TRIHALOMETHANES

February 13, 2006

MEMORANDUM TO: All Participants in the Public Comment Process on Trihalomethanes

RE: Comments Received and Actions Taken

Actions Taken

The Secretariat of the Federal-Provincial-Territorial Committee on Drinking Water (Secretariat) appreciates the comments received from participants in the public comment process on the document entitled "Trihalomethanes in Drinking Water." After due consideration of ***all*** comments received on the trihalomethanes (THMs) consultation document during the comment period, the Federal-Provincial-Territorial Committee on Drinking Water (Committee) decided at its October 2005 meeting to adopt a Maximum Acceptable Concentration (MAC) of 0.1 mg/L (100 µg/L) for THMs in drinking water, based on a locational running annual average of a minimum of quarterly samples taken at the point in the distribution system with the highest potential THM levels. The MAC for bromodichloromethane (BDCM) in drinking water was set at 0.016 mg/L (16 µg/L), monitored at the point in the distribution system with the highest potential THM levels. Utilities should make every effort to maintain concentrations as low as reasonably achievable without compromising the effectiveness of disinfection.

The THMs guideline technical document was rewritten to reflect the consensus opinion of the Committee and subsequently approved by the Federal-Provincial-Territorial Committee on Health and Environment in November 2005.

Comments Received and Responses

Below is a brief summary of the ***major*** comments received (◆) by the Secretariat during the public comment period and responses to them:

Guideline

◆ The relevant THM exposure level for pregnant women is not an annual average value, but the THM level that occurs during the various stages of a woman's pregnancy. Therefore, we suggest that the guidelines be changed to reflect a maximum THM level (such as 100 µg/L) that is based on a "never-to-exceed" level.

The MAC that has been established is a risk management decision based on the risk assessment and represents a trade-off between achievability, practicability, feasibility, and cost.

- Keeping the THM and BDCM levels below the MACs may require a combination of processes, including pre-oxidation, process optimization, new treatment processes and alternative disinfectants; therefore, the appropriate process selection and cost implications are significant.

  These are implementation issues that should be discussed with the appropriate provincial or municipal jurisdictions.

- It would be difficult to isolate the estimated process capital costs to meet THM compliance requirements from turbidity compliance requirements.

  We agree. Economic concerns will have to be discussed with appropriate provincial authorities.

- Small changes in the proposed 16 µg/L MAC for BDCM may have large economic and operational consequences with insignificant benefit to human health.

  The 16 µg/L MAC is based on the fact that BDCM is a "probable carcinogen." This level is close to effects observed in epidemiological studies (see the Rationale on BDCM, Section 12.2). Economic and operational considerations are implementation issues that should be discussed with the appropriate provincial or municipal jurisdictions.

- We recommend that the current MAC for THMs not be reaffirmed but further lowered to reflect its potential carcinogenicity. We feel that because they are carcinogenic, the MAC for THMs should be as low as possible. We should strive to reduce the MAC as sanitation and detection technology improves. A chloroform guideline of 0.03 mg/L may be a goal to strive for in the future.

  The MACs have been determined based on the scientific information actually available on the toxicity of THMs and BDCM. The guideline technical document does indicate that levels should be as low as possible without compromising water disinfection.

- Due in part to species-specific issues and a lack of relevant data from human health studies, it is not possible to confirm that 16 µg/L is an appropriate guideline for BDCM.

As is written in the Classification and Assessment section (Section 11.0), the risk assessment is based on a key animal study and is supported by epidemiological studies on reproductive effects and by recent mechanistic data.

- We feel that keeping the MAC the same creates no incentive to further reduce THM concentrations and limits innovation in treatment technology that could occur by reducing the target.

  The establishment of the MAC was a risk management decision based on risk assessment and represents a trade-off between achievability, practicability, feasibility, and cost. The decision to give incentives or not is at the provincial or municipal level of jurisdiction.

- Very little justification was given as to why the THM MAC was set as it was. The document needs to explain, in detail, the reasons for the selection — whether it was cost, logistics, precedent, or a combination of these. Also, although the MACs are said to be achievable, no evidence is presented to corroborate this claim.

