Assessment of Impaired Beneficial Uses of the Bay of Quinte

IBU #9: Taste and Odour of Drinking Water

Prepared for the Bay of Quinte Remedial Action Plan

January 2003 FINAL REPORT
Ministry of the Environment  
133 Dalton Avenue  
P.O. Box 820  
KINGSTON, ON  
K7L 4X6

Attention;  Mr. Robert Hellier

Dear Mr. Hellier;

RE:  BAY OF QUINTE RAP  
IMPAIRED BENEFICIAL USE #9  
RESTRICTIONS ON DRINKING WATER CONSUMPTION  
TATSE AND ODOUR

We have completed and attached 20 copies of the assessment report of impaired beneficial use #9 described above. If you have need of any further copies, they can be produced upon request.

If you have any questions, please contact me at 613-968-3434

Yours truly,  
Quinte Conservation

Bryon Keche, P.Eng.  
Water Resources Engineer

Copy to:  Mr. Barry Jones, RAP Coordinator  

RAP \ Taste and Odour 2003

2003 January 17
EXECUTIVE SUMMARY

This report has been prepared to assess and report on the status of the taste and odour impaired beneficial use in the Bay of Quinte drinking water. Identified by the International Joint Commission as an area of concern, the Bay of Quinte Remedial Action Plan has been established toward the objective of improving the use of the bay.

The impairment of taste and odour in drinking water has been assessed by comparing trends in the water quality to the established delisting targets.

Data received from the Drinking Water Surveillance Program and local treatment plants was analysed for trends in phosphorus, chemical usage indicators, as well as exceedences of Maximum Acceptable Concentrations (MAC) of contaminants. The results showed that total phosphorus concentrations and chemical usage have not declined. Exceedences of MAC have, however, declined.

The data evaluated in this investigation does not indicate the drinking water taste and odour impairment is a restored beneficial use. This is due to difficulty in comparing the data from the base year period to the period of interest because of many environmental, process and procedural changes that have taken place.

It has been recommended that the taste and odour impairment to drinking water be reevaluated using a more clearly defined benchmark. This could include direct sampling of the opinions of the end users about the quality of their drinking water.
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INTRODUCTION
The quality of drinking water, in communities whose source is the Bay of Quinte, has been impaired as a result of the high levels of nutrients present in the bay. This report has been prepared, in accordance with the terms of reference set out in the Five-Year Work Plan 2001-2005, to determine if the impairment to the quality of drinking water has been restored in these Bay of Quinte communities.

Contained within the report is a discussion on the development of the targets for restoration and how the data has been collected and evaluated to determine the progress toward achieving the targets. Also included are recommendations for future study.

BACKGROUND
The International Joint Commission identified the Bay of Quinte as an Area of Concern in 1985 for high levels of pollution. The pollutants ranged from nutrients (most notably phosphorus) to bacterial contaminants and various toxins.

Since then, the Bay of Quinte Remedial Action Coordinating Committee (now known as the Bay of Quinte Restoration Council) was formed to identify the problems and work towards restoring the impaired beneficial uses of the bay.

Ten of 14 beneficial uses have been identified in the Bay of Quinte\(^1\) as impaired. These are:

<table>
<thead>
<tr>
<th>No.</th>
<th>Impaired Beneficial Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Restrictions on fish and wildlife consumption</td>
</tr>
<tr>
<td>3</td>
<td>Degradation of fish and wildlife populations</td>
</tr>
<tr>
<td>6</td>
<td>Degradation of benthos</td>
</tr>
<tr>
<td>7</td>
<td>Restrictions on dredging activities</td>
</tr>
<tr>
<td>8</td>
<td>Eutrophication or undesirable algae</td>
</tr>
<tr>
<td>9</td>
<td>Restrictions on drinking water consumption, or taste and odour problems</td>
</tr>
<tr>
<td>10</td>
<td>Beach closures</td>
</tr>
<tr>
<td>11</td>
<td>Degradation of aesthetics</td>
</tr>
<tr>
<td>13</td>
<td>Degradation of phytoplankton and zooplankton populations</td>
</tr>
<tr>
<td>14</td>
<td>Loss of fish and wildlife habitat</td>
</tr>
</tbody>
</table>

\(^1\) Stage 2 Report, Bay of Quinte RAP Coordinating Committee, 1993, p 13
As part of a 5-year plan to delist the Bay of Quinte as an Area of Concern the Restoration Council has put forward targets to be achieved over the next five years for the reduction or elimination of impairments to the beneficial uses. The targets have measurable objectives, which can be indicators that the delisting targets have been met, or the objectives may help to identify trends in the improvement of the quality of the water and sediment in the bay.

This report is an assessment of the status of impairment nine.
Development of Restoration Targets

High algal concentrations have affected the taste and odour of municipal drinking water drawn from the bay. The goal of the Bay of Quinte RAP is to restore the trophic status of the bay to conditions similar to those recorded around 1930\(^2\). The period since the 1930’s saw an increase in turbidity and an associated shift in fish population from bass to walleye, which prefer the more turbid waters of a hypertrophic system.

Delisting Targets

The goal for the restoration of IBU #9 has been further refined in the Five-Year Work Plan\(^3\) to the following three targets:

1) Using the period between 1989 and 1994 as a base period, demonstrate a positive trend or change in the taste and odour of Bay of Quinte drinking water.

2) Demonstrate that the Ontario Drinking Water Surveillance Program (ODWSP) maximum acceptable concentrations (MAC) for treated drinking water have been met and exceeded.

3) Record no exceedences of safe levels of trihalomethanes (THM) in drinking water at the ODWSP at the Bayside, Belleville and Deseronto water treatment plant sampling locations.

The scope of this study did not permit independent field investigations, but included a search of existing data sets. Data was made available by the Ministry of the Environment, collected through the Drinking Water Surveillance Program from many water treatment plants including the Belleville and Deseronto plants.

In addition to the DWSP database, the Belleville and Deseronto plants kept additional records of direct measurements of several other water quality parameters. This additional data has also been made available for use in this study.

\(^2\) Ibid p 56
\(^3\) BQRAP Restoration Council Five-Year Work Plan 2001-2005, Fred Stride Consulting, p 25
How the Targets are Measured

The Restoration Council has agreed upon and developed the following five delisting objectives to measure progress toward achieving the delisting targets. The objectives listed below have been reproduced from the Five-Year Plan4.

Objective #1 A reduction in algae levels from the base year levels (1989-1994) as anticipated by reduced phosphorus concentrations in the upper Bay of Quinte in the raw water intake at the Belleville water treatment plant.

Objective #2 Fewer taste and odour complaints compared to the base year period in the Belleville, Deseronto and Bayside drinking water supplies.

Objective #3 A reduction in chemical usage levels from the base year levels as anticipated by reduced phosphorus concentrations in the upper Bay of Quinte at the Belleville, Deseronto and Bayside water treatment plants.

Objective #4 No ODWSP MAC exceedences reported since 1993. No significant increase in trihalomethane (THM) levels in Bay of Quinte drinking water from the levels reported in the 1993 Bay of Quinte Stage 2 Report.

Objective #5 No safe level exceedences of THM in Bay of Quinte drinking water at the noted DWSP sampling sites.

Analysis

In this section of the report each of the five water quality objectives is discussed in order of their presentation above.

1) Reduction in Algal Concentration as anticipated by reduced phosphorus concentration.

High levels of algae frequently cause taste and odour problems in drinking water5. This happens when algae decomposes in anoxic conditions. As well, large accumulations of

4 Ibid p 25
5 Stage 2 Report, Bay of Quinte RAP Coordinating Committee, 1993, p 54

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decomposing algae along shorelines produce offensive odours.

