MINNEHAHA CREEK
WATERSHED DISTRICT
QUALITY OF WATER, QUALITY OF LIFE

Meeting: Board of Managers
Meeting date: 6/8/2023
Agenda Item #: 12.1
Item type: Board Discussion

Title:	Review Findings and Maintenance Recommendations from MCWD's Stormwater Pond Data Analysis
Prepared by:	Name: Tiffany Schaufler Phone: 952-641-4513 tschaufler@minnehahacreek.org

Purpose:
To review the preliminary findings from Stantec's analysis of the Minnehaha Creek Watershed District's (MCWD) stormwater pond data and outline recommendations for future stormwater pond maintenance planning and budgeting.

Background:
The MCWD constructed its first stormwater pond in 1985. Since 1985, MCWD has constructed 26 stormwater ponds across the watershed. MCWD is responsible for the inspection and/or maintenance of these 26 stormwater ponds through ownership or cooperative agreement with its partner communities. Inspection and maintenance of these facilities is necessary to ensure that the ponds function as designed and continue to accrue their designed water resource benefit. The MCWD Board of Managers has an established policy that dictates cyclical investigation and maintenance of its stormwater management infrastructure to ensure long term water quality and water quantity function of the systems.

In 2010, the Project Maintenance and Land Management (PMLM) Program recommended pond sediment surveys of six to eleven ponds each year on a three-year rotation in order to adhere to the policy established by the Board. To conduct this work, the PMLM program budgeted annually to perform sediment surveys on a certain number of ponds. Since 2010, Stantec (formerly Wenck) has performed over 90 sediment surveys on the 26 stormwater ponds that MCWD is responsible for inspecting and/or maintaining. Generally, this means that each stormwater pond has been surveyed by Stantec three or four times over the past 12 years and has resulted in a considerable dataset that can be used to inform pond performance, sediment accumulate rates, estimated survey needs, estimated cleanout years, and estimated cleanout costs for each stormwater pond.

Summary:
In July 2022, the Board authorized a contract with Stantec to analyze MCWD's stormwater pond dataset and use it to develop a data-driven and predictive approach to stormwater pond maintenance for the PMLM program. At the June 8, 2023 Board of Manager's meeting, staff will review the preliminary findings from Stantec's data analysis, how the findings are being used to develop a 20-year Stormwater Pond Maintenance Plan, and proposed next steps.

Additionally, At the June 8, 2023 Board of Mangers meeting, PMLM staff will be bringing forward a Request for Board Action to release a request for proposals for engineering and design services for 2023-2024 stormwater pond survey maintenance, which will begin to implement the recommendations from the Stormwater Pond Maintenance Plan.

Supporting documents (list attachments):
- **DRAFT Memo, Task 1: Pond Data Review**
- **DRAFT Memo, Task 2: Pond Inventory and Maintenance Planning**
- **DRAFT memo, Task 3: Retrofit Opportunities**

Stantec

DRAFT - Memo

To:	Tiffany Schaufler MCWD	From:	Ali Stone Stantec
Project/File:	227703703	Date:	January 11, 2022

Reference: MCWD Stormwater Pond Capital Improvement Planning | Task 1: Pond Data Review

Objective

Minnehaha Creek Watershed District (MCWD) is seeking to understand the basis of design for the 26 stormwater ponds owned and maintained by the District, then evaluate these ponds for which is working. Stantec has reviewed and compiled historic data for these ponds. The District provided data sources included: a GIS database with TSS, TP, impervious and permitting information, a historic O&M manual, and a historic survey and sedimentation tracking spreadsheet (primarily informed from Stantec, historically Wenck surveys). Additional resources used were historic basin analysis memos and record plans.

From the GIS database provided by MCWD, Stantec summarized the following:

- Subwatershed Drainage Areas
- Pond Drainage Areas
- Changes in impervious cover, TSS, and TP loading from 2000 to 2020
- Permits Issued per year

From the historic survey and sedimentation tracking spreadsheet, Stantec identified and summarized the following:

- Pond Dead Volume
- Sedimentation rates
- Years of increased/decreased sedimentation
- Dredging years

From the District provided “2000 O&M Plan” Stantec identified the following:

- Design intent for ponds
- Historic pollutant monitoring data

Historic basin analysis memos and record plans provided additional information. Stantec organized the data by subwatershed as broken down in MCWD’s historic sedimentation tracking spreadsheet and GIS database. The attached appendix contains the summary for six Subwatersheds within MCWD as well as a summary for each individual pond and its contributing area.

Reference: MCWD Stormwater Pond Capital Improvement Planning

Methods / Limitations

Stantec summarized impervious, TSS and TP data for each subwatershed and pondshed of interest using MCWD's GIS file. This data is displayed in tables that show changes between 2000 and 2020.

In addition, for each pondshed, Stantec determined the quantity of permit applications submitted per year and generated a boxplot. Permits are taken to be a proxy for land disturbing activities. Years with more permits than the 75th percentile are called out as years with a high quantity of permit applications. Years with less permits than the 25th percentile are called out as years with a low quantity of permit applications. Some ponds have larger watershed areas and/or or experience more development than others. The years identified as increased and decreased development are relative to the pondshed for each pond, not to each other.

It's important to address the inherent weaknesses of using this dataset as a proxy for development:

- Permit applications sometimes bypass the districts permitting process and get sent directly the local municipalities holding joint authority over the permitting.
- The available data only provides the year each permit was submitted. It does not account for other factors such as timespan of construction, plot size, or disturbed area; all of which would contribute to potential sediment released downstream.
- It is our understanding that the MCWD permitting GIS database is more comprehensive for recent years than historic years.

Similarly, Stantec compiled the data for sedimentation within each of the ponds and summarized the sediment accumulation rate over the years. Some ponds were consistent in their sedimentation rates, others were not. Because of the limited amount of data points for sedimentation rate in each pond, classifying years of increased and decreased accumulation was more subjective. This is a limitation due to dataset size. Generally, if the pond had a stretch of years with a sedimentation rate more or less than 2 percentage points compared to other years, it was called out as a timespan of increased or decreased sediment accumulation.

Sections for Design Intent and Monitoring Data summarize information within the District's 2000 O&M Plan. The section for Sediment Accumulation and Dredging Data use the summary spreadsheet provided by the District and describe what has occurred within each of the pond over the course of its lifespan. This data was also confirmed with Wenck sedimentation assessment reports.

Thank you,

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DRAFT - Memo

To:	Tiffany Schaufler Josh Wolf MCWD	From:	Ali Stone Chris Meehan Stantec
Project/File:	227703703	Date:	May 22, 2023

Reference: MCWD Stormwater Pond Capital Improvement Planning | Task 2: Pond Inventory and Maintenance Planning

Objective

Minnehaha Creek Watershed District (MCWD or District) is seeking to understand the performance of 29 (multi-cell ponds at Bde Maka Ska, Cedar Meadows, and Deer Hill were separated as an individual pond) stormwater ponds; 25 are owned and maintained by the District, 2 are maintained by the City of Wayzata, 1 is maintained by the City of Minneapolis and 3 are maintained jointly between MCWD and the City of Edina. Stantec has reviewed the sedimentation rates for these ponds and compared them to expected rates as determined by the Minnesota Stormwater Manual. Stantec has classified ponds as performing, underperforming, and not performing. For the ponds that are anticipated to reach 50% of the permanent pool volume within the next 20 years, a budgetary layout was generated for the dredging cost anticipated each year and recommended survey dates.

The attached appendix A contains the summary of historical data and future recommendations for each pond within MCWD. It also serves as an overview of pond sedimentation rates and identifies which ponds are accumulating sediment within the anticipated range.

Methods / Limitations

Classification of Pond Performance

Stantec has assumed that each of the ponds was designed according to the Minnesota Stormwater manual to appropriately size the permanent pool volume to the drainage area.

Stantec used expected accumulation guidance from the Minnesota Stormwater Manual to estimate annual accumulation rates for three categories of ponds: Single Cell System (without Pretreatment), Multi-Cell System (First Cell) and Multi-Cell System (Downstream Cells). The anticipated annual accumulation rates for each are listed below. A copy of assumptions and calculations can be found in Appendix B. Anticipated sediment accumulation ranges were rounded to the nearest 0.5%.

- Single Cell System (without Pretreatment) – 2-4% per year
- Multi-Cell System (First Cell) – 3-7.5% per year
- Multi-Cell (Downstream Cells) – 1.5-3% per year

Stantec used the compiled data from Task 1 to determine the average sedimentation rate within each of the ponds over its lifetime. This was done by calculating the sedimentation rate from the time of construction (or most recent dredging event) to the next dredging event. If a pond had been dredged multiple times, the average of the sediment accumulation rates over each cycle was taken. This was to minimize the impact of wet and dry year cycles. Some ponds were consistent in their sedimentation rates, others were not. Due to the limited size of the dataset, no definitive conclusions can be made for how a wet or dry year impacts sedimentation. This is a limitation due to dataset size. To best predict future dredging, taking the average lifespan accumulation rate is the best predictor as it generally considers wet, dry, and normal years.

Budgetary Cost Estimates

Historic Bid tabs for Stantec's sediment removal projects within the last four years were used to determine project cost per cubic yard of sediment removal, scaled by the quantity of sediment removed for each project. It was found that the cost for sediment removal decreases as the volume of required removal increases, due to construction efficiencies. A line of best fit was generated based on historic project costs and was used to estimate costs for each of the 29 ponds based on the amount of sediment that is predicted to be removed from each. The compound interest formula was applied to each cost estimate to consider annually compounding inflation (1.02%) and estimate cost in terms of the year each pond is predicted to be dredged.

Based on MPCA Stormwater Manual Guidance, it is assumed that ponds will be dredged when they reach 50% of the permanent pool volume. A limitation of these cost estimates is that ponds may be slightly more or less full when they are actually dredged. The estimates provided in this report are high-level and are intended for budgetary purposes only. As MCWD completes additional dredging projects, we recommend that project costs be tracked and used to update estimates.

A full summary of methods and equations used can be found in Appendices C and D.

Results

The results of the pond classification and budgetary cost estimates are compiled in the accompanying spreadsheet, a description the spreadsheet is included in Appendix C. Pond performance groupings are also summarized below.

The following ponds were classified as Performing:

- Excelsior
- Nokomis Amelia
- Bde Maka Ska Cell 1
- Pamela Cell 1
- Twin Lake Park
- Long Lake Park North
- Gleason 1
- Gleason 2
- Gleason 3
- Steiger

The following ponds were classified as Underperforming:
(within 0.5% of the lower range of expected sedimentation)

- Cedar Meadows West
- Cedar Meadows East
- Bde Maka Ska Cell 2
- Pamela Cell 2
- Long Lake Park South
- Glenbrook
- Lakeside
- Johnson/Rolling Hills

The following ponds were classified as Not Performing:

- 60^{th} & 1^{st}
- Nokomis Gateway
- Nokomis Knoll
- Pamela Cell 3
- County Rd 6
- Deer Hill North
- Deer Hill South
- Gideon Glean
- Swan
- Painters Marsh
- Katrina

Recommendations

Stantec recommends continuing sediment surveys on the performing and underperforming ponds. Since industry practices recommends sediment removal when ponds reach 50% full, we recommend completing sediment surveys when ponds are projected to reach 40% and 50% full. This survey frequency will allow for a checkup on each pond as capacity is approached, to verify whether the pond is nearing or ready for maintenance. A survey schedule has been developed and is provided within the accompanying spreadsheet. Survey dates can and should be adjusted based on survey data as it is collected. We do not recommend continuing to survey ponds that are categorized as not performing, as previous monitoring has shown minimal sediment accumulation and these ponds are not expected to reach 50% of the permanent pool volume within the next 20 years.

The next step is to identify possible retrofit opportunities to further maximize benefits from ponds that are classified as performing.

Pond Information

Pond ID	Watershed	Drains To	Pond Volume (CY)	Year Built	Dredging History	Likely Contaminated?	Reposonsibe for Dredging Cost	Pond Type	Most Recent Percent Full	Most Recent Survey Year	Range of Accumulation Rates	Lifetime Sediment Accumulation Rate (%/yr)	Estimated Cleanout Date	Current Year	Estimated Current % Full	Is it performing as expected?	Accumulation compared to expectation
60th & 1st	Minnehaha Creek	Diamond Lake	21,045	2000		Y	Minneapolis	Single Cell	12%	2020	0.6%	0.6%	2083	2023	14%	Not performing	Underaccumulating
Cedar Meadows West	Minnehaha Creek	Cedar Meadows East	13,000	1996	2004 (2750 CY, 21%)	Y	MCWD	Multi Cell (First Cell)	18%	2020	1.1-2.6%	1.9%	2037	2023	24%	Underperforming	Underaccumulating
Cedar Meadows East	Minnehaha Creek	Cedar Lake	5,710	1996		Y	MCWD	Multi Cell (Downstream Cell)	38%	2020	1.6%	1.6%	2028	2023	43%	Underperforming	On Target
Excelsior	Minnehaha Creek	Minnehaha Creek - Meadowbrook La	2,385	2013		N	MCWD	Single Cell	16%	2019	0.7-4.7%	2.7%	2032	2023	27%	Performing	On Target
Nokomis - Amelia	Minnehaha Creek	**Nokomis**	**22,247**	2001	2010/11 (2147 CY, 10%)	N	**MCWD**	**Single Cell**	**36%**	**2019**	**1.4-4.9%**	**3.0%**	**2024**	**2023**	48%	Performing	**On Target**
Nokomis - Gateway	Minnehaha Creek	Lake Nokomis	5,516	2001		Y	MCWD	Single Cell	6%	2019	0.2-0.8%	0.3%	2166	2023	7%	Not performing	Underaccumulating
Nokomis - Knoll	Minnehaha Creek	Lake Nokomis	6,743	2001		Y	MCWD	Single Cell	16%	2019	0-1.1%	0.9%	2057	2023	20%	Not performing	Underaccumulating
Bde Maka Ska Cell 1	Minnehaha Creek	Bde Maka Ska Cell 2	4,980	1999	2004 (3120 CY, 63%), 2011/12 (2024 CY, 41%), 2018/19 (2000, 41%	N	MCWD	Multi Cell (First Cell)	19%	2021	3.8-9.5%	8.0%	**2025**	**2023**	35%	Performing	Overaccumulating
Bde Maka Ska Cell 2	Minnehaha Creek	Bde Maka Ska Cell 3	12,690	1999	2004 (N/A)	Y	MCWD	Multi Cell (Downstream Cell)	22%	2020	1.4%	1.4%	2040	2023	26%	Underperforming	Underaccumulating
Bde Maka Ska Cell 3	Minnehaha Creek	Bde Maka Ska															
Pamela Cell 1	Minnehaha Creek	Pamela Cell 2	3,550	2001	2019 (1800, 51%)	N	Edina for first dredge then MCWD, MCWD next	Multi Cell (First Cell)	19%	2021	2.6-9.5%	6.5%	2026	2023	32%	Performing	On Target
Pamela Cell 2	Minnehaha Creek	Pamela Cell 3	3,580	2001		Y	Edina for first dredge then MCWD, Edina Next	Multi Cell (Downstream Cell)	30%	2021	0-5.7%	1.5%	2034	2023	33%	Underperforming	Variable, On Target
Pamela Cell 3	Minnehaha Creek	Lake Pamela	4,640	2001		Y	Edina for first dredge then MCWD, Edina Next	Multi Cell (Downstream Cell)	15%	2021	0-4.7%	0.8%	2065	2023	17%	Not performing	Variable, Underaccumulating
Twin Lake Park	Minnehaha Creek	**Twin Lakes**	**6,840**	1996	2004 (3403, 50%), 2012 (2080, 30%	Y	**MCWD**	**Single Cell**	**42%**	**2021**	**1-8%**	**5.6%**	**2022**	**2023**	53%	Performing	**Overaccumulating**
County Rd 6	Long Lake Creek	Long Lake	19,602	1998		Y	MCWD	Single Cell	10%	2019	0.6-1.3%	0.5%	2099	2023	12%	Not performing	Underaccumulating
Deer Hill North	Long Lake Creek	Deer Hill South	9,430	1996		Y	MCWD	Multi Cell (First Cell)	5%	2018	0.2%	0.2%	2243	2023	6%	Not performing	Underaccumulating
Deer Hill South	Long Lake Creek	County Rd 6 Pond	28,289	1996		Y	MCWD	Multi Cell (Downstream Cell)	0%	2018	0%	0.0%		2023	0%	Not performing	Underaccumulating
Long Lake Park North	Long Lake Creek	**Long Lake South**	**4,930**	1996	2004 (2410, 49%)	Y	**MCWD**	**Multi Cell (First Cell)**	**35%**	**2020**	**2-7%**	**4.1%**	**2024**	**2023**	47%	Performing	**On Target**
Long Lake Park South	Long Lake Creek	Long Lake	2,510	1996		Y	MCWD	Multi Cell (Downstream Cell)	30%	2020	1.9-3%	2.1%	2030	2023	36%	Underperforming	Variable, On Target
Gleason Lake 1	Gleason Lake Creek	**Gleason Lake 2**	**1,520**	1995	2012 (900, 59%)	N	**MCWD**	**Multi Cell (First Cell)**	**38%**	**2021**	**0.3-6.2%**	**3.9%**	**2024**	**2023**	46%	Performing	**On Target**
Gleason Lake 2	Gleason Lake Creek	Gleason Lake 3	1,050	2008	2016 (892, 40%)	Y	MCWD	Multi Cell (Downstream Cell)	17%	2021	1-8.1%	4.2%	2029	2023	25%	Performing	Variable, Overaccumulating
Gleason Lake 3	Gleason Lake Creek	Gleason Lake	1,160	2008		Y	MCWD	Multi Cell (Downstream Cell)	25%	2021	4.3-9.7%	5.0%	2026	2023	35%	Performing	Variable, Overaccumulating
Glenbrook	Gleason Lake Creek	Lake Minnetonka - Wayzata Bay	24,848	1994	2017/18 (16000, 64%)	N	MCWD	Single Cell	0%	2017	2%	2.0%	2042	2023	12%	Underperforming	Underaccumulating
Lakeside	Lake Minnetonka	**Lake Minnetonka - Wayzata Bay**	**4,868**	1994		Y	**Wayzata**	**Single Cell**	**42%**	**2014**	**1.9-3%**	**2.1%**	**2018**	**2023**	61%	Underperforming	**Underaccumulating**
Gideon Glen	Lake Minnetonka	Lake Minnetonka - Gideon Bay	1,965	2006		Y	Wayzata	Single Cell	9%	2019	0.3-0.8%	0.7%	2078	2023	12%	Not performing	Underaccumulating
Swan	Lake Minnetonka	Lake Minnetonka - Stubbs Bay	15,800	2008		Y	MCWD	Single Cell	13%	2020	0.8-3.5%	1.1%	2054	2023	16%	Not performing	Underaccumulating
Johnson/Rolling Hills	Painters Creek	Painters Creek	625	2008		Y	MCWD	Single Cell	29%	2021	0-3%	1.5%	2035	2023	32%	Underperforming	Underaccumulating
Painters Marsh	Painters Creek	Painters Creek	46,800	1985		Y	MCWD	Single Cell	18%	2020	0-0.8%	0.5%	2084	2023	20%	Not performing	Underaccumulating
Katrina	Painters Creek	Painters Marsh	4,210	1985		Y	MCWD	Single Cell	25%	2021	0.3-4%	0.7%	2057	2023	26%	Not performing	Underaccumulating
Steiger	Six Mile Creek	**Steiger Lake**		1988		Y	**MCWD**	**Single Cell**	**75%**	**2015**	**2.8%**	**2.8%**	**2006**	**2023**	97%	Performing	**On Target**

Key	Definition	Quantity of ponds in category
Performing	On Target, Overaccumulating	10
Underperforming	Underaccumulating, within 0.5% of low end of expected range*	8
Not performing	Underaccumulating	11

darker shade when variable

*Cedar Meadows is underaccumulating 1.3% less than expected but classified as underperforming because we believe MCWD should continue to monitor and dredge approximately every 25 years

Normal

Requires attention

Requires immediate attention

Pond Survey Schedule

Pond ID	Is it performing as expected?	Most Recent Percent Full	Most Recent Survey Year	Lifetime Sediment Accumulation Rate (%/yr)	Estimated Cleanout Date	Current Year	Estimated Current % Full	Pond Volume (CY)	Year Built	MCWD Pays?	Likely Contaminated?	Anticipated Cost/CY	Estimated 40% Year	Estimated 50% Year	Years between surveys
60th & 1st	Not performing	12%	2020	0.6%	2083	2023	14%	21,045	2000	N	Y	$ 48	2067	2083	17
Cedar Meadows West	Underperforming	18%	2020	1.9%	2037	2023	24%	13,000	1996	Y	Y	$ 70	2032	2037	5
Cedar Meadows East	Underperforming	38%	2020	1.6%	2028	2023	43%	5,710	1996	Y	Y	$ 107	2021	2028	6
Excelsior	Performing	16%	2019	2.7%	2032	2023	27%	2,385	2013	Y	N	$ 148	2028	2032	4
Nokomis - Amelia	Performing	36%	2019	3.0%	2024	2023	48%	22,247	2001	Y	N	$ 45	2020	2024	3
Nokomis - Gateway	Not performing	6%	2019	0.3%	2166	2023	7%	5,516	2001	Y	Y	$ 109	2132	2166	33
Nokomis - Knoll	Not performing	16%	2019	0.9%	2057	2023	20%	6,743	2001	Y	Y	$ 100	2046	2057	11
Bde Maka Ska Cell 1	Performing	19%	2021	8.0%	2025	2023	35%	4,980	1999	Y	N	$ 114	2024	2025	1
Bde Maka Ska Cell 2	Underperforming	22%	2020	1.4%	2040	2023	26%	12,690	1999	Y	Y	$ 71	2033	2040	7
Bde Maka Ska Cell 3															
Pamela Cell 1	Performing	19%	2021	6.5%	2026	2023	32%	3,550	2001	Y	N	$ 129	2024	2026	2
Pamela Cell 2	Underperforming	30%	2021	1.5%	2034	2023	33%	3,580	2001	N	Y	$ 129	2028	2034	7
Pamela Cell 3	Not performing	15%	2021	0.8%	2065	2023	17%	4,640	2001	N	Y	$ 117	2052	2065	13
Twin Lake Park	Performing	42%	2021	5.6%	2022	2023	53%	6,840	1996	Y	Y	$ 99	2021	2022	2
County Rd 6	Not performing	10%	2019	0.5%	2099	2023	12%	19,602	1998	Y	Y	$ 51	2079	2099	20
Deer Hill North	Not performing	5%	2018	0.2%	2243	2023	6%	9,430	1996	Y	Y	$ 84	2193	2243	50
Deer Hill South	Not performing	0%	2018	0.0%		2023	0%	28,289	1996	Y	Y	$ 34			
Long Lake Park North	Performing	35%	2020	4.1%	2024	2023	47%	4,930	1996	Y	Y	$ 114	2021	2024	2
Long Lake Park South	Underperforming	30%	2020	2.1%	2030	2023	36%	2,510	1996	Y	Y	$ 145	2025	2030	5
Gleason Lake 1	Performing	38%	2021	3.9%	2024	2023	46%	1,520	1995	Y	N	$ 168	2022	2024	3
Gleason Lake 2	Performing	17%	2021	4.2%	2029	2023	25%	1,050	2008	Y	Y	$ 185	2026	2029	2
Gleason Lake 3	Performing	25%	2021	5.0%	2026	2023	35%	1,160	2008	Y	Y	$ 181	2024	2026	2
Glenbrook	Underperforming	0%	2017	2.0%	2042	2023	12%	24,848	1994	Y	N	$ 40	2037	2042	5
Lakeside	Underperforming	42%	2014	2.1%	2018	2023	61%	4,868	1994	N	Y	$ 115	2013	2018	5
Gideon Glen	Not performing	9%	2019	0.7%	2078	2023	12%	1,965	2006	N	Y	$ 156	2063	2078	14
Swan	Not performing	13%	2020	1.1%	2054	2023	16%	15,800	2008	Y	Y	$ 61	2045	2054	9
Johnson/Rolling Hills	Underperforming	29%	2021	1.5%	2035	2023	32%	625	2008	Y	Y	$ 209	2028	2035	7
Painters Marsh	Not performing	18%	2020	0.8%	2060	2023	20%	46,800	1985	Y	Y	$ 11	2048	2060	13
Katrina	Not performing	25%	2021	0.7%	2057	2023	26%	4,210	1985	Y	Y	$ 121	2042	2057	14
Steiger	Performing	75%	2015	2.8%	2006	2023	97%	5,194	1988	Y	Y	$ 112	2003	2006	4

