Swan Lake

Water Quality Improvement Program

June 15, 2020

General Committee

Environmental Services
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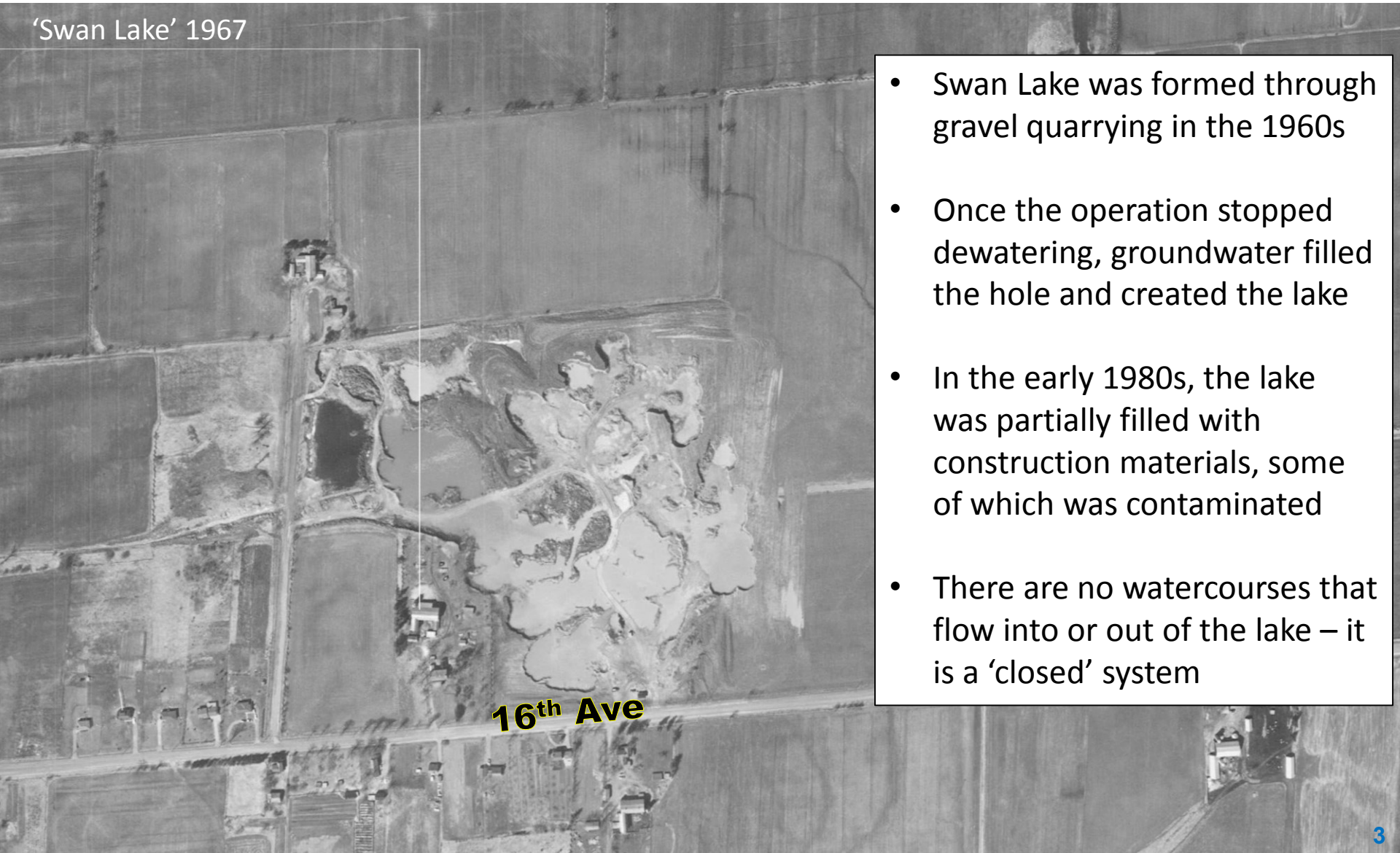
Agenda

- Purpose
- Background, Ownership & Regulatory Requirements
- Water Quality Overview & Measured Conditions
- City Activities
- Proposed Levels of Service
- Summary of Options & Treatment Strategy
- Recommendations & Next Steps

