

Ontario Water Works Research Consortium

Survey of Great Lakes Water Utilities – Taste and Odour

OWWRC

This survey was conducted at the request of the members of the Ontario Water Works Research Consortium (OWWRC). The mission of the OWWRC is to link member utilities to government and university researchers and through those links facilitate the completion of research that is of value to member communities. OWWRC's research has focused on two main projects with the aim to:

- Understand the cause of taste and odour and its distribution in the lake
- Understand the factors that influence the growth of *Cladophora* and the related periphyton in Lake Ontario; and
- Assist regional members with decision-making on control options, the management of events and communication to their customers.

More information on the research consortium is available at www.OWWRC.com

Background of the Survey

The survey was conducted to determine the location, frequency, and severity of taste and odour problems, and the success of treatment methods throughout the Great Lakes. This report summarizes the results of the survey. The survey form is contained in Appendix C.

Overview of the Surveyed Facilities

Fifty-nine respondents from the United States and Canada responded to the survey, which was administered in July and August of 2004 by the Ontario Clean Water Agency. Of these facilities, 46 draw water from one of the six Great Lakes, while 13 others draw their water from the Detroit, Niagara, St. Clair, and St. Lawrence Rivers, as well as the Welland Canal. See Appendix A for a list of facilities

The size and capacity of the surveyed facilities varies widely. Facilities ranged from small town plants to metropolitan water systems. The smallest facility was located in South Baymouth, Ontario. The municipalities of Mississauga, Milwaukee, Rochester, and Hamilton were the largest providers of water in terms of both population (all over 400 000) and daily flow (more than 200 million litres each.)

The surveyed facilities serve approximately 5 600 000 citizens and draw more than two billion litres of water from the Great Lakes every day.

Survey Findings

Filter Media

All facilities surveyed used filters except for Killarney, Ontario.

The standard sand and anthracite combination remains common. Other common systems were multimedia filtration (exact media unidentified), and a sand and granular activated carbon (GAC) combination. Four small plants used sand filters.

Daily Water Quality Parameters

Almost all facilities tested for pH, temperature, and turbidity. Chlorine, fluoride, alkalinity, hardness, and coliform were common water quality parameters. Most large plants also tested for ammonia, aluminum, HPC, bacteria, phosphates, and particle counts.

Taste and Odour Frequency

The majority of facilities experienced some taste and odour problems. T&O episodes that occurred only some years were more common than annual episodes.

Taste and odour problems, at less than annual frequency, were most common for Lakes Michigan and Ontario, while Lakes Huron and Superior had only one reported case of a taste and odour problem. All facilities on Lakes Erie and Ontario experienced some T&O. Water drawn from rivers in the Great Lakes system generally also experienced taste and odour problems.

Table 1 – T&O Episode Frequency

	Annual Episodes	Only Some Years	No T&O Problems
Total	12	39	19
Lake Erie	3	4	0
Lake Huron	1	0	5
Lake Michigan	5	12	4
Lake Ontario	1	5	0
Lake Superior	0	1	5
Detroit River	0	1	4
Niagara River	1	1	0
St. Clair River	1	1	0
St. Lawrence River	0	1	1
Welland Canal	0	3	0

Taste and Odour Seasonality

Taste and odour problems occurred during three seasons – spring, summer, and fall. Episodes were most common in summer. The summer data includes utilities that reported incidents in the late summer / early fall.

Isolated spring T&O problems can probably be linked to seasonal lake conditions. Similarly there were some isolated T&O incidents in October and November, most likely from the same phenomenon.

See Appendix B for a map of locations of taste and odour problems.

Table 2 – Seasonal Occurrences of T&O Episodes

	Spring	Summer	Fall
Total	4	33	12
Lake Erie	1	7	0
Lake Huron	0	0	1
Lake Michigan	2	12	7
Lake Ontario	1	4	1
Lake Superior	0	2	1
Detroit River	0	1	0
Niagara River	0	2	1
St. Clair River	0	2	0
St. Lawrence River	0	0	1
Welland Canal	0	3	0

Taste and Odour Monitoring

About half of the surveyed plants monitor for T&O. Of those without monitoring, less than half have T&O problems. All facilities that monitor have experienced taste and odour problems. Many with seasonal or continuous monitoring increased their monitoring during specific episodes.

Method of Control – Taste and Odour

Nineteen of the 59 facilities did not use any T&O controls.

Powdered Activated Carbon (PAC) was the most common method of T&O control, however only half of its users deemed its success satisfactory. Other methods were less common, but more effective. Some facilities employed multiple systems. The use of both PAC and KMnO₄ was common and relatively successful, compared to other methods.