Dredging Projections by Pond

Pond ID	Is it performing as expected?	Time to reach 50% full after dredged (yr)	Estimated 1st Dredge Year	Estimated Probable Cost of Dredging	Estimated 2nd Dredge Year	Estimated Probable Cost of Dredging	Estimated 3rd Dredge Year	Estimated Probable Cost of Dredging
60th & 1st	Not performing	83						
Cedar Meadows West	Underperforming	26	**2037**	$ 610,000				
Cedar Meadows East	Underperforming	31	**2028**	$ 346,000				
Excelsior	Performing	19	**2032**	$ 214,000				
Nokomis - Amelia	Performing	17	**2024**	$ 522,000	**2041**	$ 731,000		
Nokomis - Gateway	Not performing	167						
Nokomis - Knoll	Not performing	56						
Bde Maka Ska Cell 1	Performing	6	**2025**	$ 301,000	**2031**	$ 339,000	**2037**	$ 381,000
Bde Maka Ska Cell 2	Underperforming	36	**2040**	$ 642,000				
Bde Maka Ska Cell 3								
Pamela Cell 1	Performing	8	**2026**	$ 248,000	**2034**	$ 291,000	**2042**	$ 341,000
Pamela Cell 2	Underperforming	33	**2034**	$ 293,000				
Pamela Cell 3	Not performing	63						
Twin Lake Park	Performing	9	**2024**	$ 353,000	**2033**	$ 422,000	**2042**	$ 504,000
County Rd 6	Not performing	100						
Deer Hill North	Not performing	250						
Deer Hill South	Not performing							
Long Lake Park North	Performing	12	**2024**	$ 293,000	**2036**	$ 371,000		
Long Lake Park South	Underperforming	24	**2030**	$ 213,000				
Gleason Lake 1	Performing	13	**2024**	$ 133,000	**2037**	$ 172,000		
Gleason Lake 2	Performing	12	**2029**	$ 112,000	**2041**	$ 142,000		
Gleason Lake 3	Performing	10	**2026**	$ 113,000	**2036**	$ 138,000		
Glenbrook	Underperforming	25	**2042**	$ 739,000				
Lakeside	Underperforming	24	**2023**	$ 285,000				
Gideon Glen	Not performing	71	**2024**	$ 160,000				
Swan	Not performing	45						
Johnson/Rolling Hills	Underperforming	33	**2035**	$ 84,000				
Painters Marsh	Not performing	63						
Katrina	Not performing	71						
Steiger	Performing	18	**2023**	$ 296,000	**2041**	$ 423,000		

Key
Maintenance of ponds listed in yellow are to be paid for by another entity

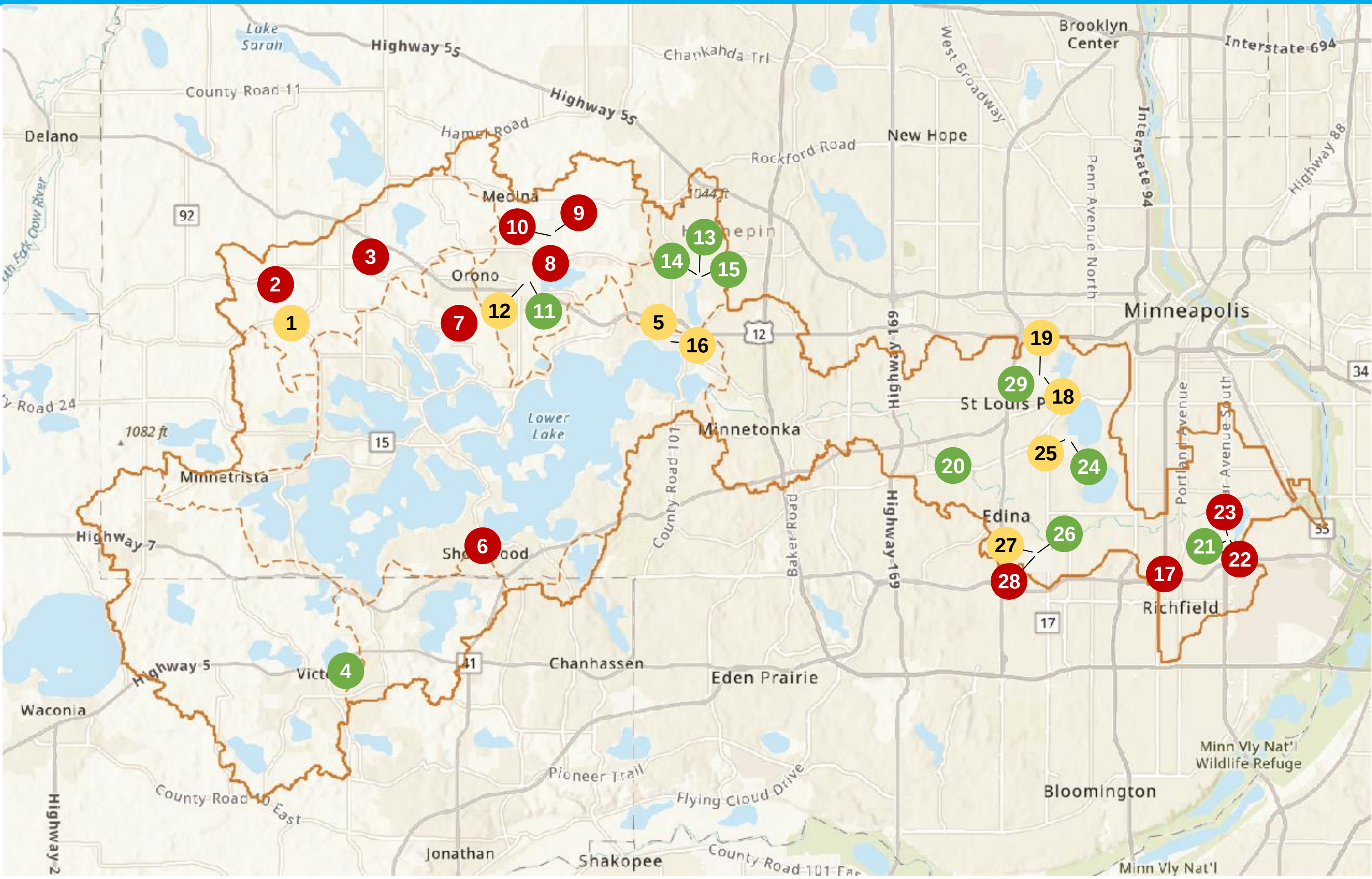
Probable Dredging Costs by Year

Year	Dredging Cost (Probable), considering only ponds for which MCWD is responsible for maintenance costs	Ponds to be Dredged
2023	$ 296,000	Twin Lake Park, Lakeside, Steiger
2024	$ 1,301,000	Nokomis - Amelia, Long Lake North, Gleason Cell 1
2025	$ 301,000	Bde Maka Ska Cell 1
2026	$ 361,000	Pamela Cell 1
2027	$ -	
2028	$ 346,000	Cedar Meadows East
2029	$ 112,000	Gleason Cell 2
2030	$ 213,000	Long Lake Park South
2031	$ 339,000	Bde Maka Ska Cell 1, Twin Lake Park
2032	$ 214,000	Excelcier, Twin Lake Park
2033	$ 422,000	Pamela Cell 1
2034	$ 291,000	Pamela Cell 1, Pamela Cell 2
2035	$ 84,000	Johnson/Rolling Hills
2036	$ 509,000	Long Lake Park North, Gleason Cell 3
2037	$ 1,163,000	Cedar Meadows West, Gleason Cell 1, Bde Maka Ska Cell 1
2038	$ -	
2039	$ -	
2040	$ 642,000	Nokomis - Amelia, Bde Maka Ska Cell 1, Twin Lake Park
2041	$ 1,296,000	Pamela Cell 1, Gleason Cell 2, Steiger
2042	$ 1,584,000	Glenbrook, Pamela Cell 1
Total	**$ 9,474,000**	
Average Annual	**$ 473,700**	

**note that these are predictions using the best available data, other factors including development and wet/dry years may impact dates

dollars account for inflation, and are presented in terms of the respective value in each respective year

Pond Sedimentation



Performing | Underperforming | Not performing

Painter Creek

1. Johnson/Rolling Hills
2. Painters Marsh
3. South Katrina Pond

Six Mile Creek

4. Steiger Wetland Pond

Lake Minnetonka

5. Lakeside Pond
6. Gideon Glen
7. Swan Lake

Long Lake Creek

8. County Road 6 Pond
9. Deer Hill Pond – North
10. Deer Hill Pond – South
11. Long Lake Park – North
12. Long Lake Park - South

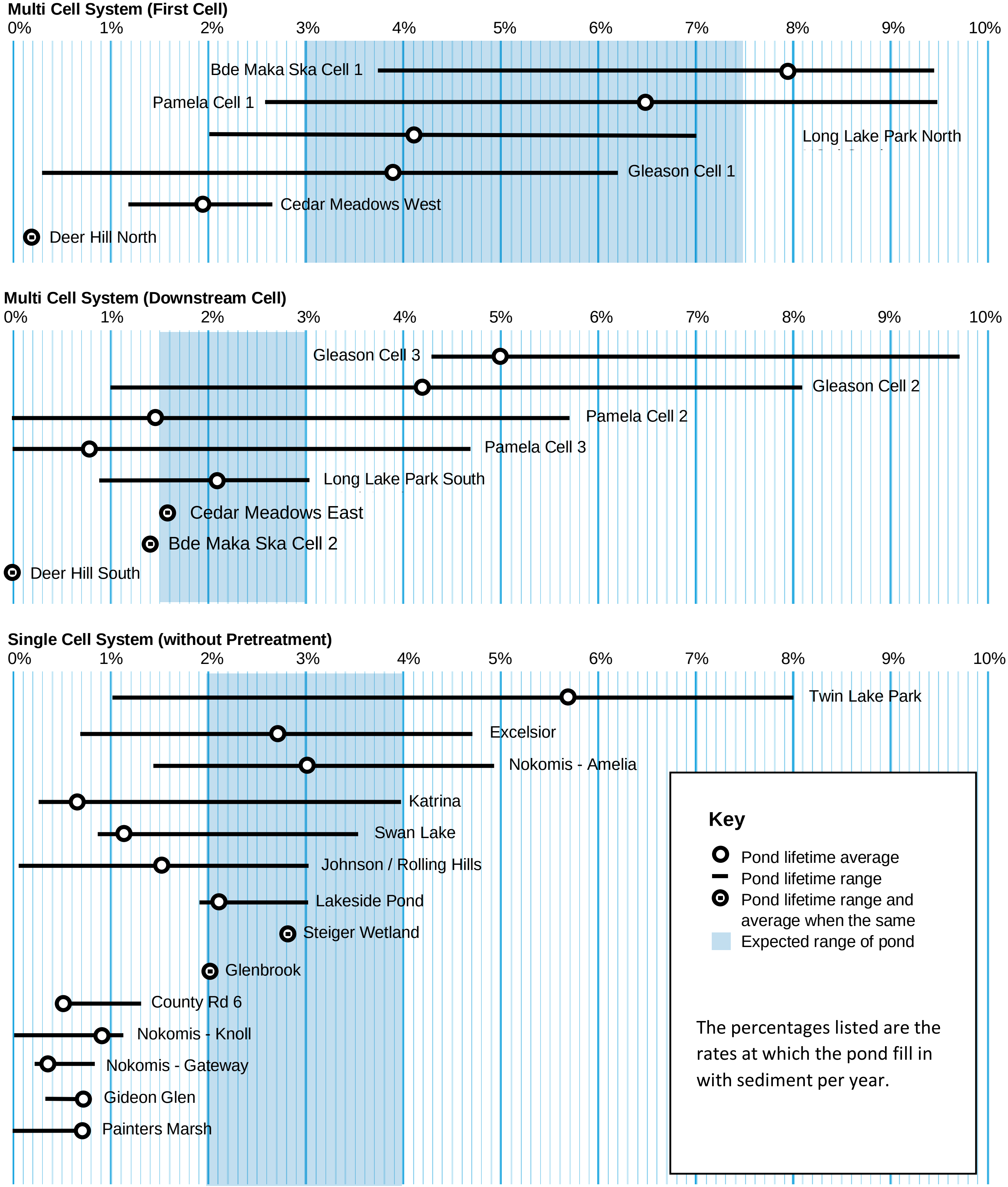
Gleason Lake Creek

13. Gleason Lake North – Pond 1
14. Gleason Lake North – Pond 2
15. Gleason Lake North – Pond 3
16. Glenbrook Pond

Minnehaha Creek

17. 60th and 1st Pond
18. Cedar Meadows – Basin 1 (W)
19. Cedar Meadows – Basin 2 (E)
20. Excelsior Pond
21. Nokomis – Amelia
22. Nokomis – Gateway
23. Nokomis – Knoll
24. SW Bde Maka Ska – Cell 1
25. SW Bde Maka Ska – Cell 2
26. Pamela Park – Cell 1
27. Pamela Park – Cell 2
28. Pamela Park – Cell 3
29. Twin Lakes Park Pond

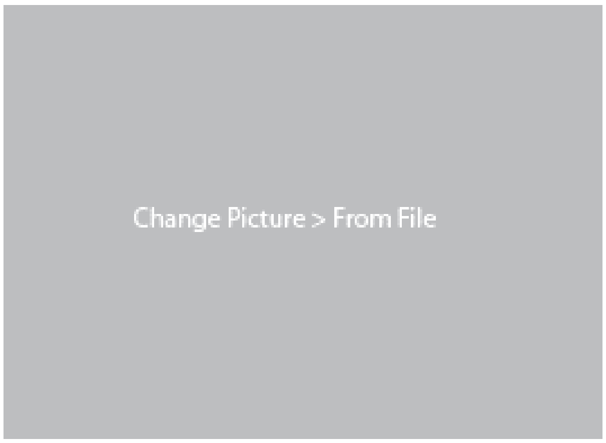
Expected and Observed Annual Sediment Accumulation Rates



Pond

1. Johnson / Rolling Hills

Drainage Area: 195 acres
Pond Volume: 0.4 AC-FT
Year Constructed: 2008



Design Intent:
Designed to capture sediment from runoff from the nearby development and gravel road (Rolling Hills Drive) before entering the onsite wetlands. The forebay will require maintenance when 50% of the pool is filled.

Monitoring Data:
No Monitoring.

Sediment Accumulation:
- 2008-2015: 3.0% per year
- 2015-2018: 1.7% per year
- 2018-2021: 0.0% per year

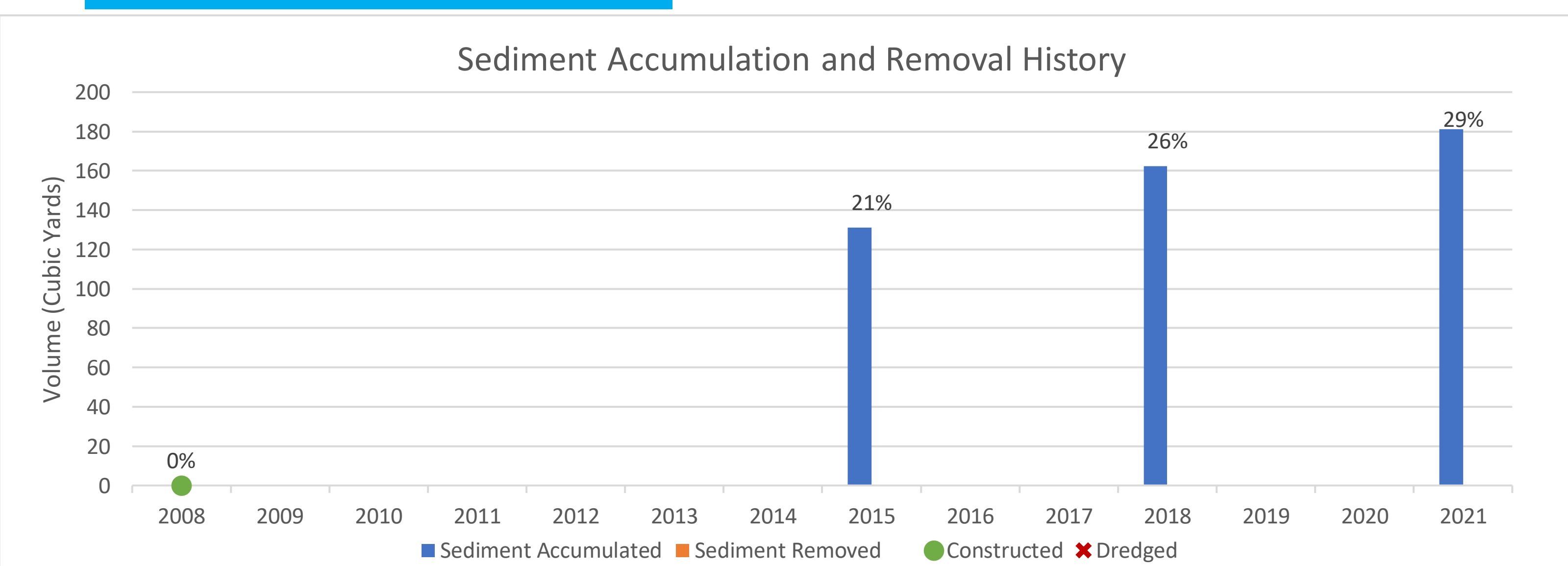
Dredging Data:
- Johnson has not been dredged since it was constructed in 2008. It was 29% full in the most recent survey conducted in 2021.

Status & Recommendations:

Underperforming
- 32% Full

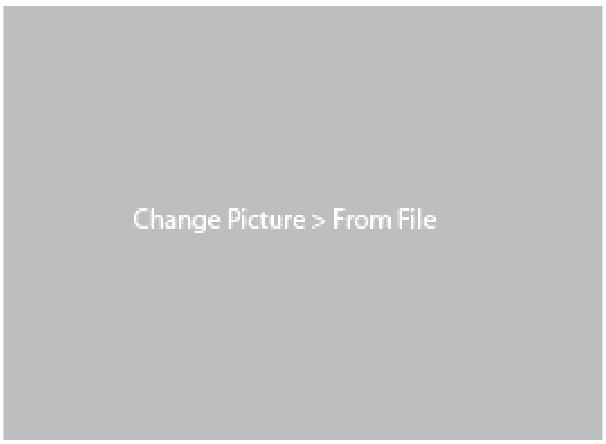
Continue Sediment Surveys
- Next Survey: 2028

Estimated Dredging: 2035
- Estimated CY to be removed: 315
- Estimated Cost: $84,500



2. Painters Marsh Pond

Drainage Area: 7,950 acres (3,600 not treated by Katrina)
Pond Volume: 29 AC-FT
Year Constructed: 1985



Design Intent:
Painters Marsh Pond was dredged and expanded in 1997 to make improvements to the sediment basin originally constructed in 1984 and 1985. This project was focused on restoring flood capacity and increasing water treatment potential.

Monitoring Data:
No Monitoring.

Sediment Accumulation:

- 1997-2020: 0.8% per year

Dredging Data:

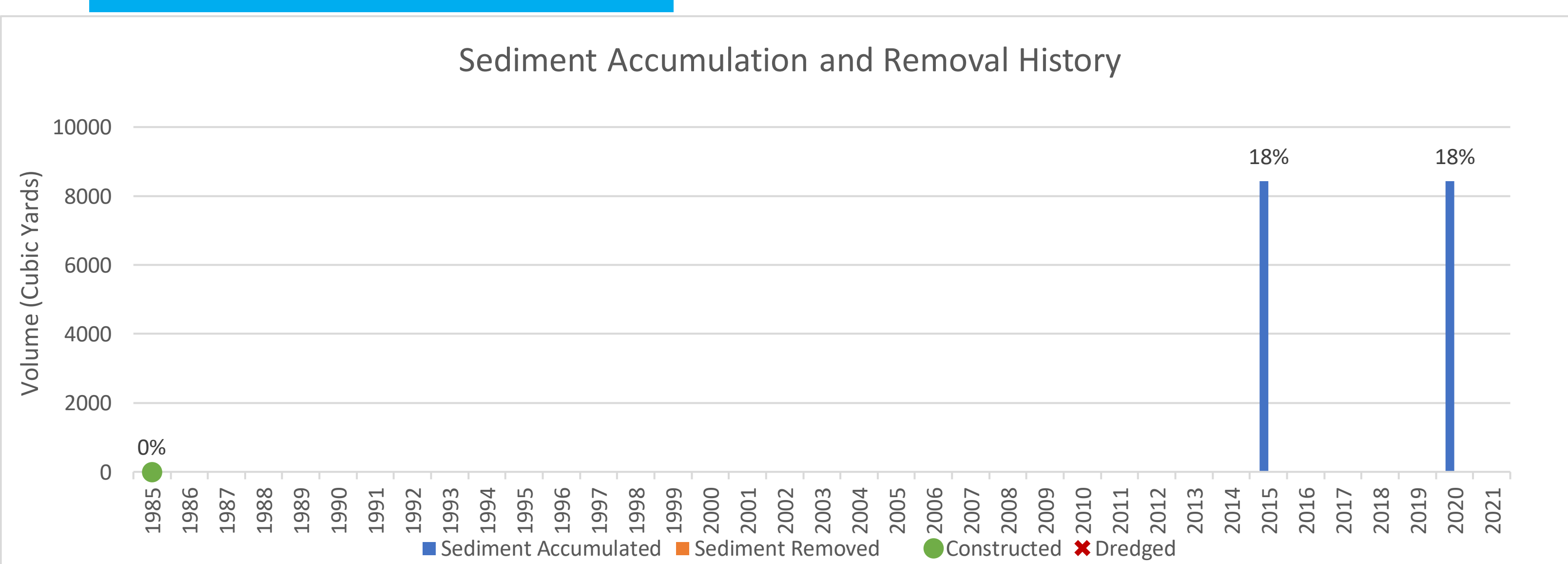
- Painters Marsh has not been dredged since its expansion in 1997.

Status & Recommendations:

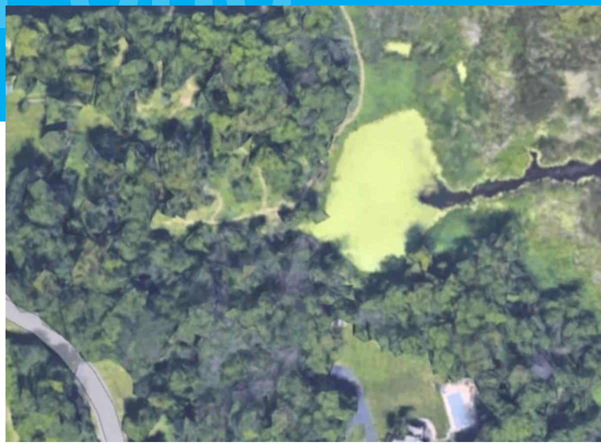
Not Performing

- 20% Full

Pause Sediment Surveys

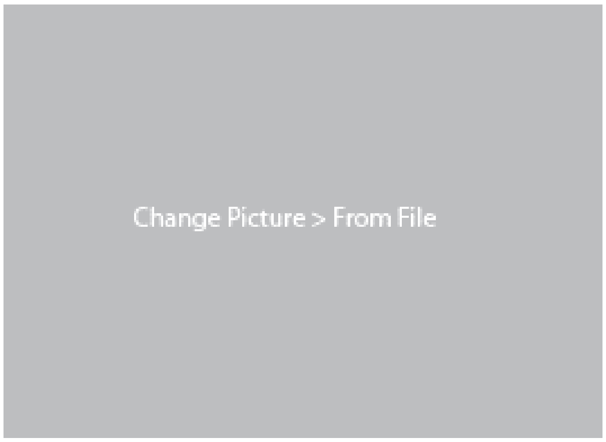


Pond



3. Katrina

Drainage Area: 3,600 acres
Pond Volume: 2.6 AC-FT
Year Constructed: 1985



Design Intent:
Katrina Pond was dredged and expanded in 1997 to make improvements to the sediment basin originally constructed in 1984 and 1985. This project was focused on restoring flood capacity and increasing water treatment potential.

Monitoring Data:
No Monitoring.

Sediment Accumulation:

- 1997-2015: 0.3% per year
- 2015-2018: 4.0% per year
- 2018-2021: 2.7% per year

Dredging Data:

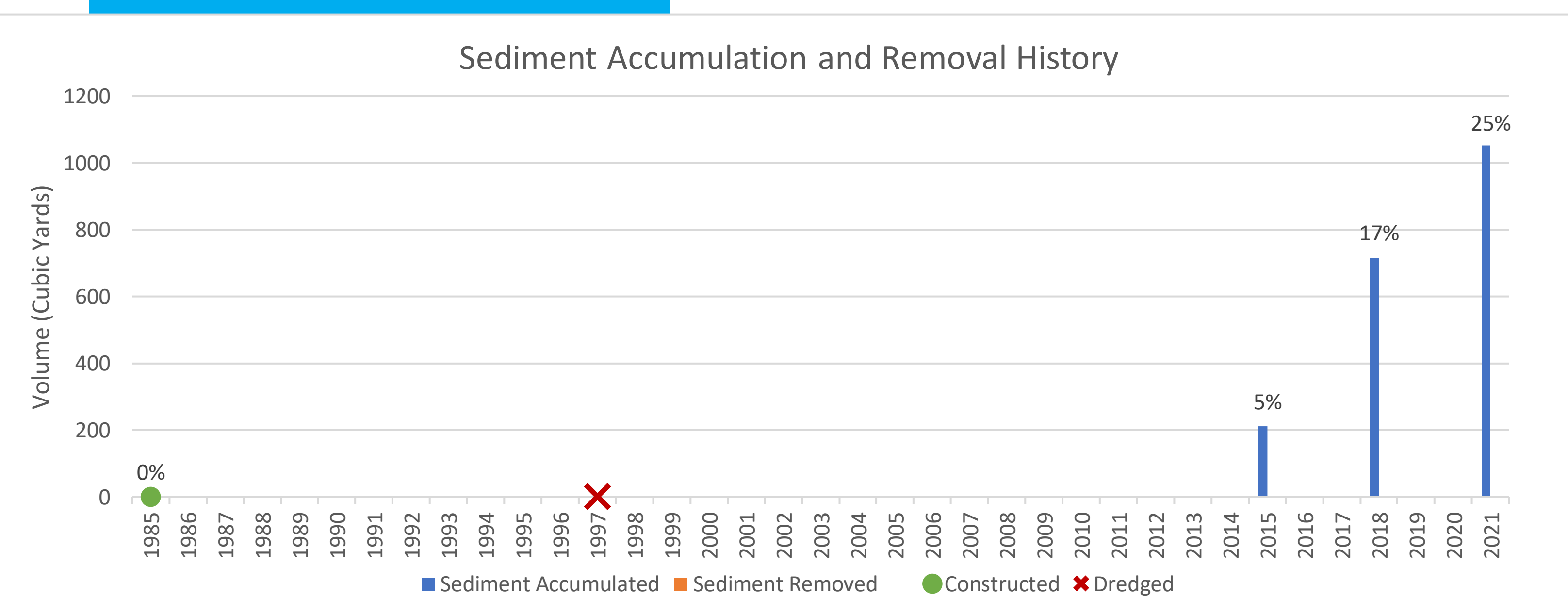
- Katrina has not been dredged since its expansion in 1997.

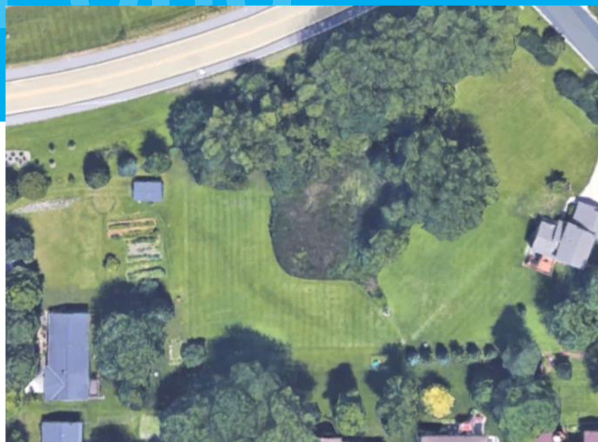
Status & Recommendations:

Not Performing

- 26% Full

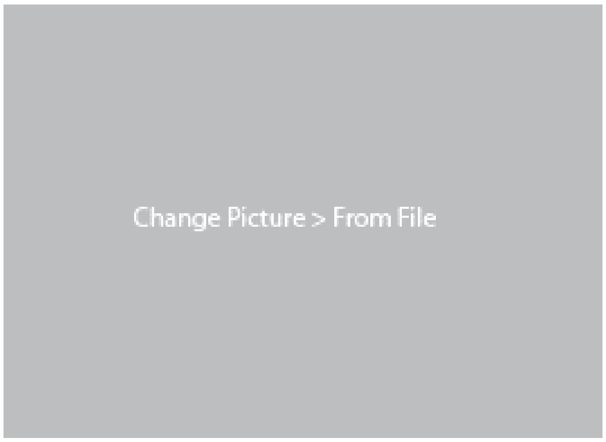
Pause Sediment Surveys





4. Steiger Wetland

Drainage Area: 250 acres
Pond Volume: 2.6 AC-FT
Year Constructed: 1988



Design Intent:
Steiger Wetland Pond was installed in 1988 with the Katy Hills housing development.

Monitoring Data:
No Monitoring.

Sediment Accumulation:

- 1988-2015: 2.8% per year

Dredging Data:

- Steiger Wetland has not been dredged since being built in 1997.

Status & Recommendations:

Performing

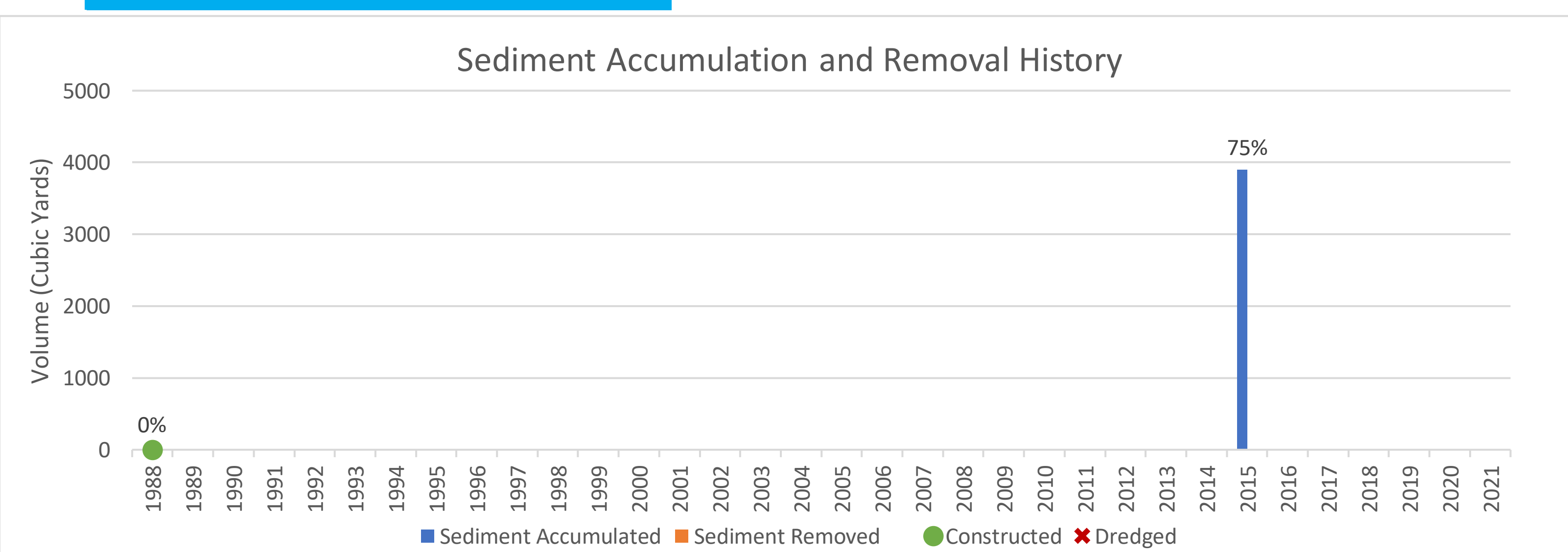
- 97% Full

Continue Sediment Surveys

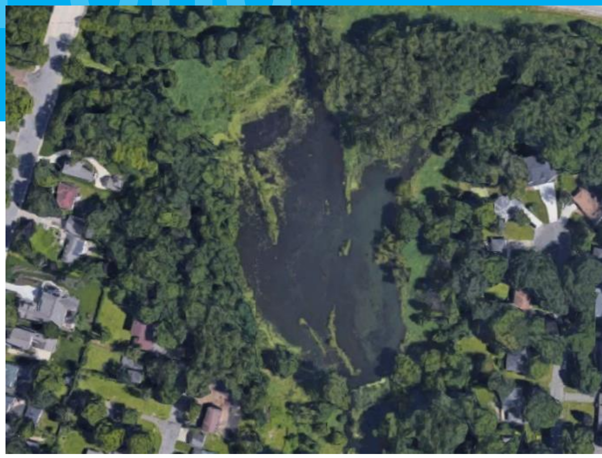
- Next Survey: 2023

Estimated Dredging: 2023

- Estimated CY to be removed: 5,040
- Estimated Cost: $577,000



5. Lakeside Pond



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Drainage Area: 75 acres
Pond Volume: 3 AC-FT
Year Constructed: 1994

Design Intent:
Lakeside Pond was created as part of the Gleason Creek Improvement project. Its design intent was flood control.

Monitoring Data:
No Monitoring.

Sediment Accumulation:

- 1994-2010: 1.9% per year
- 2010-2014: 3.0% per year

Dredging Data:

- Lakeside Pond has not been dredged since it was constructed in 1994. Lakeside pond will likely need to be surveyed and dredged.

Status & Recommendations:

Performing

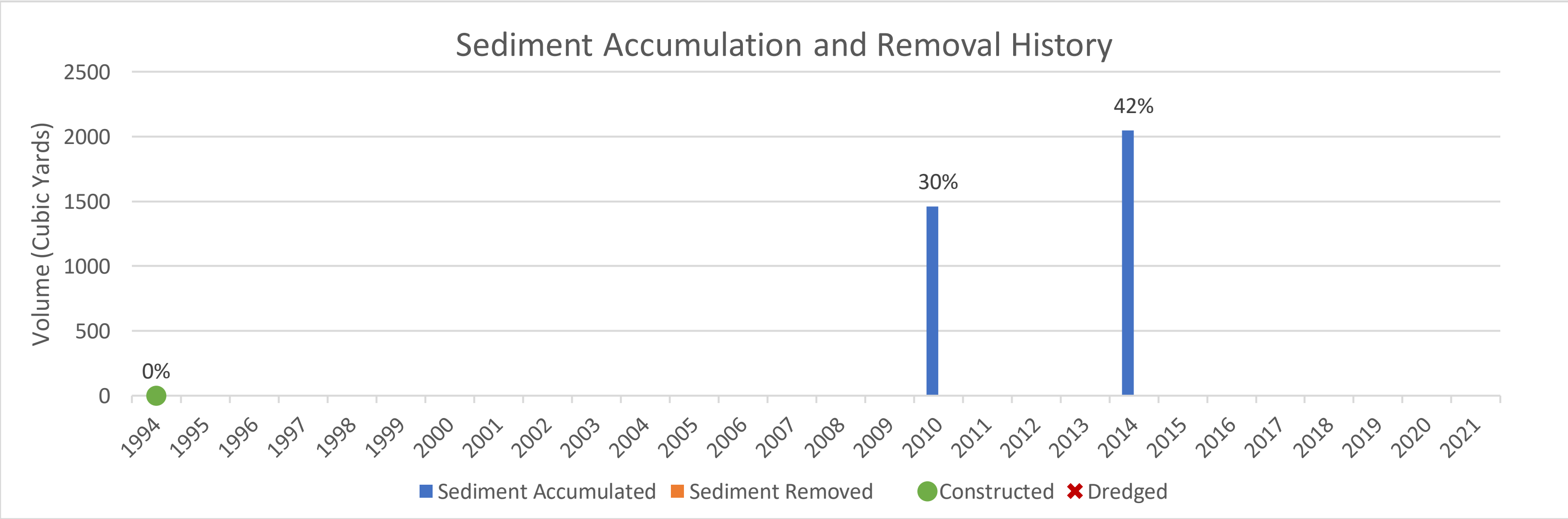
- 61% Full

Continue Sediment Surveys

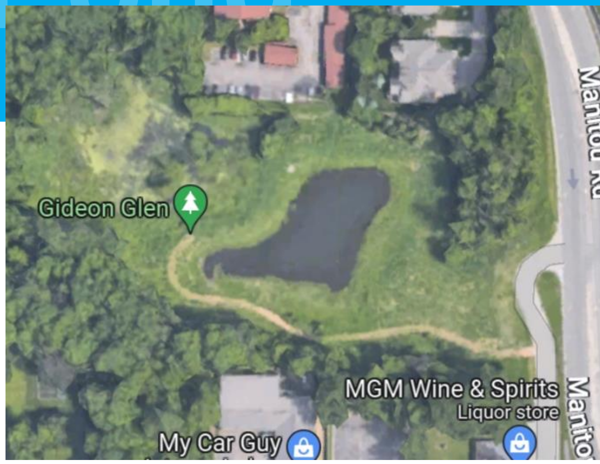
- Next Survey: 2023

Estimated Dredging: 2023

- Estimated CY to be removed: 2,970
- Estimated Cost: $347,000



Pond



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6. Gideon Glen

Drainage Area: 88 acres
Pond Volume: 1.2 AC-FT
Year Constructed: 2006

Design Intent:
Designed to treat stormwater from 88 acres, including the County Road 19/Smithtown Road/Country Club Road intersection and the shopping center and parking areas on the east side of the roadway in Tonka Bay, before it drains into Lake Minnetonka.

Monitoring Data:
No Monitoring.

Sediment Accumulation:

- 2006-2016: 0.8% per year
- 2016-2019: 0.3% per year

Dredging Data:

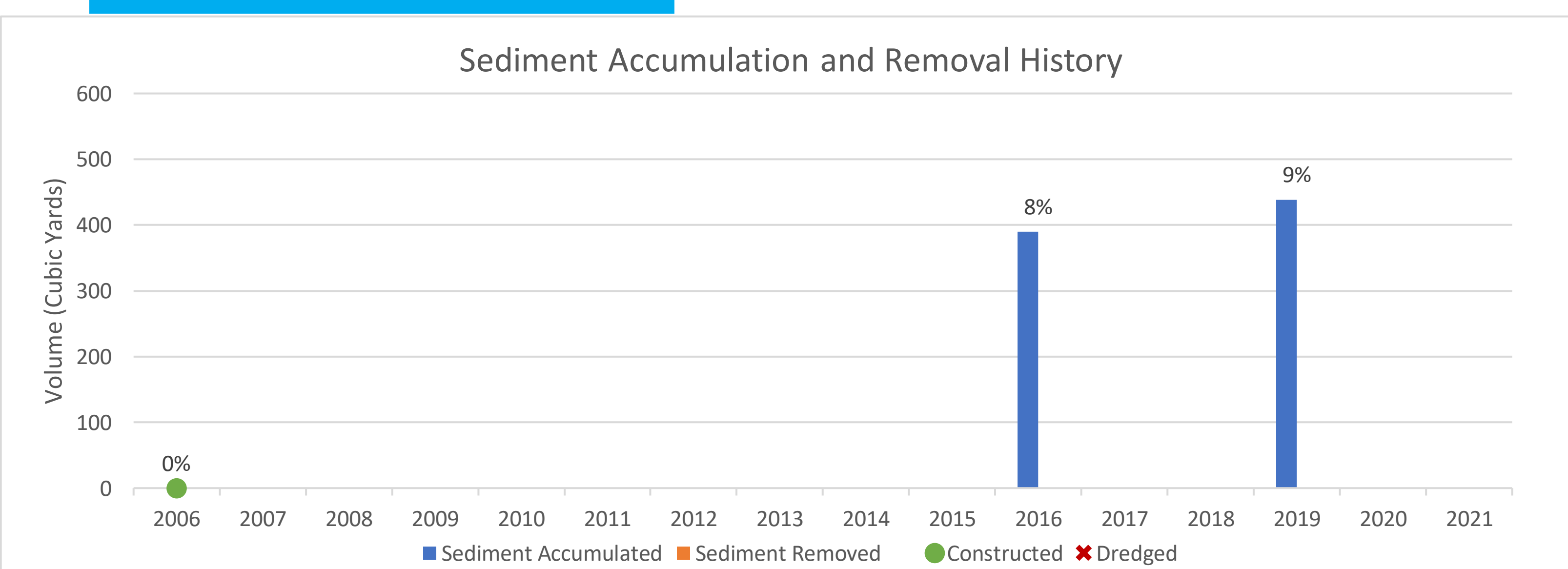
- Gideon Glen Pond has not been dredged since it was constructed in 2006.

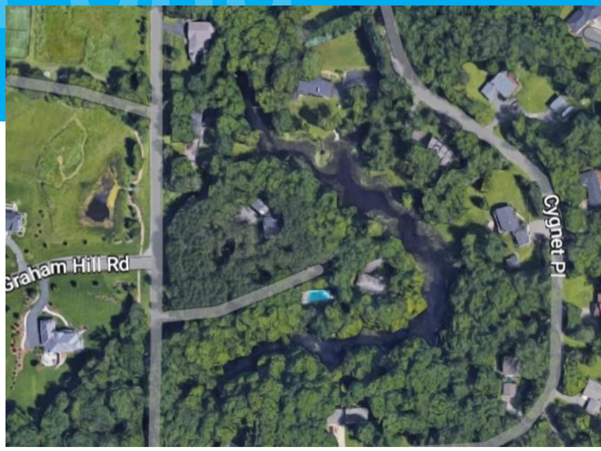
Status & Recommendations:

Not Performing

- 12% Full

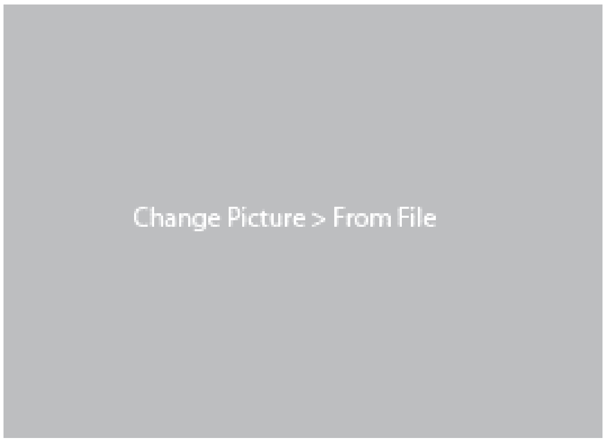
Pause Sediment Surveys





7. Swan Lake

Drainage Area: 930 acres
Pond Volume: 9.8 AC-FT
Year Constructed: 2008



Design Intent:
Swan Lake is an artificial pond, constructed sometime between 1957 and 1964 (according to Hennepin County Land Survey historical imagery) in-line on Classen Creek. The pond was excavated in 2008 by MCWD to increase water detention and sediment storage to reduce downstream pollutant loading to Stubbs Bay on Lake Minnetonka.

Monitoring Data:
No Monitoring.

Sediment Accumulation:
- 2008-2017: 0.8% per year
- 2017-2020: 2.2% per year

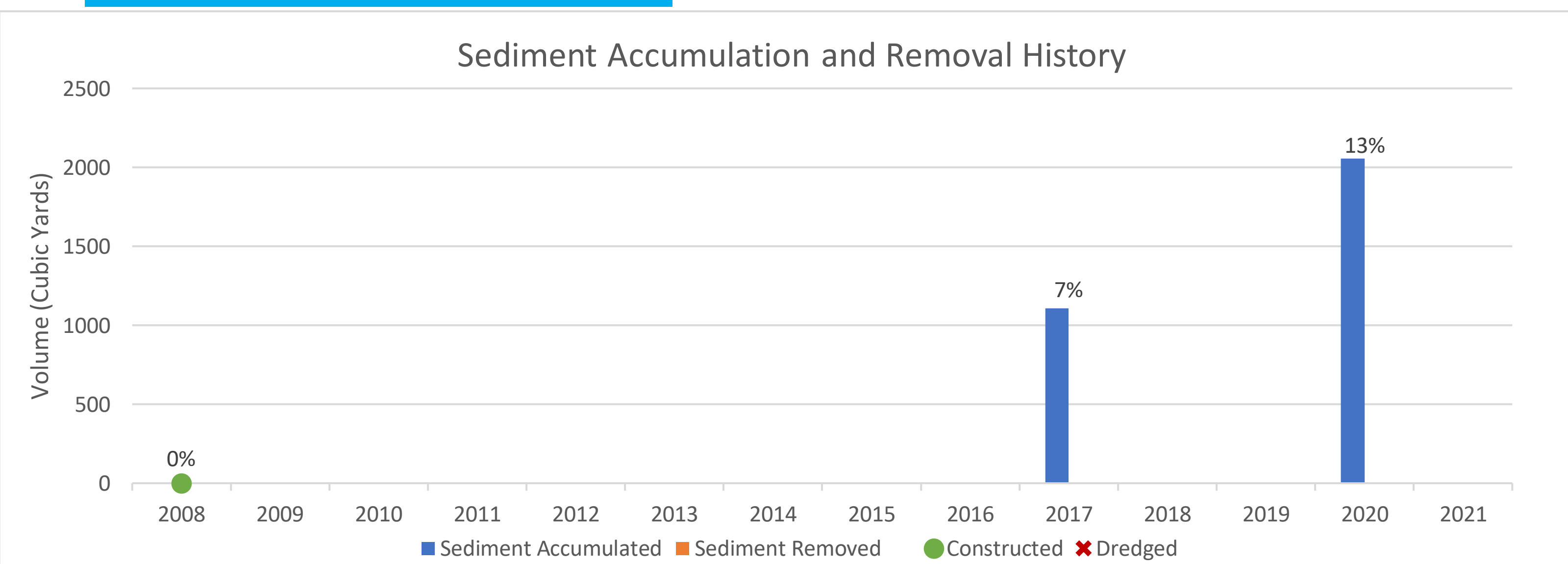
Dredging Data:
- Swan Lake has not been dredged since it was constructed in 2008.

Status & Recommendations:

Not Performing

- 16% Full

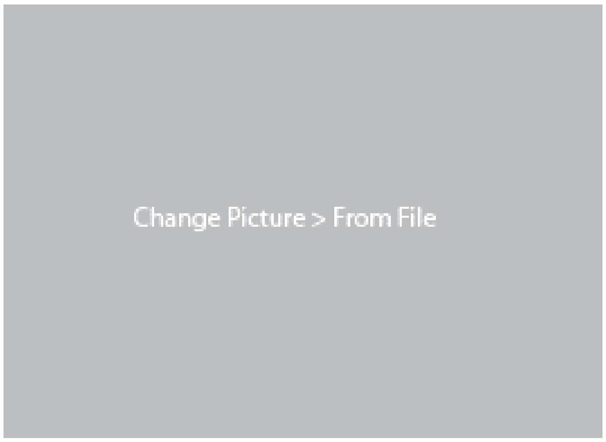
Pause Sediment Surveys



Pond

8. County Road 6 Pond

Drainage Area: 3,370 acres
Pond Volume: 12.2 AC-FT
Year Constructed: 1998



Design Intent:
County Road 6 (1997-1998) was designed to reduce sediment and nutrient loading from the northeast and northwest tributaries. It was estimated to remove 50% TP when considered in conjunction with Deer Hill. No expected removal was quantified for TSS.

Monitoring Data:
Monitored 1998

- Summer phosphorus removal rate 25%
- Decreased sediment
- Phosphorus and solids concentrations in inflow to Long Lake from Deer Hill Pond were found to be lower than estimated in the pre-project feasibility study.