Purpose

- To establish a level of service for the water quality in Swan Lake that will guide the City's activities moving forward

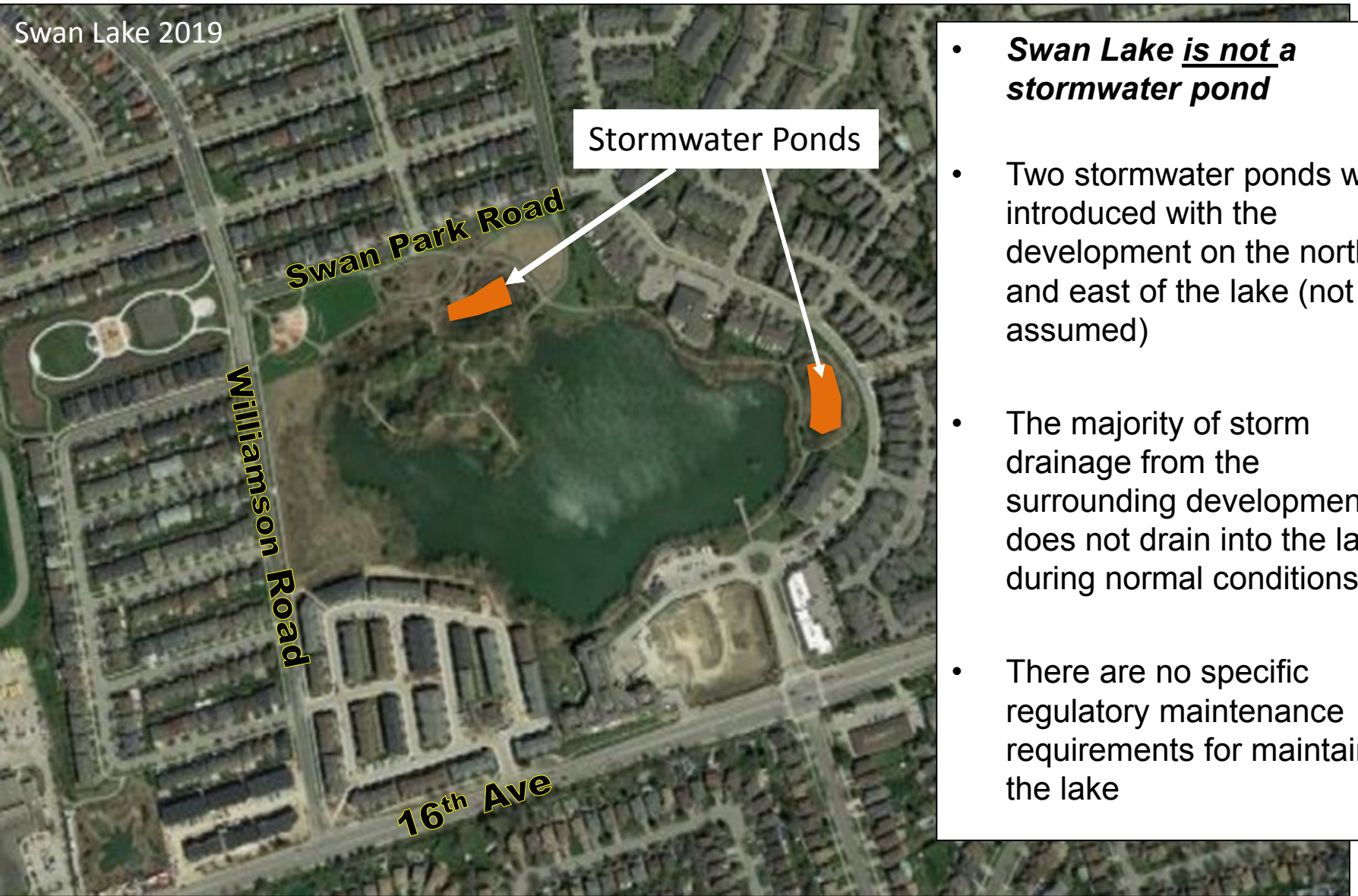
Background



- Swan Lake was formed through gravel quarrying in the 1960s
- Once the operation stopped dewatering, groundwater filled the hole and created the lake
- In the early 1980s, the lake was partially filled with construction materials, some of which was contaminated
- There are no watercourses that flow into or out of the lake – it is a 'closed' system

