Final Report

Section 319 and Clean Water Partnership Projects

Grant Project Summary

Project title: Wetland 639W Nutrient Export Reduction

Organization (Grantee): Shingle Creek Watershed Management Commission

Project start date: 10/1/2009 Project end date: 8/29/2014 Report submittal date: 7/22/2014

Grantee contact name: Tina Carstens Title: Chair

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Basin (Red, Minnesota, St. Croix, etc.): Upper Mississippi County: Hennepin

Project type (check one):

- ☐ Clean Water Partnership (CWP) Diagnostic
- ☐ CWP Implementation
- ☐ Total Maximum Daily Load (TMDL) Development
- ☒ 319 Implementation
- ☐ 319 Demonstration, Education, Research
- ☐ TMDL Implementation

Grant Funding

Final grant amount: $299,976.75 Final total project costs: $564,437.79

Matching funds: Final cash: $264,461.04 Final in-kind: $0 Final Loan: $0

Contract number: B42706 MPCA project manager: Rachel Olmanson

For TMDL Development or TMDL Implementation Projects only

Impaired reach name(s):

AUID or DNR Lake ID(s):

Listed pollutant(s):

303(d) List scheduled start date: Scheduled completion date:

AUID = Assessment Unit ID
DNR = Minnesota Department of Natural Resources

Executive Summary of Project (300 words or less)

This summary will help us prepare the Watershed Achievements Report to the Environmental Protection Agency. (Include any specific project history, purpose, and timeline.)

This project's purpose is to reduce phosphorus export from Wetland 27-639W, which is a major external phosphorus source to Impaired Water 27-0042-01, North Twin Lake, which is severely impaired by excess nutrients. North Twin Lake is the first in a chain of connected lakes, and the nutrient-rich outflow from North Twin is the single largest source of phosphorus to the downstream lakes, which are also impaired. A Feasibility Study concluded that the export is primarily caused by drawdown and drying in the wetland through growing season evapotranspiration by the dense cattail vegetation in the central wetland. This drying speeds the conversion of peat to mineral soil. Large precipitation events then sheet flow through the wetland, and the iron-bound phosphorus in the mineralized soil is released and transported through the outlet channel into North Twin Lake. The project constructed a controlled outlet for the wetland, reducing flow-through and increasing storage in the wetland. This keeps the wetland wetter, slowing soil mineralization and reducing the release of phosphorus. A new overflow outlet and channel were constructed on the upstream, west side of the wetland to convey overflow and large events. Followup monitoring was conducted for two seasons following construction, confirming an estimated reduction in total phosphorus export of 250-300 pounds annually.

Goals (Include three primary goals for this project.)

1st Goal: Reduce phosphorus export from Wetland 27-0639W by an average of 300 pounds per year.

2nd Goal:

3rd Goal:

Results that count (Include the results from your established goals.)

1st Result: Post construction monitoring suggests a reduction of 250-300 pounds phosphorus per year

2nd Result:

3rd Result:

Picture (Attach at least one picture, do not imbed into this document.)

Description/location:

Photo 1: Looking west along the new outlet weir on Wetland 639W in Crystal, Minnesota, the Spring after construction, May 2012

Photo 2: Looking south at the new overflow weir discharging into the new overflow channel on Wetland 639W in Crystal, Minnesota, the Spring after construction, May 2012

Acronyms (Name all project acronyms and their meanings.)

Wetland 639W is a wetland located adjacent to the Metropolitan Airports Commission (MAC) Crystal Airport in the cities of Crystal, Brooklyn Center, and Brooklyn Park in Hennepin County, with the DNR Public Waters Inventory number 27-0639W

Shingle Creek WMC, or the Commission, or the SCWMC is the Shingle Creek Watershed Management Commission, a joint powers Watershed Management Organization (WMO)

TAC is the Technical Advisory Committee for the project

TP is Total Phosphorus

Partnerships (Name all partners and indicate relationship to project)

Lead agency is the Shingle Creek Watershed Management Commission, a Joint Powers WMO, in partnership with member cities Crystal, Brooklyn Center, Brooklyn Park, Robbinsdale and New Hope as partial funders and Technical Advisory Committee (TAC) members;

The Minnesota Pollution Control Agency (MPCA) as a partial funder and TAC member;

The Minnesota DNR as a permitting agency and as a TAC member;

The Metropolitan Airports Commission (MAC) as owner of most of the land, which is leased to the cities of Crystal and Brooklyn Center to operate a Nature Preserve; and

The Board of Water and Soil Resources and Hennepin Conservation District as wetland Technical Evaluation Panel (TEP) members and as TAC members.