Sediment Accumulation:

- 1998-2019: 0.5% per year

Dredging Data:

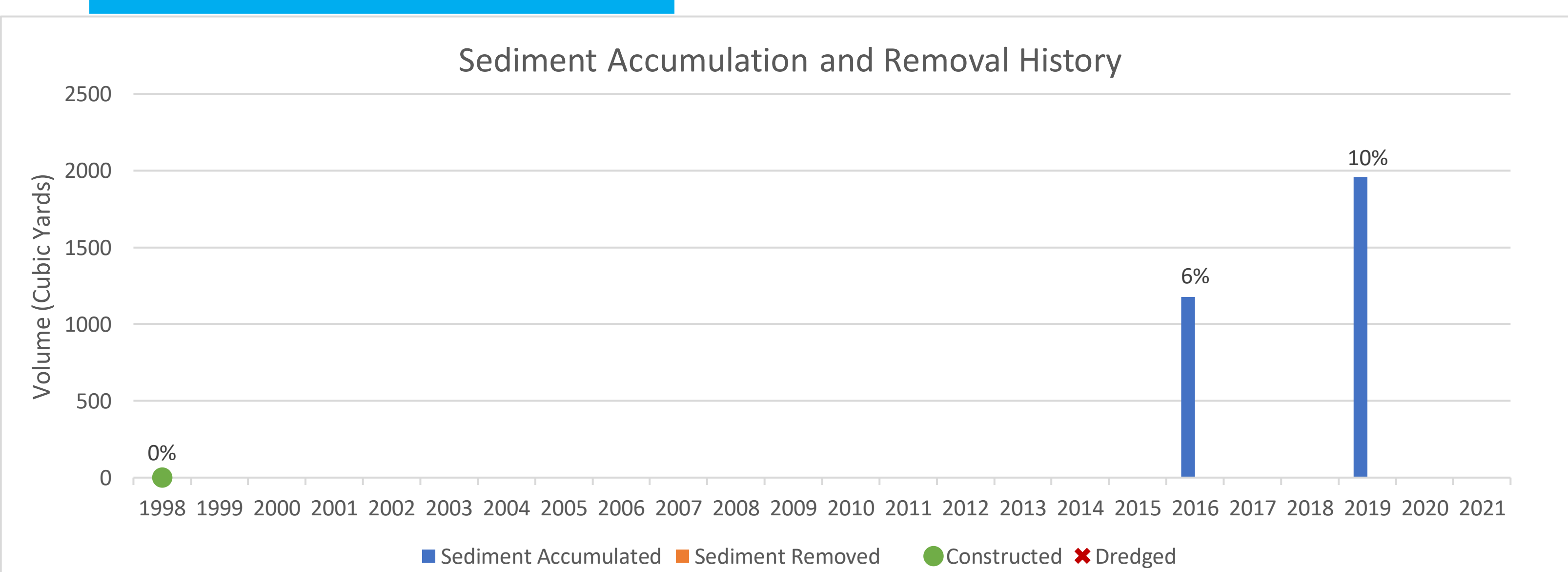
- Country Road 6 has not been dredged since it was constructed in 1998.

Status & Recommendations:

Not Performing

- 16% Full

Pause Sediment Surveys



Pond

9. Deer Hill - North

Drainage Area: 1740 acres
Pond Volume (North and South): 23.4 AC-FT
Year Constructed: 1996

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Design Intent:
Deer Hill (1995-1996) was designed to reduce sediment and nutrient loading from the northeast tributary prior to entry into the County Road 6 Pond. It was estimated to remove 60% TP. No expected removal was quantified for TSS.

Monitoring Data:
Monitored 1996, 1997, and 1998

- Summer phosphorus removal rate approximately 40-50%
- Decreased sediment
- Phosphorus and solids concentrations in inflow to Long Lake from Deer Hill Pond were found to be lower than estimated in the pre-project feasibility study.

Sediment Accumulation:

- 1996-2020: 0.5% per year

Dredging Data:

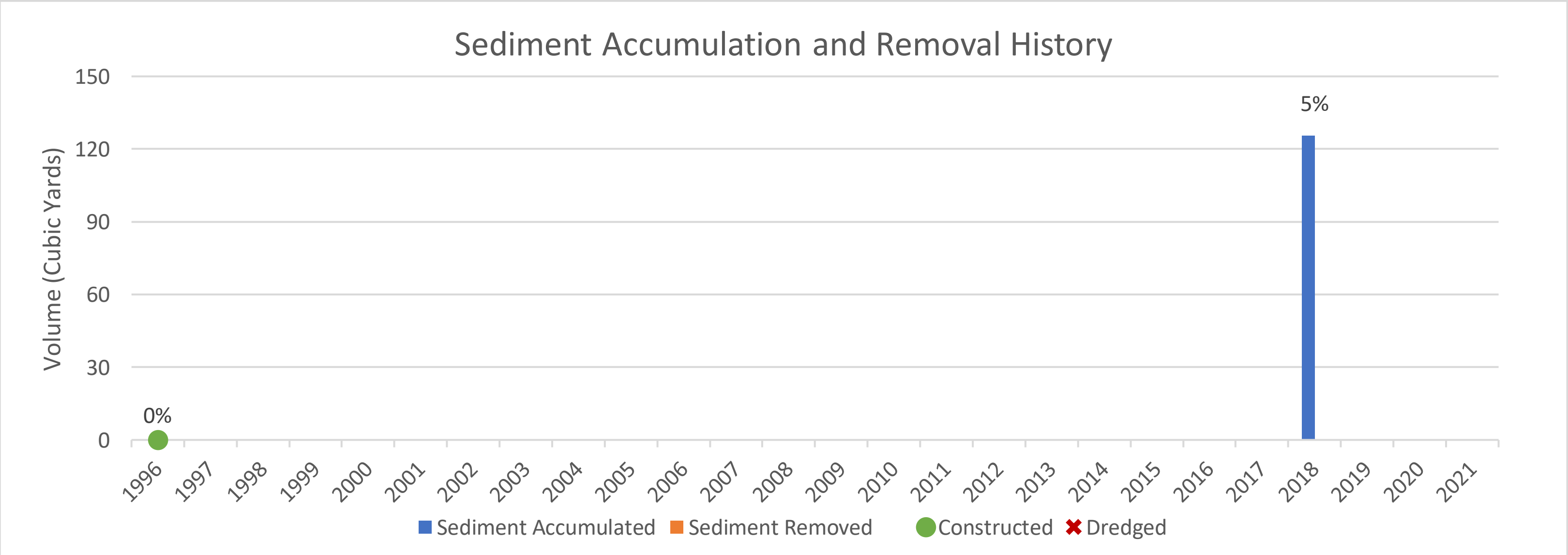
- Deer Hill - North has not been dredged since it was constructed in 1996.

Status & Recommendations:

Not Performing

- 6% Full

Pause Surveys



Pond

10. Deer Hill - South

Drainage Area: 1740 acres
Pond Volume (North and South): 23.4 AC-FT
Year Constructed: 1996

Change Picture > From File

Design Intent:
Deer Hill (1995-1996) was designed to reduce sediment and nutrient loading from the northeast tributary prior to entry into the County Road 6 Pond. It was estimated to remove 60% TP. No expected removal was quantified for TSS.

Monitoring Data:
Monitored 1996, 1997, and 1998

- Summer phosphorus removal rate about 40-50%
- Decreased sediment
- Phosphorus and solids concentrations in inflow to Long Lake from Deer Hill Pond were found to be lower than estimated in the pre-project feasibility study.

Sediment Accumulation:

- During the most recent surveys in 2007 and 2018 an insignificant amount of sediment had accumulated.

Dredging Data:

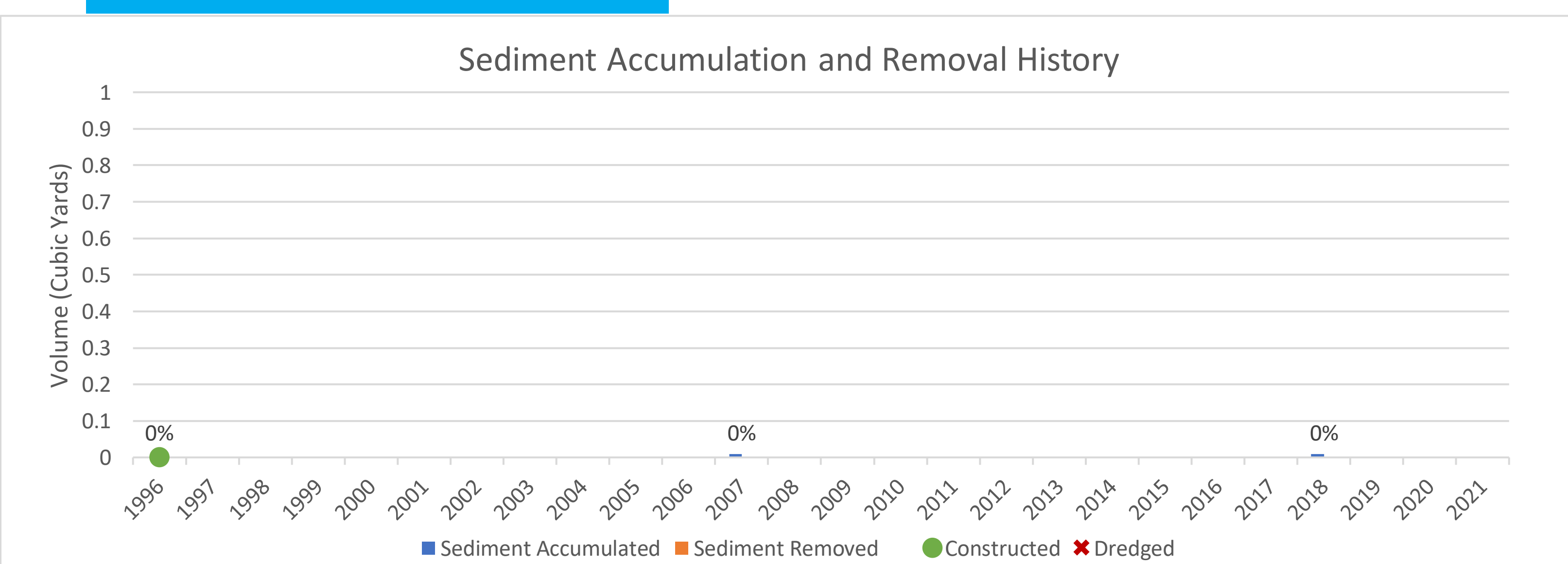
- Deer Hill - South has not been dredged since it was constructed in 1996.

Status & Recommendations:

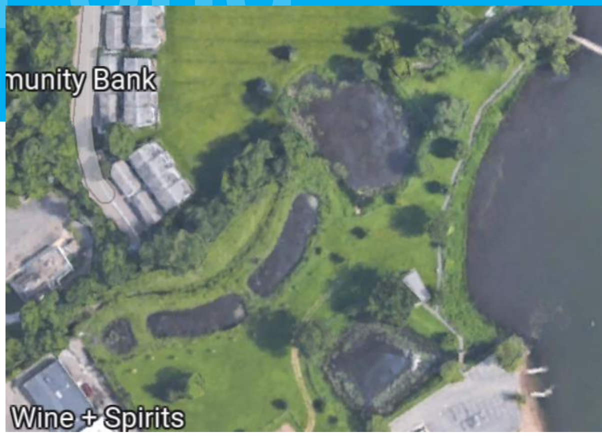
Not Performing

- 0% Full

Pause Surveys

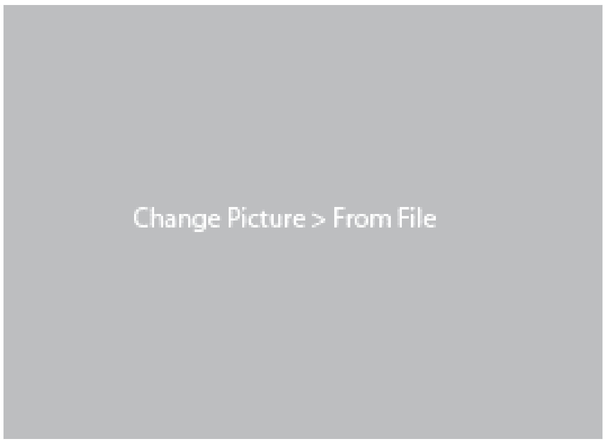


Pond



11. Long Lake - North

Drainage Area: 560 acres total
Pond Volume: 3.1 AC-FT
Year Constructed: 1996



Design Intent:
Expansion of two existing ponds: Long Lake N and Long Lake S (1995-1996) were designed to increase nutrient and sediment removal. They were estimated to remove 20% TP. No expected removal was identified for TSS.

Monitoring Data:
No Monitoring - Initial monitoring documentation indicated visible accumulation of sediment.

Sediment Accumulation:
- 1996-1998: 3.0% per year
- 1998-2004: 7.0% per year
- 2004-2014: 2.0% per year
- 2014-2020: 2.5% per year

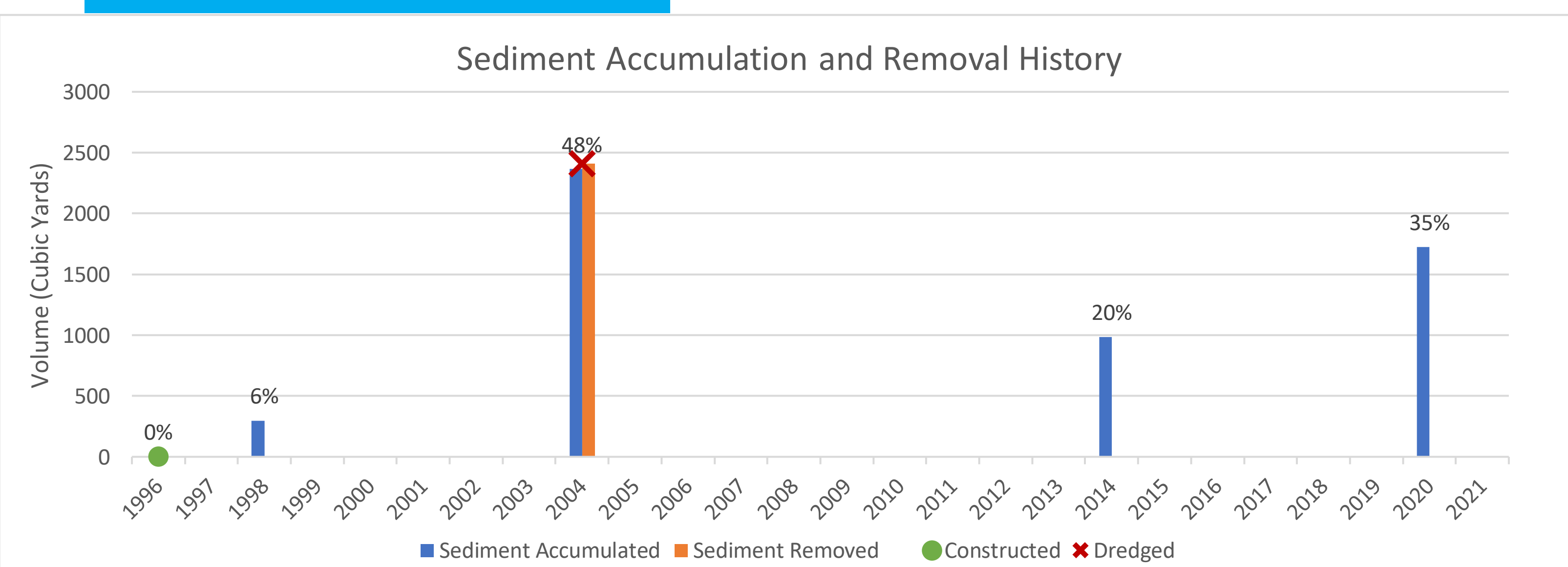
Dredging Data:
- 2004: 2,410 CY (48%)

Status & Recommendations:

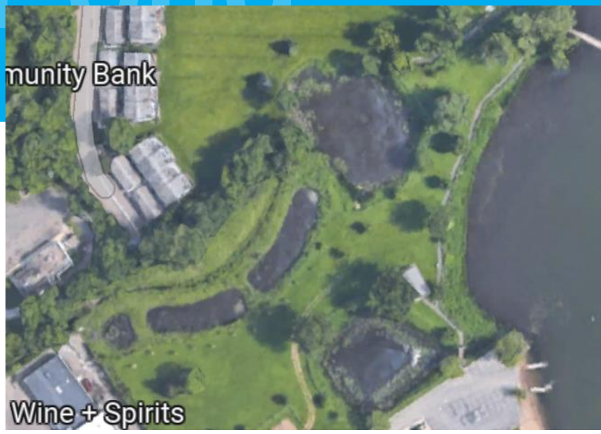
Performing
- 47% Full

Continue Sediment Surveys
- Next Survey: 2023

Estimated Dredging: 2024
- Estimated CY to be removed: 2,470
- Estimated Cost: $292,900



Pond



12. Long Lake - South

Drainage Area: 560 acres total
Pond Volume: 1.6 AC-FT
Year Constructed: 1996

Change Picture > From File

Design Intent:
Expansion of two existing ponds: Long Lake N and Long Lake S (1995-1996) were designed to increase nutrient and sediment removal. They were estimated to remove 20% TP. No expected removal was identified for TSS.

Monitoring Data:
No Monitoring - Initial monitoring documentation indicated visible accumulation of sediment.

Sediment Accumulation:

- 2006-2017: 1.9% per year
- 2017-2020: 3.0% per year

Dredging Data:

- Long Lake - South was dredged in 2006. There are no dredging or survey records to indicate how full this pond was when it was dredged.

Status & Recommendations:

Underperforming

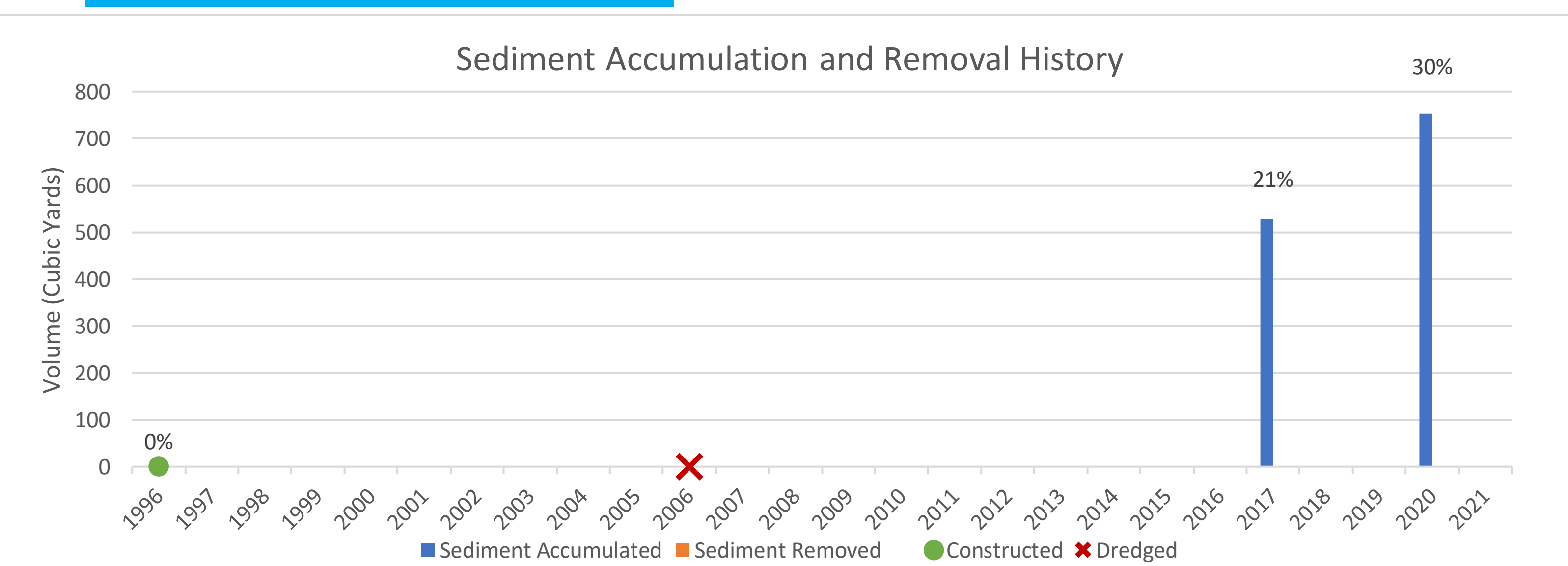
- 36% Full

Continue Sediment Surveys

- Next Survey: 2025

Estimated Dredging: 2030

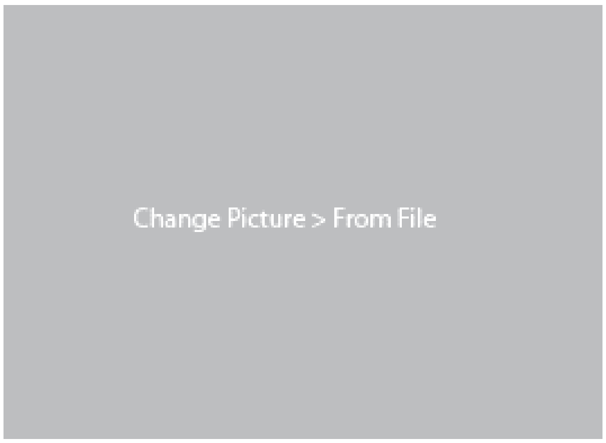
- Estimated CY to be removed: 1,260
- Estimated Cost: $213,500



Pond

13. Gleason Lake North - 1

Drainage Area: 345 acres
Pond Volume: 0.9 AC-FT
Pond Volume: 0.7 AC-FT
Pond Volume: 0.7 AC-FT
Year Constructed: 1995



Design Intent:
The design intent of the addition of two cells (Gleason ponds Cells 2 and 3) were to improve water quality in Gleason Lake. Gleason Cell 1 has been in place since 1995.

Monitoring Data:
No monitoring.

Sediment Accumulation:

- 2006-2011: 5.3% per year
- 2011-2018: 6.2% per year
- 2018-2021: 0.3% per year

Dredging Data:

- 2011: 900 CY (59%*)

*note that this pond was 85% full prior to being dredged in 2011, so not all accumulated sediment was removed at the time.

Status & Recommendations:

Performing

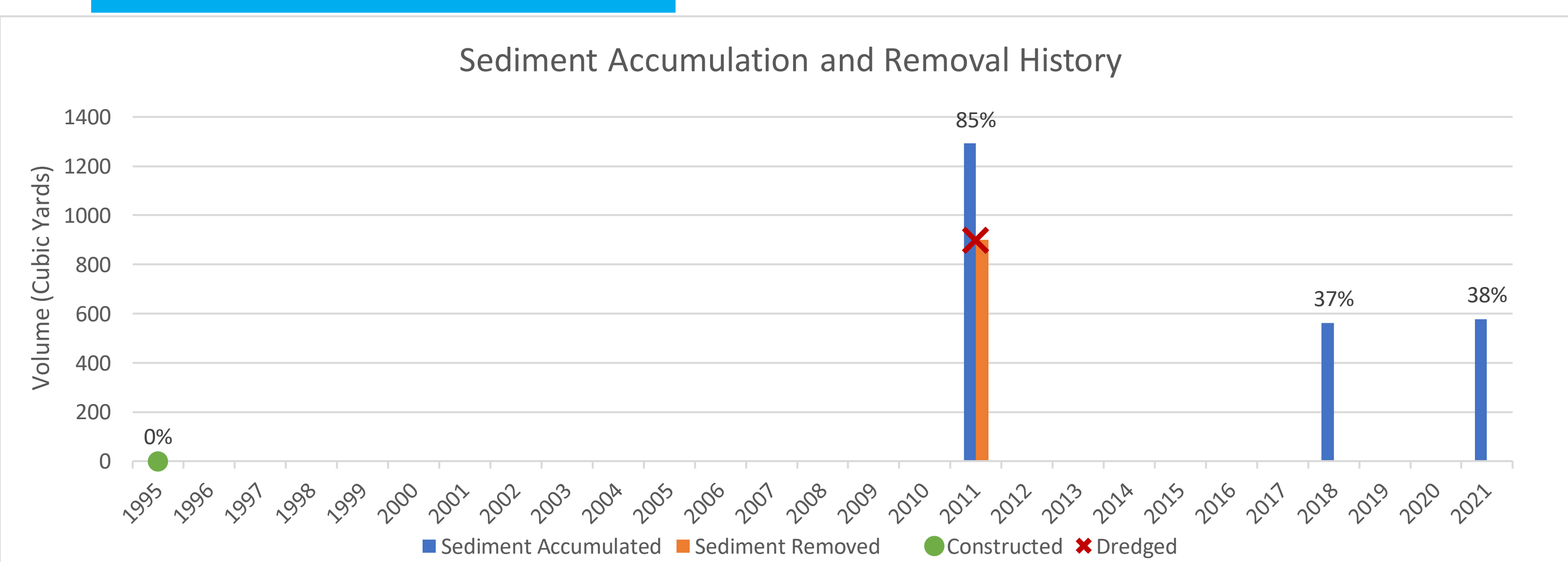
- 46% Full

Continue Sediment Surveys

- Next Survey: 2023

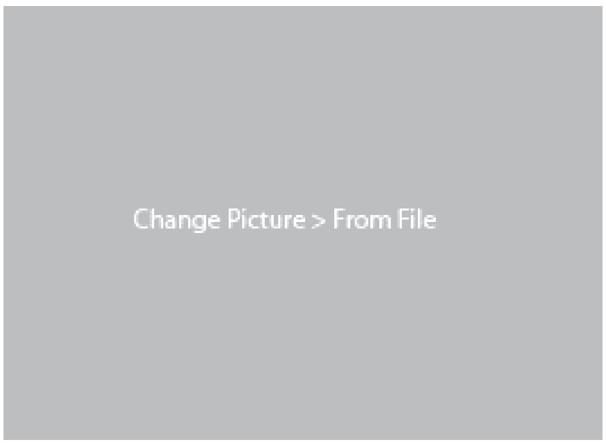
Estimated Dredging: 2024

- Estimated CY to be removed: 1,520
- Estimated Cost: $133,000



14. Gleason Lake North - 2

Drainage Area: 345 acres
Pond Volume: 0.9 AC-FT
Pond Volume: 0.7 AC-FT
Pond Volume: 0.7 AC-FT
Year Constructed: 2008



Design Intent:
The design intent of the addition of two cells (Gleason ponds Cells 2 and 3) were to improve water quality in Gleason Lake. Gleason Cell 1 has been in place since 1995.

