RESEARCH REPORT

An Application Guide for Water Reuse Systems

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AN APPLICATION GUIDE FOR WATER REUSE SYSTEMS

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ABSTRACT

This guideline application document is intended for those involved in the analysis, design, specification and operation of water reuse systems; to those who wish to become familiar with current developments in innovative water treatment systems and broaden their knowledge of water reuse problems and their solution. The contents will be of particular interest to engineers, managers, technical personnel and regulatory authorities. Information presented in this guide will be useful as a design and approval submission checklist. A how to get started and information required reference if you wish.

This water reuse application document is not intended to deal with issues associated with treated wastewater disposal to the environment and/or associated water quality discharge objectives.

References to specifications, studies and other publications are provided which can be consulted for further information on design practices and requirements for water reuse systems. A sample application form with instructions is also included which may be helpful to both applicants and review agencies. It is hoped the information provided in this document will assist in the development of approval submission procedures, guidelines and standards for water reuse applications.

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1.0 INTRODUCTION

1.1 Purpose of the Guide

Currently there are no regulatory requirements, standards or guidelines directly associated with applications for water reuse technology in Canada. Some efforts have been made to address water reuse issues in existing regulations, two notable examples are a proposed draft amendment to the British Columbia Plumbing Code dealing with recycled water (see **Appendix B**) and a Policy paper with respect to Innovative Designs and Technologies New to British Columbia. These documents serves as reference sources and impetus for this application guide. This guide presents an examination of water reuse issues in detail incorporating a number of sources to provide a more comprehensive review of concerns.

A recent report on "Regulatory Barriers To On-Site Water Reuse", prepared by Canada Mortgage and Housing Corporation, examines some of the regulatory issues in Canada associated with on-site water reuse. Potential or perceived regulatory barriers in Federal, Provincial and Territorial jurisdictions are identified and discussed in this report (please see reference documents, **Appendix A**).

In the absence of approved guidelines for water reuse and to promote good planning and design practices, this application guide has been prepared. The intent of the document is to assist persons seeking approval for a water reuse system and regulatory agencies approving water reuse systems. The focus of the report is primarily aimed at residential reuse applications. It is hoped the information in this report will facilitate a better understanding and acceptance of water reuse concepts.

1.2 Guide Contents

This guide introduces the relationship between water reuse applications, treated water quality and complexity of the system design and operation. It provides an overview and reviewer's checklist of some of the issues associated with water reuse touching on key planning, analysis and design requirements. An example application form with instructions on how to complete the form has been prepared (see **Appendix C**). In the absence of formal submission requirements, this form may be considered as a basis to outline supporting information requirements regarding approvals.

The guide examines issues germane to the development and operation of a water reuse system. This report addresses:

- **Technical Issue in the Design and Planning of Water Reuse**: Identifies a number of prominent issues which should be addressed as part of a good system design and management;
- **Operation and Monitoring Programs**: Provides an outline of operating procedures, documentation, water quality parameters and considerations needed to establish a facility monitoring program;
- **Feasibility Reports, Engineering Studies and Design Plans**: Reviews pertinent information which should be addressed in technical water reuse studies and design briefs including plan preparation requirements;

- **Application Submissions**: Provides an example application format with instructions summarizing common elements which form part of a water reuse system application. Typical statements which may form part of terms and conditions of any permit and authorization agreement are considered; and

- **Reference Documents**: References are provided for readers who wish to broaden their knowledge of water reuse systems and applications.

It is hoped the information provided in this document will assist in the development of approval submission procedures, guidelines and standards for water reuse applications.

1.3 Background

Water management programs to encourage and improve water use efficiency are being incorporated into policies by federal, provincial and municipal agencies. The concept of performing the same activities with less water is being undertaken by many of these agencies and is supported by changes in toilet, faucet and showerhead designs in recent years. Using water more efficiently through the reduction of water use by demand management, repair of leaking distribution systems and the incorporation of innovative methods and systems into the design of residential and commercial buildings, helps to reduce water consumption, preserve the natural environment and reduce the stress on our freshwater resource.

Although Canada has no regulations regarding the reuse of water an increasing number of applications are being proposed to regulatory and health agencies. In 1997, the Canada Mortgage and Housing Corporation (CMHC) commissioned a study entitled "Regulatory Barriers to On-Site Water Reuse" conducted by the Canadian Water and Wastewater Association. The study explored the potential or perceived barriers in health and environmental regulations, as well as in plumbing/building codes and municipal By-laws. Several other research reports are available through CMHC dealing with water reuse trends and case studies.

Guidelines for Canadian Drinking Water Quality and the Guidelines for Canadian Recreational Water Quality and the National Plumbing Code represent important references for water quality and distribution system guidelines. Other manuals and technical papers are available which deal specifically with water reuse practices through organizations such as the American Water Works Association, NSF International and Water Environment Federation.

