



MEMORANDUM

To: File
Prepared by: Zahra Parhizgari, Environmental Engineer
Rober Muir, Manager, Stormwater
Date: November 3, 2025

Re: **Swan Lake Water Quality Management-
Water and Chloride Budget**

Introduction

This memorandum was prepared to describe the water balance model developed for Swan Lake based on the results of InfoWorks model completed in 2025. This memo analyzes the impact of various flow diversion scenarios on the water and chloride budget in Swan Lake based on existing information on chloride concentration in the Lake and sources of chloride.

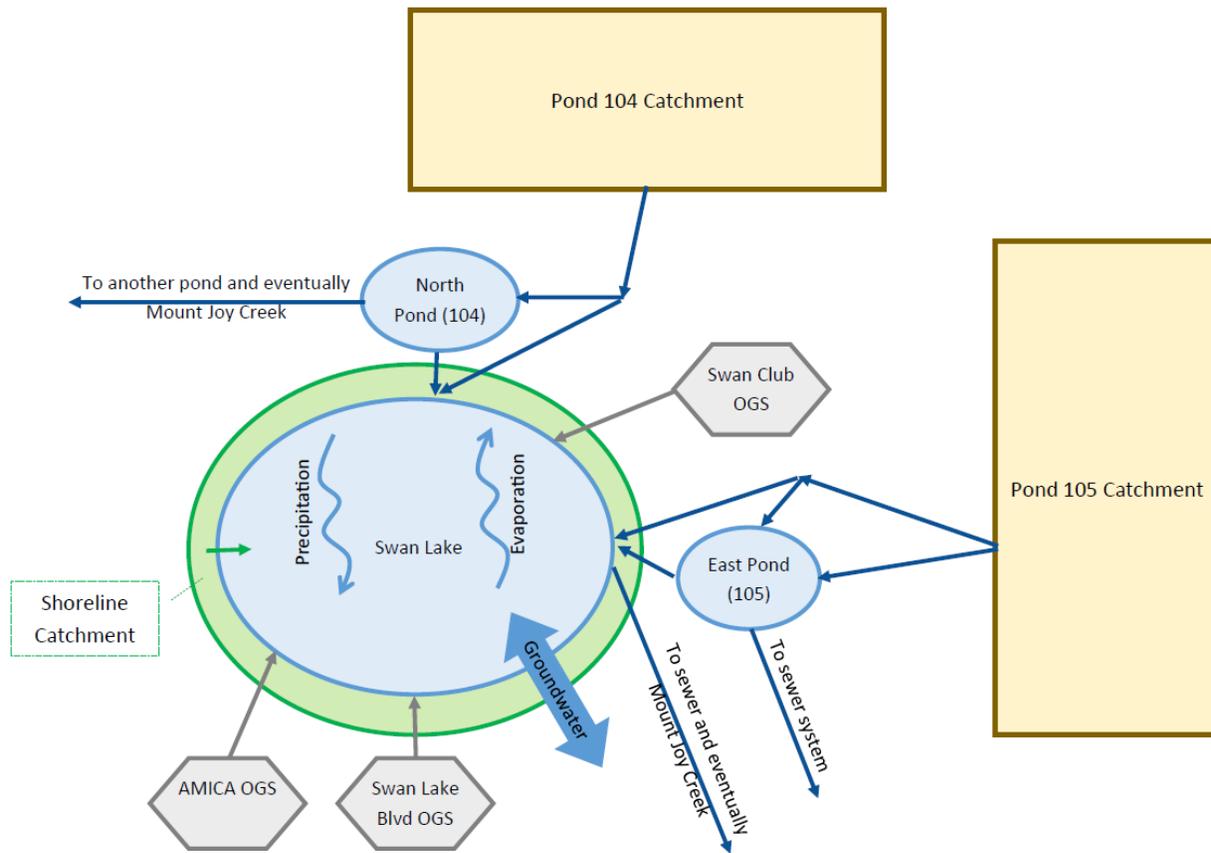
Water Flow Analysis

A conceptual model of flows in and out of Swan Lake is shown in Figure 1. Various components of this model and the methods used to quantify them are described below.