**Rationale for Selection of Indicator**

Phosphorus is the limiting nutrient in the Bay of Quinte ecosystem. All other nutrients are present in excess. This means that biomass levels generally increase in direct proportion to the availability of phosphorus. It can then be inferred that a reduction in total phosphorus concentration will be followed by a similar reduction in algal density. The phosphorus concentration trend in the Bay is a good indicator for the trend in algal concentration.

Turbidity, which is a measurement of light penetration through the water column, should also drop with reduced algal density. Light will be scattered by the presence of tiny particles making the water appear cloudy. The more particulates that are present, the more light is scattered and the less light penetration will occur. These particulates may be of inorganic (clays, silts, etc.) or organic (spores, plankton, and other various microorganisms) origin.

Turbidity cannot, therefore, be used as an absolute measure of the presence of algae since light will be scattered by suspended inorganic matter as well as by microorganisms. Nevertheless, if abiotic sources of light attenuation and background sources remain constant, then it can be expected that turbidity levels will decline with algal density.

Of the two potential indicators, algae densities will be more clearly indicated by phosphorus concentration in the bay.

**Limitations on Inferred Correlations**

Many environmental influences can affect phosphorus concentrations as well as turbidity levels. These are described below:

1) **Wind.** A strong westerly wind can stir up sediments in the Bay bringing them into the water column. A measurement for turbidity on such a day will yield extremely high readings. Phosphorus, which can be sorbed to sediments, would also be present in the water column in higher concentrations on a windy day. Data measurements collected under this atmospheric condition would not present a true picture of the Bay and should be considered as outliers.

2) **Rain.** A significant rainfall event or spring freshet can wash large volumes of
sediment and nutrients into streams and rivers discharging into the Bay. Data collected for some time after such an event will likewise reflect the concentration of the indicators.

3) **Ice.** The indicators will also be influenced by the presence of ice. The winter ice sheet shields the Bay from the effects of wind reducing the turbulence that affects both the turbidity and phosphorus concentrations associated with the resuspension of sediment. Phosphorus concentrations and turbidity would be lower during the period of ice cover.

4) **Temperature.** High summer temperatures increase algal growth and turbidity.

5) **Zebra Mussels.** Another very important environmental consideration that cannot be overlooked is the changing makeup of the Bay fauna. Zebra mussels were introduced to the Bay in the early 1990's and to some degree have affected the Bay water quality. Zebra mussels are filter feeders consuming algae and thereby reducing both turbidity and phosphorus concentration. To a point this has aided the RAP process. Phosphorus is taken up in the mussel tissue and shells. This sequestration of phosphorus reduces the phosphate concentration shifting the phosphate/phosphorus system out of equilibrium. But as the Bay reaches carrying capacity for the mussels, the equilibrium is restored and phosphate becomes more available to sustain algal growth.

All of the above factors must be considered in the interpretation of the data before inferring conclusions on the concentration of algae.

**Data Accumulation**

The Ministry of the Environment operates the Drinking Water Surveillance Program (DWSP) collecting both raw and treated water samples from Water Treatment Plants in Ontario. The samples are analyzed for many parameters. From this source, annual phosphorus and turbidity measurements for the Bay of Quinte were determined for the period of interest (1989 to present). These are presented as yearly averages of often between two to four samples.

The DWSP data did not provide the monthly averages needed for analysis of the May to October levels of phosphorus, nor was the chemical usage data included in the DWSP information. Further, the Bayside plant information could not be obtained through the DWSP reports and since it has recently begun operation, it was felt that the short period of record available directly from the plant would not contribute significantly to the study. The Bayside data was not pursued further.
Other sources of data were the Belleville and Deseronto plants. The Belleville plant regularly samples phosphorus and turbidity in the raw water and has records spanning the period of interest, with the exception of 1992 to 1995. The Deseronto plant has records of turbidity for the period of interest. Both also kept records of their chemical usage. From this data most of the analysis of the impairment to taste and odour has been completed. In some cases the DWSP data has also been provided in this report and is referred to for comparison and as a check on its representativeness.

