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Modification and Application of the Canadian Council of Ministers of the Environment Water Quality Index (CCME WQI) for the Communication of Drinking Water Quality Data in Newfoundland and Labrador

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In Newfoundland and Labrador (NL), drinking water quality monitoring is conducted by the provincial government on all public water supply systems and results are communicated to communities on a quarterly basis. This paper describes the application of the Canadian Council of Ministers of the Environment Water Quality Index (CCME WQI) as a communications tool for reporting the drinking water quality results. The CCME WQI simplifies the communication of results while integrating local expert opinion, without challenging the integrity of the data. The NL Department of Environment and Conservation successfully tested the use of the CCME WQI on selected drinking water quality data sets, and developed a phased approach for its implementation as a practical means of presenting available physical, chemical, organic and microbiological results to communities. The CCME WQI index categorization schema was modified by adding a new ranking category to incorporate local expert opinion. This paper describes the development of the phased approach for calculating water quality indices, the testing methodology used, the rationale for modifying the existing CCME WQI index categorization schema, and the implementation of an automated CCME WQI calculator in the provincial drinking water quality database. The paper also discusses the challenges encountered in using the CCME WQI especially with respect to incorporation of contaminants, microbiological and trihalomethanes data. The benefits and downfalls of this application are also discussed.

Key words: **drinking water quality, communications, Newfoundland and Labrador, water quality index, CCME**

Introduction

The Government of Newfoundland and Labrador (NL) is committed to providing clean and safe drinking water to the public by implementing a Multi-Barrier Strategic Action Plan for drinking water safety (DOE 2001). This plan is based on the principles of the multi-barrier approach whereby protection barriers are used to ensure the cleanliness, safety and reliability of drinking water. Such protection barriers include source protection, water treatment, water system operation and maintenance, and the monitoring and reporting of drinking water quality (DWQ). The NL Department of Environment and Conservation (DOEC) has attached significant importance to monitoring and reporting physical/chemical DWQ data. The NL Government is the only provincial government in Canada that has taken on this responsibility.

The province of NL covers a large geographical area (405,720 km^2) with the communities predominantly spread along the coastline. There are approximately 550 public water supply systems of which the majority service a population base in the range of 150 to 500 people. A large percentage of these small communities do not have the technical knowledge/personnel needed to interpret DWQ results. This poses unique challenges with respect to reporting DWQ in that the data needs to be communicated using simplified DWQ reporting tools.

NL Drinking Water Quality Monitoring Program

The goal of the physical/chemical DWQ monitoring program is to sample all public water supply systems at the tap for physical/chemical variables at least twice a year. Since all public water supply systems cannot be logistically sampled in just two seasons, sampling is conducted over four seasons throughout the year to accomplish the monitoring goals. Thus, some public water supply systems are sampled in the winter and summer seasons, while the others are sampled in the spring and fall seasons.

Individual public water supply systems are sampled and analyzed for 36 physical/chemical variables that range from aesthetic parameters (e.g., colour) to contaminants (e.g., arsenic) as listed in Table 1. While it is desirable to include all variables that have a health effect in the sampling program, it is not feasible to sample public water supply systems for all variables. The current list of 36 variables was chosen after carefully reviewing background ambient water quality and selected drinking water quality samples. The 36 variables sampled cover most physical/chemical variables that have Guidelines

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TABLE 1. Variables tested under the NL DOEC DWQ monitoring program

Variables tested	*Variables used in WQI calculation*	*Variable type*
Alkalinity		
pH	•	Aesthetic
Colour	•	Aesthetic
Specific conductance		
Turbidity	•	Contaminant
Hardness		
Calcium		
Manganese	•	Aesthetic
Iron	•	Aesthetic
Copper	•	Aesthetic
Zinc	•	Aesthetic
Potassium		
Sodium	•	Aesthetic
Chloride	•	Aesthetic
Fluoride	•	Contaminant
Sulfate	•	Aesthetic
Ammonia		
Dissolved organic carbon		
Total dissolved solids	•	Aesthetic
Nitrate(ite)	•	Contaminant
Kjeldahl nitrogen		
Total phosphorus		
Cadmium	•	Contaminant
Lead	•	Contaminant
Aluminum	•	
Chromium	•	Contaminant
Nickel		
Bromide		
Mercury	•	Contaminant
Arsenic	•	Contaminant
Selenium	•	Contaminant
Boron	•	Contaminant
Barium	•	Contaminant
Magnesium		
Antimony	•	Contaminant
Uranium	•	Contaminant

for Canadian Drinking Water Quality (Health Canada 1996). In addition, all public surface water supply systems are sampled four times a year for trihalomethanes (THMs). Haloacetic acids (HAAs) are monitored at selected public water supply systems. Other pesticides and organics are sampled on a case-by-case basis where there is a reason to suspect that there may be contamination from these chemicals. The current list of DWQ variables being sampled and analyzed has been accepted by the provincial Drinking Water Safety committee as being adequate to protect the public health in NL. The DWQ database is updated after each quarter for public water supply systems in which sampling was undertaken.

The Department of Government Services (GS) and the Department of Health and Community Services are jointly responsible for monitoring the microbiological quality of public water supplies in the province. This sampling activity is carried out by GS field offices throughout the province on a regular basis. Boil water advisories (BWAs) are issued when water sampling and testing detects *E. coli* or residual chlorine deficiencies. The DOEC maintains the inventory of current BWAs.

Reporting

The government is committed to reporting all available DWQ results including both physical/chemical and microbiological data. The results of the quarterly physical/chemical monitoring are reported, by the DOEC, in the form of quarterly reports as soon as the results from the laboratory have been processed and quality assurance/quality control (QA/QC) has been performed. The quarterly report is mailed to each community sampled in that quarter and is simultaneously posted on the DOEC web page (http://www.gov.nl.ca/env/).

In addition, an interpretive annual report is sent to each community summarizing the data collected every calendar year from all public water supply systems (DOE 2001). The quarterly and annual reports were designed to be displayed on a public notice board.

In addition to the quarterly and annual reports, communities are notified on a case-by-case basis when a BWA is issued for a particular public water supply system. The complete inventory of current BWAs is available on the DOEC web page to ensure public accessibility.

Need for a Communications Tool

The quarterly and annual reporting system helps to instil public confidence in the DWQ monitoring and reporting process. To ensure the communities were able to read and understand the reports, the DOEC initiated training sessions for municipal administrators and elected officials to familiarize them with the layout and contents of the quarterly and annual reports. Additionally, the DOEC formatted both the quarterly and annual reports similarly with only one difference—the annual report contains all samples collected in a calendar year, whereas the quarterly report is restricted to only those samples collected during a given quarter.

Even with this level of training, many small communities still expressed concerns regarding their ability to interpret the analytical results describing the physical/chemical water quality data. Many communities continue to call the DOEC officers for an interpretation of the results in simplified terms. Thus, it was necessary to find and implement a communications tool that could capture the DOEC officers' expert opinion and simplify the DWQ results, without challenging the integrity of the data.

The Canadian Council of Ministers of the Environment Water Quality Index (CCME WQI) was identified as a potential tool to address this issue. The aim of this project was to test the CCME WQI to determine if it could capture expert opinion of the DOEC officers, while at the same time simplify the large amounts of DWQ data for communications purposes.

The CCME WQI

Traditionally, water quality data is summarized in technical reports that are very valuable to individuals who understand the technical content, however, this information is not always useful to non-technical individuals. The CCME WQI was developed with the intent of providing a tool for simplifying the reporting of water quality data (CCME 2001). It is a tool that provides meaningful summaries of water quality data that are useful to both technical and non-technical individuals interested in water quality results. It is important to note that the CCME WQI is not a substitute for detailed analysis of water quality data and should not be used as a sole tool for management of water bodies. It was simply developed to provide a broad overview of environmental performance.

There were a number of jurisdictions and institutions that had applied some form of an index to water quality data prior to the development of the CCME WQI. In 1997, the CCME Water Quality Index technical subcommittee was formed to assess the various approaches already being used and subsequently formulate a CCME WQI that could be used nationally.

The CCME WQI has been applied successfully to several ambient water quality data sets from across Canada and is being used to communicate ambient water quality data in several provinces (CCME 2001).

The formulation of the CCME WQI is described in the Canadian Water Quality Index 1.0 – Technical Report (CCME 2001). Essentially, the model consists of three measures of variance from selected water quality objectives (Scope, Frequency, Amplitude). The "Scope (F_1)" represents the extent of water quality guideline non-compliance over the time period of interest. The "Frequency (F_2)" represents the percentage of individual tests that do not meet objectives. The "Amplitude (F_3)" represents the amount by which failed tests do not meet their objectives. These three factors combine to produce a value between 0 and 100 that represents the overall water quality. The CCME WQI values are then converted into rankings by using the index categorization schema presented in Table 2.

Testing Methodology

Initial Testing

Initial testing was aimed at determining whether the CCME WQI, when applied to provincial DWQ data, would produce rankings that reflected expert opinion on the physical/chemical state of the water quality. In this exercise, eight Regional Water Quality Officers and Watershed Management Specialists who are responsible for the sampling of the public water supply systems provided their expert opinion. The expert opinion was based on the DOEC officers' familiarity with each public water supply system and an overall review of the system's water quality data.

A total of seventeen public water supply systems was selected from across the province to represent a wide cross section of supply system sizes, technologies and water qualities (Table 3). Recent tap water data from these seventeen public water supply systems was used to calculate CCME WQI values and subsequently rank the public water supply systems according to the index categorization schema described in the CCME WQI. The results from the initial testing can be seen in Table 4. It is evident that no public water supply systems were ranked as "Poor" or "Marginal." This is a result of the selection process that ensures that the best water bodies are selected for public drinking water supply systems.

From Table 4 it is also evident that the majority of the CCME WQI results fall within the "Good" category (nine public water supply systems out of seventeen in total). When the ranking for each public water supply system was compared to expert opinion, it was found

TABLE 2. CCME WQI index categorization schema

Rank	*WQI value*	*Description*
Excellent	95–100	Water quality is protected with a virtual absence of threat or impairment; conditions very close to natural or pristine levels; these index values can only be obtained if all measurements are within objectives virtually all of the time.
Good	80–94	Water quality is protected with only a minor degree of threat or impairment; conditions rarely depart from natural or desirable levels.
Fair	65–79	Water quality is usually protected but occasionally threatened or impaired; conditions sometimes depart from natural or desirable levels.
Marginal	45–64	Water quality is frequently threatened or impaired; conditions often depart from natural or desirable levels.
Poor	0–44	Water quality is almost always threatened or impaired; conditions usually depart from natural or desirable levels.

TABLE 3. Communities selected for initial testing

Community[a]	*Serviced population*	*Water treatment*	*Source*
A	1708	Gas chlorination	Surface water
B	3613 + 862	Gas chlorination + Infiltration gallery	Surface water
C	5168	Gas chlorination	Surface water
D	5243	Water treatment plant + Gas chlorination	Surface water
E	4200	Water treatment plant + Gas chlorination	Surface water
F	7298	Gas chlorination + Fluoridation	Surface water
G	10,300	Gas chlorination + pH adjustment + Fluoridation + Iodination	Surface water
H	335	Gas chlorination	Surface water
I	3328	Gas chlorination	Surface water
J	14,160	Water treatment plant + Gas chlorination	Surface water
K	8655	Gas chlorination	Groundwater
L	570	Gas chlorination	Surface water
M	1080	Water treatment plant + Liquid chlorination	Surface water
N	2996	Gas chlorination	Surface water
O	83,780	Water treatment plant + Gas chlorination	Surface water
P		Gas chlorination + pH adjustment	Surface water
Q	7764	Gas chlorination	Groundwater

[a]Community names have been coded.

that the CCME WQI rankings generally reflected the state of each public water supply system. The rankings differed from expert opinion for three systems (communities C, I and N). In all three cases, the ranking was at the borderline between two categories. The expert opinion was consulted on each of the three cases and the experts felt the three communities were borderline situations and could thus be ranked in the adjacent category.

