

**TERMS OF REFERENCE
FOR
System Assessment Reports for Water Works**

December 2002

I DEFINITIONS

The following definitions apply throughout this document:

- a. **Municipal Public Water System** - means a water works system owned or operated by a municipality or other government body using surface water, groundwater under the influence of surface water or groundwater for the provision to the public of piped water for human consumption.
- b. **STSW (Supply/Treatment/Storage Works)** - means water works for the collection, production, treatment, storage and supply of water, but not the water distribution system or in-distribution storage solely for purposes of water demand management.
- c. **Distribution System** - means water works for the distribution of water within the system, and supplied from the STSW including any part of such works.
- d. **GMPDWS** - means the "Guidelines for Monitoring Public Drinking Water Supplies" as issued in October 2000 and as amended from time to time.
- e. **Treatment Standard** - means the "Treatment Standard for Municipal Surface Water Treatment Facilities" as issued in December 2002 and as amended from time to time.
- f. **Certification Standards** - means the "Municipal Water Treatment and Water Distribution Facility Classification and Operator Certification Standards" as issued in December 2002 and as amended from time to time.
- g. **GUDI Protocol** - means the "Protocol for Determining Groundwater Under the Direct Influence of Surface Water" as issued in December 2002 and as amended from time to time.
- h. **Ten State Standards** - means the "Recommended Standards for Water Works (1997)" as issued by the Great Lakes - Upper Mississippi River Board of State and Provincial Public Health and Environmental Managers.
- i. **AWWA** - means the "American Water Works Association" and its associated Standards, Manuals, White Papers and Policies.

- j. **NSDEL** - means the Nova Scotia Department of Environment and Labour.
- k. **System Assessment Report** - means the deliverable product of this Terms of Reference.
- l. **Engineer** - means a professional engineer as defined in the *Engineering Profession Act* and who:
 - is competent by virtue of training and experience in engineering relating to drinking water supplies to engage in practices that fulfill the requirements of this Terms of Reference; and
 - has been contracted by the owner of the water works to prepare a System Assessment Report to verify that the water works is capable of achieving current environmental standards in accordance with this Terms of Reference.

II OBJECTIVES

The purpose of the system assessment is to complete a comprehensive review of the STSW and distribution system to identify operational and physical improvements, as well as staffing requirements, to comply with the GMPDWS, Treatment Standard, Certification Standards and water quality monitoring requirements. It is expected that the System Assessment Report will document the findings of the comprehensive review such that the following principal objectives can be achieved:

- a. assess the potential for microbiological, chemical and physical contamination of the water works;
- b. assess the disinfection process and overall treatment efficacy;
- c. identify operational and physical improvements necessary to mitigate the potential for contamination, improve disinfection and overall treatment efficacy, etc. by utilizing the multiple barrier concept and to comply with the GMPDWS and the Treatment Standard;
- d. establish a monitoring regime for the STSW and distribution system to ensure compliance with the GMPDWS and the Treatment Standard;
- e. establish a monitoring regime for process monitoring within the treatment train of the STSW and distribution system;
- f. review existing monitoring capabilities, training programs, quality control, data validation and instrument maintenance programs to assess the "state of readiness" of the utility to undertake the recommended monitoring regime, including cost and time estimates for a utility to achieve compliance;

- g. identify staffing requirements to comply with the Certification Standards, including time estimates for a utility to achieve compliance.

III GENERAL REQUIREMENTS

The System Assessment Report must include:

- a. a description of the STSW and/or distribution system;
- b. an assessment of the potential for microbiological, chemical and physical contamination;
- c. compilation of existing approvals for the STSW and/or distribution system;
- d. characterization of the raw water supply source(s);
- e. an assessment of operational procedures and recommendations to comply with the GMPDWS and the Treatment Standard;
- f. an assessment of existing physical works and recommendations to comply with the Treatment Standard;
- g. recommendations for a monitoring regime for the STSW and distribution system to ensure compliance with the GMPDWS and the Treatment Standard;
- h. recommendations for a process monitoring regime for the STSW and distribution system;
- i. an operational and management plan, including appropriate staffing requirements, to comply with the Certification Standards.

The System Assessment Report is to be submitted to, and be to the satisfaction of, NSDEL.

IV COMPILATION OF APPROVALS TO OPERATE AND WITHDRAWAL PERMITS

- a. The Engineer shall compile the existing "Approval(s) to Operate" for the STSW, including Terms and Conditions, and applicable "Withdrawal Permit(s)" and include copies of these as an Appendix to the System Assessment Report.
- b. The Engineer shall prepare a summary table of approvals referred to in (a) in chronological order summarizing the approval number and a brief description of the works approved for each approval.