Table 3 – Control Methods

	PAC	GAC Cap	GAC Filter Replacement	Ozone	KMnO ₄	Other
Facilities	23	8	9	3	11	0
Satisfied Users	13	7	9	3	7	0

Facilities employing GAC Filters were split evenly on their use and preference of virgin or regenerated PAC.

GAC users generally rely on 2 to 4 year cycles to replace their filters. Many users of PAC used jar tests to determine the correct dosage, while others relied on levels set from past experience. Trial and error adjustments according to success were also common.

According to facilities that reported concentration statistics, the GAC Filter is the most successful method of T&O control. All facilities using a GAC Filter reported success against taste and odour episodes. The surveyed utilities reported less satisfaction with PAC. Table 3 also shows that a small number of the surveyed utilities used ozone with all reporting success.

Geosmin and MIB Concentrations

Geosmin and MIB statistics were not readily available. Of facilities with T&O episodes, few supplied Geosmin or MIB concentration data. Only Lake Erie, Lake Ontario and the Welland Canal have multiple concentration statistics.

Table 4 – Maximum Geosmin and MIB Concentrations

Lake	Episode Date	Geosmin Concentration	MIB Concentration
Lake Ontario	Sept 2003	25.0	< 2.0
Lake Ontario	Sept 2002	14.0	5.0
Lake Ontario	Aug 1999	51.0	8.0
Lake Ontario	Aug 1998	18.0	7.0
Lake Erie	Summer 2002	33.0	1.0
Lake Erie	Summer 1998	13.0	1.4
Welland Canal	Sep 1997	54.0	75.0
Welland Canal	Sep 1996	11.0	14.0

The western basin of Lake Ontario has good data on Geosmin and it also has the most consistent history of Geosmin spikes. The maxima for the spikes fluctuate widely from year to year. Lake Erie has experienced periodic spikes, while the Welland Canal has not had a significant level in seven years.

All regular episodes occurred in summer or early fall. Some high Geosmin and MIB concentrations were reported in late fall (October and November), however these were isolated events.

Conclusion

Taste and odour is a concern for the majority of Great Lakes water facilities, however its severity and frequency vary greatly between the Lakes.

Taste and odour problems are most frequent in late summer.

Geographically, occurrences vary. Taste and odour problems are common in Lakes Erie, Ontario and Michigan, and Great Lakes river systems. Lakes Huron and Superior, meanwhile, have few occurrences.

Geosmin statistics are limited, except for Lake Ontario where the OWWRC has sponsored research since 1999. Annual increases, with widely varying maxima, is the clear trend in Lake Ontario, with intermittent problems in Lake Erie and the Welland Canal.

Methods of taste and odour control vary. PAC is the most common, yet the least effective. GAC, in both Cap and Filter form, has been a successful method of control. Ozone use is limited, but reportedly successful.

Report for OWWRC: August 2004

Appendix A

List of Participants

Illinois

Central Lake County
Highland Park
Lake Forest
Winnetka

Indiana

East Chicago
Whiting

Michigan

Alpena
Charlevoix
Escanaba
Gladstone
Grand Haven
L'Anse
Marquette
Muskegon
Port Huron
St. Clair
Traverse City

Minnesota

Duluth
Grand Marais
Two Harbors

New York

Massena
Niagara Falls
Ogdensburg
Rochester

Ohio

Cleveland
Elyria
Mentor
Sandusky

Ontario

Amherstburg
Bruce Mines
Burlington
Echo Bay
Essex
Grimsby
Hamilton
Killarney
Niagara Falls
Oakville
Port Colborne
Sault Ste. Marie
South Baymouth
St. Catharines
Tecumseh
Union
Welland