Further Level of Distinction

The individuals providing the expert opinion felt there was a need to differentiate between water supply systems that were "Good" and those that were "Very Good" but not "Excellent."

The CCME Water Quality Index Technical Subcommittee defined the "Good" category as having CCME WQI values ranging from 80 to 94. It was felt that due to the broadness of this category it could be divided into a "Good" and "Very Good" category to provide an extra level of distinction within the "Good" category without redefining the "Excellent" category.

This re-categorization is within the spirit of the CCME WQI since, as described in the CCME WQI technical report, the categorization process is subjective and "should be based on the best available information,

TABLE 4. Assessment of original CCME WQI rankings

Community	*WQI value*	*WQI category*	*Expert opinion*	*Remarks*
A	90	Good	Good	Match
B	89	Good	Good	Match
C	95	Excellent	Good	Difference not significant; WQI value at borderline
D	93	Good	Good	Match
E	95	Excellent	Excellent	Match
F	97	Excellent	Excellent	Match
G	88	Good	Good	Match
H	73	Fair	Fair	Match
I	80	Good	Fair	Difference not significant; WQI value at borderline
J	93	Good	Good	Match
K	97	Excellent	Excellent	Match
L	97	Excellent	Excellent	Match
M	90	Good	Good	Match
N	95	Excellent	Good	Difference not significant; WQI value at borderline
O	92	Good	Good	Match
P	92	Good	Good	Match
Q	100	Excellent	Excellent	Match

expert judgment and the general public's expectation of water quality" (CCME 2001).

To implement this re-categorization, further testing was needed in order to determine the line of best fit that would separate the "Good" and "Very Good" categories according to expert opinion. This was accomplished under secondary testing.

Secondary Testing

Secondary testing was aimed at further verifying the suitability of the existing CCME WQI index categorization schema and determining the CCME WQI value that would accurately split the "Good" category into "Good" and "Very Good" categories.

Recent tap water data from an additional seventeen public water supply systems was used to calculate CCME WQI values and subsequently rank them according to the index categorization schema described in the CCME WQI (Table 5). The results from the secondary testing are added to the results from the initial testing in Table 6. The expert opinion column in this table has also been updated to differentiate between "Good" and "Very Good" public water supply systems. Once again, the CCME WQI rankings generally matched expert opinion. Twelve public water supply systems that ranked as "Good" using the CCME WQI were ranked by expert opinion as being more appropriately of "Very Good" ranking. These twelve public water supply systems were used to determine the appropriate point to split the "Good" category into "Good" and "Very Good" categories.

Though no CCME WQI value was able to split the "Good" category without any overlap, a CCME WQI value of 89 was determined to split the category most accurately. Selecting a value of 89 resulted in the public water supply systems of communities X and AF being ranked as "Good" by the revised WQI though expert opinion ranked them as "Very Good" and the water supply system of community B was ranked by the revised WQI as "Very Good" though the expert opinion ranked it as "Good." These differences were again not significant as the ranking was at the borderline between the two categories. The individuals that provided expert opinion on the public water supply systems, whereby the expert opinion differed from the revised WQI ranking, were consulted on this issue. The expert opinion agreed that the public water supply systems of communities X and AF could be reclassified to a "Good" ranking and the public water supply system of community B reclassified to a "Very Good" based on the other supplies in these categories.

The resulting new index categorization schema being used by the DOEC to communicate provincial DWQ data is listed in Table 7 and the distribution of WQI scores and revised interpretations are shown in Fig. 1.

This methodology for modifying the index categorization schema can be used by other jurisdictions that may be hesitant to use the CCME WQI to communicate their DWQ results because the existing index categorization schema in the CCME WQI does not reflect their jurisdictional water quality and expert opinion.

