Madoc Sewage Lagoon: Performance, Opportunities, and Recommendations

Summary

Moira Lake Property Owners Association

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Madoc Sewage Lagoon: Summary of Performance, Gaps & Recommendations

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1. Executive Summary

The Madoc Sewage Lagoon is a key part of Centre Hastings' wastewater treatment system. It protects public health, supports development, and helps manage environmental risk. However, it also plays a direct role in the health of local waterways — particularly Moira Lake, which is experiencing rising concern over water quality, algal blooms, and habitat degradation.

This summary report was developed by the Moira Lake Property Owners Association (MLPOA) to provide council, residents, and stakeholders with a clear, accessible overview of how the lagoon is performing, where improvements are needed, and how to plan for future risks like climate change.

Key Takeaways:

- The lagoon meets its current regulatory limits, but those limits are not designed to protect sensitive lakes like Moira Lake.
- The lagoon does not remove enough phosphorus, which is the main nutrient fueling harmful algal blooms.
- Important environmental testing is missing or outdated, including indicators of pathogens, nutrients that drive algae, and long-term ecosystem impacts.
- Climate change is already affecting lagoon performance, with early spring floods, high effluent temperatures, and summer droughts challenging the timing and safety of lagoon discharges.
- Residents report visible water quality deterioration downstream, including green water, increased weeds, and concern for fish and wildlife.

Core Recommendations:

- Upgrade testing and monitoring to reflect modern standards and local environmental risks.
- Reduce nutrient loading through improved treatment, possible upgrades, or flow controls.
- Prepare for climate impacts by planning storage, adaptive discharge timing, and monitoring key risk indicators.
- Improve transparency through public reporting and engagement.

The Madoc Lagoon is not in crisis — but it is under strain. With proactive planning and investment, the lagoon can become a model for rural infrastructure that is affordable, resilient, and environmentally responsible.

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2. Overview of the Madoc Sewage Lagoon

2.1 What is the Lagoon?

The Madoc Sewage Lagoon is a two-cell, facultative lagoon system located in Centre Hastings, operated by the Ontario Clean Water Agency (OCWA). It treats wastewater from the community and releases treated effluent into Deer Creek, which flows into Moira Lake — a popular recreational lake that is sensitive to nutrient pollution.

2.2 How It Works

The system uses natural processes (sunlight, bacteria, and settling) to break down organic matter. Alum is added regularly to reduce phosphorus. The system has no mechanical aeration or tertiary treatment, making it relatively simple and low-cost — but also less adaptable under stress.

2.3 Seasonal Discharges

Unlike continuous treatment plants, the lagoon is designed for seasonal discharges:

- Spring discharge: Between April 1 and May 20
- Fall discharge: Between November 1 and December 15

Each discharge lasts at least 21 days and must meet the effluent limits in the Environmental Compliance Approval (ECA) issued by the province.

2.4 Capacity and Limits

- Rated capacity: 1,008 cubic metres per day
- Primary treatment parameters: $CBOD_5$ (organic matter), TSS (suspended solids), TP (total phosphorus), and pH
- Monitoring: Discharges are sampled and reported to the Ministry of the Environment, Conservation and Parks (MECP)

2.5 Importance to Moira Lake

Because the lagoon discharges into Deer Creek less than 3 km upstream of Moira Lake, it directly influences nutrient loading and ecological health. This connection makes lagoon performance particularly important to local residents and lake users.

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3. Performance Overview

3.1 Regulatory Compliance

The Madoc Sewage Lagoon has consistently met the requirements of its Environmental Compliance Approval (ECA). These provincial permits set discharge limits for basic water quality indicators, including:

- $CBOD_5$ (Carbonaceous Biochemical Oxygen Demand): Measures how much oxygen is needed to break down organic material in the effluent. The lagoon performs reliably well within limits.
- TSS (Total Suspended Solids): Indicates the amount of particulate matter in the discharge. Compliance is consistently maintained.
- pH: Falls within the regulated range.
- Total Phosphorus (TP): Often approaches the maximum allowable concentration (1.0 mg/L), leaving little room for error.

From a regulatory perspective, the lagoon is functioning as intended. However, compliance with discharge limits does not always translate to environmental protection, especially for sensitive water bodies like Moira Lake.