**Discussion**

It can be seen from Figure 1 that the downward trend in phosphorus concentration at the intake for the Belleville water treatment plant, evident in the late 1970s and 1980s, appears to have leveled out to 40 µg/L in the mid 1990s. The RAP restoration target for the average concentration of phosphorus in the Bay is 30 µg/L. In the late 1990s there is a peculiar spike in phosphorus concentration reaching an average of over 60 µg/L by 1999. For 2000 and 2001 the levels dropped to approximately 45 µg/L.

**Figure 1:** Phosphorus Concentration at Belleville WTP, 1972 to Present

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6 Ibid, p 58

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A clearer look at the trend in phosphorus concentration is presented in Figure 2. On this figure a trend line has been inserted which projects the phosphorus concentration to 2005 using the available May to October averages from 1989 to 2001 (solid line). This trend line shows phosphorus concentrations increasing to possibly 50 µg/L in 2005.

**Figure 2: Phosphorus Concentration Forecast to 2005**

It is possible the data for the missing years would affect the trend line. To look at this possibility the DWSP data has been consulted. The DWSP phosphorus concentrations have been plotted on Figure 2 (lower curve) for comparison. The curve varies from the May to October averages by as little as 3 µg/L in 1998 and as much as 30 µg/L in 1999. It is clear that there is not strong agreement between the two data sets. A trend line, however, based on the DWSP data shows an increasing yearly trend in phosphorus to 30 µg/L in 2005.

It is important to remember that the DWSP data represents yearly averages of usually four samples taken at each of the seasons. The average will be very sensitive to a sample that may have been taken on a day where some environmental factor has artificially affected the readings (refer to discussion in Limitations of Inferred Correlations). This can be seen in Figure 3 where a spike in DWSP's Deseronto data occurred in 1996. One extremely high reading sent the normal average of usually below 30 µg/L to above 55 µg/L.
Figure 3: DWSP Phosphorus Concentrations

Furthermore, a sample taken in winter would be often below 20 µg/L and this would bring the average down. Figure 4 shows the seasonal trend for the period 1996 to 2001. During January to April phosphorus concentrations are consistently below 20 µg/L.

Figure 4: Seasonal Variation of Phosphorus at Belleville

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To check on the validity of using the DWSP data for a projection of phosphorus trends a yearly average curve was generated using weekly readings and plotted against the May to October readings for the period of 1996 to 2001. It is evident that the yearly average curve consistently plots below the May to October curve as would be anticipated by our understanding of expected lower readings during winter months (see Figure 5). The difference between the curves is often 10 to 15 \( \mu g/L \).

Figure 5: Validation of DWSP Data

![Phosphorus Levels 1996 to 2001](image)

It is arguable, based on the above, that the DWSP data generally follows the trend in the May to October data. Thus, the increasing DWSP trend line seen earlier on Figure 2 tends to support the observation that the total phosphorus concentration in the upper Bay is increasing.

Understanding the Results

The phosphorus indicator does not demonstrate a reduction in the concentration of algae in the upper bay. In fact, since the data shows that the phosphorus concentration has increased, by comparison to the base years (1989 to 1994), it is inferred that the concentration of algae is also increasing.

This was an unexpected finding. Further research was completed to determine the
reliability of the conclusion reached from the Belleville water treatment plant data. A comparison was made to other published phosphorus data and an analysis of turbidity levels was undertaken. The results of the two supplemental investigations are provided below.