  The establishment of the MAC was a risk management decision made by the Federal-Provincial-Territorial Committee on Drinking Water based on risk assessment and represents a trade-off between achievability, practicability, feasibility, and cost.

- It is not appropriate to establish a MAC for BDCM until further health risk studies have been completed, for the same reasons contained in the World Health Organization's (WHO) Summary Statement on THMs of September 2004 in the Rolling Revision of the WHO Drinking Water Guidelines.

  This comment is against the precautionary principle in public health. We believe that the information on BDCM is adequate to perform a risk assessment. The context of WHO for establishing guidelines is different from the one in North America, so it is not possible to compare the two.

- We have noticed that sometimes when the THM level was under 100 µg/L, the BDCM level still exceeded the proposed MAC of 16 µg/L.

  That is why we have developed a specific guideline for BDCM, which is an indicator of the presence of other brominated THMs.

- The proposed guideline statement that "*Utilities should make every effort to achieve the lowest concentrations possible without compromising the effectiveness of water disinfection*" needs to be qualified or deleted. It provides an open-ended expectation that utilities should make every effort to reduce THMs to the lowest concentrations possible even if THM levels

are well below the MAC. This could be misinterpreted by some public or regulators. Also, the document does not provide detail on expected health risk improvements at levels below 80 µg/L. Therefore, no rationale is presented for this proposed guideline.

We do not agree. We want levels of THMs as low as possible, especially because they may be indicators of the presence of other disinfection by-products (DBPs).

- The document states that there is no significant expected difference in health risk between setting the limit at 80 or 100 µg/L. This statement/justification is highly speculative. A more extensive review by the U.S. Environmental Protection Agency (EPA) has indicated that the THM limit should be set to less than 100 µg/L. In fact, if the total daily intake, as calculated based on the U.S. EPA guideline, is used, the THM limit should be 24 µg/L.

  The tolerable daily intake (TDI) has been derived from the no-observed-adverse-effect level (NOAEL) for the key study divided by uncertainty factors that are based on assumptions coming from different policy decisions than those used by the U.S. EPA.

- Saying that "there is no significant expected difference in health risk" discredits the scientific work done previously and demonstrates little respect for the scientific process.

  We do not agree. An uncertainty factor of more than 2000 has been used for this assessment, based on commonly accepted risk assessment principles and expert judgement.

- A discussion on the economic or risk implications associated with the decision to raise the value by 25% would provide justification to disregard the calculated value.

  Establishment of the MAC is a risk management decision made by the Federal-Provincial-Territorial Committee on Drinking Water based on risk assessment and represents a trade-off between achievability, practicability, feasibility, and cost.

  Executive Summary

- In Section 2.2, Exposure, sentence 1, "because of the increase in organic matter" is not correct. Our 12-month survey has shown that the organic matter does not vary very much between summer and winter. The DBP levels are higher in summer than in winter because of the kinetic effect. The sentence should read "because the rate of formation increases with rising temperature."

  The sentence will be changed accordingly.

Application of the Guideline

- The guideline needs to recognize that specific sections of a distribution system can consistently have high levels of THMs.

  We agree that specific sections of a distribution system can have higher levels of THMs. The provincial/territorial regulations and/or policies will address this point.

- Clearer guidance should be provided on the sampling and monitoring of THMs. Specific questions and concerns that should be addressed include the following:
  - The term "extremities" of the distribution system needs to be clarified/defined.
  - Sampling locations should be selected based on estimates of residence time and distribution system flow configuration rather than distance per se.
  - Modelling and/or background surveys may be necessary to identify sample sites that are appropriate and feasible with respect to access and related issues.
  - Quarterly monitoring is not sufficient. The document indicates that "*increased frequency may be required for facilities using surface water sources during peak by-product formation periods*." However, no procedure is presented to establish the occurrence of a peak by-product formation period.
  - It would be more valuable to increase sampling during periods of poor water quality, as the THM sampling in winter months, in particular, only lowers the annual average.
  - There is no guidance as to how many samples are advisable.
  - Are the samples taken before the chlorination step or after final treatment?
  - The study does not clearly state how and where these samples are analysed.
  - Another issue that should be addressed is the standardization of the monitoring programs by water treatment plants.
  - We recommend that the monitoring of THMs be increased in frequency from quarterly to monthly, especially in areas that have previously been shown to have difficulties reaching the set MAC.
  - The presence of booster stations within a water distribution system can impact the formation of THMs. THM concentrations downstream of a booster have been reported to be up to four times higher than those measured in sections of the distribution system that do not have booster stations. THM levels in these sections should not be averaged with other THM measurements, but reported separately.

  The provincial/territorial regulations and/or policies will address these points.

- It is difficult to tell whether the intent is for the water supplier to average the quarterly values from each single location or whether the values from all locations at the extremities of the system should be averaged. If the intent is for a locational average, then the language needs to be improved.

  The guideline statement and the Application of the Guideline section (Section 3.0) have been amended to indicate that the guideline is to be measured as a locational running annual average of quarterly samples.

  Exposure

- Chloroform appears to be ubiquitous in the home and environment, but the significance of a constant daily presence is not relayed. This data set had great potential to be a supporting reason why the MAC was set as it was, but was not taken advantage of.

  Please refer to Section 5.6 of the document on the estimates of total exposure to chloroform. This section takes into account multi-route exposure.

- In Section 5.1, second paragraph, first sentence, "Levels of chloroform, the most common THM, are generally higher in treated," it should be noted that the terms chlorination and treatment are not synonymous.

  We agree. This change (from "treated" to "chlorinated") will be made.

- In Section 5.1, sentence 5, "higher concentration of precursor materials" should read "higher rates of formation" (as in Section 2.2).

  The sentence will be changed to "higher concentrations of precursor organic materials ... and especially because the rate of formation of DBPs increases with rising temperatures."

- THM exposure levels are cited in other accompanying sections (5.4 and 5.6). For consistency, exposure levels should also be included in Section 5.5 (Swimming pools and hot tubs).

  Only general information about potential exposure to THMs in recreational environments such as swimming pools and hot tubs has been included.

- In Section 5.6 on the exposure to THMs from pools, it is interesting to note that the exposure to THMs can be more than one order of magnitude higher for people that swim on a regular basis. Why are THMs in public swimming pools not regulated? Should a recommendation be made to regulate public swimming pools?

  This is not relevant to the present guidance technical document.

- In Section 5.6, the last paragraph states that "*the main pathways ... are inhalation of indoor air and ingestion of tap water*." However, Table 1 shows showering to contribute 50% of the exposure.

  We agree. Table 1 will be deleted, and the text will be adjusted to reflect the change.

- For exposure, a "litre-equivalent" value is chosen with no description as to how or why.

  This explanation is found in Section 5.2 of the document on multi-route exposure through drinking water.

  Analytical Methods

- Out of several analytical techniques used to determine THMs, the liquid–liquid extraction method appears to be a preferred one. Is this information communicated to the prospective laboratories that typically determine THMs and select analytical methods?

  The provincial/territorial regulations and/or policies will address this point.

- Section 6.2 reflects information provided earlier. However, a paragraph should be added after the second paragraph to emphasize the impact of a pH adjustment requirement. "Data from recent Health Canada studies indicate that 1,1,1-trichloro-2-propanone and trihalogenated aldehydes will degrade in water to their corresponding THMs at increased pH and temperature. However, they are stable in water at sampling/storage conditions (pH 4.5, 4°C)."

  This addition will be made to the Analytical Methods section.

  Treatment Technology

- More detail should be given in the treatment technology section. For example:
  - It should be noted that oxidizing organic matter with ozone, potassium permanganate, and other oxidizing agents at the pre-treatment stage could play an important role in reducing THM precursors.

- S The benefit of biological filters for both surface water and groundwater is well known and should be noted.
- S The discussion should include a reference to conventional oxidation and advanced oxidation technologies as effective approaches to remove/convert THM precursors.
- S The discussion should include a reference to the need for coagulation prior to ultrafiltration to effectively remove THM precursors.
- S If BDCM formation occurs in distribution systems, it may necessitate a switch from chlorine to chloramines for distribution system residual maintenance. In cases where BDCM is an issue, brominated chloramine-related DBPs may also be an issue.