1.4 Water Reuse System Requirements

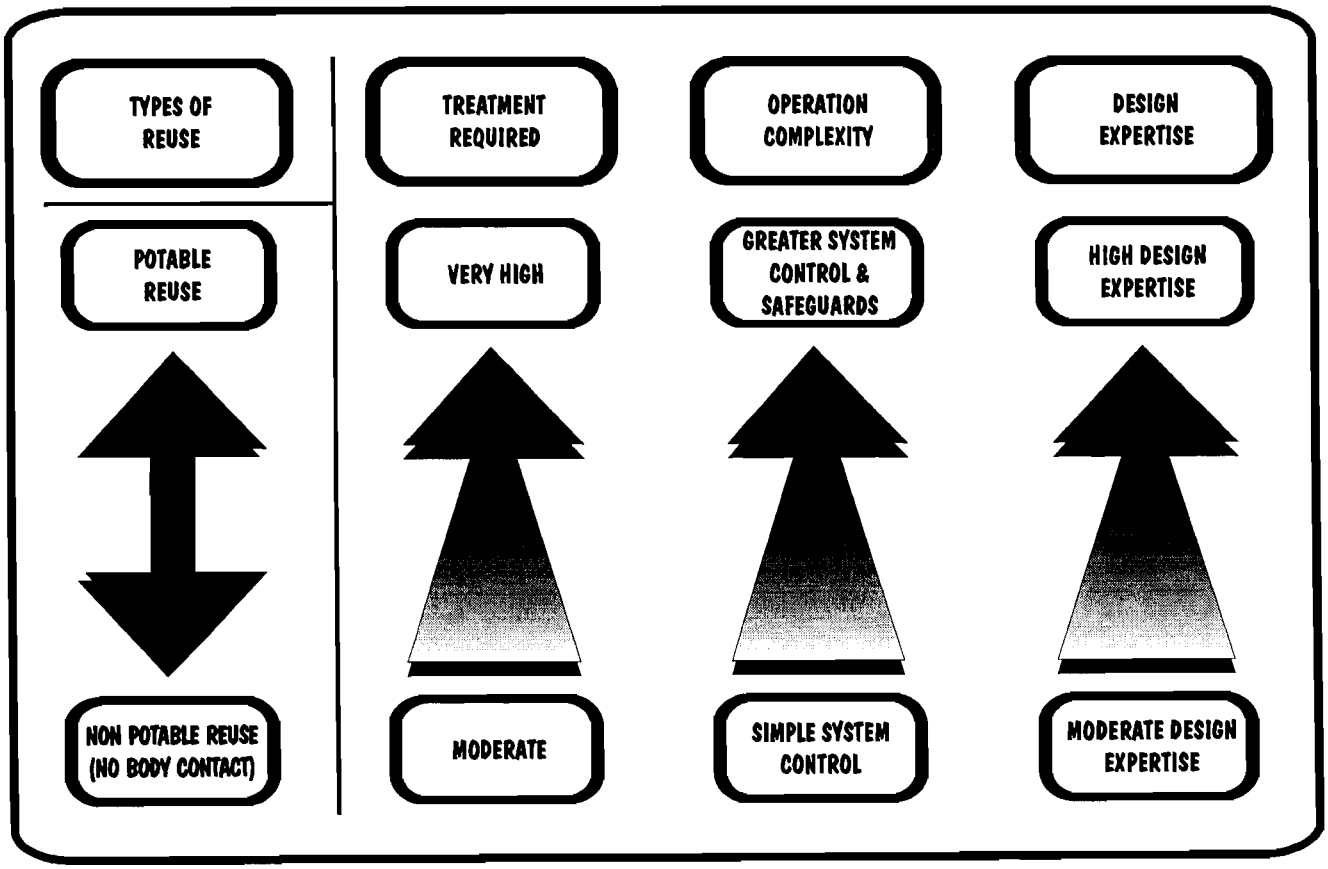
Process and treatment requirements for any water reuse system will depend primarily on the intended water application and source / treated water product. Although there is no explicit Canadian standard for water reuse other than current drinking water standards, there is a need to establish water reuse guidelines and standards. For direct potable water reuse a standard different than the current drinking water standard is required.

Drinking water standards have developed on the presumption that water supplies are derived from relatively unpolluted freshwater sources. This is not the case with reuse systems. There are unknowns

with respect to health and exposure issues associated with reused water considering that only a small fraction of chemical and pathological contaminants in water can be identified. Developing a National water reuse standard may establish distinctions between reuse classifications (i.e. potable and non potable uses) and within the broader non potable categories (i.e. toilet flushing and washing).

Figure 1 illustrates a hierarchy of different types of reuse and requirements for water quality, system complexity and level of design expertise. System complexity reflects both process design expertise, treatment requirements and operational intricacies. It is expected that submission requirements associated with reuse approval applications will reflect similar system complexity issues.

Figure 1
Water Reuse System Expertise and Complexity



1.5 Approval Procedures

District or regional authorities and/or municipalities in each jurisdiction will likely have specific procedural concerns as mandated through respective policies, regulations and by-laws as they relate to the approval of a water reuse project. In some cases existing policies dealing with the approval of water treatment systems will contain provisions involving the consideration of experimental or research projects which may be helpful. To determine specific requirements in your area, local authorities/municipalities should be consulted to confirm the participants in the process and approval procedures to be followed.

Projects involving small housing communities or a segment of a community which may have adverse effects on one or more components of the environmental will likely require an environmental study to be conducted. In such cases, procedural aspects contained in environmental assessment legislation will likely dictate the steps to be followed.

For small residential reuse projects an enclosed sample application form may be considered. This form is presented in **Appendix D**. All applications should be accompanied by a study and supporting documentation along with applicable plans and specifications.

1.6 Definitions

For the purpose of this document, the following definitions of grey water and potable / non potable water are considered.

Light Grey Water: Used household water from tubs and showers excluding sinks, washing and toilet water.

Grey Water: Used household water from sinks, tubs, showers and washing, excluding toilet water.

Non potable water: Water intended for use other than potable purposes.

Potable water: Water intended for drinking, cooking and cleaning. The quality of water conforms to regulatory authority drinking water quality requirement.

2.0 PLANNING AND DESIGN ISSUES

This section provides a review of some of the planning and design issues and concerns relating to water reuse systems.

2.1 Water Reuse System Classifications

One of the early planning aspects for water reuse systems is to define the purpose of the project; whether it is intended to serve primarily as a single or multi purpose function. There are several general classifications which can be used to describe water reuse systems; classifications characterized in terms of the user, water product purpose and / or quality standards. Some common water reuse categories currently used are identified in **Table 2.1**.

Table 2.1
Water Reuse System Categories

Source: CMHC report "Regulatory Barriers to On-Site Water Reuse" (Residential Systems)	Source: USEPA Reuse Categories
- Potable Uses - Human Contact (bathing, washing) - Indirect Use (e.g. toilet use, clothes washing) - Irrigation of private food crops - Lawn Irrigation	- Unrestricted Urban - irrigation of public areas, toilet flushing, etc. - Restricted Urban - irrigation of controlled public access areas such as golf courses. - Agricultural (Food crops) subsequent classifications can apply as to whether the food crop is consumed raw or processed. - Agricultural (Non food crops - fodder, pasture lands, etc.) Unrestricted Recreational (water recreational impoundments with activities involving body contact) - Restricted Recreational - impoundments limited to non body contact activities such as boating. - Environmental (Wetlands) - Industrial (primarily cooling system makeup, process water etc.)

Other terms and definitions which are commonly used to categorize reuse applications include:

- Direct and indirect reuse systems (indirect reuse generally refers to groundwater reclamation from water applied to land based irrigation / percolation systems);
- Public and private reuse systems;
- Potable and nonpotable (refers to drinking or non-drinking water);
- Restricted and Unrestricted (refers to water contact access controls or restrictions); and
- Light grey (shower water), grey water (wash water) and black water (residential wastewater).

Examples of water reuse in residential buildings and communities include the following:

- Potable water
- Toilet and urinal flushing;

- Lawn watering / irrigation;
- Fire Protection;
- Showering and bathing;
- Prime water traps; and
- Surface cleaning/flushing.

A range of other reuse activities exist in conjunction with industrial, agricultural and commercial applications.

2.2 Source Water Quality

The establishment of water reuse treatment requirements for a project should reflect an understanding of health hazards and associated risks as well as the need to meet minimum aesthetic and nuisance standards. Health hazard and risk evaluations involve an assessment of problems derived from direct water contact or ingestion. Evaluations can be related to pathogenic microorganisms and toxicological issues (effects associated with physical or chemical constituents in the water). Aesthetic and nuisance parameters are concerned with the appearance and palatability of the water.

A range of constituent concentrations typically found in raw untreated water sources such as light grey water and raw domestic wastewater are outlined in **Table 2.2.**

Table 2.2
Raw Water Quality

Constituent (mg/L unless otherwise noted)	Range Expected for Light Grey Water (Literature Values)	Range Expected in Untreated Domestic Wastewater (Metcalf & Eddy)
Total Solids		350-1200
TDS		250-850
TSS	33-160	105-325
BOD5	220-328	110-400
COD		80-290
Total Nitrogen	12-17	250-1000
Organic Nitrogen		20-85
Total Phosphorus	26-59	4-15
Chlorides		30-100
Sulfate		20-50
Alkalinity (as CaCO3)		50-200

Constituent (mg/L unless otherwise noted)	Range Expected for Light Grey Water (Literature Values)	Range Expected in Untreated Domestic Wastewater (Metcalf & Eddy)
Total coliform (counts/100mL)	10^1-10^4	10^5-10^8

In general all constituents in the source water for reuse systems should be fully investigated. A complete and comprehensive water analysis to determine a full spectrum of parameters is advisable.

2.3 Water Chemistry Issues

A brief review of some of important terms and key parameter relating to the chemistry of water is presented. The description of various parameters includes identification of unit measurements, treatment problems and unit treatment processes.