Implementation of CCME WQI on the Provincial Drinking Water Quality Database

The provincial DWQ database has been implemented in the enterprise level Oracle database. Results are received electronically from the chemical analysis laboratory and are incorporated into the database after being quality checked for missing and mislabelled samples. Quarterly

TABLE 5. Communities selected for secondary testing

Community	*Serviced population*	*Water treatment*	*Source*
R	176	Liquid chlorination	Surface water
S	256	Liquid chlorination	Surface water
T	5222	Water treatment plant + Gas chlorination	Surface water
U	410	Gas chlorination	Surface water
V	344	Liquid chlorination	Surface water
W	46	Liquid chlorination	Groundwater
X	3559	Gas chlorination	Surface water
Y	1726	Liquid chlorination + Greensand filtration	Groundwater
Z	470	Liquid chlorination	Surface water
AA	640	Liquid chlorination	Surface water
AB	1245	Water treatment plant + Gas chlorination	Surface water
AC	574	Gas chlorination + pH adjustment	Surface water
AD	814	Gas chlorination	Surface water
AE	560	Gas chlorination	Surface water
AF	222	Liquid chlorination	Surface water
AG	416	Gas chlorination + Filtration	Surface water
AH	1849	Gas chlorination	Groundwater

TABLE 6. Assessment of revised WQI rankings

Community	*WQI value*	*WQI ranking*	*Expert opinion*	*Revised WQI ranking*[a]
A	90	Good	Very Good	Very Good
B	89	Good	Good	Very Good
C	95	Excellent	Very Good	Excellent
D	93	Good	Very Good	Very Good
E	95	Excellent	Excellent	Excellent
F	97	Excellent	Excellent	Excellent
G	88	Good	Good	Good
H	73	Fair	Fair	Fair
I	80	Good	Fair	Good
J	93	Good	Very Good	Very Good
K	97	Excellent	Excellent	Excellent
L	97	Excellent	Excellent	Excellent
M	90	Good	Very Good	Very Good
N	95	Excellent	Very Good	Excellent
O	92	Good	Very Good	Very Good
P	92	Good	Very Good	Very Good
Q	100	Excellent	Excellent	Excellent
R	84	Good	Good	Good
S	85	Good	Good	Good
T	92	Good	Very Good	Very Good
U	81	Good	Good	Good
V	82	Good	Good	Good
W	94	Good	Very Good	Very Good
X	88	Good	Very Good	Good
Y	100	Excellent	Excellent	Excellent
Z	87	Good	Good	Good
AA	85	Good	Good	Good
AB	93	Good	Very Good	Very Good
AC	73	Fair	Fair	Fair
AD	84	Good	Good	Good
AE	83	Good	Good	Good
AF	88	Good	Very Good	Good
AG	87	Good	Good	Good
AH	93	Good	Very Good	Very Good

[a]After the "Good" category was split into two categories at WQI value of 89.

and annual reports are generated automatically for each community through a series of queries that produce customized reports.

It is planned that the CCME WQI values and ranks for each public water supply system will also be computed automatically when the reports are generated. To accomplish this, the CCME WQI model is being implemented into a Visual Basic (VB) application that will read from the Oracle tables. This VB application will read in the drinking water data, water quality guidelines and the index categorization schema presented earlier in Table 7 to compute the CCME WQI values and subsequently rank each public water supply system. This is a work in progress and is expected to be implemented in time for the spring 2004 quarterly report mail-out. The ranking will be updated when new data is collected for a public water supply system.

The automation of the CCME WQI necessitates the development of essential data selection protocols. The CCME WQI technical report requires that the CCME WQI be run with at least four variables sampled at least four times (CCME 2001). The VB application is being developed to automatically select the six most recent water quality samples to be used in the calculation of the CCME WQI, thus satisfying the second requirement of at least four samples. It was decided to use six samples instead of the minimum of four samples to reduce the effect of any one sample on the ranking. Sample results below detection limits will be included in the analysis by assuming that the results are equal to zero. Not all variables listed in Table 1 will be used in the computation of the CCME WQI. As indicated in Table 1, the 24 variables for which there are Guidelines for Canadian Drinking Water Quality will be used (Health Canada 1996).