**Comparison to Other Published Total Phosphorus Data**

This disappointing trend in phosphorus concentration at the Belleville water treatment plant intake appears to be somewhat substantiated by published total phosphorus concentrations at a sampling point in the Bay near Belleville. On page 20, Figure 2 of Monitoring Report #11 a chart of total phosphorus concentration at various locations is presented. Stn B (Belleville sampling location) shows an almost identical trend in concentration as those reported by the Belleville water treatment plant (reproduced as Figure 8 in the Appendix). However, the values are lower. For example, the 1997 value at Stn B is approximately 27 μg/L (3 μg/L lower than the water treatment plant data). Similarly, the 1999 spike is reported to be approximately 41 μg/L (about 20 μg/L lower than the same spike recorded at the water treatment plant).

While Monitoring Report #11 supports the Belleville water treatment plant data, it also highlights the effect on phosphorus concentration by environmental influences listed earlier. In this case, the rebound of total phosphorus concentration was reported to be due to the influence of the suspected dieback of the zebra mussel population.

**Supplemental Turbidity Review**

It is anticipated that an increase in phosphorus concentration in the bay would likewise indicate a higher concentration of algae. The higher algal concentration would again lead to high turbidity readings. A check on the reliability of the total phosphorus indicator has been made by comparing the turbidity in the bay from year to year at the Belleville and Deseronto plants.

Turbidity measurements were plotted from both the DWSP database and records kept by the two water treatment plants. Once again, the DWSP numbers have been averaged using between 2 to 4 samples per year. The resulting curves are shown on Figure 6. Noticeable is an extraordinary spike in 1996 in the DWSP numbers for Deseronto. This is the same year where the spike occurred in the DWSP phosphorus concentrations.

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Evidently, a sample was taken on a very turbid day or an error occurred while inputting the number in the database.

Figure 6: Bay of Quinte Turbidity at Belleville and Deseronto

The more reliable curves are those developed using data obtained from the B.U.C. (Belleville) and OCWA (Deseronto) plants that have been created from readings taken several times a week. Both curves show a downward trend in turbidity while the DWSP curves do not. The Bay of Quinte waters are becoming slightly less turbid.

This suggests a possible decline in algal levels, contrary to the total phosphorus indicator. The decrease in turbidity does not support a conclusion that algae concentrations are increasing.

Conclusion

The total phosphorus indicator trend, which suggests the concentration of algae in the bay could be increasing, does not lead to the conclusion that Objective#1 has been reached. Since there is some ambiguity in the application of the data it is suggested that a revised approach may be needed to conclusively assess the target. This will be further discussed in the recommendations section at the end of this report.
2) **Taste and Odour Complaints**

No analysis of taste and odour complaints by residents in Belleville or Deseronto was possible as neither plant kept records of complaints for the period of interest and therefore this water quality indicator could not be discussed.

Beginning in 2002, however, the treatment plants will begin keeping records of taste and odour complaints. Due to the lack of these records, the trend in complaints by water users will not form part of the analysis of the impaired beneficial use restoration goal.

3) **Reduction in Chemical Use**

The average yearly concentration of chemicals used to treat the raw bay water have been presented on Figure 7. It is anticipated that a reduction in the amount of chemical usage by water treatment plants on the Bay of Quinte would indicate improved water quality and hence an improvement in taste and odour.

**Figure 7: Chemical Usage, Belleville and Deseronto**

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Chlorine

Bay of Quinte water treatment plants rely upon chlorine to kill pathogens. Higher turbidity reduces the effectiveness of chlorine on pathogens and as a result an increased chlorine dosage is required. As was discussed earlier, phosphorus concentrations and turbidity levels are linked (see section on Rationale for Selection of Indicator). It is anticipated then, that reduced phosphorus concentrations should lead to reduced chlorine use.

From Figure 7, it is evident that Belleville’s use of chlorine has generally been decreasing since a recorded high of about 54 mg/L between 1988 and 1990 to a low of approximately 37 mg/L in 2000. There is, however, a noticeable increase in chlorine use in 2001. This has been attributed, by the plant operator, to the increase of desired residual concentration of chlorine in the distribution system from past levels of 0.8 mg/l to a desired level of about 1.8 mg/l. This has been in response to the Walkerton tragedy.