Property Ownership

Regulatory Requirements

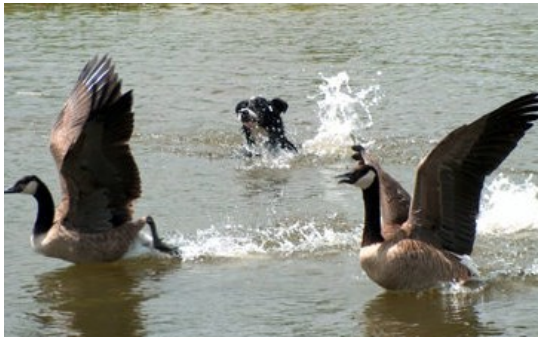


- ***Swan Lake <u>is not</u> a stormwater pond***
- Two stormwater ponds were introduced with the development on the north and east of the lake (not yet assumed)
- The majority of storm drainage from the surrounding development does not drain into the lake during normal conditions
- There are no specific regulatory maintenance requirements for maintaining the lake

Water Quality Overview

- Lakes are classified as follows:
  - Oligotrophic (pristine)
  - Mesotrophic (clear with some submerged plants)
  - Eutrophic (somewhat unclear, lots of plant growth)
  - Hyper-eutrophic (unclear, with frequent algal blooms)

- Swan Lake appears to have had water quality issues since it was formed – unlikely that it was in a mesotrophic state or better since early 90s



- The system is 'closed' – no flushing means that contaminants will build up over time and water quality will get worse

- As water quality worsens, the following occurs:
  - Water clarity decreases
  - Loss of desirable fish species and fish kills
  - Extent and frequency of algae blooms increase

City Activities

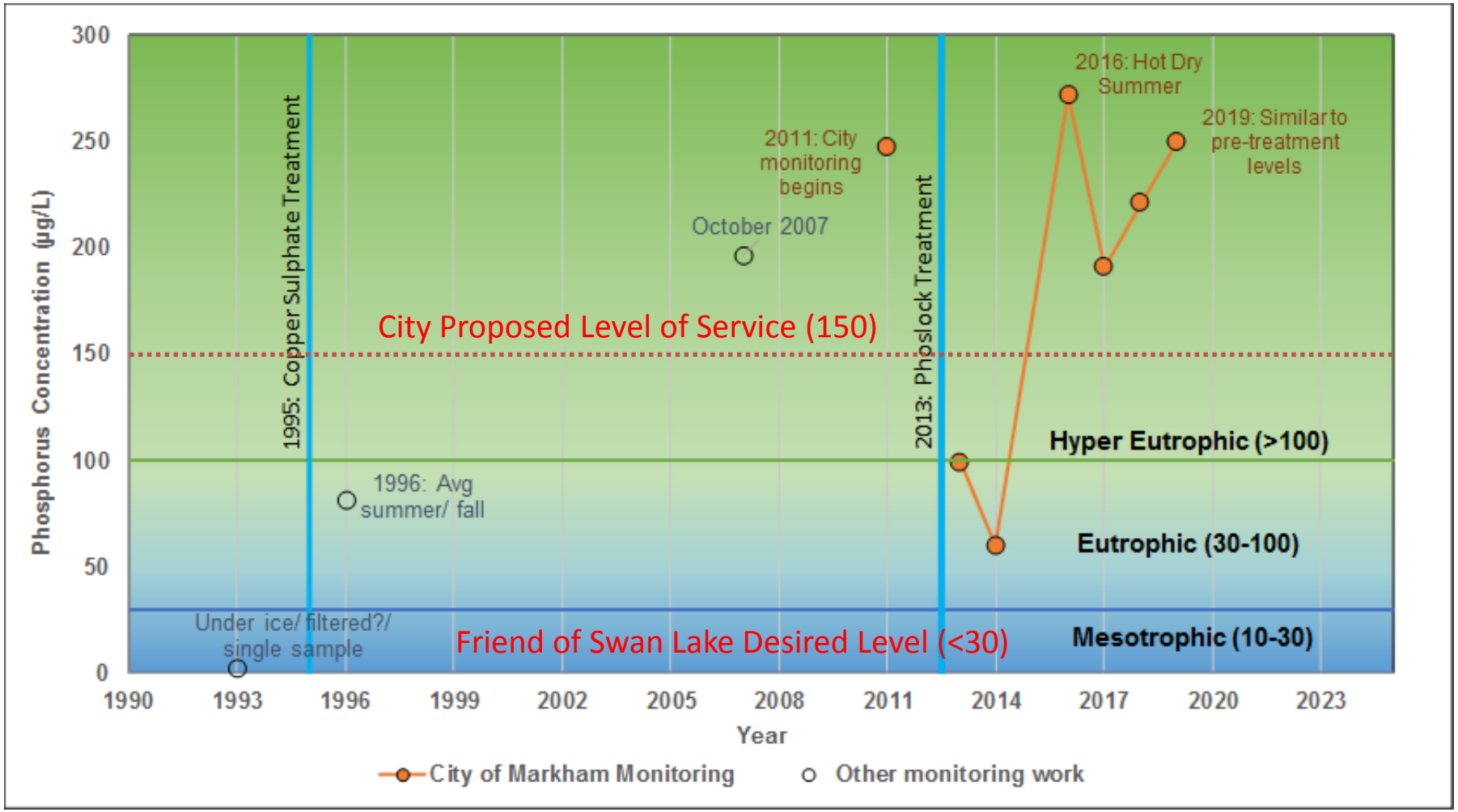
- The City has completed the following activities at Swan Lake
  - 2011 City initiated monitoring – Lake at Hyper-eutrophic level (extremely rich in nutrients)
  - 2013 Phoslock application
  - 2014 Geese control initiated (hazing/egg oiling/shoreline planting)
  - 2019 Water quality strategy study initiated