Pennsylvania

Erie

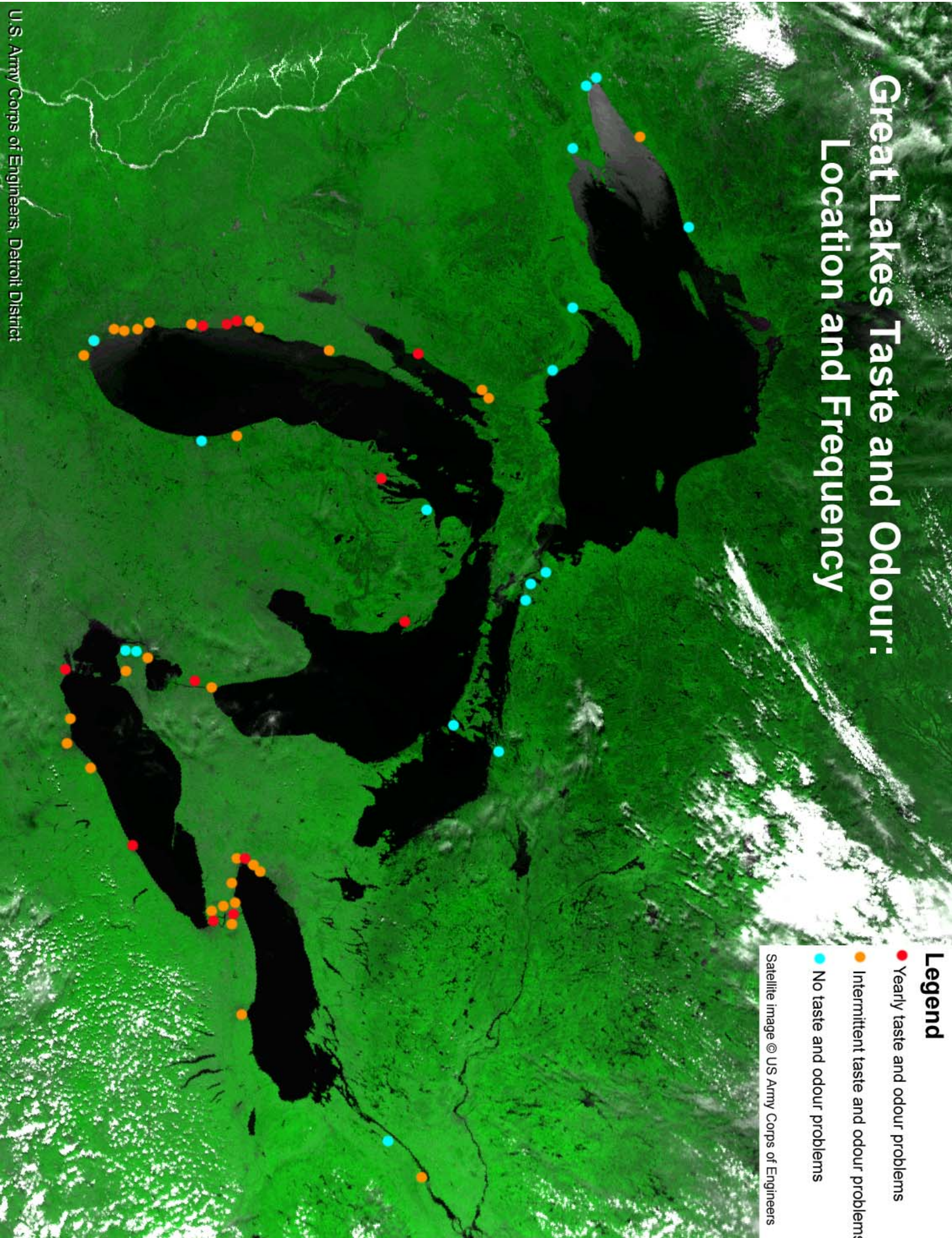
Wisconsin

Ashland
Cudahy
Kenosha
Manitowoc
Marinette
Milwaukee
North Shore Water Commission
Racine
South Milwaukee
Superior

Great Lakes Taste and Odour: Location and Frequency

- Legend**
- Yearly taste and odour problems
 - Intermittent taste and odour problems
 - No taste and odour problems

Satellite image © US Army Corps of Engineers



Appendix C
Taste and Odour Controls and Management
– A Survey of Water Treatment Facilities –

Part A: Facility Information

1. Contact Information

Municipality:

Facility Name:

Address:

Telephone:

Fax:

Contact Person:

Email:

2. Source water:

3. Average daily flow (units):

4. Population served:

5. Length and Depth of intake (units):

6. Any extension or change of location to intake:

Reason:

7. # of Filters and Type of Filter Media:

8. Water quality parameters collected daily:

Part B: History of Taste and Odour Episodes

1. Taste and Odour episodes at facility in past:

- Yearly Only some years None

2. During which seasons do the episodes occur?

- Winter Spring
 Summer Fall

3. Monitoring of taste and odour compounds:

- Seasonally / Continuously
 Monitoring increased when episode occurs
 No Monitoring for taste and odour compounds

4. If only monitoring when an episode occurs, what triggers monitoring (when do you start monitoring?) (eg. Community Complaints, Flavour Profile Analysis Panel, Sampling Data, other early warning system)

5. Location of sampling:

- Lake Intake Treated Other:

6. Length and intensity of last two episodes that resulted in serious community concerns:

Max Concentration during episode:			
Year	Date	Geosmin (ng/L)	MIB (ng/L)
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>

Part C: Controls Used

1. Method of Taste and Odour Controls Used:

- PAC GAC Cap GAC filter replacement
 Ozone KMn4 Other

2. If using GAC, how do you determine when to change media?

Did you use regenerated or virgin GAC?

- Regenerated Virgin

If using regenerated, are you satisfied with its performance?

3. If using PAC how do you determine the dosage?

4. If using O₃ how do you determine the dosage?

5. Approximate annual cost of treatment over last three years (or last year's cost):

6. Relative success of treatment and experience: