cost calculations

4.0 Permits

All of the proposed project alternatives will require a Public Waters Work Permit from the Minnesota Department of Natural Resources (MNDNR). Some of the projects may require an U.S. Army Corps of Engineers (USCOE) permit and if the sediments in Schaper Pond contain elevated levels of PAHs or other contaminants a MPCA permit may be required.

4.1 Public Waters Work Permit

The MNDNR regulates projects constructed below the ordinary high water level of public waters or public water wetlands, which alter the course, current, or cross section of the water body. Public waters regulated by the MNDNR are identified on published Public Waters Inventory (PWI) maps. Because Schaper Pond is a public waters wetland, the proposed work will require a MNDNR public waters work permit. This permit process is subject to a 45- to 60-day approval cycle.

4.2 Section 404 Permit

The USCOE regulates the placement of fill into wetlands under Section 404 of the Clean Water Act (CWA) if the wetlands are hydraulically linked to a water of the United States. In addition, the COE may regulate all proposed wetland alterations. If dredging operations can be conducted such that no fill or mats need to be placed in the wetland to allow equipment access for dredging, the dredging project would not likely require a USCOE permit. However, given the size of Cell 2 and the size of the vegetated wetland area around the open water portion of Cell 2, it is expected that material or mats would need to be placed in the wetland to access required dredge areas. It is likely that dredging of Cell 2 would require a USCOE permit.

Based upon other projects similar to this one, it is expected that the proposed diversion project will involve little, if any, grading or excavation within wetlands. It is expected that construction of the diversion pier or walkway will not require a USCOE permit; however, the need for a USCOE permit should be discussed with the USCOE once a preferred alternative has been identified.

4.3 Minnesota Wetland Conservation Act

The Minnesota Wetland Conservation Act (WCA) regulates filling and draining wetlands and excavating within Type 3, 4, and 5 wetlands. In addition, WCA may regulate all types of wetland alteration if any wetland fill is proposed. The WCA is administered by local government units

(LGU), which include: cities, counties, watershed management organizations, soil and water conservation districts, and townships. The City of Golden Valley is the LGU for the proposed project site. The Minnesota Board of Water and Soil Resources (BWSR) oversees administration of the WCA statewide. The proposed dredging project will involve grading or excavation within wetlands. When the preferred project alternative is identified, this impact should be assessed and contact made with the LGU.

4.4 Minnesota Pollution Control Agency (MPCA)

Material excavated below the MNDNR's ordinary high-water level is considered to be dredged material, which is defined as waste and regulated by the MPCA. A guidance document for managing dredged material is available on the MPCA website at:
http://www.pca.state.mn.us/water/dredgedmaterials.html.

Whether a permit is required to dispose of dredged material depends on the volume, quality of the material and the disposal option selected. Because the volume of dredged material from Cell 2 is expected to be less than 3,000 cubic yards, a permit will not like be required but a notification form needs to be sent in to the MPCA 30 days prior to dredging. If the material is contaminated or is suspected of being contaminated, grain size and chemical analysis of the sediment would be required. If the grain size data suggest that the sediment has the potential to be contaminated or the chemical analysis shows that the sediment is contaminated, then the need for a permit will need to discussed with the MPCA.