Monitoring Data:
No monitoring.

Sediment Accumulation:

- 2006-2015: 8.1% per year
- 2015-2018: 7.0% per year
- 2018-2021: 1.0% per year

Dredging Data:

- 2016*: 892 CY (40%**)

*Note Gleason 2 and 3 were dredged jointly in 2016 and the total combined amount removed from both was 892 CY.

**Note Gleason 2 and Gleason 3 were 57% and 68% full prior to being dredged in 2016, so not all accumulated sediment was removed at the time.

Status & Recommendations:

Performing

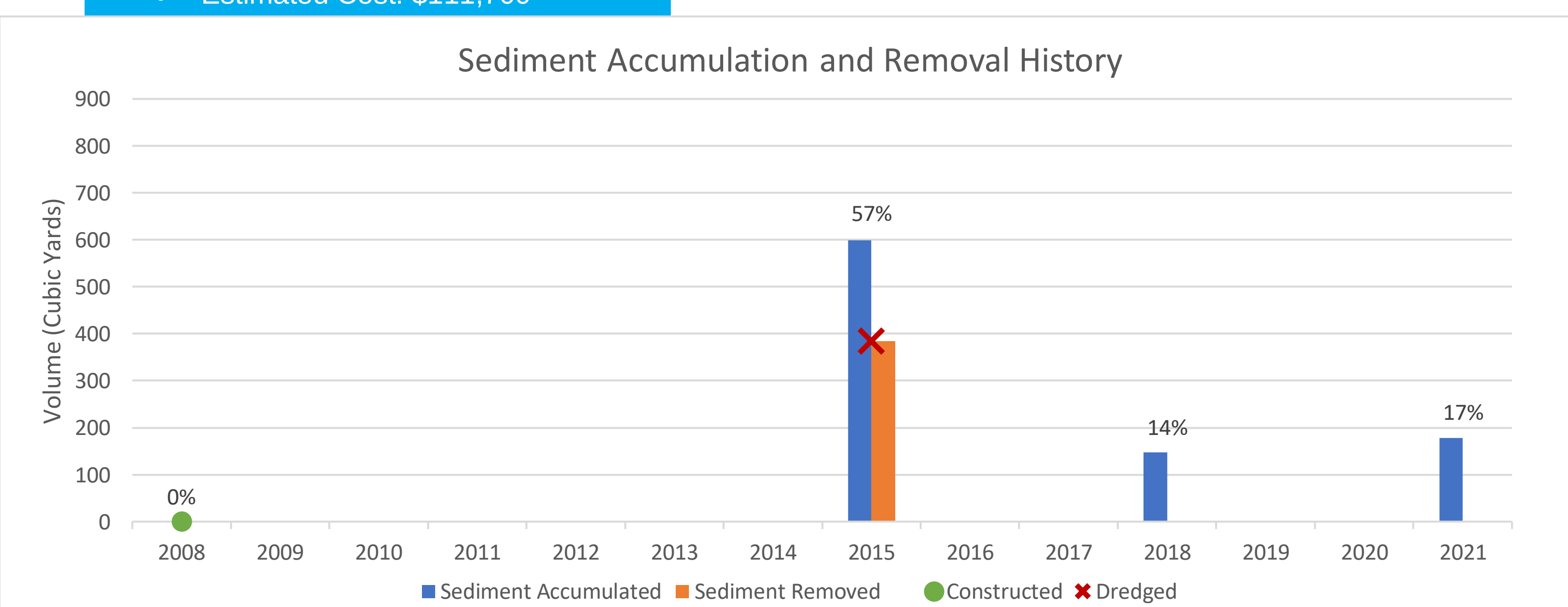
- 25% Full

Continue Sediment Surveys

- Next Survey: 2026

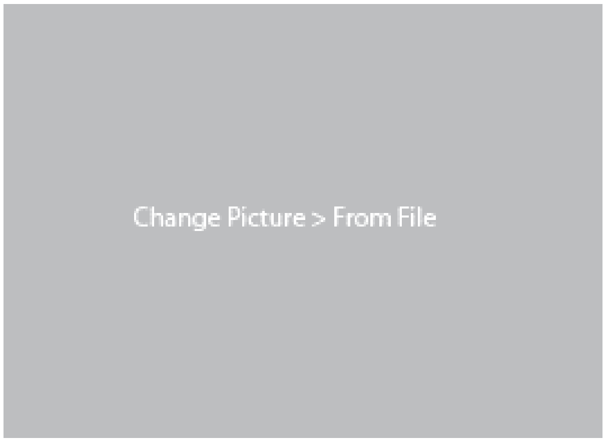
Estimated Dredging: 2029

- Estimated CY to be removed: 525
- Estimated Cost: $111,700



15. Gleason Lake North - 3

Drainage Area: 345 acres
Pond Volume: 0.9 AC-FT
Pond Volume: 0.7 AC-FT
Pond Volume: 0.7 AC-FT
Year Constructed: 2008



Design Intent:
The design intent of the addition of two cells (Gleason ponds Cells 2 and 3) were to improve water quality in Gleason Lake. Gleason Cell 1 has been in place since 1995.

Monitoring Data:
No monitoring.

Sediment Accumulation:
- 2006-2015: 9.7% per year
- 2015-2018: 6.0% per year
- 2018-2021: 4.3% per year

Dredging Data:
- 2016*: 892 CY (40%**)

*Note Gleason 2 and 3 were dredged jointly in 2016 and the total combined amount removed from both was 892 CY.

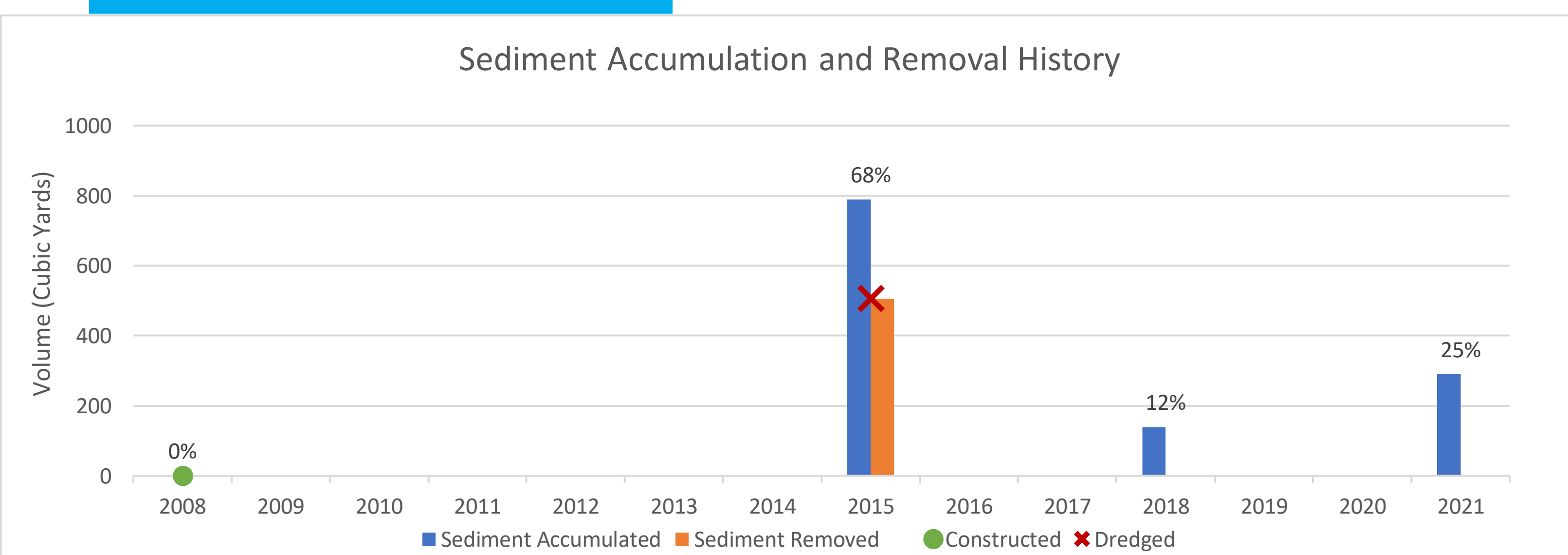
**Note Gleason 2 and Gleason 3 were 57% and 68% full prior to being dredged in 2016, so not all accumulated sediment was removed at the time.

Status & Recommendations:

Performing
- 35% Full

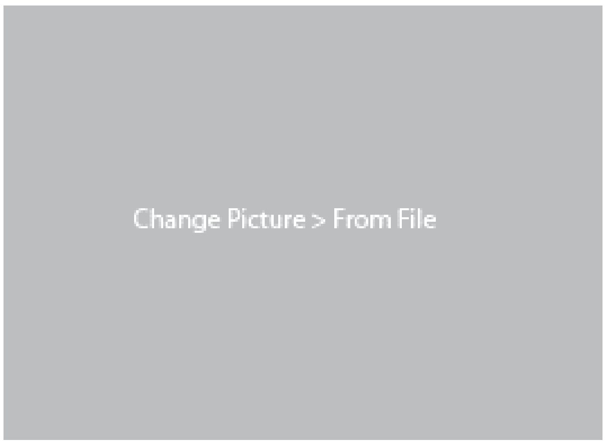
Continue Sediment Surveys
- Next Survey: 2024

Estimated Dredging: 2026
- Estimated CY to be removed: 580
- Estimated Cost: $111,700



16. Glenbrook Pond

Drainage Area: 4,360 acres
Pond Volume: 15.4 AC-FT
Year Constructed: 1994



Design Intent:
Glenbrook Pond was expanded in 1994 as part of the Gleason Creek Improvement project. Its design intent was flood control.

Monitoring Data:
No monitoring.

Sediment Accumulation:

- 1994-2016: 2.0% per year

Dredging Data:

- 2017: 16,000 (64%*) after a 2016 survey showed that it was 44% full.

**Note Glenbrook was 44% full prior to being dredged in 2017, so it's possible the pond was enlarged.

Status & Recommendations:

Underperforming

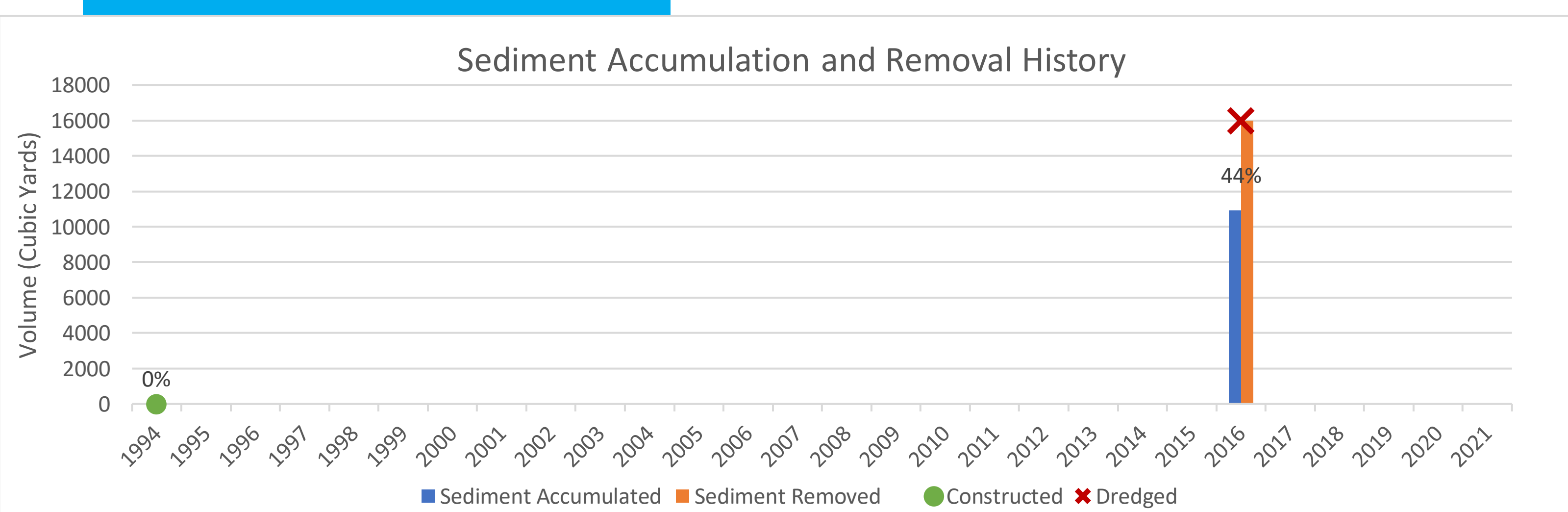
- 12% Full

Continue Sediment Surveys

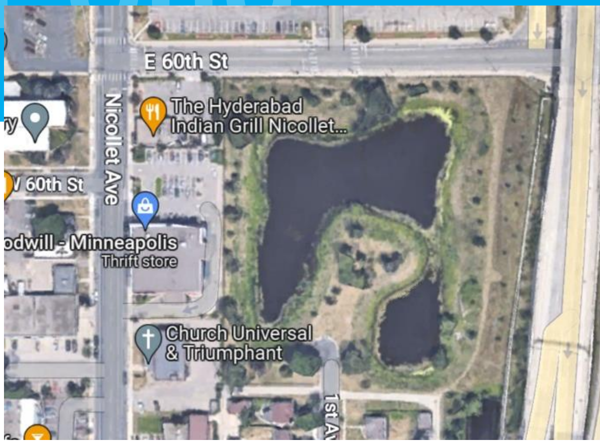
- Next Survey: 2037

Estimated Dredging: 2042

- Estimated CY to be removed: 12,400
- Estimated Cost: $738,900

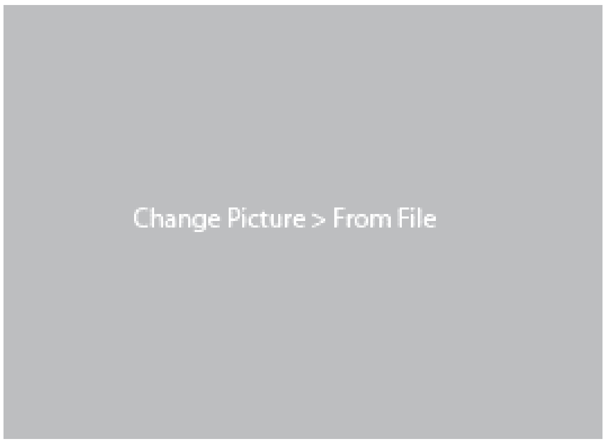


Pond



17. 60th and 1st

Drainage Area: 194 acres
Pond Volume: n/a
Year Constructed: 2000



Design Intent:
61st and 1st was designed to minimize local flooding problems and improve water quality. The primary goal was storage to alleviate frequent flooding in the area.

Monitoring Data:
No Monitoring data exists, but it was anticipated during design that that the pond would remove 100 lbs of phosphorus per year from the drainage area, with primary benefit being to Diamond Lake.

Sediment Accumulation: Cell 1

- 2000-2020: 0.6% per year

Dredging Data: Cell 1

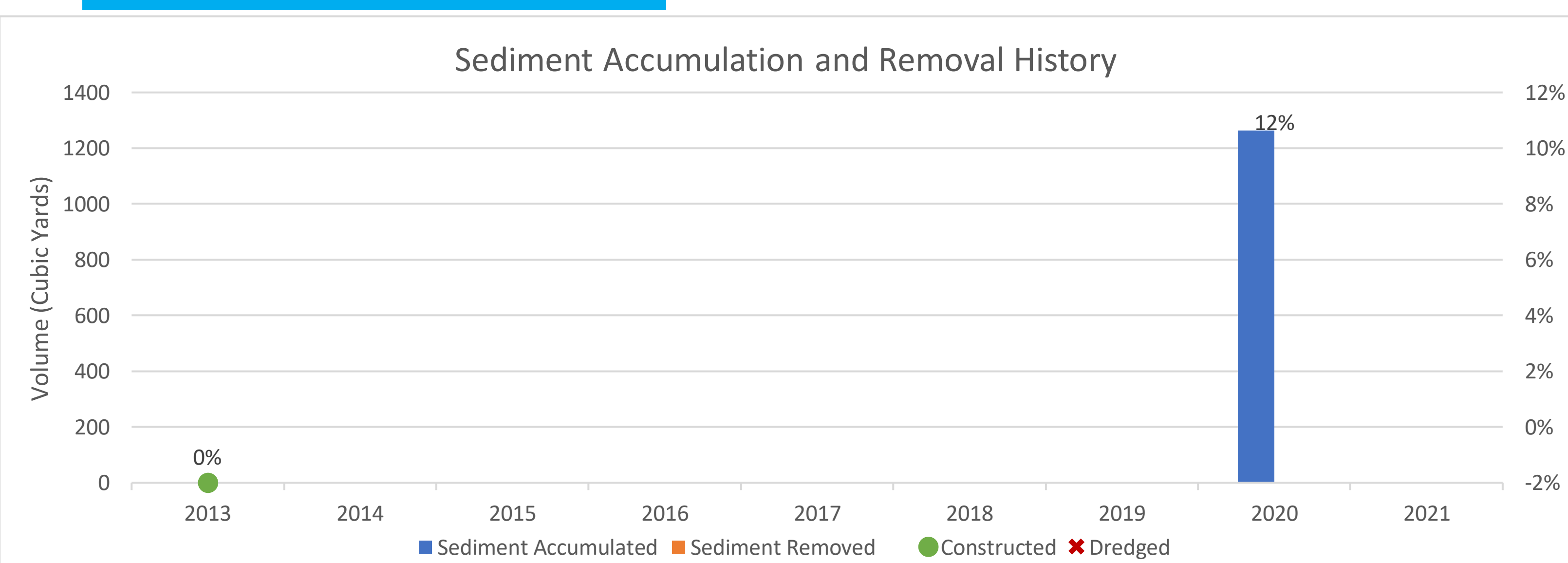
- 60th and 1st has not been dredged since it was constructed in 2000

Status & Recommendations:

Not Performing

- 14% Full

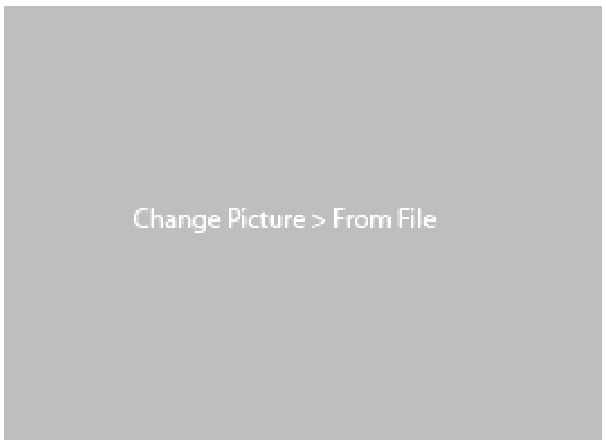
Pause Surveys



Pond

18. Cedar Meadows - 1 (W)

Drainage Area: 223 acres
Pond Volume: 8.1 AC-FT
Year Constructed: 1996



Design Intent:
Cedar Meadows detention pond and wetland was created as part of a larger project with the intent to improve water quality entering Cedar Lake. Cedar Meadows treats local runoff flowing from Twin Lakes before entering Cedar Lake.

Monitoring Data:
Performance monitoring was conducted in 1997 and showed a 40% phosphorus removal and 80% TSS removal. However, in 1998 the phosphorus removal dropped to 21% and the TSS removal to nearly zero. A large presence of rough fish in the pond, disturbing the bottom sediments and damaging aquatic plant life was suspected to have caused this dramatic drop. In 1998, efforts were taken to remove and keep the fish out of the pond.

Sediment Accumulation:
- 1996-2004: 2.6% per year
- 2004-2020: 1.1% per year

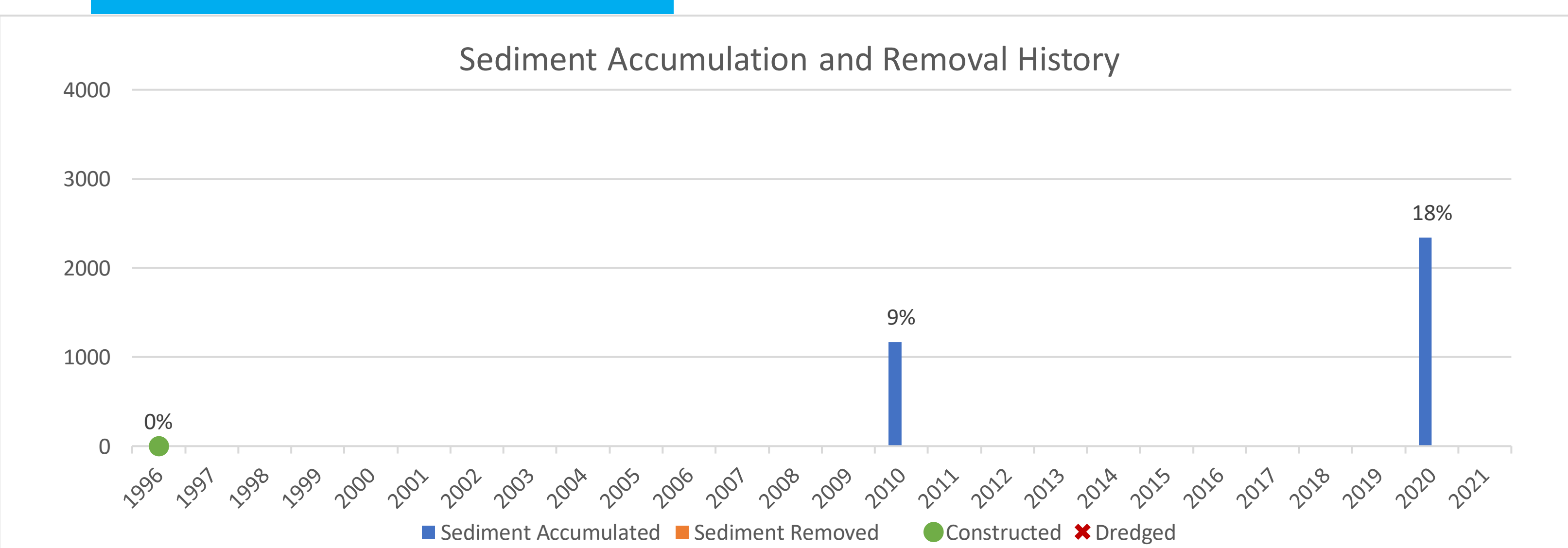
Dredging Data:
- 2004: 2,750 (21%)

Status & Recommendations:

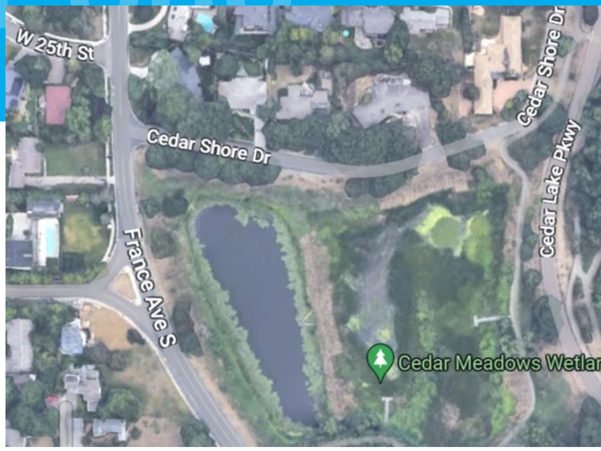
Underperforming
- 24% Full

Continue Sediment Surveys
- Next Survey: 2032

Estimated Dredging: 2037
- Estimated CY to be removed: 6,500
- Estimated Cost: $610,100



Pond



19. Cedar Meadows - 2 (E)

Drainage Area: 223 acres
Pond Volume: 8.1 AC-FT
Year Constructed: 1996

Change Picture > From File

Design Intent:
Cedar Meadows detention pond and wetland was created as part of a larger project with the intent to improve water quality entering Cedar Lake. Cedar Meadows treats local runoff flowing from Twin Lakes before entering Cedar Lake.