Dissolved Minerals
Measurement of dissolved minerals electronically can be expressed as specific conductance or resistance. These parameters are usually measured as ohms per centimetre (resistance) or micromhos per centimetre (conductance). As the resistance increases, the conductivity and dissolved mineral level decreases.

pH (acidic or basic)
The term pH represents the reciprocal of the hydrogen ion concentration measured on a log scale. The measurement is expressed between 14.0 (basic) and 0.0 (acidic) with 7.0 representing a neutral or mid point. The acidity of a solution increased by a factor of 10 between log scale units (i.e. 6 to 7).

Turbidity
Turbidity represents a measure of the transmission of light through a volume of water. The higher the turbidity value the more particles there are in the water. Particles can include fine sand, silt or clay.

Bacteria
Bacteria counts are often expressed in plate counts where bacterial colonies are incubated in a volume of the sample and the colonies are counted. The count is usually reported as most probable number of (MPN) colonies per 100 mL of sample volume.

Dissolved Solids
Total dissolved solids represents the total minerals dissolved in the water sample. The majority of dissolved solids comprise cations: Calcium, Magnesium and Sodium, and Anions: Chlorides, Sulfates and Carbonate.

Alkalinity
Alkalinity is a measure of the presence of anions (negatively charged ions) in the water. The term is often used in conjunction with pH. The predominate anions are carbonates, bicarbonates and hydroxide.

Water Hardness
Water hardness is a measure of the presence of calcium, magnesium, related chlorides and sulfates in the

water, often expressed as equivalent calcium carbonate levels. One indication of water hardness is the amount of soap added to water required to precipitate hardness, indicated when soap foam suds form. Water hardness combined with alkalinity represents a primary source of scale formation. Water hardness compounds can form a hardness scale or when combined with detergents an insoluble soap compound.

Iron
Iron in water can cause rust staining and an iron sludge which can clog pipes and valves. The sludge is the end product of bacteria which consume iron. Iron in the water can result in staining at levels greater than 0.2 mg/L (parts per million) and can impart a metallic taste to the water.

Manganese
Manganese in the water when oxidized can result in a black stain in levels as low as 0.05 PPM.

Sulfates
Sulfate compounds can have a laxative effect, form a scale at high concentrations and cause a "totten egg" odour (hydrogen sulfide).

A chemical analysis of the water supply will indicate the need for water treatment corrective measures. A variety of chemical, filtration and disinfection treatment processes can be considered to solve specific problems. Unit processes and operations used and their potential for contaminant removal are presented in **Table 2.3** (adapted from Metcalfe & Eddy - Wastewater Engineering Treatment, Disposal, Reuse)

Table 2.3
Water Treatment Unit Processes

Constituent	Unit process or operation							
	Primary Treatment	Coag.-Floc.-Sed.	Filtration	Carbon Adsorption	Selective Ion Exchange	Reverse Osmosis	Chlorination	Ozone
BOD	②	①	①	①	②	①		③
TSS	①	①	①	①	①	①		①
Oil & Grease	①	②	①	②				
Total Coliform		①	③	①			①	①
TDS						①		
Iron	②	①	①	①				
Manganese	③	②	①	②				
Colour	③	①	③	①		①		①

Constituent	Unit process or operation							
	Primary Treatment	Coag.-Floc.-Sed.	Filtration	Carbon Adsorption	Selective Ion Exchange	Reverse Osmosis	Chlorination	Ozone
Foaming Agents	②	②	①	①		①		③
Turbidity	②	①	①	①		①		
TOC	②	①	②	①	③	①		①

Symbols:
① > 50% removal of influent concentration
② = 25 - 50 % removal of influent concentration
③ = 25 % removal of influent concentration
Blank denotes no data or inconclusive results.

2.4 Treated Water Quality

A selection of water quality guidelines considered by various agencies in regulating water quality are presented in **Table 2.4**. Copies of select guidelines for water reuse from various sources including the Guidelines for Canadian Drinking Water Quality are included in **Appendix C**.

Table 2.4
Water Reuse Treatment Guidelines

Water Quality Parameter	Urban Reuse - USEPA (non-potable)	Light Grey Water Reuse in Pilot Plant - CMHC Toilet Reuse Pilot Project - Ottawa.	Canadian Drinking Water Quality	Canadian Recreational Water Quality
pH	6 - 9		6.5 - 8.5	6 - 9
BOD5	≤10			
Turbidity	≤2 ntu (average 24 hour) not to exceed 5 ntu any time	<20 NTU	≤1 NTU	≤50 NTU
Coliform	No detectable fecal coli/100 mL, not to exceed 14/100 mL in any one sample	Conform to Drinking Water Standards	No detectable	200 *E. Coli* / 100 mL
Disinfection	1 mg/L Cl_2 residual			
Colour		<30 TCU	≤15 TCU	

Water Quality Parameter	Urban Reuse - USEPA (non-potable)	Light Grey Water Reuse in Pilot Plant - CMHC Toilet Reuse Pilot Project - Ottawa.	Canadian Drinking Water Quality	Canadian Recreational Water Quality
Suspended Solids	5 to 30 various States (Unrestricted Urban Reuse)	<10 mg/L		
Iron		<1.0 mg/L	≤0.3 AO	
Manganese		<0.5 mg/L	≤0.05 AO	

NTU = nephelometric turbidity unit
TCU = true colour unit
AO = aesthetic objective.

2.5 Design Flow

Designing the water reuse system requires an analysis and understanding of the system flow requirements. This requires balancing the untreated water supply with the reuse water demand and process water requirements; a water budget analysis. Variations and fluctuations in both supply and demand must be understood. Difference in hourly, daily and seasonal demand and availability can be attenuated through the use of flow equalization tanks or the use of alternative or back-up water sources.

Water budget analysis programs are available to assist in system design. One such program, WATERSAVE, has been developed for CMHC by the Centre for Water Resource Studies of the Technical University of Nova Scotia. WATERSAVE is an interactive, MS Windows-based program. The program analyses water and wastewater flows in a residential system, calculates concentrations of a given parameter throughout the system and determines the distribution of heat and water temperature in the system. It is a tool for designers with functions to facilitate the design of water reuse systems, examine water conservation measures, determine the capacity of rain cistern systems and analyse heat energy.

2.6 Treatment Process Reliability

In general terms treatment process reliability is a measure of the system process to consistently meet performance objectives. One of the key performance objectives is to protect public health through maintaining adequate treatment levels and providing safe secure water. Reliability can be expressed as the percentage of time or probability that the treatment level objective can be met.

Each process unit component can provide a barrier preventing the passage of untreated water or contaminants into the distribution system. The more barriers and redundancies incorporated into the overall system design, particularly unit process treatment efficiencies, the better the overall treatment removal performance and reliability. Of particular interest in multiple barrier designs is the removal of pathogens.

Measurements of overall reliability of a water reuse system should take into consideration the various factors which affect treatment performance. Factors which influence the outcome include the size and capacity of equipment components, equipment efficacy, operating conditions, and system service maintenance.

One approach in establishing a reliable process train is to utilize multiple units, each individually capable of meeting a high level of removal performance. Redundancy in the treatment system allow the process to readily meet targeted removal rates even if one of the system units should fail. Of course adding redundancy into the system can be costly therefore the need for multiple barriers should reflect the consequential risks of a failure. For pathogens, health risks may be high while for other parameters, the consequences of failure may not so immediate or obvious.

One method which can be used to evaluate reliability is a Monte Carlo based analysis. A Monte Carlo analysis can be used to appraise the probability of process failure as a function of the probability of failure and success of individual units. Backup or duplicate processes can serve to dramatically reduce the probability of failure. An example to illustrate this outcome follows:

Example:
Assuming the performance of a unit treatment process relies on two independent and identical components each with a low failure probability ($p=0.01$), then the probability of a system process failure incorporating the two units in series can be calculated as follows:

$P = p_1p_2 + p_1q_2 + q_1p_2$ *where:* P = *probability of treatment process failure*
p_1 = *probability of failure of the individual unit*
q_1 = *probability of success of the individual unit*

In this case the probability of a system treatment failure is 0.0199 calculated below:

$P = .01 \times .01 + .01 \times .99 + .99 \times .01$
$= 0.0199$

The effect of adding a backup system with similar probabilities changes the failure outcome of this example by two orders of magnitude to a failure probability of 0.000199, shown as follows:

$P = p^2 (2 - p^2)$ *(simplified probability equation)*
$= 0.000199$

By increasing the unit processes in series the uncertainty associated with the overall process decreases. The above example illustrates that system process reliability can not be evaluated solely by considering components in isolation but rather is the product of cumulative probabilities.

To appraise concerns which address the overall process reliability, research performance test results for individual units and water quality parameters can be considered. Alternatively if suitable data exists, performance results from an identical or similar process can be used to substantiate the process reliability.

Other factors which improve process reliability include operational safeguards such as warning alarms, process controllers and monitoring instruments. The inclusion of the means to regulate and control the

process further helps to improve the overall treatment process reliability.

2.7 Multiple Barriers

The concept of multiple barrier is the use of several different processes each of which may be effective in removing target contaminants. As previously mentioned, pathogen removal represents a key health related concern with treating contaminated water. Some examples of treatment process barriers are provided in **Table 2.5.**

Table 2.5
Multiple Barrier Processes and Selective Contaminates

Contaminants	Barriers
Viruses, bacteria and protozoa	High-pH lime clarification Ultraviolet irradiation Reverse osmosis Filtration (Micro/Ultra/Nano) Ozonation Chloramination
Metals and Inorganic	Clarification Activated Carbon adsorption Reverse osmosis
Organics	Clarification Activated carbon adsorption reverse osmosis air stripping

2.8 Health and Safety Issues - Distribution System

The distribution system should be designed to conform to all applicable plumbing code requirements. In the absence of such requirements a list of general guidelines and safety precautions has been compiled for consideration:

- **Piping.** Water reuse piping should be well separated from domestic water pipes. A proposed amendment prepared for the British Columbia Plumbing Code provides a review of plumbing practices (see Appendix A);
- **Colour coding**. Reuse water valves and outlets should be appropriately marked and signed to warn the public that the water is not safe for drinking or direct contact. Colour coding pipes and appurtenances to differentiate the reuse distribution system should be practised. The use of different discharge fitting sizes and types (hose bibs, faucets, etc.) will help to preclude hose

interchanges;

- **Pressure limitation**. Limit water pressure on the reuse system to a level lower than the potable system to reduce the likelihood of an unwanted flow reversal into any potable water supply line. Reduced pressure zone devices and backflow preventers should be used at all potable connections;
- **Education.** An education program can be helpful to inform users of such a system, its merits and potential negatives if the wastewater is used for purposes other than as intended;
- **System Design**. A new water reuse system or retrofitting an existing water system to collect wastewater must be designed by competent individuals who are familiar with associated health and safety issues. System piping and components, including treatment and control equipment must be secure from the building occupants;
- **Fire stop seals**. Fire stopping must be maintained at all piping wall penetrations;
- **Connections**. Where a connection to the potable water system is required for backup purposes, fail safe pressure regulating and backflow devices will be required. Direct connections to a potable system shall not be made without installing proper backflow protection device(s);
- **Location**. Non potable water should not be installed in close proximity to food preparation areas or where there is a risk of human ingestion;
- **Testing**. After installation and before system operation, enclosed portions of the system should be tested for conformance with pressure requirements and leaks;
- **Other precautions**. Considerations may be required to prevent pets, etc. from drinking from the water closet bowl; and
- **Facility safety**. Treatment facility locations shall conform to all safety regulations with respect to heating, lighting, ventilation, electrical components, access to work area, storage and handling of chemical, etc. The site shall confirm to all local codes, regulations and/or municipal by-law requirements.

2.9 System Expandability

The capability and limitations of the water reuse system should be clearly defined. Limiting factors or technical issues which should be examined can include:

- supply source;
- disposal requirements;
- storage;
- process equipment components;
- distribution system;
- water demand;
- economic feasibility;
- life cycle issues;
- environmental impacts; and
- regulatory requirements.

Based on a recognition of system constraints, the potential for system expansion from supply and potential demand perspectives should be considered and identified. The system should be designed with sufficient flexibility to accommodate any future growth or expansion. This flexibility should also take into account life cycle issues and the need to be able to perform service maintenance or replace system components as

they age or emerging technologies become available.

2.10 System Testing

Following installation of the water reuse system, all components in the system should be inspected and tested in accordance with manufactures instructions. All system connections particularly non potable / potable interface devices should be thoroughly inspected and tested.

Backflow preventers should be tested and certified by the Canadian Standards Association (CSA). Regular follow-up inspections and testing of backflow preventers should be performed by qualified persons to ensure such devices are working properly to CSA standards.

Initial system testing and commissioning, before connection to any untreated water source, can be performed using potable water. The reuse treatment facility and distribution system should be charged, pressurized and leak tested. All system components and pipes should be checked. Dye tests can be used to confirm that backflow prevention devices are working adequately by depressurizing the potable water system and activating the non-operating reuse system. Opening fixtures on the potable system when depressurized can confirm that safeguards are working properly.

Subsequent to pressure and leak testing of the system, commissioning the treatment system is required. All process components should be checked to ensure they are operating properly. Sampling taps in the process can allow individual component performances to be checked and monitored. Sufficient commissioning time should be allocated to work out any problems encountered and become familiar with the operation.

2.11 System Management

Proper maintenance and operation of the system is necessary and may require some effort to ensure the treatment performance objective is realised. Maintenance and repair procedures should be established and documented. Records should be kept of system operating conditions, problems, routine maintenance activities, changes and additions to the system based on the system operations experience.

A system operation and maintenance manual should be prepared. In preparing the manual the following information should be considered:

- facility design plans, layout, construction and commissioning date;
- names of all system components, manufacture specifications and parts list;
- description of the system including the name of the designer;
- description of the distribution system including layout plan;
- summary of system design and operating parameters;
- copies of all system permits and associated terms and conditions;
- copies of all performance monitoring test results;
- summary of water quality (raw and treated) parameters;
- description of all unit operation components (function, safety procedures, normal operations, emergency provision, and maintenance requirements);

- description of all monitoring and reporting requirements;
- description of contingency plans to deal with emergency/treatment problems, etc.;
- explain any instrumentation available to measure or control the process;
- describe any associated equipment (pressure reducing valves, regulators, flow meters, monitoring equipment, etc.);
- outline power supply and electrical panel;
- outline any test procedures requirements (inspections, testing frequency, duration, etc.);
- outline any routine maintenance or preventative maintenance tasks and schedules (a maintenance log book should be kept);
- describe any system upsets, repairs or problems encountered;
- describe alarm functions;
- describe supervisory control and data acquisition systems and control functions, etc. is available;
- provide a diagram of sampling points, tests, and testing instruments;
- list any safety equipment;
- describe by-pass operations, functions and steps required to by-pass equipment; and
- provide any additional references such as guidelines, design manuals, standard methods for examination and testing of water, preventive maintenance documents, and other operation and maintenance references.