These comments are all valid, but the discussion of available treatments is intended to be general and not to address this level of detail.

◆ The government should examine other treatment options, such as using chloramines, and access their individual cost effectiveness. This should be done giving the plants as much information as possible, thus increasing their ability to achieve the lowest concentration of THMs feasible.

This discussion should be directed to the appropriate provincial or territorial jurisdictions. It is recognized that different treatment technologies imply the formation of different DBPs.

◆ In the discussion, nanofiltration/ultrafiltration membranes are not included as alternative primary disinfection strategies. Many jurisdictions are providing log disinfection credits for membrane systems since these processes can remove certain pathogens simply based on size exclusion. Discussion should include a reference to log removal credits for membrane systems.

Please refer to the microbiological guideline technical documents for a discussion on log removal credits for treatment processes.

◆ In Section 7.1, it should state “use of alternative primary disinfectants.” Chlorine has to be used as the “secondary” disinfectant to provide the required residual. Chlorine, as well as other disinfectants, can be used as the primary disinfectant.

Yes, we agree, but no change was made, as “alternative disinfectants” includes “alternative primary disinfectants.” Please refer to the microbiological guideline technical documents for more details about disinfection.

- How should a treatment plant respond if total THMs are less than 100 µg/L but BDCM exceeds 16 µg/L? It would likely be impractical to specifically target bromide.

  Treatment will have to meet the BDCM guideline. It is recognized that bromide removal requires a specific treatment process.

- The government should take responsibility for residential water treatment since individuals with lower incomes may not be able to afford filters or have access to a blender for aeration.

  The guidelines and guideline technical documents address only technological and health issues.

- In Section 7.2.1 on filtration devices, I would add "The result from a recent Health Canada study indicates that the performance of the filters to remove chlorinated DBPs is dependent on filter type, brand, chlorinated DBP group, flow rate, water quality and age of the filter."

  The information will be added as suggested.

- In section 7.2.1 on filtration devices, you might want to add a sentence to caution consumers that use of filters in areas of high turbidity may not be advisable because the filters clog up very quickly under conditions of high turbidity.

  The sentence will be added as suggested.

- The discussion should include reference to nanofiltration and reverse osmosis point-of-use membrane systems for THM removal.

  There is no reference to point-of-use/point-of-entry membrane systems since they are not certified by NSF International for the removal of THMs.

- When customers ask what can be done about chlorinous taste and odour, we advise them that a granular activated carbon (GAC) filter is an option, but so is placing a container of water in the refrigerator for a few hours. Boiling and aerating in a blender also work. This is effective for the chlorinous taste and odour, but is it effective for chloroform?

  For removal of chloroform, we recommend GAC filters, but not placing the container of water in the refrigerator for a few hours, boiling, or aerating.

  Classification and Assessment

- The toxicity assessment modelling of THMs is questionable. Uncertainty factors are obviously "uncertain," but no description of the selection process was made (i.e., why was 3 chosen over 10 for the LOAEL to NOAEL conversion?).

  These decisions are based on commonly accepted risk assessment principles and expert judgement.

- It is questionable whether or not a point estimate can accurately describe the risk for all parts of a population given that single terms were used to describe the body weight and intake when the THMs MAC was calculated.

  A probabilistic approach would be better but requires a larger database, which is not available. The current approach is broadly endorsed internationally.

- The validity and reliability of the Heywood et al. (1979) research were not effectively communicated. The results are based entirely on the endpoint of fatty cysts in the liver. No other organs or effects were used to assess toxicity.

  As explained in the classification and assessment section of the document (Section 11.0), we have found that the Heywood et al. (1979) study was the most appropriate.

- Although the linear multistage (LMS) model is linear at low doses, the parameters do not correspond to actual physiological phenomena.

  The LMS model is very conservative and was deemed appropriate to use under these circumstances.