Section 1 – Work Plan Review

All tasks and activities identified in the Work Plan were completed. Two Work Plan modifications were made. Change Order 1 revised hourly labor rates for some subtasks and reallocated hours between subtasks to reflect actual hours spent. The total contract amount increased slightly to reflect an increase in project cash match. Change Order 2 revised completion dates for certain tasks that were delayed for reasons beyond the contractor's control. There were no changes to the contract amount or the budget.

Objective 1 Design and Construction Engineering

Task 1.1 Final Construction Plans and Specifications. Based on the results of previous monitoring and observation of conditions in the wetland, the previously-completed Feasibility Study recommended option was to construct a controlled outlet. The final design included a long weir along the outlet of the wetland, an overflow weir upstream of the central wetland basin, and a channel in the adjacent upland to convey overflow from the weir to a point downstream of the outlet weir. The final plans and specifications and engineer's estimate were prepared. The project was advertised, bids were opened, and the contract awarded to the lowest responsible bidder. During construction it was determined that an additional overflow would be necessary, and the design was modified to include two relief valves in the outlet weir that could be operated under high water conditions.
Task 1.2 Construction Management. Completed construction observation, reviewed and approved contractor pay requests and change orders, and prepared as-builts.

Objective 2 Complete Improvement Project

Task 2.1 Construction Contract. The project was let in January 2011 and complete in November 2011. Additional work was completed in winter 2013 to extend a short drainage ditch to alleviate seasonal flooding of an adjacent ball field and wood chip trail.

Objective 3 Monitoring

Task 3.1 Flow and Water Quality Monitoring. Post-construction flow and water quality monitoring at the inlet and outlet of the wetland were completed in 2012 and 2013. Additional grab samples and flow estimates were periodically taken in the overflow channel. In addition, water elevation was continuously monitored adjacent to both the primary outlet structure and the overflow outlet structure to estimate frequency and duration of discharge from the wetland.
Task 3.2 Data Interpretation. Monitoring results were compiled and converted to seasonal total phosphorus loads. The results were compared to pre-construction monitoring data to estimate the load reduction achieved by the project.

Objective 4 Prepare and Submit Semiannual Reports

Task 4.1 Semiannual and Final Report. Semiannual reports and the project final report were completed and submitted on a timely basis.

Section II – Grant Results

Measurements

In 1999 the Shingle Creek WMC modeled the watershed draining to Upper Twin Lake, and conducted some limited monitoring of the primary inputs into the lake to help calibrate that model. It was noted that the measured concentration and associated load from the subwatershed draining through Wetland 639W was far higher than the model predicted. The Commission suspected that Wetland 639W, rather than being a sink for total phosphorus was acting as a source. Follow up monitoring in 2002 at the inlet and outlet of the wetland confirmed that the discharge load was far greater than the inflow load. (See Tables 1 and 2.)

In 2008 the Commission received a Section 319 grant from the MPCA to conduct additional monitoring, perform a diagnostic study, and complete a feasibility report detailing options for reducing phosphorus export from the wetland. Analysis of the monitoring data and observation of conditions in Wetland 639W suggested that the likely reason phosphorus is released from the wetland is the de-saturation of the central basin during the summer by the dense cattails that dominate the basin. When groundwater is drawn down, the desaturated soil becomes aerobic, and mineralizes faster than it would were it saturated. Thus, instead of tying up organic phosphorus in slowly decomposing peat, the phosphorus is transformed into an inorganic form that is bound with iron as ferric phosphate. When the soil becomes flooded again, the ferric iron is reduced to more soluble ferrous compounds that are released into the water column and discharged in outflow. The vegetation and soil also become friable, and as stormwater sheet flows across the wetland, the organic material and mineralized soil particles are mobilized and conveyed downstream to Upper Twin Lake.

That feasibility study concluded that the most viable and effective means of mitigating this phosphorus discharge would be to construct a controlled outlet structure to store runoff in the wetland, keeping the soil saturated for longer periods. Because the wetland borders residential areas, an overflow structure and channel would also be necessary to minimize potential for flooding from larger rain and snowmelt events.

This project, Wetland 639W Nutrient Export Reduction, constructed the two new outlet structures and the overflow channel (Figure 1). In addition to the overflow channel, two emergency relief valves were installed in the primary outlet structure. These are exepected to operate only in very wet conditions or in the early spring when there is a large snowpack to melt. The relief valves discharge water from a pool at the downstream end of the wetland. Phosphorus is released from the sediments into the water stored in the pool, so when the relief valves are opened they release nutrient-enriched flow.

Prior to construction and for two years post-construction flow and water quality were monitored at the wetland inflow and outflow as well as in the overflow channel and in a channel downstream of the relief valves. The data in Tables 1 to 4 and Figures 2 and 3 below show that the amount of total phosphorus exported from the wetland depends on the volume of water exported, and whether that discharge is made via the overflow channel or the relief valves. Preconstruction, 2002 was an average precipitation year and 2008 was a dry year. During the monitoring period in 2002, 786 acre-feet of runoff flowed into the wetland at 63rd Avenue N, and 970 acre-feet flowed out. Some of that additional flow was the discharge of water stored in thewetland, some was groundwater, and some was from some small areas of overland flow direct to the wetland. The calculated montioring period TP load coming into the wetland was 263 pounds, while an estimated 725 pounds was discharged to the wetland. During the dry preconstruction year 2008, 277 acre-feet flowed into the wetland, but only 32 acre-feet flowed out. The outlet channel was dry most of the season, as vegetation in the wetland likely evapotranspired most of the runoff discharged into it. As a result, the discharge load was very low, estimated at 24 pounds.

Figure 1. Wetland 639W outlet modification components.

Table 1. Inflow load and concentration to Wetland 639W at 63rd Avenue North for various monitoring periods.

		Precipitation		Flow		Total Phosphorus		Ortho Phosphorus	
Year	Monitoring Period	Monitoring period (inches)	Annual (inches)	Acre-ft	Runoff (inches)	TP (ug/L)	Load (lbs)	OP (ug/L)	Load (lbs)
1999									
2002	5/3 to 10/25	21.27	33.47	786	9.77	123	263	72	154
2008	5/20 to 11/19	10.73	27.10	277	3.44	184	139	103	78
2012	3/28 to 11/16	24.69	30.21	257	3.19	311	217	77	54
2013	4/4 to 10/23	30.92	35.90	127	1.58	207	71	103	36

Note: Concentrations are flow-weighted means.

Table 2. Outflow load and concentration from Wetland 639W for various monitoring periods.

		Precipitation		Flow		Total Phosphorus		Ortho Phosphorus (ug/L)	
Year	Monitoring Period	Monitoring period (inches)	Annual (inches)	Acre-ft	Runoff (inches)	TP (µg/L)	Load (lbs)	OP (µg/L)	Load (lbs)
1999	?	?	27.34	908	7.32	481	1189	?	?
2002	5/4 to 10/25	21.27	33.47	970	7.82	275	725	148	390
2008	5/20 to 9/11	10.73	27.10	32	0.26	271	24	76	7
2012	4/20 to 11/16	22.52	30.21	108	0.87	252	74	142	42
2013	4/4 to 8/28	26.1	35.90	106	0.85	465	134	153	44

Note: Concentrations are flow-weighted means.

Table 3. Outflow load and concentration in the Wetland 639W overflow channel.

	Flow		Total Phosphorus		Ortho Phosphorus	
Year	Acre-ft	Runoff (inches)	TP (µg/L)	Load (lbs)	OP (µg/L)	Load (lbs)
2012	79	?	252	54	142	30
2013	33	?	289	26	110	10

Note: Concentrations are flow-weighted means.

Table 4. Outflow load and concentration discharged from the wetland 639W relief valves.

	Flow		Total Phosphorus		Ortho Phosphorus	
Year	Acre-ft	Runoff (inches)	TP (µg/L)	Load (lbs)	OP (µg/L)	Load (lbs)
2012	29	?	252*	20	142*	11
2013	73	?	545	108	173	34

Note: Concentrations are flow-weighted means.
*No concentration data available, assumed the concentration measured in the overflow channel.

Figure 2. Monitoring season Wetland 639W inflow and outflow TP load.