- To manage the conditions and **slow** the rate of water quality degradation, the following ongoing activities are required:

  - Water Quality Monitoring – to assess the state of the lake and plan future activities (started since 2011)
  - Geese control – to reduce nutrient loading into the lake (started since 2014)
  - Fish Management – to reduce number of bottom feeding fish which stir up sediment containing nutrients (NEW recommendation in this report)
  - Signage maintenance

- The annual cost for these activities are $45,000.

Measured Phosphorus Levels in Swan Lake



Level of Service

Community Request

- Significant improvement to water quality
  - Mesotrophic level (10-30µg/l phosphorus concentration)

City Proposed Level of Service

- Balanced approach to lake management, based on Consultant recommendations
- Maintain water quality at an acceptable level during typical weather conditions
  - Low end Hypereutrophic state in the lake (~150µg/l phosphorus concentration)
  - Complete treatment after 2 summers measured above 150µg/l

Potential Options Explored

Option #	Name	Description
#1	Do Nothing	Suspending all work
#2	Status Quo	Existing water quality monitoring and geese control program
#3	Biological Treatment	Aquatic plantings, fish stocking, etc. to biologically remove phosphorus
#4	Chemical Treatment	Dosing of the lake with aluminum or Phoslock® to reduce nutrient levels which lead to algae growth in the water
#5	Aeration	Using bubblers, fountains, etc. to add oxygen to the water and prevent algae from growing
#6	Withdrawal and Treatment	Pump water out of the lake, treat water, and pump back into lake
#7	Partial Filling	Fill shallow lake areas where algae blooms are most prominent
#8	Complete Filling	Fill lake in and convert area to green space and/or larger park
#9	Inlets/Outlet Modification	Redirect drainage from surrounding subdivisions into the lake to allow flushing of the system through a new outlet
#10	Dredging	Remove the sediment from the bottom of the lake as it is the primary source of nutrients

Option 1 - Do Nothing

Overview of Option

No water quality work at Swan Lake would be pursued in the future

Costs

$0

Technical feasibility & effectiveness	•	High end hyper-eutrophic state with very high nutrient levels and extensive algae growth would be expected – does not meet City or Community Level of Service
Environmental benefits & impacts	•	Environment degradation with severe algae blooms in the short term is expected
Social benefits	•	Lake would become eyesore and emit odour - negative impact to recreational use of surrounding park

Not Recommended – would not improve water quality

Option 2 – Continue Ongoing Activities

Overview of Option

Continue with the existing geese management and water quality monitoring programs

Costs

$45,000 / year

Technical feasibility & effectiveness	• High end hyper-eutrophic state with very high nutrient levels and extensive algae growth would be expected – does not meet City or Community Level of Service
Environmental benefits & impacts	• Environment degradation would be delayed, but severe algae blooms in the medium to long term is expected
Social benefits	• Lake would become eyesore and emit odour - negative impact to recreational use of surrounding park