Drainage and Stormwater System

The Swan Lake catchment area is 42.9 ha (excluding the lake itself). In the Swan Lake catchment, runoff is collected by local storm sewers and conveyed to the North and East Ponds. Low intensity rainfall events drain directly into these ponds, while high intensity events are diverted to Swan Lake when flow levels are high enough to spill over weirs located at the inlet of each pond. The outflow from both Swan Lake and the East Pond (#105) is then collected by downstream storm sewers, ultimately discharging to the creek. The outflow from the North Pond (#104) is received by sewers which eventually discharge to City Pond #102 (not shown).

The major industrial, commercial, and institutional (ICI) zone in the study area is along the south shoreline of Swan Lake. Runoff in this area is pre-treated by three OGS units before draining to Swan Lake.

Figure 1: Swan Lake Conceptual Site Model

Modelling

In 2019, a PCSWMM model was developed by staff to model both minor and major systems continuously for all years since 2009. This model was further refined in subsequent years until 2022.

In 2023, the City retained AECOM Canada to develop a dual drainage hydraulic model using InfoWorks ICM to assess the feasibility of diverting stormwater runoff from the Lake without increasing the flood risk within the study area or downstream location. Details of methods used, and assumptions applied can be found in the Swan Lake Flow Diversion Assessment report (AECOM, May 2025).

As part of the modeling exercise, a continuous simulation was conducted for precipitation data from 2009 to 2024 for existing conditions, and for a representative year, which was determined to be 2013, for flow diversion scenarios.

Precipitation and Evaporation

Meteorological parameters are the most frequently measured and affect several components of the water balance analysis.

Precipitation data in 5-min intervals are available from the Markham Museum meteorological station, complemented with data from the Mount Joy Community Center station. Daily minimum, average, and maximum temperature are available from the Buttonville Airport station up to 2018 and from Toronto North York station after 2018.

Evapotranspiration (ET) rates are traditionally not measured and were calculated using climate data from the nearest stations, HY058. Based on data availability and the required resolution, ET was estimated using the Priestley-Taylor model (Priestley & Taylor, 1972).

Outflow

Once the Swan Lake water level exceeds an elevation of 208.3 m, excess storage is released through the foundation drain collection (FDC) system. A 165 mm orifice plate located at the outlet side of the Lake headwall adjacent to the East Pond controls the outflow from Swan Lake to the FDC system. The Lake release rate is limited to 100 L/s to accommodate the downstream drainage constraint at the 16th Ave. storm sewer (2-year peak flow of 1.166 m³/s).

Since there is no measurement of outflow, collected water level data were used to estimate outflow by assuming that discharge starts when the water level reaches an elevation of 208.3 m, i.e., the invert of the overflow weir. Water level data are available since 2017 for the ice-free periods.

Groundwater Exchange (and other uncertainties)

Available reports, including the 1995 Environmental Master Plan, various geotechnical reports prepared in support of development applications in the area, as well as reports on the methane gas ventilation system, were reviewed to develop an estimate of groundwater exchange between the Lake and the surrounding area. Based on these reports, groundwater flow in and out of the Lake was estimated to range between 10 and 300 m³/day; however, there is not enough spatial and temporal resolution to use these values in the water balance analysis.

Water Balance Results

A summary of the annual water balance results is provided in Table 1. Direct precipitation and evaporation from the Lake are based on data from meteorological stations. Inflow from various catchments is based on InfoWorks model simulation results. Outflow was estimated based on measured water level and limited measured outflows. The balance of all estimated components is shown as 'Balance', which could be attributed to uncertainties in the model assumptions, including outflows, as well as groundwater contribution.

Table 1: Average Water Balance Flows (m³/mon) for Existing Conditions for the Period of 2009-2024

Month	Direct Precipitation	Evaporation	North Pond	East Pond	Shoreline Runoff	SLB OGS	AMICA OGS	SC OGS	Outflow	Balance
Jan	2065	-388	383	1521	164	124	294	63	-2185	-2082
Feb	2062	-785	61	806	175	135	331	66	-1846	-1037
Mar	2653	-2645	300	1424	230	178	416	88	-2489	-174
Apr	4208	-4520	412	2084	390	298	695	152	-4572	846
May	3131	-7337	292	1501	309	244	551	119	-3667	4917
Jun	4320	-8380	579	1909	340	282	633	132	-5094	5297
Jul	3670	-8829	908	2602	340	305	599	131	-3893	4212
Aug	3633	-6989	901	2666	293	267	561	110	-3915	2490
Sep	2994	-4180	478	1826	257	213	465	99	-3284	1109
Oct	3613	-1803	296	1855	294	217	547	114	-3340	-1756
Nov	2270	-714	109	1178	201	143	373	77	-1965	-1663
Dec	2683	-317	75	1183	256	184	467	99	-2394	-2300

Note: Compared to the previous water balance analysis, that was based on a less detailed PCSWMM model, the current analysis shows lower flows from the North Pond and the uncontrolled shoreline runoff. These refinements affect the calculation of the un-accounted or the 'Balance' component.