Monitoring Data:
Performance monitoring was conducted in 1997 and showed a 40% phosphorus removal and 80% TSS removal. However, in 1998 the phosphorus removal dropped to 21% and the TSS removal to nearly zero. A large presence of rough fish in the pond, disturbing the bottom sediments and damaging aquatic plant life was suspected to have caused this dramatic drop. In 1998, efforts were taken to remove and keep the fish out of the pond.

Sediment Accumulation:
- 1996-2020: 1.6% per year

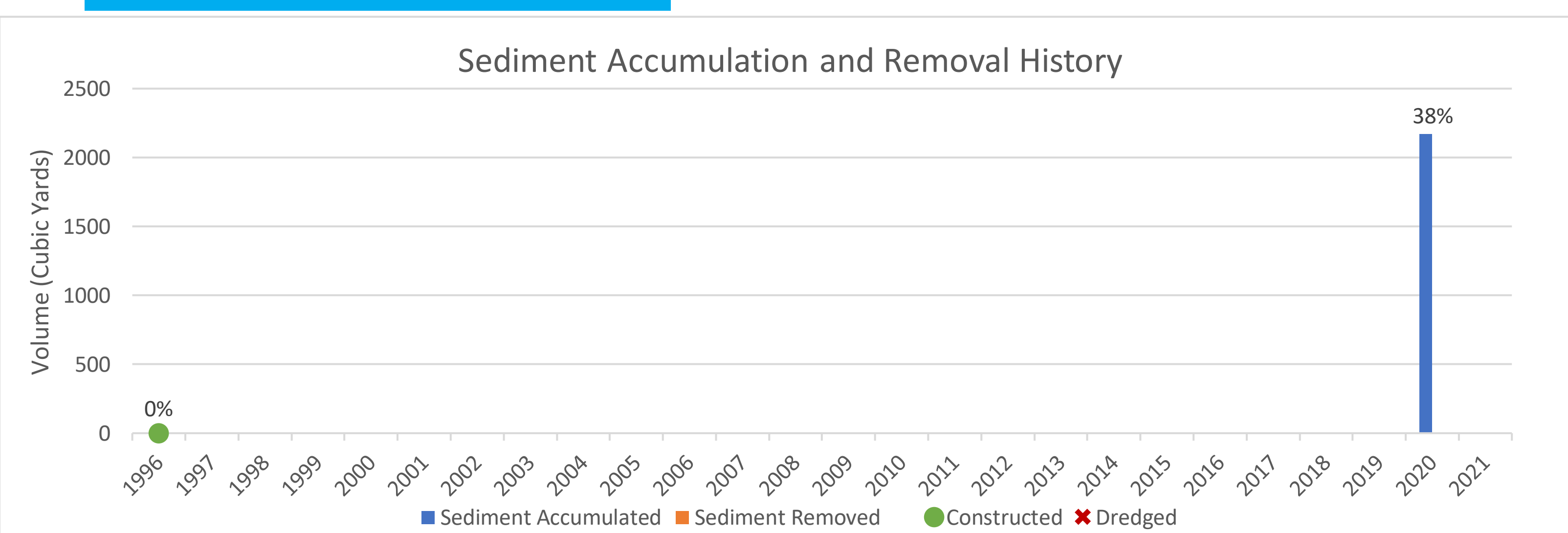
Dredging Data:
- Cedar Meadow - East has not been dredged since it was constructed in 1996.

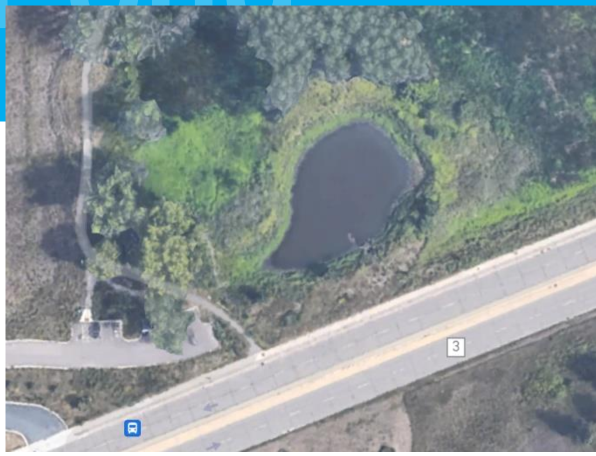
Status & Recommendations:

Underperforming
- 12% Full

Continue Sediment Surveys
- Next Survey: 2023

Estimated Dredging: 2028
- Estimated CY to be removed: 2,900
- Estimated Cost: $345,600





20. Excelsior

Drainage Area: 79 acres
Pond Volume: 1.5 AC-FT
Year Constructed: 2013

Design Intent:
Designed to treat stormwater from 79 acres that previously flowed untreated into Minnehaha Creek. It was estimated to remove 41 pounds of total phosphorus annually. The pond has a 1.72 ac-ft pretreatment filtration basin with a 2ft normal water depth designed to receive runoff from the existing 36” diameter RCP crossing Excelsior Blvd and the 18” RCP capturing flow from Excelsior Way. Stormwater is controlled by a one-foot filtration berm.

Monitoring Data:
No monitoring data

Sediment Accumulation:

- 2013-2016: 4.7% per year
- 2016-2019: 0.7% per year

Dredging Data:

- Excelsior has not been dredged since it was constructed in 2013.

Status & Recommendations:

Performing

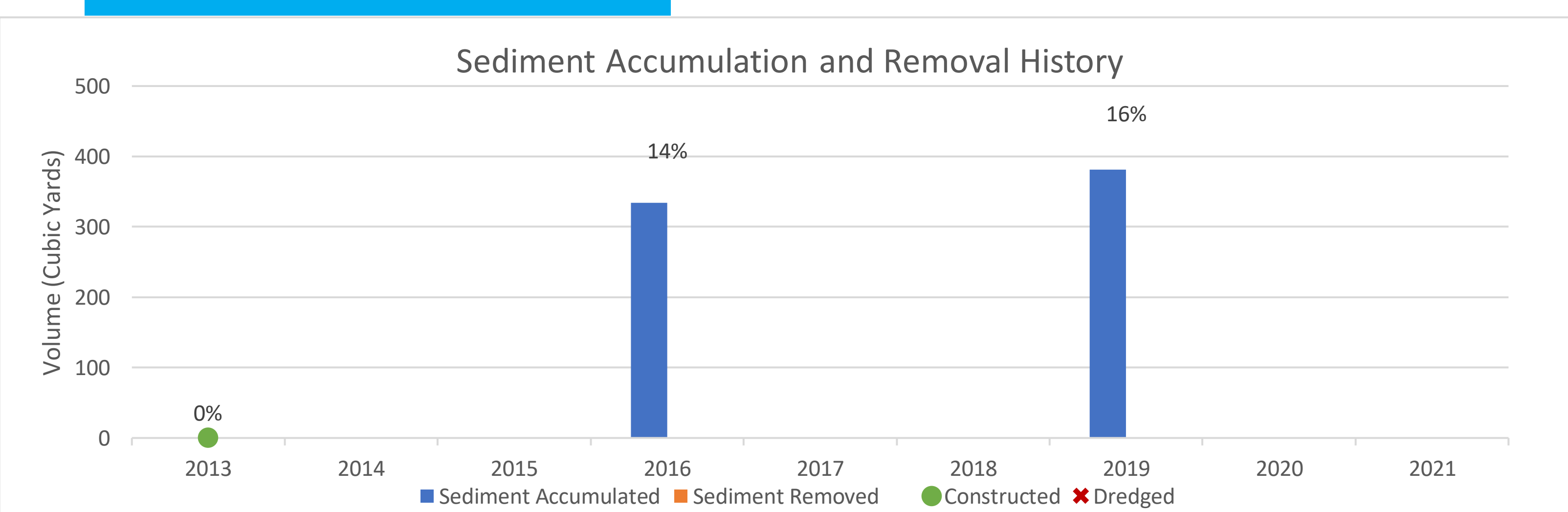
- 27% Full

Continue Sediment Surveys

- Next Survey: 2028

Estimated Dredging: 2032

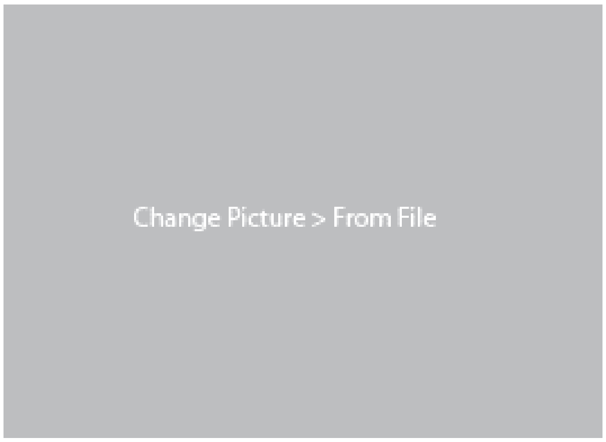
- Estimated CY to be removed: 1,200
- Estimated Cost: $214,500



Pond

21. Nokomis - Amelia

Drainage Area: 307 acres
Pond Volume: 13.8 AC-FT
Year Constructed: 2001



Design Intent:
The design intent of Amelia Pond was to improve water quality in Lake Nokomis.

Monitoring Data:
No monitoring data.

Sediment Accumulation:
- 2001-2010: 1.4% per year
- 2010-2016: 4.2% per year
- 2016-2016: 4.9% per year

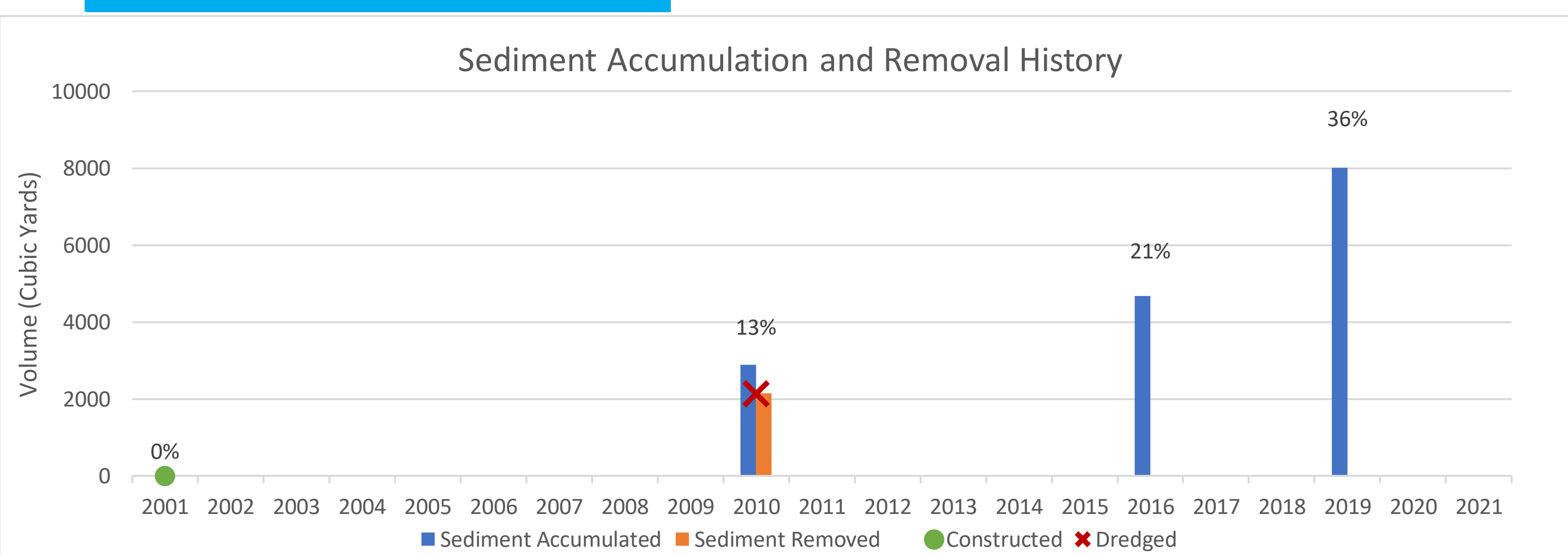
Dredging Data:
- 2004: 2,147 CY (10%)

Status & Recommendations:

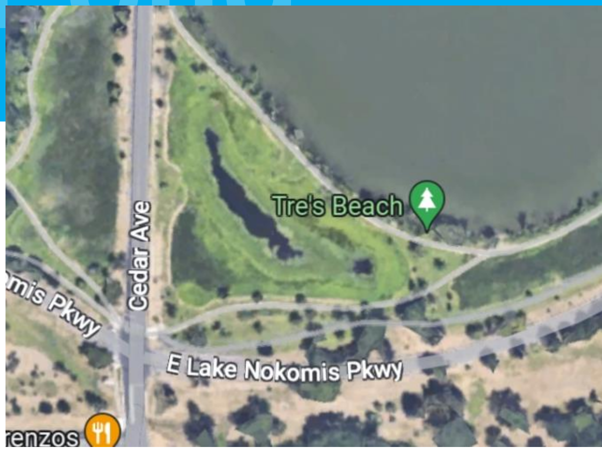
Performing
- 27% Full

Continue Sediment Surveys
- Next Survey: 2023

Estimated Dredging: 2024
- Estimated CY to be removed: 11,124
- Estimated Cost: $521,900

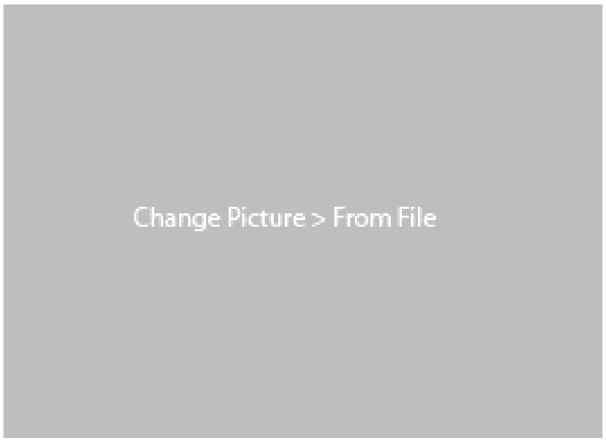


Pond



22. Nokomis - Gateway

Drainage Area: 307 acres
Pond Volume: 3.4 AC-FT
Year Constructed: 2001



Design Intent:
The design intent of Gateway Pond was to improve water quality in Lake Nokomis.

Monitoring Data:
No monitoring data.

Sediment Accumulation:

- 2001-2010: 1.4%
- 2010-2016: 0.8%
- 2016-2019: 0.6%

Dredging Data:

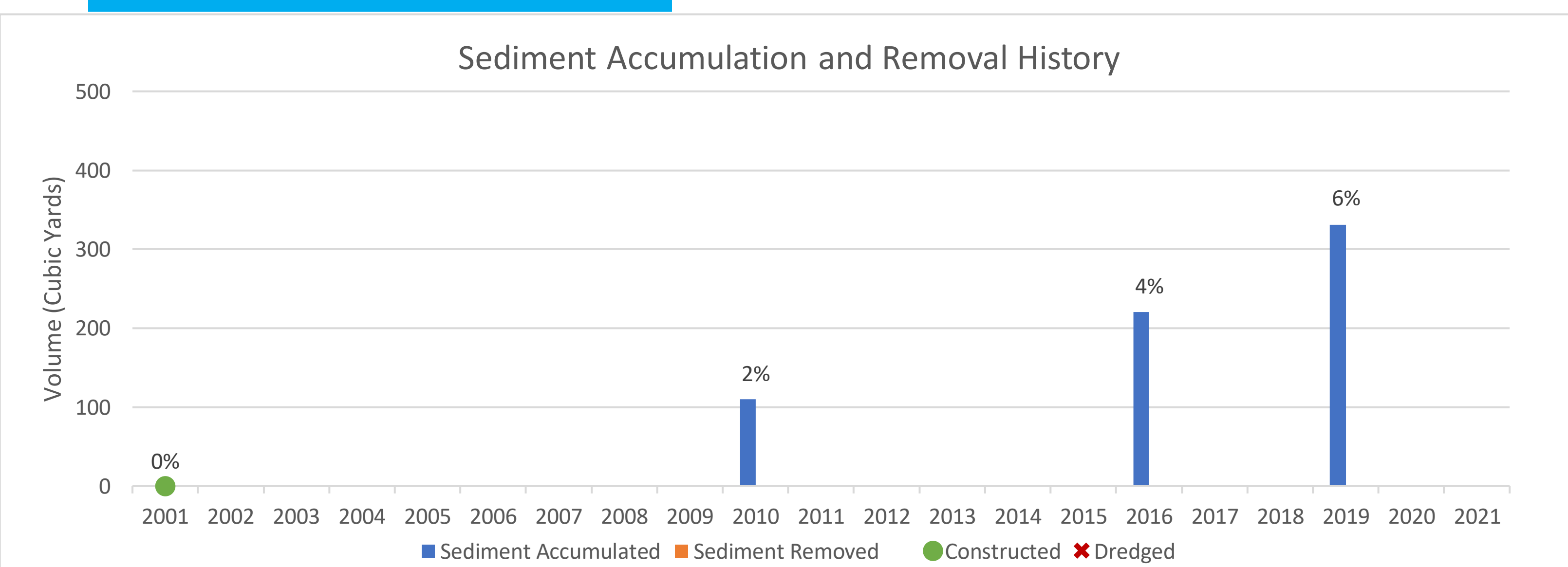
- Gateway has not been dredged since it was constructed in 2001.

Status & Recommendations:

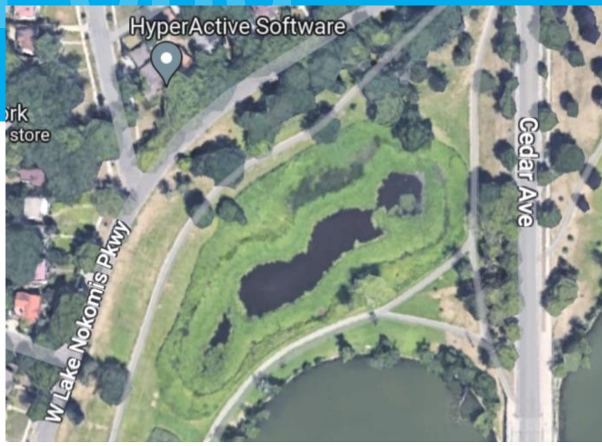
Not Performing

- 7% Full

Pause Surveys



Pond



23. Nokomis - Knoll

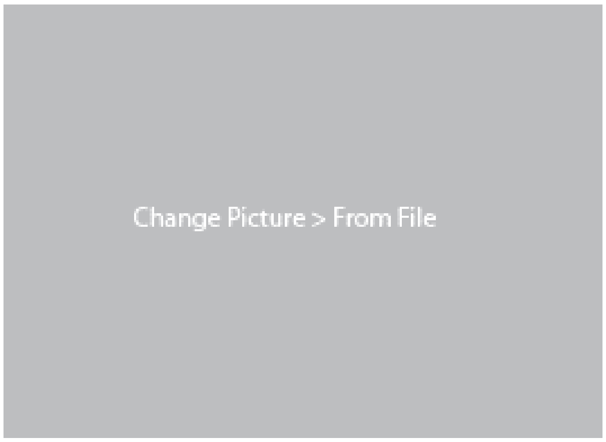
Drainage Area: 307 acres
Pond Volume: 4.2 AC-FT
Year Constructed: 2001

Design Intent:
The design intent of Knoll Pond was to improve water quality in Lake Nokomis.

Monitoring Data:
No monitoring data.

Sediment Accumulation:
- 2001-2005: 0.0%
- 2005-2016: 1.1%
- 2016-2019: 0.0%

Dredging Data:
- Knoll Pond has not been dredged since it was constructed in 2001.

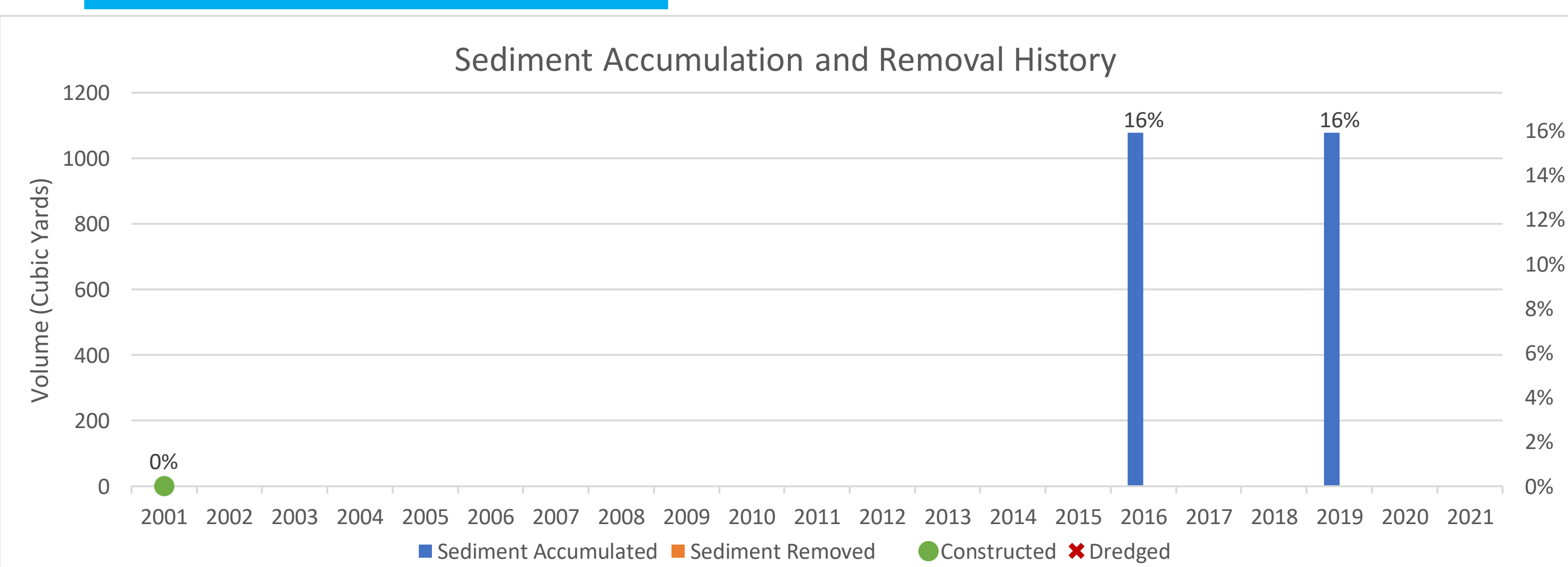


Status & Recommendations:

Not Performing

- 20% Full

Pause Surveys



Pond

24. Bde Maka Ska - 1

Drainage Area: 990 acres
Pond Volume: 3.1 AC-FT
Year Constructed: 1999

Design Intent:
Bde Maka Ska is a 3-celled system with a drainage area of 990 acres. The design intent of this system was to provide water quality treatment for urban runoff before draining into Lake Bde Maka Ska.

Monitoring Data:
Performance Monitoring was conducted in 1999 that indicated a 66% phosphorus removal and 85% TSS removal rate.