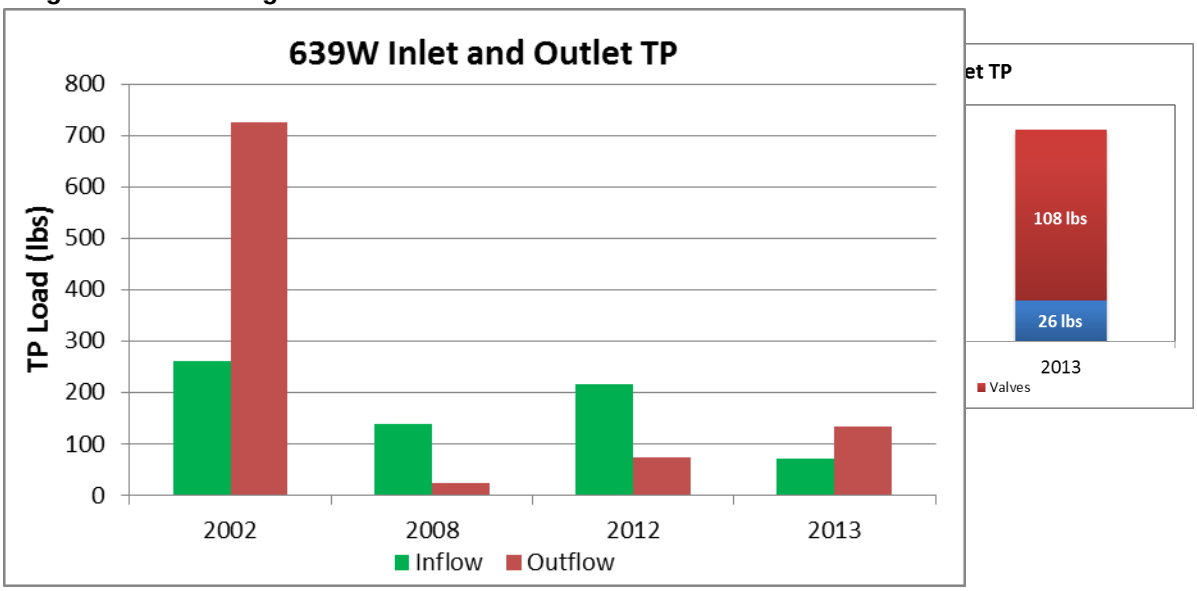

Figure 3. Monitoring season Wetland 639W outlet hydrology and TP load.

Post construction, flow into the wetland is intended to be contained as much as possible in the wetland, both to slow soil mineralization and to limit the outflow of nutrient-rich discharge. In post-construction 2012, the outflow (108 acre-feet) was less than the inflow (257 acre-feet) and the discharge load (74 pounds) was less than the load into the wetland (217 pounds). However, this was not the case in 2013, when the outflow volume was still less than the inflow volume, but the outflow TP load (134 pounds) was greater than the inflow load (71 pounds). The difference resulted from how the overflow channel and relief valves were operated in those two years.

The project was initially designed to discharge mainly from the overflow channel, which is on the upper west end of the wetland and where there is less sediment release of dissolved phosphorus. However, a quirk of topography in the wetland - a slight but significant ridge in the center of the wetland – meant that runoff stored in the east side of the wetland was unable to access the overflow outlet. Water tended to pool on the lower east side, flooding a trail and an adjacent ballfield. The relief valves installed in the outlet structure are intended to relieve that flooding. Heavy spring rains in 2013 filled the wetland storage, and the relief valves were operated to reduce the subsequent flooding. Figure 3 shows the significant difference in volume discharged from the two outlets between 2012 and 2013. In 2013 the majority of the outflow from the wetland was released through the valves. The average TP concentration in outflow through the channel was 289 µg/L, while the concentration of outflow from the valves averaged 545 µg/L. This explains the increase in TP load discharged in 2013.

To minimize the discharge of high TP concentration outflow, a channel extension was completed at the end of 2013 to provide a flowpath across the higher ground to allow pooled storage to flow west to the overflow outlet. This should reduce the amount of time that the relief valves need to be operational, and should further reduce the TP load discharged from Wetland 639W. Even with the relief valves operating, the mass of TP discharged from the wetland during the monitoring period in 2013 was 134 pounds, compared to 725 pounds preconstruction in 2002.

Products

The work products produced include construction project plans and specifications, as-builts, shop drawings, and materials tests; monitoring data, including flow and water quality at the inlet and outlet of the wetland and the overflow channel and continuous elevation data for the pools upstream of each weir; construction photos and logs; and the physical structures themselves.

Public Outreach and Education

Property owners adjacent to the project were invited to an open house prior to completion of the plans and specifications. The open house explained the purpose of the project and expected outcomes, and also discussed potential construction impacts such as noise, traffic, fumes, etc. Articles on the project appeared in city newsletters, and a short news report was produced and aired by Twelve TV, Northwest Community Television, which serves the cities in northwestern Hennepin County.

The outlet modification is a permanent structure and will remain in place indefinitely. The City of Crystal operates the relief valves, and continues to fine-tune operations to minimize the amount of time the valves must be open.

This project, and the feasibility study before it, highlighted the need to look closely at heavily impacted flow-through wetlands as potential sources of phosphorus and sediment to downstream receiving waters.

Final Expenditures

Attached.