Flow Diversion Scenarios

The following flow diversion scenarios were evaluated for impacts on water quantity and quality in Swan Lake:

1. Redirecting minor system flow from the AMICA OGS and Swan Lake Blvd. OGS units to the 16th Ave. sewers.
2. Redirecting the "first flush" portion (the most pollutant-laden runoff) of the minor system flow from the AMICA OGS and Swan Lake Blvd. OGS units to the 16th Ave. sewer.
3. Redirecting minor system flow from AMICA OGS and Swan Lake Blvd. OGS units to the Lake outlet.
4. Redirecting minor system flow from Swan Club OGS to the North Pond.
5. Adjusting the flow splitter weir for the East Pond and North Pond to reduce flow bypass to the Lake (5a). A modified version of this scenario was also modeled with upsizing of the inflow pipes (5b).
6. Expanding the storage capacity in the East Pond and North Pond to reduce flow bypass to the Lake (6a). Variations of this scenario included expanding the storage capacity for only the North Pond (6b), and only the East Pond (6c).
7. Several combinations were assessed, including Scenario 4 combined with Scenario 5a (7a), Scenario 4 combined with Scenario 5b (7b), and Scenario 4 combined with Scenario 6b (7c).
8. Creating underground storage capacity to attenuate the flows from AMICA OGS and Swan Lake Blvd. OGS before they enter the local sewer system.

Table 2 provides total annual flows into the Lake from each catchment under different flow diversion scenarios.

Table 2: Average Water Balance Flows (m³/year) for the Representative Year for Flow Diversion Scenarios

Scenario	Pond 104	Pond 105-north outlet	Pond 105-south outlet	SLB OGSs	AMICA OGSs	SC OGSs	Total Flow Reduction
Baseline	2586	4351	1355	2501	5770	1232	-
S1	2586	4351	1355	0	0	1232	46%
S2	2586	4351	1355	0	0	1232	46%
S3	2586	4351	1355	0	0	1232	46%
S4	2815	4351	1355	2501	5770	0	6%
S5a	1131	1407	704	2501	5770	1232	28%
S5b	896	1112	758	2501	5770	1232	31%
S6a	0	0	0	2501	5770	1232	47%
S6b	0	4351	1355	2501	5770	1232	15%
S6c	2586	0	0	2501	5770	1232	32%
S7a	1331	4351	1355	2501	5770	0	14%
S7b	1075	4351	1355	2501	5770	0	15%
S7c	0	4351	1355	2501	5770	0	21%
S8	2586	4351	1355	0	0	1232	46%

Chloride Analysis

Background

Chloride concentration has been increasing in urban lakes due to de-icer application for winter maintenance of roads and walkways. Chloride does not biodegrade, readily precipitate, volatilize, or bioaccumulate. It does not adsorb readily onto mineral surfaces, and therefore when introduced, concentrations remain high in surface water.

Chloride guidelines developed for generic environmental data include a long-term guideline (120 mg/L) and a short-term guideline (640 mg/L). The long-term guideline has been developed to protect all organisms (i.e., present in Canadian aquatic systems) against negative effects during continuous, indefinite exposure. The short-term guideline aims to protect most species against lethality during a sudden increase in chloride concentration for a short period (24-96 hrs). These guidelines may be over-protective for areas with an elevated concentration of chloride and associated adapted ecological communities. For such circumstances, it has been suggested that site-specific (higher) targets be derived considering local conditions such as water chemistry, background concentrations, and aquatic community structure.

Chloride Concentration

Water quality is regularly monitored at two shoreline sites, the Dock (S1) and the Bridge (S2). The water depth at the dock is approximately 2.5-3 meters, representing deeper sections of Swan Lake, and this station has historically been used to represent the 'whole lake'. The water depth at the bridge is about 0.5 meters deep, and it is used to represent the conditions of the shallow bays around Swan Lake.