Dealing with Challenges and Issues

Challenges encountered in using the CCME WQI as a communications tool for DWQ data relate primarily to the incorporation of other factors that could impair the quality of water or render water unsuitable for con-

TABLE 7. Revised WQI index categorization schema

Rank	*WQI value*	*Description*
Excellent	95–100	Water quality is protected with a virtual absence of threat or impairment; conditions very close to natural or pristine levels; these index values can only be obtained if all measurements are within objectives virtually all of the time.
Very Good	89–94	Water quality is protected with a slight presence of threat or impairment; conditions close to natural or pristine levels.
Good	80–88	Water quality is protected with only a minor degree of threat or impairment; conditions rarely depart from natural or desirable levels.
Fair	65–79	Water quality is usually protected but occasionally threatened or impaired; conditions sometimes depart from natural or desirable levels.
Marginal	45–64	Water quality is frequently threatened or impaired; conditions often depart from natural or desirable levels.
Poor	0–44	Water quality is almost always threatened or impaired; conditions usually depart from natural or desirable levels.

sumption and the issue of public acceptance. A public water supply system that ranks favourably may still not be suitable for human consumption due to the exceedance of any one contaminant (e.g., arsenic) in the most recent sample, the absence of residual chlorine, microbiological contamination or a THMs exceedance.

Currently, if contaminants of human health concern are detected in the most recent sample taken from a public water supply system, the exceedance reporting system requires that the community be directed to the appropriate health authority for more information on the necessary precautions and potential health implications. To account for situations where an otherwise favourably ranked public water supply system showed an exceedance of a contaminant, a routine in the VB application first checks the results of the most recent sample for exceedances of any contaminant. If any exceedances are flagged, the VB application will list all the contaminants detected in the most recent sample and will not rank the public water supply system. It will also print a cautionary qualifier on the CCME WQI report to alert the consumer to the presence of the contaminants and direct them to the appropriate authority. A cautionary qualifier would read as follows:

"Lead - The maximum acceptable concentration for lead in drinking water is 0.010 mg/L and the most recent sample collected from your community has a concentration higher than the limit. For some people this contaminant may have adverse health related effects. Please contact your regional Medical Officer of Health who is available to provide you with more information on the necessary precautions and potential health implications."

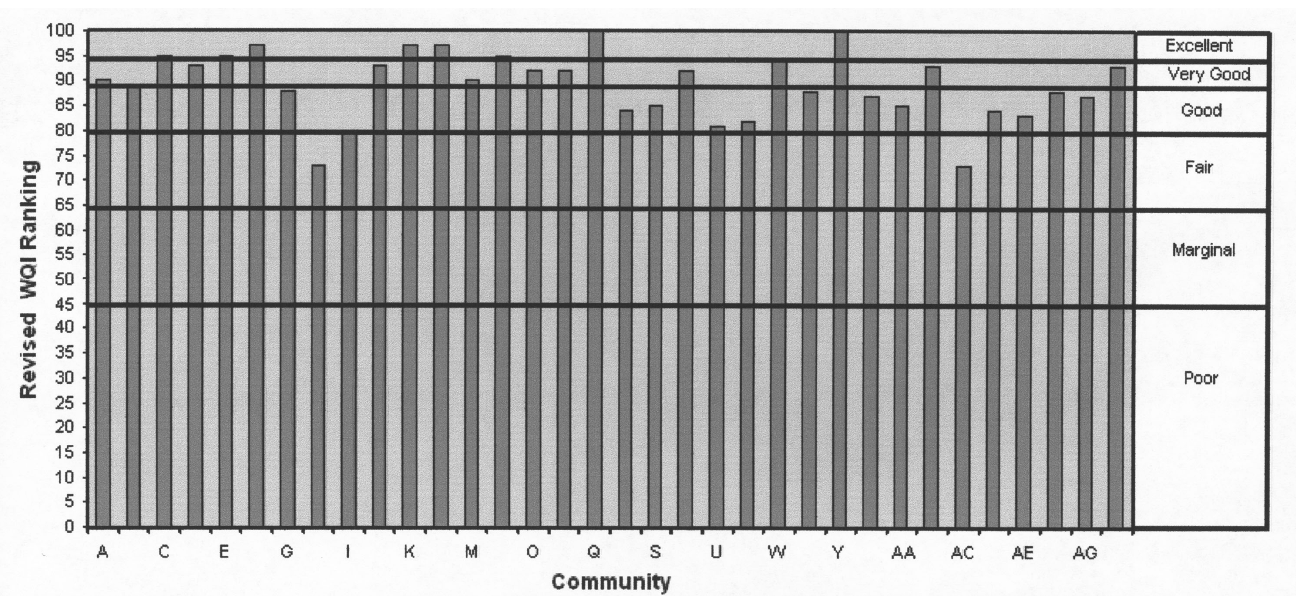

Fig. 1. Distribution of water quality using revised WQI rankings.