3.2 The Compliance vs. Protection Gap

Ontario's Provincial Water Quality Objectives (PWQOs) offer science-based guidance on what is needed to protect aquatic ecosystems. They are not enforceable, but they provide a standard for evaluating environmental impact:

- 0.03 mg/L TP for rivers and creeks
- 0.02 mg/L TP for lakes

While the Madoc Lagoon meets its legal effluent limit of 1.0 mg/L TP, this is 30 to 50 times higher than the PWQO for Moira Lake. As a result, every discharge introduces a nutrient load that contributes to algae growth, aquatic weed proliferation, and long-term eutrophication in the lake.

Example: A TP concentration of 0.80 mg/L during spring discharge may be compliant under the ECA, but still poses a major risk to Moira Lake, which can only tolerate 0.02 mg/L to avoid nutrient loading.

3.3 No Phosphorus Load Cap for the Lake

Currently, there is no total phosphorus "budget" or cap established for Moira Lake. This means:

- The cumulative nutrient load from the lagoon and other sources is not managed holistically.
- It is impossible to say whether the lagoon is discharging more or less than its "fair share" of phosphorus.
- Management decisions are made without a clear link to lake health outcomes.

This lack of a load-based management framework is a major policy gap in protecting the lake from long-term degradation.

3.4 Availability vs. Accessibility of Performance Data

OCWA provides annual reports that include detailed effluent data for each seasonal discharge. These reports are submitted to the Ministry of the Environment, Conservation and Parks (MECP) and confirm that the system meets its legal obligations.

However, these reports:

- Do not analyze long-term trends (e.g. is phosphorus going up, down, or staying the same?)
- Do not calculate or report total phosphorus load (e.g. total kilograms per year to Moira Lake)
- Do not assess compliance with PWQOs
- Are not publicly visualized or summarized in plain language

This creates a transparency gap: although the data exist, there is no accessible reporting framework to help council or the public understand whether the lagoon is improving, worsening, or holding steady in environmental terms.

3.5 Performance Summary

In short:

- The lagoon is legally compliant with its discharge permit.
- It is not aligned with the phosphorus levels needed to protect Moira Lake.

- OCWA data is available, but not interpreted or communicated in a way that supports accountability or informed decision-making.

A new performance framework — based on nutrient loads, PWQO targets, and trend reporting — is needed to align day-to-day operations with long-term environmental protection.

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4. Gaps in Monitoring & Testing

Enhancing Environmental Insight

While the Madoc Sewage Lagoon operates within its current regulatory framework, its monitoring program could benefit from modernization and expansion. Current testing focuses on core compliance parameters, but does not fully capture the environmental risks posed to Deer Creek and Moira Lake — particularly regarding nutrients, biological health, and long-term trends.

This section identifies areas where supplemental monitoring would improve understanding of lagoon performance and better align the system with the environmental sensitivity of downstream waters.

4.1 High-Priority Gaps

⚠️ 1. Phosphorus Speciation

Current testing only measures total phosphorus (TP). This does not tell us how much is in the most harmful, bioavailable form — soluble reactive phosphorus (SRP) — which fuels algal blooms.

Why it matters: Even if total phosphorus appears “acceptable,” high SRP can trigger algal growth.

Recommendation: Add SRP testing during each discharge and consider tracking other nitrogen forms (e.g., ammonia, nitrate).

⚠️ 2. Pathogen Indicators

Indicators like E. coli and Enterococci are no longer tested. These are essential for understanding risks to recreational users downstream, especially children, boaters, and anglers.

Recommendation: Reinstate microbial testing during discharge periods to assess public health risk.

⚠️ 3. Groundwater Monitoring

There is no testing of groundwater near the lagoon, despite potential seepage of nutrients or pathogens into shallow aquifers that could affect nearby wells or creeks.

Recommendation: Install 3–5 perimeter wells to test for nitrate, ammonia, chloride, and bacteria twice per year.

⚠️ 4. PWQO Comparison

Effluent and receiving water data are only evaluated against ECA limits, not against Provincial Water Quality Objectives (PWQOs) that define safe concentrations for aquatic life.

Recommendation: Include PWQO comparisons in all discharge reporting to support environmental accountability.

⚠️ 5. Dissolved Oxygen (DO)

DO is not currently measured downstream. Low oxygen is a common effect of nutrient-rich effluent and is a direct cause of fish kills and biodiversity loss.

Recommendation: Use portable or continuous sensors to monitor DO at discharge points.

4.2 Medium-Priority Gaps

⚠️ 6. Biological/Ecological Monitoring

No monitoring of aquatic life is currently done — including fish, invertebrates, or plants — even though changes in biological communities are one of the clearest indicators of ecological stress.

Recommendation: Conduct benthic macroinvertebrate and fish surveys every 3–5 years in Deer Creek and Moira Lake.