In the earlier years of monitoring, sampling was completed at the deepest point in the Lake (Main or Central station, S3). Samples were not analyzed for chloride regularly, but conductivity was measured frequently. Conductivity has been found to be linearly related to chloride concentration in roadway runoff; however, there is higher variability in pond outlets due to the presence of other ions (MNDOT, 2017). About 60 Swan Lake samples with both chloride and conductivity measurements were reviewed, and a strong correlation was found between the two constituents, where conductivity ($\mu\text{s}/\text{cm}$) is about three times chloride concentration (mg/L).

Monthly averages for the three Lake stations (Dock, Bridge, Central, or S1/S2/S3) averaged over all depths (when available) are provided in Table 3.

Water quality testing results indicated that samples taken between 2017 and 2021 contained high chloride levels and decreased considerably since 2022 after the East pond inlet blockage was removed.

Monthly values have been highest in April-July and lower in Aug-Nov. Few data points are available for Jan-Mar as the Lake is frozen during this period. A possible explanation could be that chloride concentrations in the runoff are highest during snowmelt (March-April). Lake concentrations remain high through the spring and part of the summer until the Lake water is diluted with precipitation and unsalted runoff.

Table 3: Monthly Average Concentration of Chloride (mg/L) in the Lake

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Annual Average
2011								568	529	388		492
2012			294									294
2013		199			424		436	404	348	311	220	341
2014	318			462	432	481	472	401	300	320	239	383
2017				732	638	502	429	417	409	438	398	477
2018				457	585	558	590	615	393	392	345	511
2019				581	544		585	656	575	608	570	596
2020				711	717	717	762	749	742	753	717	737
2021	749		700	784	762	733	624	968	613	515	480	679
2022			255	438	447	485	500	490	463	470	438	425
2023	810		280	353	373	343	332	305	250	285	353	356
2024	695			253	255	230	203	193	190	210	253	257

Note: Estimated based on conductivity for 2011-2014, when few measurements of chloride are available.

Since 2022, water samples have been collected from various inlets to the Lake and analyzed for chloride. These data, along with scattered data from previous years, are shown in Table 4. Based on this limited dataset, chloride concentration in the winter melt/spring runoff from the pond catchments is about 1200 mg/L (average of pond inlet measurements). This concentration would not usually end up in the Lake, except through the East Pond bypass during the period that the northern inlet was blocked. At other times, the bypass would carry 'cleaner' water (after the first flush), with concentrations around 250 mg/L .

Samples were also collected from the Swan Lake Blvd. (SLB), AMICA OGS and Swan Club OGS (SC OGS- since 2024 after outlet cleanout) at the outfall to the Lake. The outfalls were not flowing during some sampling events, in which case, samples were collected from the pool of water

present. Average runoff concentrations from samples collected from SLB OGS, AMICA OGS SC OGS was about 1000 mg/L (excluding two samples assumed outliers).

Samples were also collected from the shoreline runoff, which resulted in very low chloride concentrations (about 25 mg/L).

Table 4: Chloride Concentrations in Inflow and Outflow from Ponds and OGSs

Date	East Pond			North Pond			OGSs		
	Pond Inlet	Pond	Inflows to Lake (bypass)	Pond Inflow	Pond	Inflow to Lake (bypass)	AMICA-OGS	SLB-OGS	SC-OGS
3/26/2021	957	343	-	98.5	199	-	-	-	-
4/11/2021	-	-	131	79	-	-	-	-	-
1/13/2022	-	-	-	-	-	-	-	3160	-
2/15/2022	2340	-	-	2120	-	-	360	836	-
3/6/2022	380	410	-	410	180	-	610	1200	-
3/16/2022	3700	-	-	3100	-	-	470	4800	-
3/24/2022	1200	-	150	1100	-	-	240	1900	-
4/6/2022	2800	-	350	-	-	-	1100	-	-
5/5/2022	-	-	370	-	-	-	-	-	-
1/18/2023	2000	-	240	1200	-	-	120	-	-
2/8/2023	3900	-	-	650	-	-	450	-	-
2/9/2023	360	-	-	340	-	-	300	420	-
3/24/2023	1300	-	180	765	-	120	-	-	-
1/15/2024	1900	-	270	210	-	-	2100	3300	4200
1/26/2024	560	-	150	-	-	280	-	320	680
2/29/2024	2467	-	333	-	-	-	-	-	-

Note: Some samples were from very low flow conditions and were excluded from averages.