Not Recommended – would not improve water quality

Option 3 - Biological Treatment

Overview of Option

Filtration of lake contamination by aquatic plants, fish stocking, or injection of live micro-organisms

Costs

$50,000

Technical feasibility & effectiveness	• Technology not well suited to conditions in this lake – successful reduction in phosphorus levels are very low • High end hyper-eutrophic state with very high nutrient levels and extensive algae growth would be expected – does not meet City or Community Level of Service
Environmental benefits & impacts	• Environment degradation with severe algae blooms in the short term is expected
Social benefits & costs:	• Lake would become eyesore and emit odour - negative impact to recreational use of surrounding park

Not Recommended – would not sufficiently improve water quality

Option 4 - Chemical Treatment

Overview of Option

Periodic application of a chemical (Phoslock, aluminum compounds or other) that would reduce the nutrient concentration in the water that leads to algae blooms

Costs

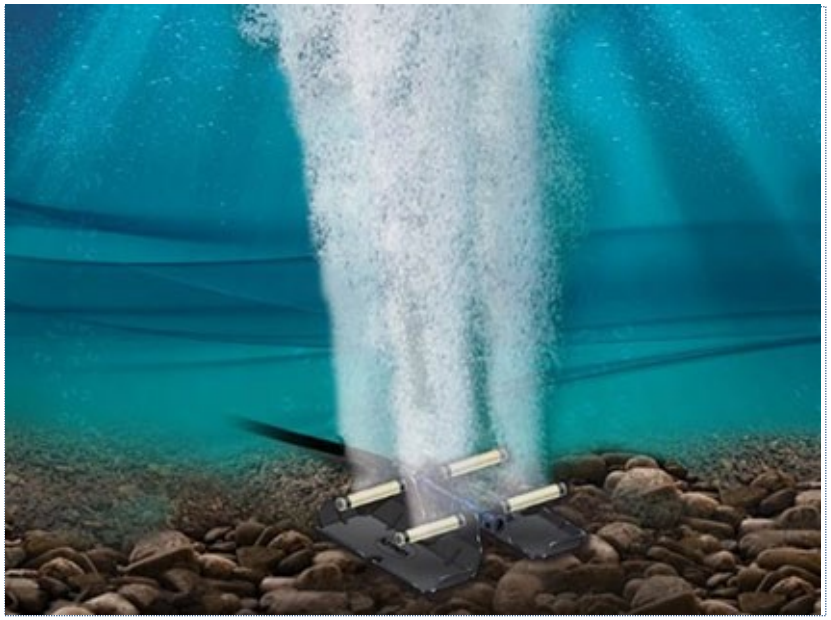
$250,000 per application (Applications at a 3-7 year interval are required to maintain City Level of Service)

Note: Applications required at 2 year interval without ongoing activities

Technical feasibility & effectiveness	• Past chemical treatment has been shown to be effective in improving water quality to eutrophic state • Would be suitable for meeting City Level of Service but not Community Level of Service
Environmental benefits & impacts	• Improves water quality and would be capable of sustaining some aquatic habitat
Social benefits	• With improved water quality, lake would return to a visual amenity, but no direct recreational use would be allowed

Option Suitable in Meeting City Level of Service

Option 5 - Aeration



Overview of Option

Addition of oxygen to the Lake to reduce internal nutrient loading from bottom sediment by underwater aerators

Costs

$100,000

Technical feasibility & effectiveness	• Mixing caused by aeration may result in further resuspension of nutrients, increasing algal growth • High end hyper-eutrophic state with very high nutrient levels and extensive algae growth would be expected – does not meet City or Community Level of Service
Environmental benefits & impacts	• Environment degradation with severe algae blooms in the short term is expected
Social benefits & costs:	• Lake would become eyesore and emit odour - negative impact to recreational use of surrounding park

Not Recommended – Would not improve water quality

Option 6 - Withdrawal and Treatment

Overview of Option

Construction of pumping station to remove nutrient rich water from bottom of lake, treat, and return to lake