⚠️ 7. Chlorophyll-a / Algal Biomass

No measurement of chlorophyll-a, a key indicator of algae growth, is performed in downstream waters.

Recommendation: Test chlorophyll-a and algal biomass seasonally to track eutrophication risk.

4.3 Lower-Priority Gaps

⚠️ 8. Metals

No routine testing for metals (e.g., copper, zinc) is conducted, despite potential cumulative impacts from wastewater.

Recommendation: Conduct metals scans every 3–5 years.

⚠️ 9. Chemical Oxygen Demand (COD)

COD gives a broader picture of all oxygen-demanding substances than $CBOD_5$ alone.

Recommendation: Include COD during spring discharge to supplement organic load tracking.

⚠️ 10. TSS Fractionation

It's unknown whether solids in the effluent are mostly organic (e.g. algae) or inorganic (e.g. sand/silt).

Recommendation: Add volatile/fixed solids testing to distinguish.

⚠️ 11. Toxicity Testing

No whole-effluent toxicity tests are currently performed. These bioassays (e.g., Daphnia survival) evaluate whether combinations of pollutants cause harm even if individual chemicals seem low.

Recommendation: Conduct basic toxicity screening every 3–5 years.

4.4 Gap Summary

The current testing regime is focused on minimum legal compliance — not on measuring ecological harm, public health risk, or the lagoon's contribution to Moira Lake degradation.

Expanding the monitoring program would:

- Improve decision-making
- Help meet public expectations
- Better prepare for future regulations
- Provide an early warning system for environmental harm

5. Climate Vulnerabilities

Adapting to a Changing Operating Environment

Ontario's climate is changing — and with it, the performance and risks associated with lagoon-based wastewater systems like Madoc's. Rising temperatures, extreme rainfall events, longer growing seasons, and summer droughts are already affecting lagoon operation and downstream water quality. These impacts are expected to intensify in coming decades, and should be considered in both monitoring and long-term infrastructure planning.

5.1 Observed Impacts on the Madoc Lagoon

🔄 Unpredictable Spring Conditions

In recent years, spring snowmelt and rainfall have become more intense and erratic. This causes:

- Rapid filling of lagoon cells
- Shortened retention times
- Elevated flows into Deer Creek at sensitive times

These conditions increase the risk of nutrient-rich, under-treated effluent being discharged during vulnerable periods for aquatic life.

🔥 High Effluent Temperatures

Warmer spring and fall temperatures are leading to higher effluent temperatures during discharge periods. Warm water:

- Holds less oxygen
- Increases biological activity (algal growth)
- Can stress coldwater aquatic species

Combined with elevated phosphorus, this creates ideal conditions for harmful algal blooms and aquatic weed expansion.

💧 Drought and Low Summer Flows

While spring brings excess water, summers are increasingly dry. This:

- Reduces dilution in Deer Creek
- Leaves residual nutrients in place longer

- Concentrates pollutants and decreases oxygen downstream

These trends increase the ecological impact per unit of discharge, even when effluent meets permit limits.

5.2 Future Risks (Looking Toward 2050)

Climate projections for Southern Ontario include:

- Warmer average temperatures year-round
- More frequent extreme weather events (e.g., 1-in-100 year rainfalls)
- Longer ice-free seasons and growing periods
- Greater variability in seasonal flows

For the Madoc Lagoon, this could mean:

- More frequent near-capacity events
- Need for off-schedule discharges to manage volume
- Greater public concern and scrutiny during extreme years
- Higher treatment demands without matching infrastructure

5.3 Recommendations for Climate Adaptation

To maintain performance and public trust under changing conditions, the following strategies are recommended:

✅ **1. Expand Storage Flexibility**

Explore options to increase storage buffering during wet years to delay discharge when necessary.

✅ **2. Improve Real-Time Monitoring**

Use sensors for water temperature, dissolved oxygen, and conductivity in receiving waters to track stress conditions.

✅ **3. Align Discharge Timing with Forecasts**

Use hydrologic and weather forecasts to better schedule discharges, avoiding periods of drought or extreme heat when possible.

✅ **4. Plan for Future Disinfection**

As effluent temperatures rise, **pathogen survival increases**. While disinfection is not currently required, planning for future UV or solar-assisted disinfection would support long-term resilience.

✅ 5. Incorporate Climate Risk in Asset Planning

Future capital planning and asset renewal (e.g. pumps, valves, cell upgrades) should factor in climate risk profiles to extend system life and protect performance.

5.4 Summary

Climate change is not a distant concern — it is already influencing the conditions under which the lagoon operates. By taking **proactive steps now**, the Municipality can reduce the risk of costly compliance issues, environmental harm, and public concern in the future. Lagoon systems can be resilient, but only if designed and operated with flexibility, foresight, and robust monitoring.

6. Public Observations

A Gap Between Experience and Official Performance

Residents of Moira Lake have consistently observed troubling signs in recent years — including algae blooms, excessive aquatic weed growth, murky water, and signs of ecological decline. These concerns are based on direct, lived experience, particularly during and after lagoon discharge periods.

At the same time, official reports indicate that the Madoc Lagoon is operating "within compliance." This has created a perception gap: residents see environmental degradation, while official data suggest everything is functioning normally.

This misalignment raises important questions:

- Are the right things being measured to detect environmental harm?
- Do compliance standards reflect the needs of sensitive receiving waters like Moira Lake?
- Is monitoring and reporting aligned with real-world impacts felt by the community?

The divergence between what people are seeing and what reports are showing highlights the need for:

- More comprehensive environmental monitoring
- Transparent and plain-language communication with the public
- A broader understanding of success beyond compliance

In summary, the lake community's experience should be treated not as anecdotal noise, but as an important signal — one that warrants attention, investigation, and better alignment between science, operations, and lived reality.

7. Summary of Recommendations

Practical Actions for Protection, Performance & Public Confidence

To better align lagoon operations with environmental protection goals, public expectations, and future climate realities, the following recommendations are proposed. They are grouped into four categories: Monitoring Improvements, Environmental Protection, Climate Resilience, and Community Engagement.

🧪 A. Monitoring Improvements

1. Add nutrient speciation testing
Include soluble reactive phosphorus (SRP) and nitrogen forms (ammonia, nitrate) to assess true nutrient risk.

2. Reinstate pathogen testing
Test for E. coli or Enterococci during discharge periods to assess downstream health risks.

3. Monitor against PWQOs
Compare effluent to Provincial Water Quality Objectives (PWQOs), not just ECA limits.

4. Establish groundwater wells
Install perimeter wells to monitor for possible lagoon seepage into aquifers.

5. Add downstream dissolved oxygen (DO) monitoring
Track DO in Deer Creek to detect eutrophication stress.

6. Test chlorophyll-a and algal biomass
Assess downstream algal growth during summer and post-discharge periods.

7. Introduce periodic bioassays (toxicity testing)
Test whole effluent toxicity every 3–5 years using standard methods.

🌿 B. Environmental Protection

8. Track phosphorus loading to Moira Lake
Estimate total kilograms of TP discharged annually, not just concentrations.

9. Set or advocate for a Moira Lake nutrient cap
Work with provincial agencies to define the lake's carrying capacity.

10. Evaluate alum dosing strategy
Optimize or expand phosphorus removal with targeted chemical dosing reviews.

11. Incorporate biological monitoring
Sample fish and benthic communities downstream every 3–5 years to track ecological response.

🌞 C. Climate Resilience

12. Improve discharge timing flexibility
Use weather and flow forecasts to adjust discharge schedules for safety and efficiency.

13. Plan for extreme weather events
Evaluate storage capacity and risk from early melt, heavy rain, or drought.

14. Monitor effluent temperature and conductivity
Track key indicators of stress in real time, especially during warm seasons.

15. Begin long-term planning for disinfection
Explore UV or solar-assisted pathogen control as climate warms and risk increases.

🧭 D. Community Engagement & Transparency

16. Publish plain-language summaries
Provide easy-to-read annual updates for council and residents, showing results and trends.

17. Share real-time or seasonal data publicly
Use web dashboards or bulletins to communicate effluent quality and discharge timing.

18. Host open houses or briefings
Engage residents in understanding the system and its connection to Moira Lake.

19. Involve local voices in future planning
Include MLPOA or public representatives in any watershed advisory or capital planning discussions.

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8. Conclusion

From Compliance to Stewardship

The Madoc Sewage Lagoon is currently operating within its legal requirements, but growing evidence — from environmental indicators, resident observations, and emerging climate risks — suggests that compliance alone is no longer enough.

Moira Lake is a sensitive and valued ecosystem. Protecting it requires a shift toward proactive monitoring, transparent reporting, and adaptive planning. The recommendations

in this report offer practical steps to strengthen performance, restore public confidence, and ensure that the lagoon continues to serve the community — not just legally, but responsibly and sustainably.

Now is the time to move from minimum standards to environmental stewardship.