Sources of Chloride

Salt usage data were obtained from the City's Road department and the Swan Lake Village Corporation.

Winter maintenance of 1 km of the catchment roads and sidewalks is completed by the City of Markham. The City prescribes and tracks the quantity of salt distributed to the City roadways based on current and future forecast models and temperatures to determine the required action and material usages in compliance with the desired service level of service and O.Reg. 239/02 requirements.

The City has used an average of 2,650 kg of salt per year over the past five years. Swan Lake Blvd (130 m of primary roads) received 920 kg of salt per year, while local roads north of Swan Lake (880 m) received 1730 kg of salt per year. About 40 salting events are completed for primary roads and 10 for local roads each year.

The remaining roads and parking areas, as well as private walkways and driveways are serviced privately.

As per the Village Amenities Committee (VAC) (M. Petit personal communication, February 2, 2022), the Village Corporation employs "a qualified, reputable cleaning and maintenance service employing Smart About Salt principles to plow/shovel and their insurance recommend the de-icing

methods of rock salt, applied as necessary to maintain their insurance and mitigate potential claim”. The amount of rock salt applied is about 88-110 tons per winter season, of which 30% is applied to the 14 km of single-lane kilometers of roadways plus parking areas, and 70% is applied to unit walkways and driveways and mail locations.

Information on salt usage in the AMICA property (0.75 ha) serviced by an OGS is not available. The amount of salt used in residential driveways north of Swan Park Road is not known. Table 5 provides the assumption used for salt usage in each catchment area.

Table 5: Salt Usage Assumptions

Area	Maintained by	Road Length (m)	Walkway/ Driveway/ Parking** (ha)	Road Salt (kg/yr)	Walkway/ Parking Salt (kg/yr)	Salt used (ton/event)	Cl Content ★ (kg/event)	Retention in soil
East Pond- north catchment	VAC	7800*	7.7	16600*	38500 *	1.4	496	0.4
East Pond- south catchment	VAC	1900*	1.9	4200 *	9600 *	0.3	124	0.4
North Pond	VAC	4300*	4.3	9200*	21400 *	0.8	230	0.5
SLC OGS	VAC	0	0.1	0	500 *	0.01	8	0
North Pond	City (local roads)	880	0	1700	10000 ***	1.2	115	0.35
SL Blvd	City (primary road)	130	0	900	0	0.02	14	0
AMICA OGS	AMICA	0	0.4	0	2000 +	0.1	31	0

Notes:

* 14 km (and associated salt usage) divided based on catchment area fractions (69% East pond, and 31% North Pond- in the East pond catchment, 80% drains to north inlet and 20% to south inlet)

** Assumed 50% of the surface area

*** Assumed the same application rate as in the Village by local resident

+ Assumed the same application rate as SLC OGS

★ 60% of rock salt is chloride

To refine the number of salting events for calculation purposes, snowfall information for each day was used, with a summary shown in Table 6.

Table 6: Annual Snowfall and Estimated Number of Salting Events

Year	Total Snowfall (cm)	Number of Snow Days (snowfall>0)	Estimated Number of Salting Events
2009	155	31	38
2010	81	33	35
2011	155	42	50
2012	105	30	35
2013	180	44	53
2014	176	37	44
2015	90	29	34
2016	163	43	51
2017	109	26	32
2018	144	39	48
2019	172	29	39
2020	151	31	37
2021	74	19	24
2022	119	26	30
2023	112	16	21
2024	63	14	17

Chloride Transport

Chloride in salting materials is readily dissolved in water and transported overland by runoff or infiltrated into soils, contaminating groundwater and surface water. A fraction of chloride in applied road salt is retained by soil and is not observed in surface runoff.

As a result, salt loading to surface water occurs primarily in winter and spring during melt conditions but continues through the summer and fall via the discharge of impacted groundwater, dry deposition of dust to the lake surface, non-point source runoff washing dry salt from land surfaces. Salt accumulated in the ponds could also be discharged into the Lake through the flushing of stormwater ponds.

Source Contributions to Chloride Levels in the Lake

In order to identify the most efficient strategy for reducing chloride loading to the Lake, a high-level estimate was made of the contribution of different sources. Two independent methods were used for this estimate, and adjustments were made to achieve similar results between the two methods.

The first method uses available runoff concentrations and modelled flows to estimate chloride input to the Lake. Model assumptions include:

- Runoff volumes were divided into catchments with different salting arrangements based on catchment areas.

- Runoff produced from December to April contains chloride concentrations of 250 mg/L for pond flows, 800 mg/L for SLB and SC OGS flows and 600 mg/L for AMICA OGS (after adjusting for consistency between the two methods). Chloride concentration in other months, and from the shoreline catchment was assumed at 25 mg/L.
- The northern inlet to the East Pond was blocked between 2018 and 2021, during which, chloride concentration in the lake inflow was set at 1200 mg/L.

The second method uses salt usage data and event numbers, as well as assumptions related to salt retention in soil. Model assumptions include:

- Salting operation occurred from December to March based on the number of snow events in each month (snowfall information from Toronto Buttonville station and Toronto North York station).
- Salt usage data were used to estimate the amount of salt applied in each catchment per event and the corresponding amount of chloride in runoff from the area.
- The fraction of runoff from each area discharged to the Lake (after passing through stormwater controls, if applicable) was estimated from the InfoWorks model. Average fractions were about 7% for the North Pond catchment and 11% for the East Pond (80% when the inlet was blocked) over all years. Monthly values were used in the calculations.
- Lower salt usage (up to 50%) was considered for years before 2016 to achieve similar results to the first method.

Estimated contributions are provided in Table 7 for the two methods. Average of the two methods for the last three years of calculations are shown in this table as well, indicating about three tons of chloride input into the Lake annually, half of which is from the three OGSs (no chloride treatment or water retention), about one ton from the East pond and about half ton from the North pond.

Given the many assumptions made for these estimates, the results should be used with caution. Nonetheless, both methods show a significant increase in chloride loading from the untreated runoff from the East Pond catchment. The blocked inlet causing this load was cleared in 2021, and therefore, this load will not be present in the future.

Table 7: Chloride Contribution (ton/yr) Estimated using Runoff Concentrations / Salt Usage Data

Year	Pond 104-Village	Pond 104-City	Pond105-south	Pond105-north	SC OGS	SL Blvd	AMICA OGS
Runoff Con. (mg/L)	250	250	250	1200	1000	1000	600
Salt Usage (ton/event)	0.77	1.17	0.34	1.38	0.01	0.02	0.05
2009	0.21/0.26	0.1/0.13	0.26/0.21	0.41/0.85	0.33/0.15	0.65/0.52	0.97/0.58
2010	0.19/0	0.09/0	0.18/0	0.32/0	0.26/0.13	0.5/0.47	0.81/0.52
2011	0.01/0	0/0	0.01/0	0.01/0	0.21/0.19	0.35/0.68	0.65/0.75
2012	0.11/0	0.05/0	0.08/0	0.22/0	0.21/0.14	0.42/0.48	0.66/0.54
2013	0.12/0.18	0.05/0.09	0.1/0.15	0.27/0.61	0.33/0.2	0.65/0.69	0.97/0.77
2014	0.07/0	0.03/0	0.06/0	0.14/0.01	0.21/0.15	0.4/0.52	0.62/0.58
2015	0.19/0.1	0.09/0.05	0.19/0.07	0.32/0.27	0.19/0.13	0.36/0.44	0.57/0.49
2016	0.01/0.02	0.01/0.01	0.05/0.09	0.09/0.36	0.33/0.34	0.63/0.63	1/1.32
2017	0.07/0.11	0.03/0.05	0.09/0.12	0.21/0.48	0.38/0.24	0.77/0.43	1.17/0.95
2018	0.12/0.08	0.06/0.04	0.09/3.46	16.04/13.83	0.32/0.27	0.61/0.48	1.1/1.07
2019	0.16/0.44	0.08/0.22	0.23/3.56	18.74/14.23	0.34/0.27	0.64/0.48	1.32/1.07
2020	0.67/0.74	0.31/0.37	0.65/3.28	25.17/13.14	0.47/0.25	0.95/0.44	1.66/0.98
2021	0.58/0.08	0.27/0.04	0.34/2.06	18.48/8.22	0.32/0.16	0.72/0.29	1.06/0.64
2022	0.08/0.15	0.04/0.08	0.09/0.12	0.16/0.49	0.29/0.22	0.56/0.39	1.11/0.86
2023	0.22/0.22	0.11/0.11	0.19/0.14	0.39/0.57	0.28/0.16	0.56/0.28	1.02/0.61
2024	0.51/0.35	0.24/0.18	0.5/0.35	1.06/1.41	0.41/0.13	0.82/0.23	1.53/0.52
Average of 2022-2024	0.26	0.12	0.23	0.68	0.25	0.47	0.94

Chloride Reduction due to Flow Diversion Scenarios

The runoff concentration methodology was applied to various flow diversion scenarios.

Table 8 provides total chloride contribution into the Lake from each catchment under different flow diversion scenarios for the representative year, 2013.

Unit costs for chloride reduction for each scenario were calculated based on the diversion scenario cost estimate provided in AECOM (2025) as shown in Table 9. A summary of other potential impacts is also provided for each scenario.

Table 8: Total Chloride Contribution (ton/year) for the Representative Year for Flow Diversion Scenarios

Scenario	Pond 104	Pond 105-north outlet	Pond 105-south outlet	SLB OGSs	AMICA OGSs	SC OGSs	Total Chloride Contribution
Baseline	0.17	0.27	0.10	0.46	0.87	0.24	2.12
S1	0.17	0.27	0.10	0.00	0.00	0.24	0.78
S2	0.17	0.27	0.10	0.00	0.00	0.24	0.78
S3	0.17	0.27	0.10	0.00	0.00	0.24	0.78
S4	0.18	0.27	0.10	0.46	0.87	0.00	1.88
S5a	0.07	0.08	0.05	0.46	0.87	0.24	1.78
S5b	0.06	0.07	0.05	0.46	0.87	0.24	1.76
S6a	0.00	0.00	0.00	0.46	0.87	0.24	1.58
S6b	0.00	0.27	0.10	0.46	0.87	0.24	1.95
S6c	0.17	0.00	0.00	0.46	0.87	0.24	1.75
S7a	0.08	0.27	0.10	0.46	0.87	0.00	1.78
S7b	0.07	0.27	0.10	0.46	0.87	0.00	1.78
S7c	0.00	0.27	0.10	0.46	0.87	0.00	1.70
S8	0.17	0.27	0.10	0.00	0.00	0.24	0.78

Table 9: Unit Price for Chloride Reduction for Flow Diversion Scenarios

Scenario	Cost (M\$)	Chloride Reduction (ton/yr)	Cl reduction cost (\$M/ton/yr)	Other Potential Impacts
S1	7.06	1.34	\$5.29	Requires downstream pipe upgrade
S2	1.11	1.34	\$0.83	Risk of backflow
S3	1.76	1.34	\$1.32	-
S4	0.28	0.23	\$1.18	Low effectiveness due to constraint at North Pond
S5a	0.03	0.34	\$0.09	Increases risk of basement flooding, potential for bypass, ownership
S5b	0.12	0.36	\$0.35	Increases flow bypass, ownership
S6	2.96	0.54	\$5.50	Disturbance and loss of park and maintenance area, ownership
S6b	1.66	0.17	\$9.71	Significant soil removal, disturbance and loss of park area, ownership
S6c	1.30	0.37	\$3.54	Constraint by roadway and trails, limited space for pond cleaning, ownership
S7a	0.29	0.33	\$0.86	Ownership
S7b	0.32	0.34	\$0.92	Ownership
S7c	1.90	0.41	\$4.58	Significant soil removal, disturbance and loss of park area
S8	6.10	1.34	\$4.56	Requires underground storage construction

Chloride Management and Mitigation Strategy

The 2021 Swan Lake Long-Term Management Plan is currently under review to evaluate the outcome of management activities implemented to date and determine the need for any new measures. If the review indicates a need to further reduce chloride concentrations (which are already within the interim targets), further studies could be completed on the scenarios with the highest reduction and least adverse effects, such as redirecting OGS flows.

Research into the effectiveness of biochar for chloride removal is also underway by York University through partial funding by the City of Markham.

Other measures that could be considered if chloride concentration is found to affect the Lake's health may include managing the de-icing material application rate and type (e.g., sand and salt mix or other material instead of rock salt, salting equipment calibration) to achieve an optimum value that addresses safety concerns as well as chloride load.

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