Sediment Accumulation:

Cell 1
- 1999-2004: 13% per year
- 2004-2011: 4% per year
- 2011-2018: 6% per year
- 2018-2021: 10% per year

Dredging Data:

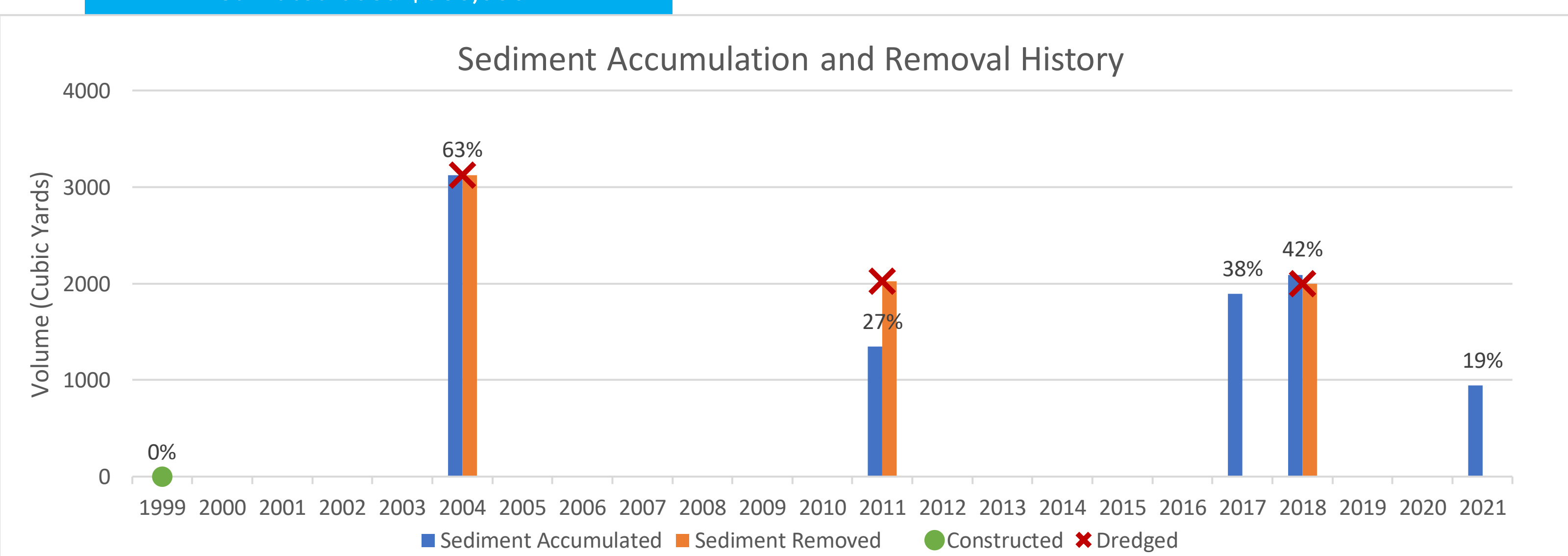
Cell 1
- 2004: 3,120 CY (63%)
- 2011: 2,024 CY (41%)
- 2019: 2,000 CY (40%)

Status & Recommendations:

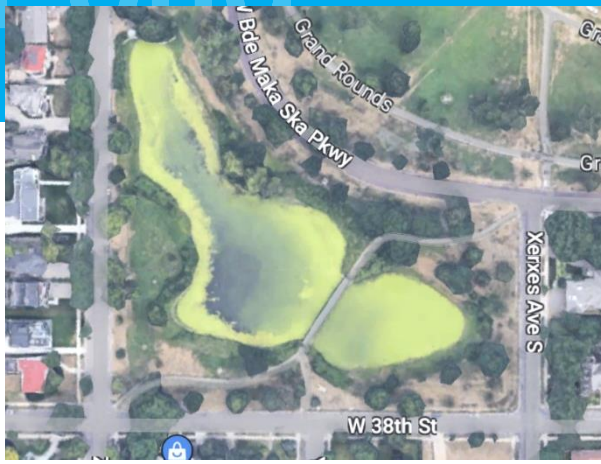
Performing
- 35% Full (2023 Estimate)

Continue Sediment Surveys
- Next Survey: 2024

Estimated Dredging: 2025
- Estimated CY to be removed: 2490 CY
- Estimated cost: $300,600

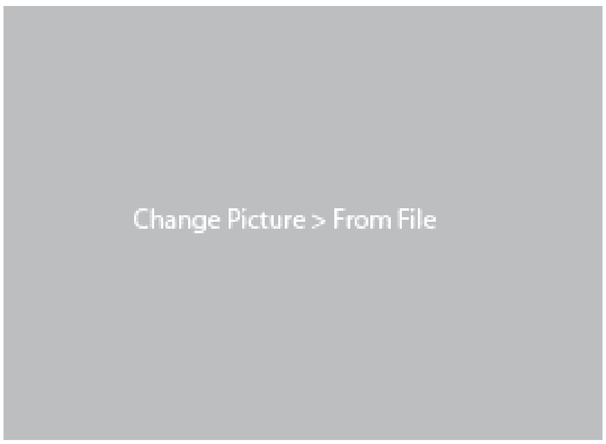


Pond



25. Bde Maka Ska - 2

Drainage Area: 990 acres
Pond Volume: 7.9 AC-FT
Year Constructed: 1999



Design Intent:
Bde Maka Ska is a 3-celled system with a drainage area of 990 acres. The design intent of this system was to provide water quality treatment for urban runoff before draining into Lake Bde Maka Ska.

Monitoring Data:
Performance Monitoring was conducted in 1999 that indicated a 66% phosphorus removal and 85% TSS removal rate.

Sediment Accumulation:

- 1999-2021: 3% per year

Dredging Data:

- Dredged in 2004 and the quantity of sediment removed was not recorded.

Status & Recommendations:

Underperforming

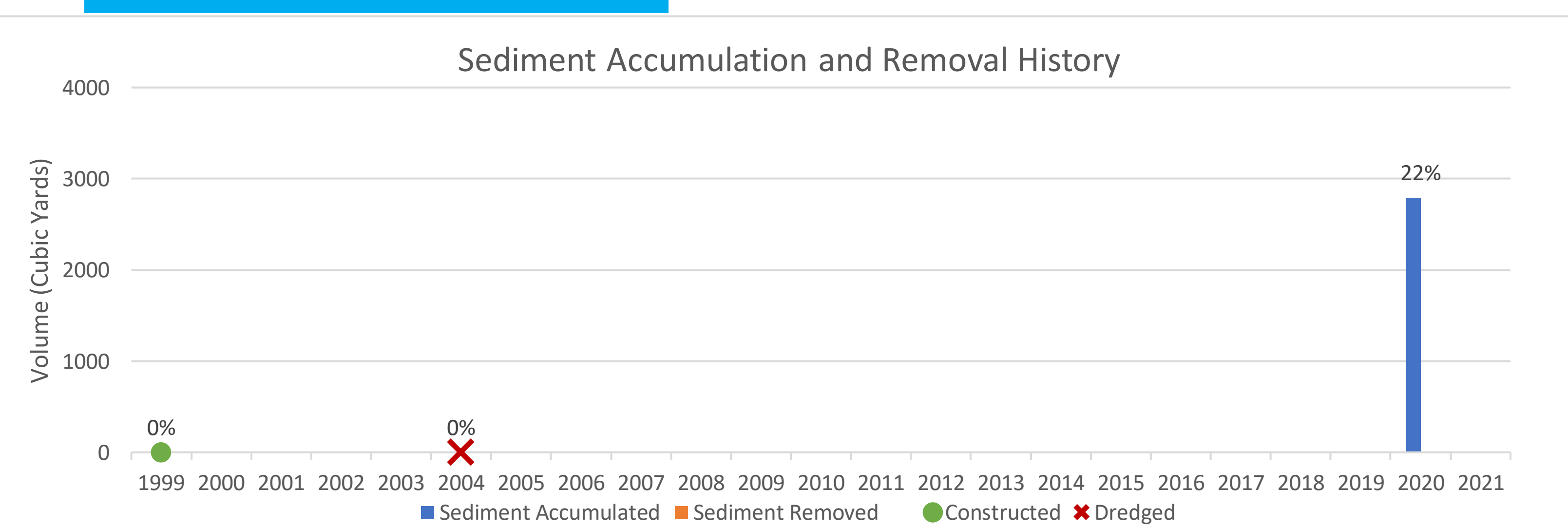
- 26% Full (2023 estimate)

Continue Sediment Surveys

- Next Survey: 2033

Estimated Dredging: 2040

- Estimated CY to be removed: 6350 CY
- Estimated cost: $642,000



Pond

26. Pamela Park - 1

Drainage Area: 297 acres
Pond Volume: 2.2 AC-FT
Year Constructed: 2001

Design Intent:
The design intent of the Pamela Park ponds was to treat stormwater and provide water quality improvements.

Monitoring Data:
No monitoring.

Sediment Accumulation:
2001-2015: 2.6%
2015-2018: 7.7%
2018-2021: 9.5%

Dredging Data:
2019. 1,800 CY (51%)

Status & Recommendations:

Performing

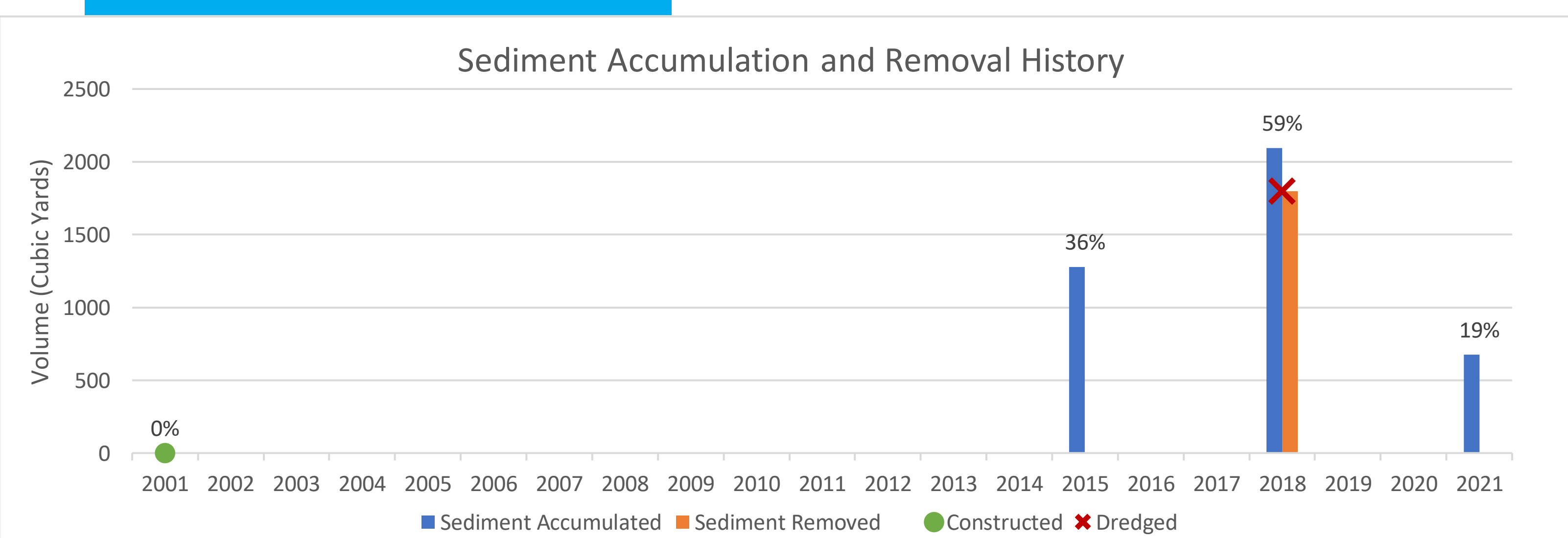
- 32% Full

Continue Sediment Surveys

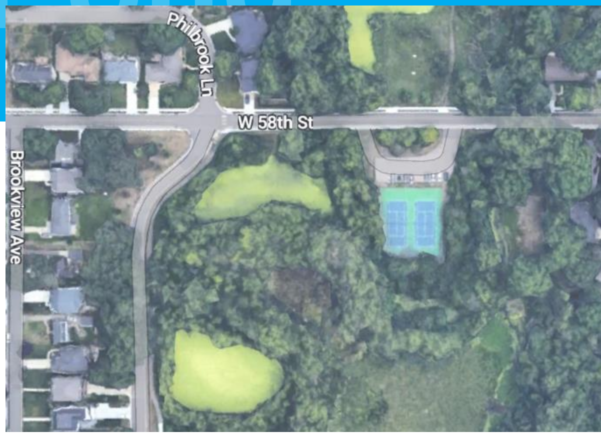
- Next Survey: 2024

Estimated Dredging: 2026

- Estimated CY to be removed: 1,780
- Estimated Cost: $248,400



Pond



27. Pamela Park - 2

Drainage Area: 297 acres
Pond Volume: 2.2 AC-FT
Year Constructed: 2001

Change Picture > From File

Design Intent:
The design intent of the Pamela Park ponds was to treat stormwater and provide water quality improvements.

Monitoring Data:
No monitoring.

Sediment Accumulation:
2001-2015: 1.5% per year
2015-2018: 5.7% per year
2018-2021: 0% per year

Dredging Data:
Pamela Park Cell 2 has not been dredged since it was constructed in 2001.

Status & Recommendations:

Underperforming

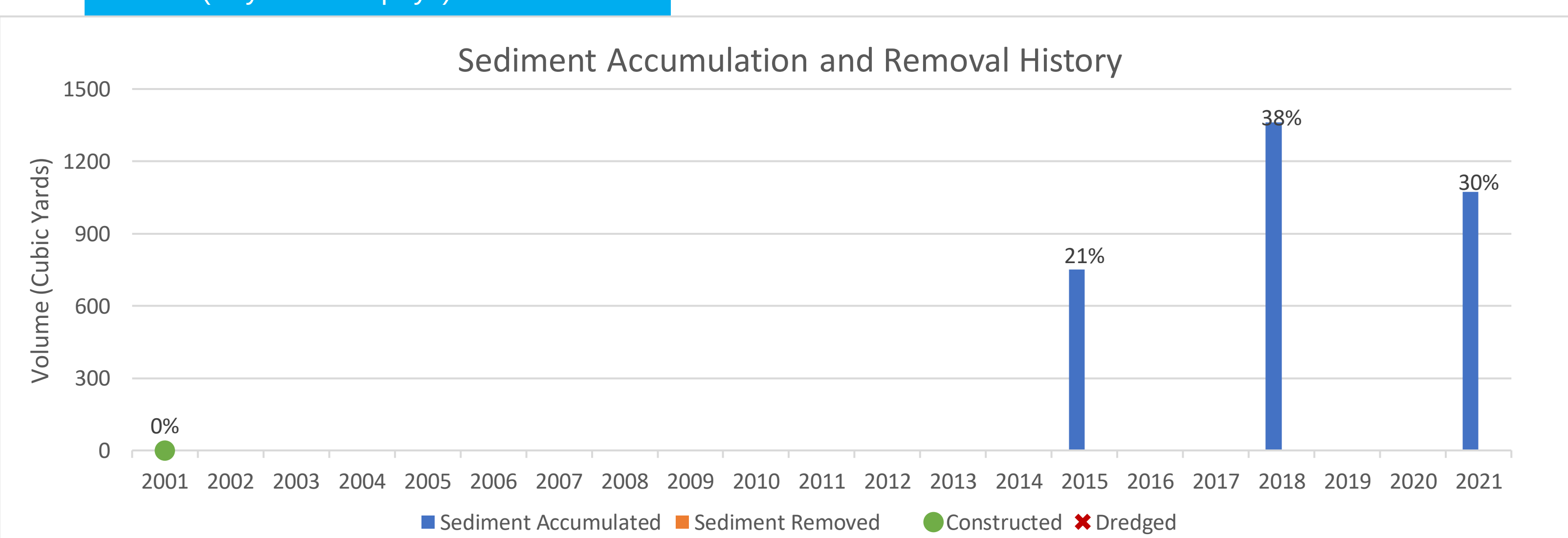
- 33% Full

Continue Sediment Surveys

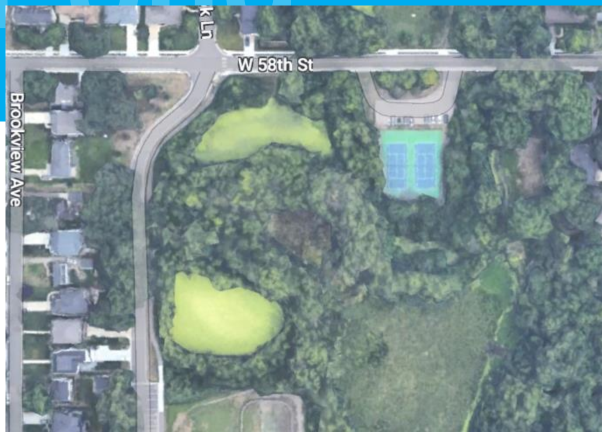
- Next Survey: 2028

Estimated Dredging: 2034

- Estimated CY to be removed: 1,790
- Estimated Cost: $292,600 (City of Edina pays)



Pond



28. Pamela Park -3

Drainage Area: 297 acres
Pond Volume: 2.9 AC-FT
Year Constructed: 2001

Change Picture > From File

Design Intent:
The design intent of the Pamela Park ponds was to treat stormwater and provide water quality improvements.

Monitoring Data:
No monitoring.

Sediment Accumulation:
2001-2015: 0.3% per year
2015-2018: 4.7% per year
2018-2021: 0% per year

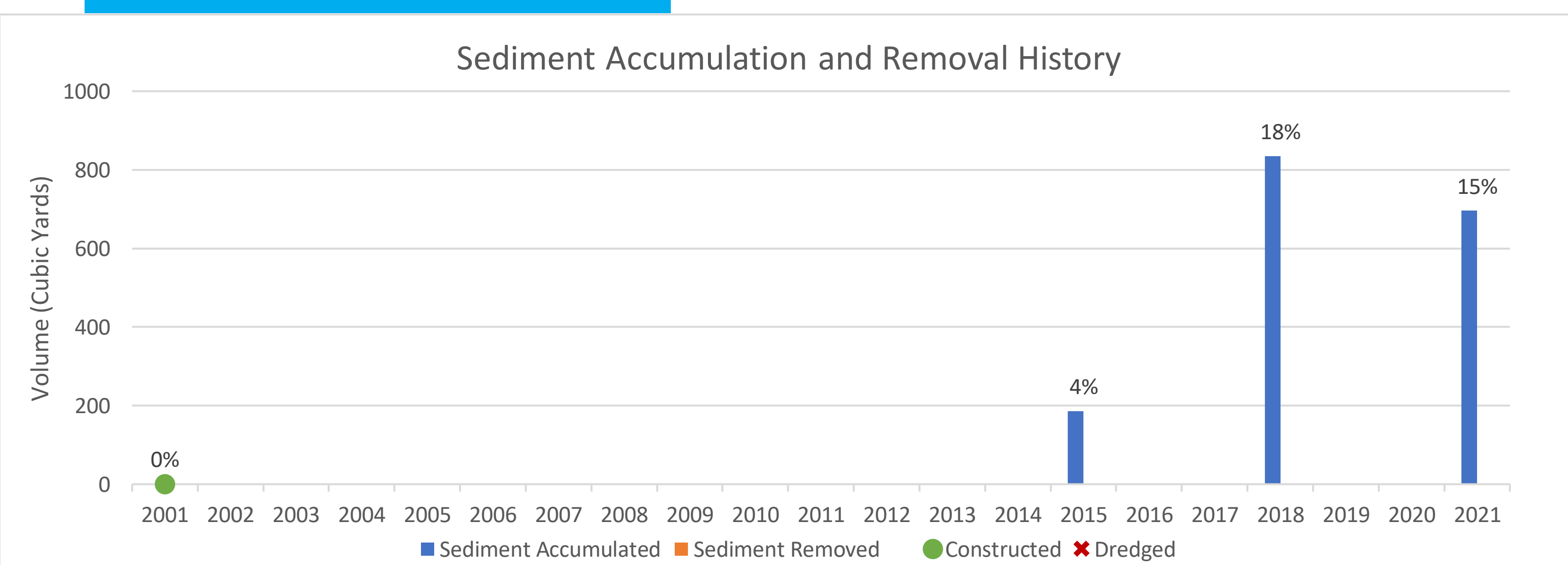
Dredging Data:
Pamela Park Cell 3 has not been dredged since it was constructed in 2001.

Status & Recommendations:

Not Performing

- 17% Full

Pause Surveys



Pond

29. Twin Lake Park Pond

Drainage Area: 1,390 acres
Pond Volume: 4.2 AC-FT
Year Constructed: 1996

Design Intent:
Twin Lake Park Pond is a single pond with a drainage area of 1,390. This pond was created as part of a larger project with the intent to improve water quality entering Cedar Lake. Twin Lake Park Pond treats water before entering Twin Lakes which ultimately drain to Cedar Lake.

Monitoring Data:
Performance monitoring was conducted 1996-1997 right after the ponds were built. In an average year (not dry or wet) Twin Lake Park pond showed a 25% phosphorus removal rate.

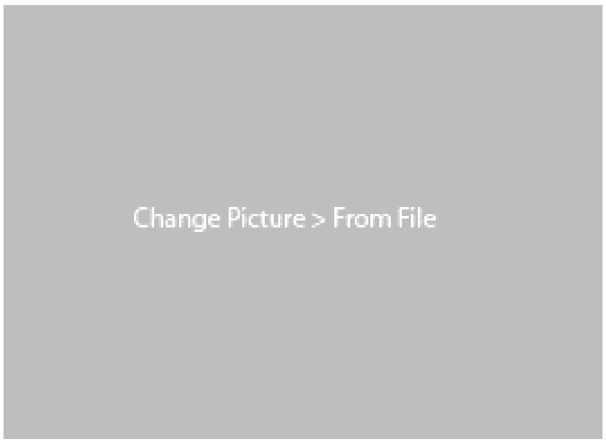
Sediment Accumulation:

- 1996-2004: 6% per year
- 2004-2011: 6% per year
- 2011-2021: 5% per year

Dredging Data:

- 2004: 3,403 CY (50%)
- 2012: 2,080 CY (*30%)

*Note this pond was 41% full prior to being dredging in 2012, so not all of the accumulated sediment was removed at that time.



Status & Recommendations:

Performing

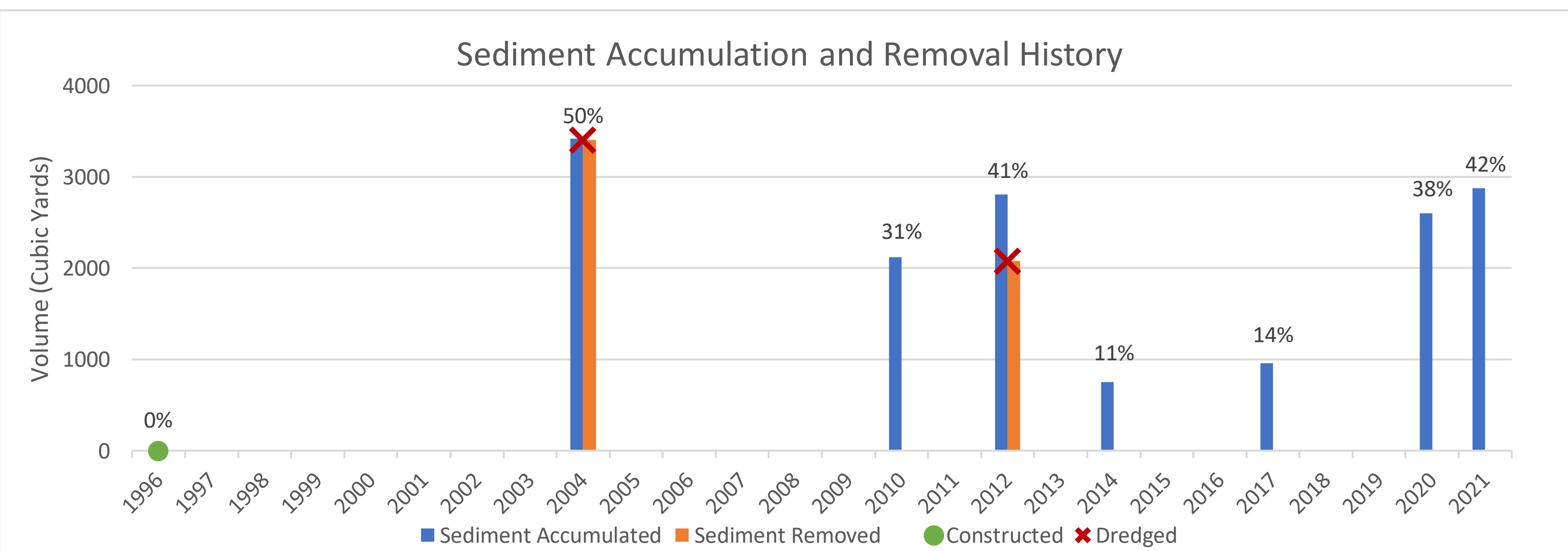
- 53% Full (2023 Estimate)

Continue Sediment Surveys

- Next Survey: 2024

Estimated Dredging: 2024

- Estimated CY to be removed: 4,020 CY
- Estimated cost: $375,100



Appendix B: Expected Accumulation Rate Calculations

According to the Minnesota Pollution Control Agency (MPCA) Minnesota Stormwater Manual, if no upstream BMP is present, ponds are to be designed with a forebay for pretreatment and a primary pool downstream. According to MPCA guidance, the forebay should be sized at 10% of the permanent pool volume. The Stormwater Manual provides guidance that forebays should be cleaned every 5-7 years and stormwater pond primary pools should be cleaned approximately every 25 years (or when a pond's permanent pool volume reaches 50% full).