A sound operation and maintenance program which provides for regular water quality testing and process performance monitoring is essential to ensure the proper functioning of a water reuse treatment facility.

A typical unit operation descriptor outline which may be considered in an operations manual is explained in **Table 2.6.** This example is adapted from the Ontario Ministry of Environment, Master Model Operations Manual for Water Supply Systems.

Table 2.6
Equipment Component Unit Operation Descriptor

Descriptor	Comments
Functional Overview	State the Unit Operator purpose
Unit Operation Description	Describe equipment and spare parts in detail
Safety Procedures	List all safety-related concerns
Normal Operations	Provide information on starting, operating and stopping equipment.
Bypass Operations	Explain how to redirect the water reuse system treatment process around a particular equipment component if possible and potential consequences of a bypass.
Emergency Provisions	State procedures for personnel, equipment, etc. in case of equipment failure. Outline contingency plan in the event of an emergency or failure of the equipment to meet performance requirements. Outline triggering mechanisms. One contingency plan action may be to shut down the operation or revert to an emergency back-up system.

Descriptor	Comments
Flow Control	Describe the instrumentation or procedures used to control the rate at which the process or equipment produces or operates including backwash operations and controls, if applicable.
Handling and Storage	Use of chemicals, or any material or equipment handling precautions.
Monitoring and Reporting	List all reporting procedures and documentation as may be necessary..
Additional References	List any pertinent materials such as books, reports, manufactures specifications, etc.
Maintenance	List the routine maintenance tasks for the equipment and trouble shooting reference where required.

2.12 Monitoring, Testing and Reporting

Monitoring of the water reuse system is an integral part of system operation and maintenance. Requirements for monitoring and reporting should depend on the purpose of the water reuse and be in proportion to the potential for risk to public safety and health. Monitoring requirements and reporting for a small communal reuse system may be similar to efforts associated with a small water treatment plant. The monitoring, testing and reporting requirements for small systems sized for a single residential dwelling may have to be established on a case-by-case basis.

In unorganized territories and areas where there are no structured municipalities, it is recognized there may be some difficulty to ensure compliance and adherence with regulatory requirements. To ensure a degree of success in such localities, the following guidance is provided for the system proponent.

1. Retain a competent and experienced professional to design the facility.
2. Procure reliable equipment from reputable manufacturers.
3. Provide a higher degree of process treatment reliability in the design including system automation and controls.
4. Commission an extensive operation and maintenance manual.
5. Ensure professional organization and manufacturers can and will provide support and training.

Monitoring and reporting requirements should be concerned with:

- specifying the type of monitoring to be perform and equipment to be used including calibration requirements;
- identify the frequency of testing;
- outline observation reporting requirement (equipment readings, general system status, upsets, etc.);
- identify the party responsible for gathering and analysis of the samples;
- indicate sample handling and storage requirements; and
- describe any compliance reporting and/or record keeping functions.

An example of water quality testing requirements in association with the Toronto Healthy Homes system is outlined in **Table 2.7**.

Table 2.7
Toronto Healthy Homes Monitoring Requirements

Project: Toronto Health Homes	
On-site water reuse system: Residential wastewater reuse/recycling for non-potable uses.	
Monitoring Requirements (Equipment): Flow measuring devices. Equipment to be calibrated at regular intervals not exceeding one year. Equipment accuracy to be within +/- 5%.	
Raw and Treated Water Tests (Parameters and Frequency):	
Quarterly	Weekly
Alkalinity	Total Coliform
Hardness	Fecal Coliform
Calcium	Turbidity
Sodium	Colour
Iron	pH
Copper	
Lead	
Zinc	
Arsenic	
Aluminium	
Manganese	
Conductivity	
Chloride	
Sulphate	
Ammonia + Ammonium (N)	
Total Kjeldahl Nitrogen	

Reuse or reclaimed water standards in use in Washington State are presented in **Table 2.8** together with monitoring requirements.

Table 2.8
Monitoring Requirements for Reclaimed Water Use - Washington State

Requirements for projects generating Class A reclaimed water for use in toilet and urinal flushing, and specified commercial / industrial processes.		
Parameter	Sample Type & Frequency	Compliance Requirements
BOD	24 hour composite, collected at least weekly	Shall not exceed 30 mg/L determined monthly, based on the arithmetic mean of all samples collected during the month

Requirements for projects generating Class A reclaimed water for use in toilet and urinal flushing, and specified commercial / industrial processes.		
TSS	24 hour composite, collected at least daily	Shall not exceed 30 mg/L determined monthly, based on the arithmetic mean of all samples collected during the month
Total Coliforms	Grab sample collected at least daily	Compliance determined daily, based on the median value determined from the bacteriological results of the last 7 days for which analysis have been completed.
Turbidity	Continuous recording turbidimeter	Filtered wastewater shall not exceed an average operating turbidity of 2 NTU, determined monthly and not exceeding 5 NTU at any time.