Deseronto’s chlorine dosage has risen overall from 1989 to 2001, but is noticeably more varied. Some of this variation can be attributed to breakdowns of the flocculent treatment system that would result in a higher suspended solids concentration. The amount of chlorine was increased during these periods in order to compensate for the loss of flocculent treatment.

In addition to Walkerton and plant mechanical failures, the presence of zebra mussels has also influenced the way chlorine is used in water treatment. Chlorine has been found to reduce fouling of the intake pipes caused by the mussels and plant operators have been using more chlorine as a result.

These changing ‘environmental factors’ suggest that all things have not remained equal for a good comparison to be drawn between chlorine concentration and water quality. Chlorine usage is not a good indicator of the quality of the bay.

Alum

Both plants also use a flocculent, such as alum, to remove suspended solids (turbidity) in their treatment processes. Turbidity is largely an aesthetic quality, but can, at higher levels, inhibit the operation of chlorin and become a health risk. Greater alum use can indicate increased turbidity.
Alum can also precipitate phosphorus, which is associated with sediment in the bay\(^8\), out of suspension. A corresponding reduction of phosphorus is achieved in the drinking water. The amount of flocculent used can indicate trends in phosphorus concentration in the raw water.

Belleville’s use of alum (dark line of Figure 7) appears to be on the rise in recent years with a significant increase in dosage since 1999. This follows the general trend of the increasing phosphorus concentrations since 1989, but conflicts with the trend of the last three years. Nineteen ninety-nine saw both a spike in phosphorus levels and the lowest dosages of alum. The following two years phosphorus levels returned to ‘normal’ while the dosage of alum continued to increase.

Deseronto’s flocculent concentration has not been plotted since there have been several process changes, long periods of equipment failure and variations in recording.

**Conclusion**

The amounts of chemicals used by both plants do not appear to follow trends in either total phosphorus concentration or turbidity. It is likely that process changes over the period of interest and the zebra mussel invasion could better account for the variation in chemical usage than the quality of raw water. There is no clear trend to indicate a reduction in chemical usage by the Belleville and Deseronto plants, and so, objective #3 has not been attained.

4) **MAC Exceedences**

Information for this section of the report was available through the Ministry of the Environment’s DWSP reports.

Certain chemical parameters, when exceeded in drinking water, can negatively affect human health or may reduce the aesthetic quality of the water. Maximum acceptable concentrations of those parameters have been established to limit the risk to health of users and to ensure that the taste, odour, and clarity of the water are good\(^9\).

In the Belleville drinking water supply there were exceedences of the maximum

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\(^8\) Stage 2 Report, Bay of Quinte RAP Coordinating Committee, 1993, p 55


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acceptable concentrations of trihalomethanes (>100 µg/L) in every year up to 1998. No further exceedences have been recorded since then. Two exceedences of turbidity occurred in 1990.

In the Deseronto drinking water there were exceedences of turbidity in 1990, 1991, and 1993. None have been recorded since that time. No exceedences of trihalomethanes have been recorded since 1993.

Conclusion

The objective for no MAC exceedences since 1993 has not been met at the Belleville plant. However, since no exceedences have been reported at the Deseronto plant, the objective was achieved there. Progress has been made toward achieving objective #4.

5) Safe Level Exceedences of THM

Trihalomethanes are product of chlorination of water containing naturally occurring organics. These are chloroform, bromodichloromethane, chlorodibromomethane, and bromoform. THMs are health-related chemical parameters that may have adverse health affects in concentrations above 100 µg/L.

It is difficult to ascertain what is meant by ‘safe level’ exceedences. If this refers to MAC exceedences for health, Trihalomethanes have exceeded safe levels as described in the above section of this report. This objective should be clarified in future updates to the Five-Year Plan.