Costs

Capital cost: $5,000,000

Annual Maintenance: $50,000

Technical feasibility & effectiveness	• Would require a pumping station, and significant maintenance • Lake conditions are not well suited to this technology - unlikely to be successful in meeting City or Community Level of Service
Environmental benefits & impacts	• Environment degradation with severe algae blooms in the short term is expected
Social benefits:	• Lake would become eyesore and emit odour - negative impact to recreational use of surrounding park

Not Recommended – Would not improve water quality

Option 7- Partial Filling

Overview of Option

- Fill the north arm and low-lying wet areas that are most conducive to algae growth and conversion of these areas to bioswales or terrestrial wildlife habitats

Costs

$1,500,000

Technical feasibility & effectiveness	• Removes water from area most prone to dense algae growth and replace with wetland or naturalized area (bioswale) • Significant grading and tree removals required for construction • High end hyper-eutrophic conditions would remain in the remainder of the lake
Environmental benefits & impacts	• Additional wildlife habitat could be created • Removal of large trees and natural area to perform construction would be required
Social benefits & costs:	• Lake would become eyesore and emit odour - negative impact to recreational use of surrounding park

Not Recommended – No benefit to most of lake, and high environmental disturbance required

Option 8 - Complete Filling

Overview of Option

- Lake to be entirely filled in, and park area to be expanded

Costs

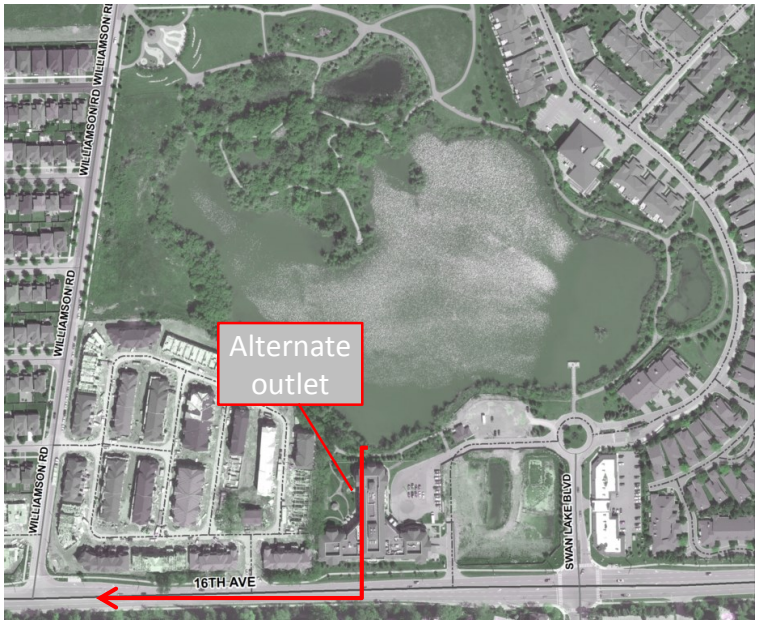
Capital cost: $15,000,000

Annual cost: $45,000 (park maintenance)

Technical feasibility & effectiveness	• Very large scale operation required (Over 1000 trucks full of material would be required) • Water quality issues would no longer exist as lake would be removed
Environmental benefits & impacts	• Significant improvements to terrestrial habitat possible • Loss of aquatic area & associated habitat
Social benefits & costs:	• Loss of the Lake as a community feature • Large space available for park and recreational areas

Not Recommended - Removal of Lake is not desired, and costs are prohibitive

Option 9 - Inlets/Outlet Modification



Overview of Option

- Create a new outlet for the Lake and direct low flows from storm ponds into the Lake for flushing purposes

Costs

Not Applicable – Not Constructable

Technical feasibility & effectiveness	• Significant feasibility issues associated with constructability/ groundwater table impacts • Water from SWM ponds would add nutrients, offsetting any flushing benefit • Hyper-eutrophic state with high nutrient levels and algae growth
Environmental benefits & impacts	• Environment degradation with severe algae blooms in the short term is expected
Social benefits & costs:	• Lake would become eyesore and emit odour - negative impact to recreational use of surrounding park

Not Recommended - Technically not feasible

Option 10 – Dredging

Overview of Option

- Chemical treatment and dredging of the Lake to remove sediment containing nutrients released into water.
- Construction of a large dewatering facility within park area requiring closure of amenity areas

Costs

$30,000,000 (15 Year Frequency)

Technical feasibility & effectiveness	• Lake is roughly 30x the size of a typical stormwater pond – requires large scale operation and construction of a dewatering facility which would require the closure of significant park space for up to 3 years • Project needs to be repeated every 15 years • At best, would produce fluctuation between Mesotrophic and hyper-eutrophic conditions
Environmental benefits & impacts	• Significant short term improvement to aquatic environment – would allow significant additions of plantings and fish to lake
Social benefits & costs:	• Lake could potentially be used for recreation, and would result in significant amenity improvements to park • Dredging operation would require frequent long term disturbance to park

Not Recommended- Option may meet Community Level of Service, but requires severe park disturbance and has prohibitive cost

Summary of Options Review

Option #	Name	Recommended for Implementation?	Estimated Cost
#1	Do Nothing	☒	$0
#2	Status Quo	☒	$45,000/year
#3	Biological Treatment	☒	$50,000
#4	Chemical Treatment	☑	$250,000 (3-7 year interval required)
#5	Aeration	☒	$100,000
#6	Withdrawal and Treatment	☒	$5,000,000 and $50,000/year maintenance cost
#7	Partial Filling	☒	$1,500,000
#8	Complete Filling	☒	$15,000,000
#9	Inlets/Outlet Modification	☒	N/A – Not Constructible
#10	Dredging	☒	$30,000,000 every 15 years

How Often to Do Chemical Treatment?

Option #	How Often?	Benefits/Impacts	Annualized Lifecycle Cost
1	After one summer measured above 150 ug/L on average (approximately every 4 years)	• Algae growth expected in hot dry years, and **may** be present in isolated locations in other years • No recreational use of the lake permitted	$250,000 every 4 years (Approximately $62,500/year)
2	After two summers measured above 150 ug/L on average (approximately every 5 years)	• Algae growth expected in hot dry years, and **is likely** to be present in isolated areas in other years • No recreational use of the lake permitted	$250,000 every 5 years (Approximately $50,000/year)
3	After three summers measured above 150 ug/L on average (approximately every 6 years)	• Algae growth expected in hot dry years, and **will** be present in isolated areas in other years • No recreational use of the lake permitted	$250,000 every 6 years (Approximately $41,667/year)

Staff Recommendation: Option 2 – two summers measured above City level of service would trigger capital request for the following year

Swan Lake Park

- Friend of Swan Lake have also requested an interest in working with the City on a long term restoration plan associated with:
  - Terrestrial habitat
  - Aquatic habitat

- City focus at this time is on water quality of the lake before further opportunities are explored for the above areas

- Parks staff are currently working with Friends of Swan Lake on opportunities to enhance the park and trail experience at Swan Lake Park

- Parks staff will work with Friends of Swan Lake to establish a stewardship program such as our existing 'Adopt a Park' program

Recommendations
Water Quality Improvement Program

1. **Continue with existing program at $40K a year**:
   - Water Quality Monitoring
   - Geese control
2. **Introduce Fish Management program** in 2021 at a cost of $5K per year,
3. **Introduce a Chemical Treatment** in 2021
   - Cost for chemical treatment is $250,000 per treatment
   - Chemical Treatment to be completed in Spring of 2021
   - 25 year Life Cycle be updated based on 5 year cycle @ $250,000 = $1.25M over 25 years
4. Adopt a balanced approach in maintaining **water quality at an acceptable level during typical weather conditions** with the following level of service:
   - Low end Hypereutrophic state in the lake (~150µg/l phosphorus concentration)
   - Two consecutive summers of exceeding City level of service would trigger another chemical treatment in the following year

Recommendations:

1. That the presentation, titled "Swan Lake Water Quality Improvement Program" be received; and,

2. That Council approve the following Swan Lake Water Quality Program:
    a. Continue annual water quality monitoring
    b. Continue with annual geese control
    c. Introduce a new fish management program in 2021
    d. Introduce a chemical treatment program commencing in 2021, established such that chemical treatment be completed when average summer phosphorus concentrations in Swan Lake are above 150 ug/L for two consecutive summers; and,

3. That Council direct staff to contact the private property owners who own a portion of Swan Lake to obtain financial contribution to the Swan Lake Water Quality Improvement Program; and further,

4. That Staff be authorized and directed to do all things necessary to give effect to this resolution.