- c. The Engineer shall prepare a summary table of available withdrawal permits referred to in (a) in chronological order identifying each permit number, expiry date, name of the water source it applies to (e.g., Well No.) and permitted withdrawal limits.
- d. The Engineer shall prepare a summary table of actual withdrawals for the past three years and compare these to the permitted withdrawal limits. Where no withdrawal permit(s) exists, actual withdrawals shall be summarized on a monthly basis as follows: average day, maximum day and total monthly flow.
- e. The Engineer shall summarize the history of the development of the water works and also identify whether a back-up supply is available for use to supply the community, including the dates that the back-up supply was used in the last three years, the length of time the back-up supply was used and the reason(s) why. The Engineer shall also described the procedures/protocols that were applied when the back-up supply was used.

V DESCRIPTION OF THE STSW

- a. The Engineer shall prepare a description of the STSW, including works for the collection, production, treatment, storage and supply of water, but not the water distribution system. Where practicable and in accordance with (b) below, description(s) currently contained within the "Approval(s) to Operate" compiled in Section IV should be used.
- b. This description shall be in sufficient detail to permit NSDEL to utilize the description provided for a new "Approval to Operate" for the water works.
- c. This description shall include the types, number and sizes of all process units and equipment including waste stream treatment and disposal facilities, and shall include critical process design parameters (e.g. intake velocity, mixing rates in rapid mix and flocculation tanks, surface settling rates and retention times in settling tanks, filtration and backwash rates in filters, chemical feed rates, chlorine concentration/time (CT) factors.).

Note: Particular attention is required in describing the complete disinfection system, including contact facilities, in detail. CT calculations must be included for the worst case conditions between the application point and the first user (i.e. highest pH, lowest temperature and lowest anticipated residual).

- d. The assessment of the physical works shall include a review of on-line instrumentation, their installation, maintenance and operation. The Engineer shall inspect all on-line monitors (e.g., flow, level, pressure, turbidity, chlorine

residual) to ensure that they have been installed correctly and that they are in good running order.

- e. The description of works shall also include a schematic process flow diagram of the STSW with process units and equipment identified, as well as points of connection to the distribution system.
- f. The STSW description(s) shall be categorized into separate descriptions for each self-contained water supply system or sections of water supply systems that are separated or normally separated from the rest of the water supply system within a municipality or have separate connection points to the distribution system.

Note: Where individual STSWs feed separated or normally separated distribution systems, a separate System Assessment Report must be submitted for the STSW(s) associated with each of the separated or normally separated distribution systems.

- g. Each point of water collection at each well or each point of intake for a surface water supply shall be identified by separate UTM coordinates.
- h. Each location of an STSW shall have the approximate centre of the facility (facilities) identified by UTM coordinates.

VI DESCRIPTION OF THE DISTRIBUTION SYSTEM

- a. The Engineer shall prepare a description of the distribution system, including pressure districts and/or service areas, pumping stations, in-distribution storage and supplementary chlorination facilities. Where practicable and in accordance with (b) below, description(s) currently contained within the "Approval(s) to Operate" compiled in Section IV should be used.
- b. This description shall be in sufficient detail to permit NSDEL to include the description provided within the scope of a new "Approval to Operate" for the water works.
- c. This description shall include the name, address and size of the facilities and types, number and sizes of all process units and equipment in the facilities.
- d. The Engineer shall prepare a drawing of the distribution system highlighting:
 - the extent of the distribution system and showing all dead ends;
 - available distribution system data (e.g. pipe materials, age, known watermain breaks, etc.);
 - the pressure districts and/or service areas, pumping stations, in-distribution storage and supplementary chlorination facilities;

- location of dead ends;
 - serviced areas outside the municipal boundary, if any; and
 - existing sampling locations.
- e. For serviced areas outside the municipal boundary, the Engineer shall summarize legal arrangements, if any, made by the owner of the water works and the adjoining municipality or relevant party.

VII ASSESSMENT OF POTENTIAL FOR CONTAMINATION

- a. The Engineer shall undertake a review of the STSW and any supplementary chlorination facilities serving the distribution system to assess the potential for microbiological, chemical or physical contamination using the following:
- a visual inspection of the above facilities (including well head protection if a ground water supply or watershed management practices for surface and ground waters) for the purposes of identifying potential sources and pathways of contamination to the physical works;
 - available records of water quality testing which exceeded drinking water requirements for the last 2 years.
- b. The Engineer shall undertake a review of results of bacteriological and chlorine residual sampling and analysis taken from the distribution system for purposes of identifying locations within the distribution system which may need further assessment as potential sources of bacterial contamination or respecting chlorine residual enhancement using the following:
- available records of microbiological testing which exceeded drinking water requirements for the last 2 years;
 - review of existing cross-connection control programs;
 - analysis of available distribution system data (e.g. pipe materials, age, known watermain breaks, etc.) and suspected deficiencies.

Note: The Engineer shall be required to confirm that the number of samples taken from the distribution system are adequate to appropriately characterize the distribution system water quality and that the sample collection "chain of custody" is documented. In addition, the Engineer shall be required to summarize the frequency, location and rationale for microbiological, chemical and physical monitoring to ensure water quality is maintained throughout the distribution system (see Section XI).

- c. Step 1 of the GUDI Protocol shall be completed for each groundwater source (e.g. well, spring, infiltration gallery, etc.) in the STSW. For each groundwater source, a clear conclusion shall be made as to whether the source is potentially under the direct influence of surface water or not under the direct influence of

surface water.

- d. The Engineer shall document the findings of the review for (a), (b) and (c) of this section and make recommendations to mitigate the potential for microbiological, chemical and physical contamination.
- e. Should, at any time during the assessment, the Engineer discover direct sources of microbiological contamination or malfunctioning chlorination equipment, he/she shall immediately notify NSDEL and the owner of the water works.

VIII CHARACTERIZATION OF RAW WATER SUPPLY SOURCE

- a. The Engineer shall characterize the raw water of each individual source of the STSW's raw water supply, including all back-up supplies. For the purposes of characterization, parameters to be evaluated shall include all those listed in the GMPDWS and the Treatment Standard, as well as the health-related Guidelines for Canadian Drinking Water Quality. To evaluate trihalomethanes (THMs), a THM formation potential test shall be conducted if no actual THM results are available. The Engineer shall utilize the source raw water sampling and analysis records available from the owner of the STSW, and any additional sampling and analysis that may need to be undertaken for a complete characterization.

Note: Results of the treated water analyses are not acceptable for the purpose of raw water characterization, regardless of the type of treatment involved, including disinfection.

Where general knowledge and/or historical data indicate that, in the water source in question, a particular parameter is consistently absent or below the level of concern, such a parameter need not be included in the analyses, provided that, for each such parameter, the Engineer has provided either the actual historical data confirming absence, or a statement that the he/she has assured him/herself of such absence based on a review of historical data.

For multi-well systems, raw water characterization may not need to be done for each source well separately, provided that a hydrogeological study, concluding that the raw water characteristics for the particular wells should be identical, has been completed and the Engineer submits a copy of same as an Appendix to the System Assessment Report. This does not apply to the bacteriological characteristics of raw water that must be done separately for each well regardless of the findings of the hydrogeological study.

- b. Based on the raw water characterization required by (a) above, the Engineer

shall:

- review raw water quality to determine the capability to comply with the GMPDWS and the Treatment Standard;
- identify treatment which may be necessary to assure compliance;
- identify parameters which may impact treatment of the water, and influence operation of the system.

Note: If a back-up supply is available for use to supply the community it should be described and characterized as part of the System Assessment Report. The Engineer shall also confirm the intentions of the owner of the water works to:

- 1) upgrade the back-up supply to comply with the GMPDWS and the Treatment Standard; or
 - 2) initiate a boil water advisory whenever the back-up supply is used in accordance with the Treatment Standard.
- c. In addition to the determinations made in accordance with (a) and (b) above, the Engineer shall, if appropriate, identify further work necessary to determine the potential for formation of disinfection by-products (DBPs).
- d. In addition to the determinations made in accordance with (a) and (b) above and VII (c), the Engineer shall, if appropriate, identify further work necessary to determine whether a groundwater supply is under the direct influence of surface water.

IX ASSESSMENT OF OPERATIONAL PROCEDURES

- a. The Engineer shall review and document the current state of the Operations Manual available to the owner of the water works to determine if the manual:
- exists;
 - is current;
 - contains adequate requirements respecting operation, maintenance (including calibration) of equipment utilized for flow measurement and automated analysis of water samples.
- b. The Engineer shall document the findings of this review and the inspection (see Section V, Item d) and make recommendations respecting any deficiencies identified in the Operations Manual review and/or by the inspection.
- c. The Engineer shall review general operational procedures, including cross-connection control programs and flushing/swabbing programs, and make recommendations for improvements that may be required to mitigate the

potential for microbiological, chemical and physical contamination of drinking water.

- d. In addition to the determinations made in accordance with (b) and (c) above, the Engineer shall review the standard operating procedures and/or contingency plans for ensuring distribution system water quality during disruptions in system integrity.

Note: Coliform bacteria, including *E. coli*, can enter any water supply after a watermain repair, replacement or other disruption in the water distribution network. The American Water Works Association (AWWA) has published disinfection and sampling/analysis guidelines for the installation and replacement of water mains (Haas *et al.* 1998). Standard operating procedures describing flushing, chlorination procedures and sampling/analysis are a must during any distribution system main disruption. The System Assessment Report must include a review of main replacement programs, main repair procedures (including disinfection practices and sampling strategies to ensure microbiological quality is maintained following new main installations or main repairs).

- e. In addition to the determinations made in accordance with the above, the Engineer shall confirm that an emergency contingency plan exists and is regularly reviewed and practiced by staff.

X ASSESSMENT OF PHYSICAL WORKS ASSOCIATED WITH THE STSW

- a. The Engineer shall review the existing STSW with particular attention to works necessary to ensure the robustness of the system utilizing the multiple barrier concept. The review should consider the following documents:
 - GMPDWS;
 - Treatment Standard;
 - Other industry accepted standards (e.g. AWWA, Ten State Standards).
- b. The System Assessment Report, under the heading "Ability to Comply" shall discuss the ability of the existing STSW to comply with the requirements of the GMPDWS and the Treatment Standard.
- c. The Engineer shall make recommendations for operational and physical improvements that should be implemented to achieve compliance with the GMPDWS, the Treatment Standard and other industry accepted standards.

XI DETERMINATION OF A MONITORING PROGRAM FOR THE ENTIRE WATER WORKS TO ENSURE COMPLIANCE

- a. The Engineer shall recommend a site-specific monitoring program for the STSW and the distribution system based on the findings of the System Assessment Report.
- b. This program shall include:
 - parameters to be monitored;
 - sampling locations;
 - sampling frequency;
 - type of sampling (i.e., compliance/process monitoring, and raw water/treated water/distribution system monitoring, etc.);
 - rationale;
 - chain of custody requirements.
- c. The Engineer shall review existing monitoring capabilities, training programs, quality control, data validation and instrument maintenance programs to assess the "state of readiness" of the utility to undertake the recommended monitoring regime, including cost and time estimates for a utility to achieve compliance.
- d. The Engineer shall identify the accredited laboratory that will conduct the compliance monitoring testing for the owner of the STSW and/or the distribution system on a parameter-by-parameter basis.

XII PREPARATION OF AN OPERATIONAL AND MANAGEMENT PLAN

- a. The Engineer shall estimate any changes in facility classification that may occur as a result of implementing recommended works to achieve compliance with the GMPDWS and the Treatment Standard.
- b. In addition to the determinations made in accordance with (a) above, the Engineer shall identify adequate staffing requirements, including managerial and operational expertise.
- c. The Engineer shall review existing staffing levels, operator certification status, operational experience, educational and training backgrounds and identify discrepancies with the Certification Standards, including time estimates for a utility to achieve compliance.
- d. In addition to the determinations made in accordance with (c) above, the Engineer shall recommend a continuing education program to ensure managers and operators receive adequate training to refresh their skills and acquire knowledge about new developments in their field, remain aware of risks to public

health, and understand the measures that must be taken in the event of an emergency. The Engineer shall also recommend a continuing education program to ensure operators can meet certification renewal requirements.

XIII PREPARATION AND SUBMISSION OF A REPORT

- a. The Engineer shall prepare a written System Assessment Report outlining their findings and recommendations that shall be relied upon by NSDEL in support of further decisions to be made by NSDEL.
- b. Three (3) copies of the System Assessment Report shall be submitted to NSDEL. The report shall be completed to the satisfaction of NSDEL.
- c. The System Assessment Report shall contain a signed declaration made by the Engineer responsible for the report, as follows:

"I, the undersigned, hereby declare that to the best of my knowledge, the information contained herein and the information in support of this submission is complete and accurate in accordance with my obligations under the *Engineering Profession Act* and its regulations.

I further declare that this submission has been prepared in reasonable accordance with the published terms of reference for this submission, despite any qualifications in the agreement contracting me, and I acknowledge that the NSDEL and the Owner will be relying on the accuracy of this report."

- d. The System Assessment Report shall also be submitted to NSDEL electronically.