- A strong, recognized model was used for BDCM modelling, although no data were presented, and a quick conclusion was offered. A more thorough explanation of the model should have been presented.

  This explanation is not presented in this guideline technical document because it is a summary of the technical report. For more information, please refer to the technical report entitled "Unit Risks for Bromodichloromethane (BDCM) in Drinking Water," which is referenced in the text as Health Canada (2003b).

- Two completely different procedures are used to arrive at exposure levels for THMs and BDCM. The different procedures used make it difficult to critically evaluate the information presented.

  The procedures used depend on the nature of the health effects.

- Conservative estimations are made but are mixed with non-conservative estimates,and it is unclear when and how conservative vs. non-conservative estimates are used. Non-standard assumptions are used needlessly and complicate the process.

  These estimates are based on commonly accepted risk assessment principles and on expert judgement.

  Rationale

- It is disconcerting to note that the lowest level of BDCM associated with potential fetal loss is greater than or equal to 20 µg/L. Further discussion should follow this statement, which would justify the fact that only a 4 µg/L difference separates customers from daily consumption and potential fetal loss.

  It is a risk management decision. As written in Section 12.2, the evidence is currently insufficient to determine whether BDCM in drinking water causes reproductive effects in humans. Moreover, the LMS model for cancer is very conservative in risk estimation. The level of 16 µg/L is based on a risk of 1×10^{-6}, which is below the levels seen in epidemiological studies.

- In Section 12.0, the second paragraph states that "*When drinking water is treated to reduce THMs and HAAs, the level of other chlorinated disinfection by-products may also be reduced in the process*." This is not always the case, as recent studies indicate that under specific conditions, alternatives to chlorination such as chloramines may produce increased concentrations of DBPs with toxicities far more potent than those regulated, such as iodoacetic acid. Therefore, some approaches to reducing DBPs may increase health risks for certain utilities.

  In this sentence, we emphasized "may" also be reduced in the process and not "will" also be reduced in the process, because we know that this is not always the case.

  General Comments

- In a Health Canada study, it was concluded that haloacetic acid (HAA) levels often equalled or exceeded THM levels. The costs associated with meeting the THM/BDCM regulations may not be as high as predicted, since much of the cost may also be associated with achieving other pending regulations. It may make more sense to develop these two guidelines concurrently from both a limit setting and a logistical and economical perspective.

  As the THMs guideline is simply reaffirmed, it will not be associated with new costs. In addition, HAA is currently under evaluation. Actually, HAA and THM levels have the same precursors, and efforts made to diminish one will serve to diminish the other (see Section 12.0 of the document on Rationale). Also, you should note that modifying levels of THMs may increase levels of HAAs.

- HAA levels have been found to equal or exceed THM levels. HAAs may in fact be a better indicator of DBPs. Also, the relationship between THMs and HAAs is significant, and a joint review would have been helpful in limit setting.

  HAAs are actually under evaluation. It is not feasible to join THMs to HAAs, because they are too different in their behaviours.

- The report ends without any conclusion. A reiteration of the final limits and decisions made would be useful and would end the report in a more finalized way.

  Please refer to the guideline statement. A conclusion is not appropriate for this type of report.

- The document did not provide the scenario for Saskatchewan regarding compliance or non-compliance of THMs and BDCM. Surface water in Saskatchewan typically has high organic matter, higher than many other provinces and territories in Canada. In 2001, out of 548 municipalities in Saskatchewan, 108 communities exceeded the THM limit.

  This discussion should be directed to the appropriate provincial or territorial jurisdiction. Sam Ferris, the Committee on Drinking Water representative from Saskatchewan, can be contacted for information on the specific scenario of this province.

If You Have Questions or Comments

If you have any questions or comments on the THMs drinking water document, please contact:

Water Quality and Health Bureau
Safe Environments Programme
Healthy Environments and Consumer Safety Branch
Health Canada
269 Laurier Ave West
3rd Floor, A.L. 4903A
Ottawa, Ontario
K1A 0K9

Tel.: 613- 948-2568
Fax: 613-952-2574
E-mail: water_eau@hc-sc.gc.ca