Microbiological contamination is also a major issue that must be considered. To measure microbiological contamination, the province follows the *E. coli* guideline of 0/100 mL. This essentially translates into a presence or absence scenario/test for *E. coli*. Since the F_3 factor of the CCME WQI cannot be calculated appropriately for presence or absence scenarios, microbiological contamination was incorporated in the planned WQI reports indirectly by using the inventory of current BWAs. If a supply is affected by microbiological contamination it would be placed under a BWA, so by flagging supplies on BWA, microbiologically affected sites can be screened out. On computation of the CCME WQI, a routine in the VB application checks the inventory of current BWAs to see if a particular public water supply system is under a BWA. If it is under a BWA, the application will not rank the water supply and it will print a cautionary qualifier to the effect that the physical/chemical water quality was not ranked due to the presence of a BWA.

In NL, the quarterly and annual reports also include the results of THMs sampling. Presently, THMs are not included in the CCME WQI computations due to the way the THMs guideline is calculated as a running annual average. This does not allow it to be analyzed by the CCME WQI in the same way as other variables. Therefore, the VB application will check the most recent THMs running annual average for each water supply. If the running annual average is above the recommended THMs guideline the application will not rank the water supply and will print a cautionary qualifier to the effect that the water quality was not ranked due to the presence of a THMs exceedance.

In essence, the application will work in a phased approach to incorporate factors (contaminants, microbiological agents, lack of chlorine residual and THMs) that could impair the quality of water or render water unsuitable for consumption. The first stage of the application will check for contaminants in the most recent sample, BWA and THMs exceedances. If any of these are detected the public water supply system will not be ranked. Once a public water supply system passes the first stage, then, in the second stage, the application will compute the CCME WQI and rank the water supply based on the index categorization schema presented in Table 7. The phased approach presented in the preceding paragraphs and summarized in Fig. 2, is a practical means of presenting available physical, chemical, organic and microbiological results to communities.

The public acceptability of the CCME WQI to communicate ambient water data has been demonstrated through various applications (CCME 2001). However, the public acceptability of using this tool for communicating DWQ will be tested for the first time through this application and based on the public response, modifications may have to be made to the phased approach.

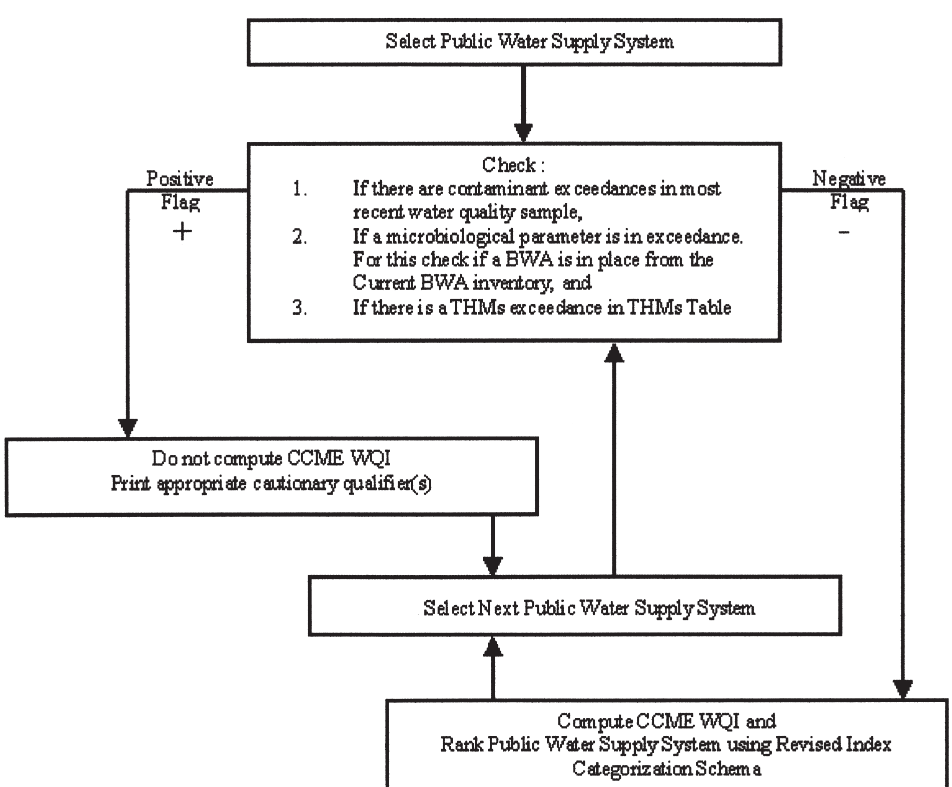

Fig. 2. Phased implementation schema.

Benefits and Downfalls

This is the first application of the CCME WQI to communicate DWQ results in Canada. The benefits of using the CCME WQI as a tool to communicate DWQ results are several. The water quality indices are calculated using a systematic process of comparing DWQ data to guidelines. The use of the CCME WQI throughout the province ensures that the rankings are computed in a consistent manner thus eliminating the personal bias/subjectivity introduced by different DOEC officers. The modification of the index categorization schema allows provincial/local expert opinion to be systematically incorporated into the interpretation of DWQ results. The automated generation of WQI rankings is a practical means for dramatically improving the interpretation of DWQ results. The results are simple to understand yet are sophisticated enough to incorporate the complexities introduced by BWAs, THM exceedances and contaminant exceedances.

The downfalls of using the CCME WQI are the same associated with any tool that summarizes data (i.e., a loss of information). Any single representation of data (e.g., in terms of an index or an average) does not capture a complete representation of the situation. The DOEC, in realization of this, does not intend to use the CCME WQI to replace detailed analysis of DWQ data. The CCME WQI, as any model, is also sensitive to the inputs (i.e., number of variables and number of samples). The use of too few or too many variables and samples can change the results. To reduce the effect of variables and sample size, the same variables are being analyzed for all public water supply systems and the six most recent samples are being used for the computation of the water quality indices. It is also important in using this tool to clearly define the specific set of variables used in the computation of the WQI.

Conclusions and Recommendations

Experiences gained through the monitoring and reporting of provincial DWQ, have made it apparent that involvement and understanding of water quality must first take place at a community level in order to ensure clean and safe drinking water. In recognition of this need, the DOEC tested the CCME WQI as a tool that could be used to rank public water supply systems in a way that would reflect the expert opinion of the DOEC officers while at the same time, simplify the large amounts of DWQ data for communications purposes. The initial testing of the CCME WQI indicated that it was a viable communications tool. The CCME WQI results from the initial seventeen public water supply systems generally reflected expert opinion. The index categorization schema in the CCME WQI was refined to reflect expert opinion on DWQ data and again tested successfully with seventeen additional public water supply systems. The CCME WQI methodology is now being programmed into a VB application so that CCME WQI reports can be generated automatically from the provincial DWQ database. The application will work in a phased approach to incorporate factors (contaminants, microbiological agents, lack of chlorine residual and THMs) that could impair the quality of water or render water unsuitable for consumption. This is a work in progress and is expected to be implemented in time for the spring 2004 water quality monitoring program quarterly reports. The experience gained in using the CCME WQI will be used to further fine-tune the index categorization schema if needed.

Finally, the CCME WQI could also be used by other jurisdictions to communicate DWQ monitoring results, however, the exact implementation of the CCME WQI will depend largely on the design of the DWQ monitoring program. The methodology for modifying the index categorization schema and the phased approach schema (for incorporating contaminants, microbiological agents, lack of chlorine residual and THMs) presented in this paper will be useful for these jurisdictions.

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