The ponds located within the Minnehaha Creek Watershed are designed in a few different ways and thus Stantec has used this guidance from the MPCA to extrapolate expected accumulation rates. These methods are described below.

Design Level efficiencies are also applicable. Ponds designed to treat more runoff are more efficient at TSS removal compared to those designed to treat less. See below for Design Level efficiencies as listed in the Minnesota Stormwater Manual.

MIDS Stormwater Pond Design Level[1]	Permanent Pool Volume (V_{pp}), ft^3	Water Quality Volume (V_{wq}), ft^3	Pollutant reduction (%)[2]			
			TSS	TP	PP	DP
Design Level 1	≥ 1,800 ft^3 per acre of tributary area	<= 1 inch from impervious area	60	34	62	0
Design Level 2		<= 1 inch from impervious area	84	50	84	8
Design Level 3		<= 1.5 inch from impervious area	90	60	90	23

<u>**Traditional Pond:** this is a pond with a forebay and primary pool</u>

Within the forebay the anticipated accumulation is expected to be 50% every 5-7 years. Note that there are not any MCWD ponds that truly fit this definition, but this scenario is what State guidance is based on, so it is detailed here as a reference point.

Forebay

$$Low\ End\ Accumulation\ Rate\ (per\ year) = \frac{50\%}{7} = \mathbf{7}\%$$

$$High\ End\ Accumulation\ Rate\ (per\ year) = \frac{50\%}{5} = \mathbf{10}\%$$

Within the primary pool the anticipated sedimentation is approximately 25 years. To account for system variability and estimate a reasonable range, we have added thirty percent on the front and tail end of 25 years giving a range from 16.6-33.3 years thus:

Primary Pool

$$Low\ End\ Accumulation\ Rate\ (per\ year) = \frac{50\%}{33.3} = \mathbf{1.5}\%$$

$$High\ End\ Accumulation\ Rate\ (per\ year) = \frac{50\%}{16.6} = \mathbf{3}\%$$

<u>**Single Cell Pond:** this is a pond with no pretreatment and no forebay.</u>

In this scenario, the sediment usually captured in the forebay would now be dispersed across the main pool resulting in the following:

$$Low\ End\ Accumulation\ Rate\ (per\ year) = \frac{7\%}{10} + 1.5\% = \mathbf{2.2}\%$$

$$High\ End\ Accumulation\ Rate\ (per\ year) = \frac{10\%}{10} + 3\% = \mathbf{4}\%$$

<u>**Multi Cell Pond:** this is a pond system with multiple cells. There is no pretreatment prior to the multi-cell system.</u>

First Cell

In this scenario, the first cell is acting as a Single Cell Pond, only it's a fraction of the size. Of the MCWD ponds, the first cell of the multi cell systems generally range between 1/3 and 1/5 of the overall pond system volume. Thus, similar to the single cell pond, we take the expected accumulation for a forebay, and distribute it over a larger range. In the equations below the $0.\overline{3}$ and 0.2 represent how a first cell is typically between 1/3rd and 1/5th of total systems size, 0.1 represents how forebays are typically 1/10th of a ponds size.

$$Low\ End\ Accumulation\ Rate\ (per\ year)_1 = 7\% / \frac{0.\overline{3}}{0.1} = 2.3\%$$

$$High\ End\ Accumulation\ Rate\ (per\ year)_1 = 10\% / \frac{0.2}{0.1} = 5\%$$

$$X_1 = Accumulation\ before\ effieciency\ factor\ is\ applied$$

Because decreasing the size of the pond decreases efficiency, we account for this using the Design Level efficiencies. Due to their larger size, first cells are more efficient than forebays. We use the Design levels as a proxy to extrapolate that a Design Level 3 pond that is approximately 3-5 times larger than Design Level 1 is 1.5x more efficient.

$$Efficiency = \frac{Design\ Level\ 3}{Design\ Level\ 1} = \frac{90\%\ removal}{60\%\ removal} = \mathbf{1.5}$$

$$Low\ End\ Accumulation\ Rate\ (per\ year) = 2.3\% * 1.5 = \mathbf{3.2}\%$$

$$High\ End\ Accumulation\ Rate\ (per\ year) = 5\% * 1.5 = \mathbf{7.5}\%$$

Downstream Cells: downstream ponds act similar to the primary pool in Traditional Pond/Forebay systems.

Within the downstream cells, like primary pools of single celled ponds with forebays, the anticipated sedimentation is approximately 25 years. To account for system variability and estimate a reasonable range, we have added thirty percent on the front and tail end of 25 years giving a range from 16.6-33.3 years thus:

$$Low\ End\ Accumulation\ Rate\ (per\ year) = \frac{50\%}{33.3} = \mathbf{1.5}\%$$

$$High\ End\ Accumulation\ Rate\ (per\ year) = \frac{50\%}{16.6} = \mathbf{3}\%$$

Appendix C: Survey Data, Survey Schedule & Cost Estimates

The accompanying spreadsheet (Capital Improvement Summary) is used to summarize pond information, predict future dredging requirements, and generate dredging cost estimates over the next 20-year period. The spreadsheet contains 4 tabs: Pond Info, Cost, Survey & Dredge Estimator, Pond History, and Expected Accumulation Rates.

Pond Info

Pond Info contains the summarized data for each of the MCWD ponds including:

- Watershed
- Drainage Area
- Downstream Waterbody
- Pond Volume
- Year Built
- Dredging History
- Anticipated Contamination Status
- Party Responsible for Dredging Cost
- Pond Type: Single Cell, Multi-Cell (First Cell), Multi-Cell (Downstream Cell)
- Most Recent Percent Full
- Most Recent Survey Year
- Range of Accumulation Rates over ponds lifetime
- Lifetime average sediment accumulation rate[1]

From the most recent percent full, most recent survey year and lifetime average sediment accumulation rate, the following were calculated:

- Estimated Cleanout Date (Equation 1)
- Estimated Current Percent Full (Equation 2)

From the lifetime average accumulation rate and the expected accumulation rates calculated and described in Appendix B and in the Expected Accumulation Rates tab of this spreadsheet, each pond was classified in two ways:

- Performance Status (Description 1)
- Accumulation Compared to Expectation (Description 2)

[1] The lifetime average sediment accumulation rate was calculated using the historic sedimentation records. The average accumulation between construction and dredge or between dredges was calculated for as many times as the pond had been dredged. If it had been dredged multiple times each of those values were averaged. If the pond had never been dredged then the value was calculated using the accumulation rate from its construction to most recent survey.

Equation 1: Estimated Cleanout Date

$$\frac{0.5 * Most\ Recent\ \%\ Full}{Lifetime\ Average\ Accumulation\ Rate} * Most\ Recent\ Survey\ Year$$

Equation 2: Estimated % Full

$$[(2023 - Most\ Recent\ Survey\ Year) * Lifetime\ Accumulation\ Rate] + Most\ Recent\ \%\ Full$$

Description 1: Performance Status

Performance Status was determined by taking the lifetime sediment accumulation rate and comparing it to the expected accumulation rates calculated in Appendix B. The spreadsheet color codes each pond and associated information based on performance status.

- Performing (green) | If a pond had a lifetime sediment accumulation rate exceeding or 0.5% above the lower end of it's expected range, it was classified as performing.
- Underperforming (yellow) | If a pond had a lifetime sediment accumulation rate within 0.5% of the low end of the expected range it was classified as underperforming.
- Not Performing (red) | If a pond had a lifetime sediment accumulation rate below 0.5% of the low end of the expected range it was classified as not performing.

Description 2: Accumulation Compared to Expected

Accumulation compared to expected was classifies as On Target, Underaccumulating or Overaccumulating based on the expected accumulation rates calculated in Appendix B.

- If it was above the expected range, it was classified as Overaccumulating.
- If it was within range, it was classified as On Target.
- If it was below the range, it was classified as Under Accumulating.

In addition, if a pond had a wide range of accumulation rates between categories, it was also noted as variable and highlighted a shade darker within the spreadsheet.

Cost, Survey & Dredge Estimator

This tab carries over some of the same information from the Pond Info tab, but additionally includes information to help estimate cost including the following. Note that costs and survey needs were not estimated for ponds that were classified as not performing and were outside of the 20 year range.

- Anticipated Cost for Dredging / CY[2]
- Estimated 40% of PPV Year [Equation 3]
- Estimated 50% of PPV Year [Equation 4]
- Years between surveys [Equation 5]
- Years to reach 50% of PPV (from cleanout/construction) [Equation 6]

From this information the following was calculated for each of the applicable ponds:

- Estimated 1st Dredge [Equation 7]
- Estimated 2nd Dredge [Equation 8]
- Estimated 3rd Dredge [also Equation 8]
- The Estimated Cost for each anticipated dredge event was also calculated, taking into account future cost based on the year it would require dredging. [Equation 9]

Equation 3: Estimated 40% Full Year

$$\frac{0.4 - Most\ Recent\ \%\ Full}{Lifetime\ Sediment\ Accumulation\ Rate} + Most\ Recent\ Survey\ Year$$

Equation 4: Estimated 50% Full Year

$$\frac{0.5 - Most\ Recent\ \%\ Full}{Lifetime\ Sediment\ Accumulation\ Rate} + Most\ Recent\ Survey\ Year$$

Equation 5: Years between surveys

$$Estimated\ 50\%\ Full - Estimated\ 40\%\ Full$$

Equation 6: Years to reach 50% Full

$$\frac{0.5}{Lifetime\ Sediment\ Accumulation\ Rate}$$

[2] The anticipated cost of dredging / CY was calculated using historic bid tabs for similar projects including Pamela Park Pond and Bde Maka Ska Cell 1 (bid in 2018). A further description of how the cost per cubic yard was determined can be found in Appendix D.

Equation 7: Estimated 1st Dredge[3]

$$\frac{0.5 * Most\ Recent\ \%\ Full}{Lifetime\ Average\ Accumulation\ Rate} * Most\ Recent\ Survey\ Year$$

Equation 8: Estimated 2nd and 3rd Dredge

$$Most\ Recent\ Dredge\ Year + Years\ to\ Reach\ 50\%\ Full$$

Equation 9: Cost of Pond Dredging[4] [5]

$$Anticipated\ Cost\ /\ CY * (Pond\ Volume * 0.5^{6}) * 1.02^{Dredge\ Year - 2022}$$

For each year, for the next 20 years, the sum of the anticipated dredging costs was computed. An average cost per year was computed to help MCWD plan a long-term budget.

Year	**Dredging Cost (Probable)**	**Ponds to be dredged**[7]
2023	$ 296,217.48	Twin Lake Park, *Lakeside*, Steiger
2024	$ 1,300,781.86	Nokomis - Amelia, Long Lake North, Gleason Cell 1
2025	$ 300,586.74	Bde Maka Ska Cell 1
2026	$ 361,764.88	Pamela Cell 1
2027	$ -	
2028	$ 345,570.11	Cedar Meadows East
2029	$ 111,661.33	Gleason Cell 2
2030	$ 213,481.15	Long Lake Park South
2031	$ 338,509.49	Bde Maka Ska Cell 1, Twin Lake Park
2032	$ 214,450.95	Excelsior, Twin Lake Park
2033	$ 421,822.16	Pamela Cell 1
2034	$ 291,028.32	Pamela Cell 1, *Pamela Cell 2*
2035	$ 84,470.49	Johnson/Rolling Hills
2036	$ 509,698.39	Long Lake Park North, Gleason Cell 3

[3] For ponds that are estimated to be over 50% Full at the time this was written (2023), the calculated first dredge year was before 2023. For those ponds, the dredge year was manually entered as 2023.
[4] 1.02 is the specified inflation rate.
[5] 2022 is the baseline for the future cost equation because the cost estimates per cubic yard were generated for 2022 dollars.
[6] Ponds are planned to be dredged when they reach 50% full; for ponds that are currently exceeding 50% full this value was manually set to their anticipated percent full in 2023 for accurate cost estimates.
[7] Italicized ponds are ponds MCWD is not responsible for paying for.

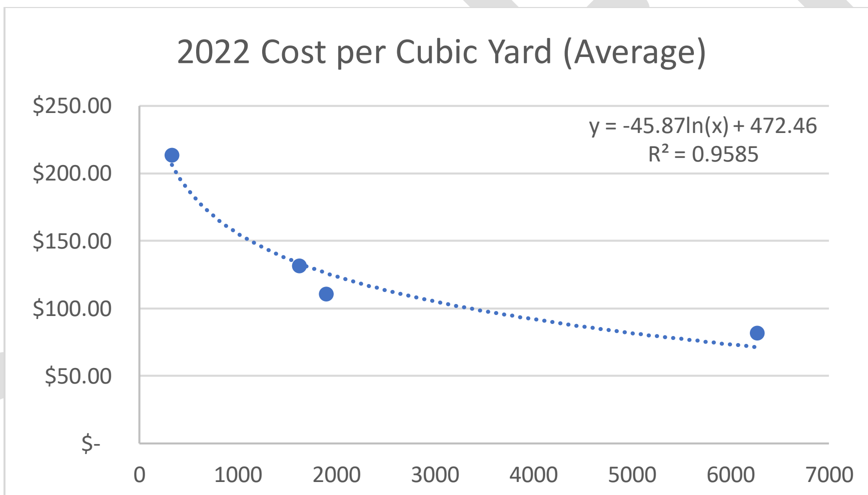
2037	$ 1,163,361.59	Cedar Meadows West, Gleason Cell 1, Bde Maka Ska Cell 1
2038	$ -	
2039	$ -	
2040	$ 642,047.36	Nokomis - Amelia, Bde Maka Ska Cell 1, Twin Lake Park
2041	$ 1,295,485.79	Pamela Cell 1, Gleason Cell 2, Steiger
2042	$ 1,584,035.93	*Glenbrook,* Pamela Cell 1
TOTAL	$ 9,778,377.77	
Average Cost/Year	$ 488,918.89	

Appendix D: Calculating Costs Using Historic Bids

This Appendix explains calculations done within the accompanying Spreadsheet, Calculating Unit Cost.

Stantec used historic bid tabs to compile project cost data[1] for 4 dredging projects: 2 in Eden Prairie (bid in 2022), 1 in Eagan (bid in 2021), and Pamela Park Pond (bid in 2018)[2]. The bid line items were filtered to only include items applicable to standard sediment removal services and summed to generate the total cost. That total cost was divided by the amount of sediment that was to be removed to obtain a unit cost: Project Cost / CY of sediment removal.

We applied a compound interest formula to compute the unit cost of all reviewed bids in 2022 dollars. The unit cost was plotted against the volume of sediment that was to be removed to generate an equation that could be used to calculate unit costs based on volume of sediment to be removed. The line of best fit was a logarithmic function of $-45.87*\ln(x) + 472.46$, where x = volume of sediment to be removed.



This logarithmic equation was used to calculate the 2022 unit cost of dredging for each of the MCWD ponds.

[1] Note that there were multiple bids for each project. Once a total was generated for each project bid, Stantec averaged those totals. Typically, the low bid is chosen so determining cost estimates using the average of the bids is a conservative approach.

[2] Bde Maka Ska Cell 1 bids were also investigated but it was found to be an outlier and we believe this is because the unusually easy access that pond has which lowers mobilization and erosion cost within the project. Thus to not artificially lower the predicted cost for dredging, Bde Maka Ska was not included in generating the line of best fit.

DRAFT - Memo

To:	Tiffany Schaufler Josh Wolf MCWD	From:	Ali Stone Chris Meehan Stantec
Project/File:	227703703	Date:	May 22, 2023

Reference: MCWD Stormwater Pond Capital Improvement Planning | Task 3: Retrofit Opportunities

Objective

Minnehaha Creek Watershed District (MCWD or District) is seeking to understand potential retrofits to enhance existing stormwater ponds. Stantec was asked to do a high-level screening and provide 1-2 options for retrofits for 4-6 of the performing ponds.

Methods / Limitations

Stantec compiled a comprehensive list of retrofits that have been implemented or are being researched across Minnesota. Sources of information included research funded by the Minnesota Research Council and MnDOT. The attached Appendix A includes the compiled list of retrofit options, intended use, and pros and cons for each.

Historic data on each of the ponds was used to inform which retrofits may best serve each pond in its current state. Information used included:

- Design Intent
- Current Issues
  - Sedimentation (rate, distribution, etc.)
  - Anoxic Conditions[1]
  - Algae presence
- Location
- Access

Recommendations

Retrofits are provided as options for four different ponds: Bde Maka Ska – Cell 1, Nokomis – Amelia, Twin Lake Park, and Gleason Cell 1

<u>Bde Maka Ska Pond - Cell 1</u>

1. Retrofit Type: Filter System

[1] Dissolved Oxygen (DO) profiles are often collected in early-season due to sediment survey timing. Ideally, more data would be collected throughout the summer and late summer to ensure an understanding of the DO profiles.

Rationale: Bde Maka Ska Pond Cell 1 receives a high dissolved phosphorus load, partially from Weber Park in Edina. Since this is not from internal loading, it could be a good option to target this dissolved phosphorus through a pumped filter system.

2. Retrofit Type: Sediment Cores to assess internal sediment loading; potential Alum Treatment or other dissolved P targeting practice

   Rationale: Bde Maka Ska Pond Cell 1 DO readings show it is anoxic which could trigger P release. Analyzing sediment cores would help understand the phosphorus release rates in the sediment and if they are high, an alum treatment could be applied. Reducing phosphorus in the water column might help algae blooms which would be particularly nice to address in an urban pond along a walking path.

<u>Nokomis - Amelia</u>

1. Retrofit Type: Pump Filter

   Rationale: Nokomis Amelia Pond has was designed with the goal to treat WQ. A filter system would help further achieve that goal. Since Nokomis Amelia Pond doesn't have the head to drive a traditional filter, a pump filter would be a good option.

2. Retrofit Type: Sediment Cores to assess internal sediment loading; potential Alum Treatment or other dissolved P targeting practice

   Rationale: Nokomis Amelia Pond DO readings show it is anoxic which could trigger P release. Analyzing sediment cores would help understand the phosphorus release rates in the sediment and if they are high an alum treatment could be applied. Reducing phosphorus in the water column might help algae blooms which would be particularly nice to address in an urban pond along a walking path.

<u>Twin Lake Park</u>

1. Retrofit Type: Pretreatment (likely storm sewer retrofit such as baffled sump or hydrodynamic separator)

   Rationale: Twin Lake Park Pond fills quickly with sediment, so capture of sediment before it reaches the pond would reduce the frequency of dredging. It may be cheaper to install a HDS and save money by dredging the pond less frequently.

2. Retrofit Type: Expand Pond

   Rationale: Twin Lake Park Pond experiences higher than expected sedimentation, indicating it may be undersized for the load it experiences. If the pond were to be expanded, less frequent dredging would be required.

<u>Gleason - Cell 1</u>

1. Retrofit Type: Baffles (to promote meander through the pond)

   Rationale: This pond has potential for short circuiting because the outlet is close to the inlet, this might be why the downstream cells are filling in more than expected, and the upstream cell is filling in less than expected. If more sediment were captured in the first cell, the sediment removal would be more concentrated and cheaper to complete.

2. Retrofit Type: Water Level Manipulation

   Rationale: By manipulating the water level in the pond, we could increase residence time and allow for further settling in the first cell of Gleason. Thus, less sediment would be washing downstream to cells 2 and 3 and dredging activity could be more consolidated to the first cell.

Appendix A: Retrofit Options

The table below contains retrofit or treatment options that may be applied to stormwater ponds. Options are grouped by primary goal type (i.e. flood control, sedimentation, phosphorus removal), though some options may be effective for multiple goals. Options are not listed in any particular order.

Retrofit or Treatment	General Notes / applicability	Pros	Cons
Flood Control			
Outlet modifications and/or normal water level changes	• Focus on sedimentation and/or flood storage and flood control	• Promote additional settling	• Permitting hurdles
Real time control	• Emerging technology, focus on flood control, utilization of existing storage capacity, opportunities to manipulate to promote additional settling	• Minimal capital expenditures and changes to land required	• Permitting hurdles • Complex design with intensive monitoring to ensure appropriate operating plan
Sedimentation			
Baffles to promote meander throughout the pond	• May help promote more sedimentation • Reduce short circuiting • Applicable if inlet and outlet are close to each other	• Promoted additional settling by providing a physical barrier and longer flow path	• Maintenance complexities • Constructability
Bathymetry modification / dredging / shape changes / adding storage	• Various modifications to pond geometry can increase residence time & settling	• Most easily implemented when constructing new ponds	• Difficult to retrofit due to space constraints
Additional pre-treatment (vegetated filter strips, sumps, hydrodynamic separators, forebays)	• Consider implementation prior to first cells of multi-celled systems • HDS can be tied into existing storm sewer, better suited for urban areas	• Reduces maintenance needs of actual pond • HDS can be underground with limited aboveground footprint • Opportunity to remove trash in urban areas	• Require routine maintenance • May require space or infrastructure tie-ins • Forebay sizing is based on “rule of thumb engineering” • Require additional real estate at inlet • HDS won’t remove dissolved P
Energy dissipation at inlet (baffles, vegetation) to minimize resuspension of sediments	• Applicable at ponds with high inflow rates • Consider implementation at first cells of multi-celled systems, if data shows scour	• Limit resuspension of particles by dissipating energy • Focus sedimentation at inlets, which focuses dredging efforts • Small footprint	• More frequent maintenance than whole-pond dredging
Dredging	• Routine removal of accumulated sediments, to be completed when permanent pool volume is 50% filled with sediment	• Potential for localized sediment removal effort	• Expensive, particularly if sediments need to be managed at landfills • Intrusive and results in significant disturbance if there is not easy access
Phosphorus Removal			
Alum dosing	• Binds sediment P release • Relevant when sediment P release is a concern in ponds that go anoxic	• Targets dissolved P • Doesn’t require physical modifications to pond • Relatively quick to implement (one season)	• Emerging practice in ponds, with unknown longevity due to sediment accumulation rates in ponds
Iron filings	• Emerging technology with unpublished results in MN • Relevant when sediment P release is a concern in ponds that go anoxic	• Targets dissolved P • Doesn’t require physical modifications to pond • Relatively quick to implement (one season)	• Results pending, especially regarding longevity • Unknown longevity due to sediment accumulation rates in ponds
Filter Bench (sand)	• Requires space adjacent to pond • Requires sufficient head to provide filtration • For ponds with high particulate P	• Minimal changes to pond footprint	• May require active system rather than passive (pumped vs gravity)

Filter Bench (iron enhanced)	• Requires space adjacent to pond • Requires sufficient head to provide filtration • For ponds with high dissolved P	• Minimal changes to pond footprint • Potential to remove dissolved P	• Clogging of iron • May require active system rather than passive (pumped vs gravity)
Cartridge filter (pumped or gravity)	• Requires space adjacent to pond • Requires sufficient head to provide filtration	• Potential to remove dissolved P • May be installed underground	• Expensive to replace cartridges • May need electrical
Mechanical aeration	• Areas of aesthetic concern, where sediment P release is an issue	• Keeps water column oxygenated with intent of limiting sediment P release • Aesthetic benefits • Limits floating vegetation	• Benefits not well established • Requires electrical
In-line alum flow treatment	• Areas with dissolved phosphorus issues	• Effective dissolved P removal	• Relatively innovative / new technology • Requires multi-celled system • Expensive • Energy and O&M intensive
Fisheries management	• Relevant when resuspension of sediment is a concern	• Biological, non-engineering solutions • Depending on migration patterns, carp barriers may be an option	• Difficult to fully resolve