Have the Targets Been Met?

The five objectives discussed above have been used a surrogates for the delisting targets. It has been stated earlier that satisfying the objectives would indicate the targets have been met. The following table provides a summary of this:

10 Ibid, p 45
<table>
<thead>
<tr>
<th>OBJECTIVE</th>
<th>SATISFIED (Yes or No)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Reduction in Algae</td>
<td>No</td>
</tr>
<tr>
<td>2) Reduction in Taste and Odour Complaints</td>
<td>NA</td>
</tr>
<tr>
<td>3) Reduction in Chemical Usage</td>
<td>No</td>
</tr>
<tr>
<td>4) No MAC Exceedences since 1993</td>
<td>No</td>
</tr>
<tr>
<td>5) No THM Safe Level Exceedences</td>
<td>No</td>
</tr>
</tbody>
</table>

The objective for algae reduction, using phosphorus as an indicator, and chemical usage reduction has not been met. Phosphorus concentrations in the upper bay are not declining. Chemical usage in the Belleville and Deseronto water treatment plants also do not appear to be declining. Taste and odour complaints could not be tracked.

While some MAC exceedences continued to be experienced at the Belleville plant until 1998, no further exceedences have been reported. In addition, the concentrations of THM showed an annual decline to 1998 falling below the MAC in the years following. It would appear that future THM concentrations could be expected to be below maximum acceptable following this trend.

In conclusion, the data evaluated in this investigation does not suggest the restoration of the drinking water impairment at this time. The process of this investigation has, however, highlighted to the author that some possibilities exist to refine the method by which the restoration of the drinking water impairment may be measured.

Health related parameters are very specifically recorded and can be readily compared to numerical benchmarks. These are largely assessed in objectives #4 and #5. However, taste and odour indicators are less conclusive, as the above discussion has identified. Has the taste and odour of the drinking water improved or degraded since 1993? No good data exists to answer this question and the above investigation has not. There have been process changes, environmental influences and procedural changes over the period of record that make direct comparisons difficult at best. There are simply too many variables. Taste and odour are subjective qualities that may be quantified and assessed better by the end user.

Additionally, upgrades to the treatment facilities have improved the processing and the quality of the drinking water. The restoration of the impairment to drinking water may be

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achieved by plant improvements without any actual improvement of the raw bay water quality.

**Recommendations**

Some recommendations are made to improve a future assessment of this impaired beneficial use.

**Recommendation #1:**
Reevaluate the impairment in 2005. This will allow four years of taste and odour complaint data to be evaluated. Include statistical comparisons of complaints in other Lake Ontario municipalities.

**Recommendation #2**
Complete a survey of end users asking their perception of the trend in water quality pertaining to taste and odour. Example: Has the taste of Belleville’s drinking water improved in the last ten years?

**Recommendation #3**
Develop chemical targets that will evaluate DWSP results of the treatment side parameters that may affect taste and odour.

**Recommendation #4**
Do direct analysis of phytoplankton species composition to determine if there is a downward trend of species known to contribute to taste and odour problems.

**Recommendation #5**
Rewrite Objective #4 to say, ‘No ODWSP health-related MAC exceedences reported since 2000.’

**Recommendation #6**
Clarify Objective #5
Appendix A:

Figure 8
Fig. 2. May-October mean concentrations of total phosphorus (a) and total chlorophyll $a$ uncorrected for phaeopigments (b) at stations B, N, HB and C in the Bay of Quinte, 1972-1999. Station N was not sampled from 1983-1988. Also shown is the dashed horizontal line indicating the interim RAP objective of 30 μg P/L for the upper bay. No chlorophyll data were available for 1977 (laboratory problem). Chlorophyll data for 1972-1984 were adjusted by +35 % to allow comparisons with post 1984 values after a methods change in early 1985 resulted in approximately 35 % higher recoveries of total chlorophyll $a$. 

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