A British Columbia Installation Guideline (1995) for recycling treatment systems, prepared by Hill, Murray & Associates Inc. for the Ministry of Health, recommends a stepped monitoring program. Initial testing of effluent parameters for: BOD_5, TSS, Fecal Coliform, Nitrogen, Phosphorous and Toxicity (at the discretion of the Ministry of Health) are recommended to commence on a daily basis progressing to a three month testing period once a steady state condition has been reached for domestic wastewater effluent.

2.13 Process Design Parameters

An outline of design parameters associated with various unit processes is presented in **Table 2.9.**

Table 2.9
Selected Design Process Parameters

Process	Parameters
Plant influent	Flow Rate Water Quality
Flocculation - Sedimentation - Coagulation process	Flow rate Detention time Chemical dosage Velocity gradients Overflow rate Flow rate of waste sludge pH set point
Filter	Flow Rate Hydraulic loading rate Length / frequency of filter backwash Backwash loading rate Pressure drop

Process	Parameters
Reverse osmosis / Micro/Ultra Filtration Unit	Feed flow rate Number of elements Membrane type Feed pressure Product conductivity Product water recovery / rejection Backwash loading rate Chemical backwash rate
Carbon adsorption	Flow rate Carbon type Throughput rate Hydraulic loading rate Length of carbon backwash Backwash flow rate Backwash loading rate
Disinfection	Flow rate UV- number of lamps UV-Intensity of lamps Ozone - Ozone residual Ozone - Concentration / dosage Ozone - Ozone produced Ozone - Generator air flow Ozone - Generator power consumption Chlorine - dosage / residual

3.0 PLANS AND STUDIES

Studies and plans should accompany all applications for approval of a water reuse system. Requirements for study reporting and plan preparation will depending on the complexity of the system and treatment requirements. This section provides a checklist of various issues to be addressed in engineering studies, plans and specifications.

3.1 Engineering Study

The engineering study should account for all considerations requested by the approving authorities. Section 2.0 reviews some of the issues and concerns which may be considered . The report should clearly establish the need for the project and be able to demonstrate the project viability. Supporting documentation from epidemiology studies, comprehensive health and toxicology studies and treatment performance research findings may be required in conjunction with the approval of systems where risk exposures are perceived to be high or in conjunction with approval of experimental systems.

Study contents may include, but not necessarily be limited to, the following information:

1. Introduction
- purpose of the study;
- type of approval being requested;
- project / community description;
- location of the work;
- public consultation programs;
- background information;
- current problems;
- summary of background or supporting information;

2. Project Description
- design criteria and requirements;
- health and safety concerns;
- project intended use;
- project costs;
- water supply and demand requirements;
- waste handling and disposal;
- untreated water quality;
- water treatment requirements;
- design flows;
- treatment process train;
- system capacity;
- system expansion requirements;
- environmental impacts;
- special requirements / considerations or adverse conditions;

3. System Description
- equipment description, selection and component design;

- treatment requirements;
- design guidelines;
- process design analysis and assumptions;
- electrical equipment and energy requirements;
- controls, instrumentation and metering;
- distribution system;
- chemical requirements;
- piping and pumping design;
- other utility connections;
- general layout and system location;

4. **System Operation and Monitoring**
   - operation program;
   - maintenance program;
   - monitoring program and reporting;
   - contingency plan;
   - health and safety concerns;
   - duration of the project.

5. **Supporting Information, Documentation and Design Calculations**
   - design calculations;
   - supporting information;
   - equipment specifications;

Where the proposed works incorporate processes that are innovative or experimental, include equipment and materials where reliable data from full scale applications are not available. The following submission information may be required:

6. **Experimental Processes**
   - existing data on proposed process;
   - testing program results;
   - list of known applications or pilot plants;
   - discussion of the effects of failure of the process and steps to be taken to preclude health hazards;
   - discuss liabilities associated with the proposal;
   - supplementary monitoring, testing and reporting required; and
   - duration of the experimental process.

3.2 Plans

Plans should clearly indicate the location, layout and size of all components in the reuse water system including wastewater discharge lines, valves, sampling points, potable water lines, piping, meters, instrumentation, connection details, electrical wiring and appurtenances. A general site plan should illustrate the location of all warning signs, site access, distribution system, wash basins, etc. Plans should be available on-site and always kept up to date with all modifications noted.

Detail drawings clearly show the nature of design. The details should show proposed and existing water

system, pipe sizes, material, fittings and class of pipes, and details of all associated structures and retrofits which may be associated with construction of the proposed system. Detail plans of specific components and pertinent features of the site should also be provided.

A site plan shows the location of major works, the size and topography of the property containing the reclaimed water system, the location of all potential sources of contamination, and the layout and size of existing and proposed plant structures on the site. Hydraulic process gradelines within the process should also be identified.

A schematic flow diagram of the proposed works should be included. A sample process diagram is illustrated on the next page. This process diagram relates to a sample water reuse treatment process and is not intended as a wastewater treatment/discharge operation. Items which may be considered for inclusion in the process diagram include:

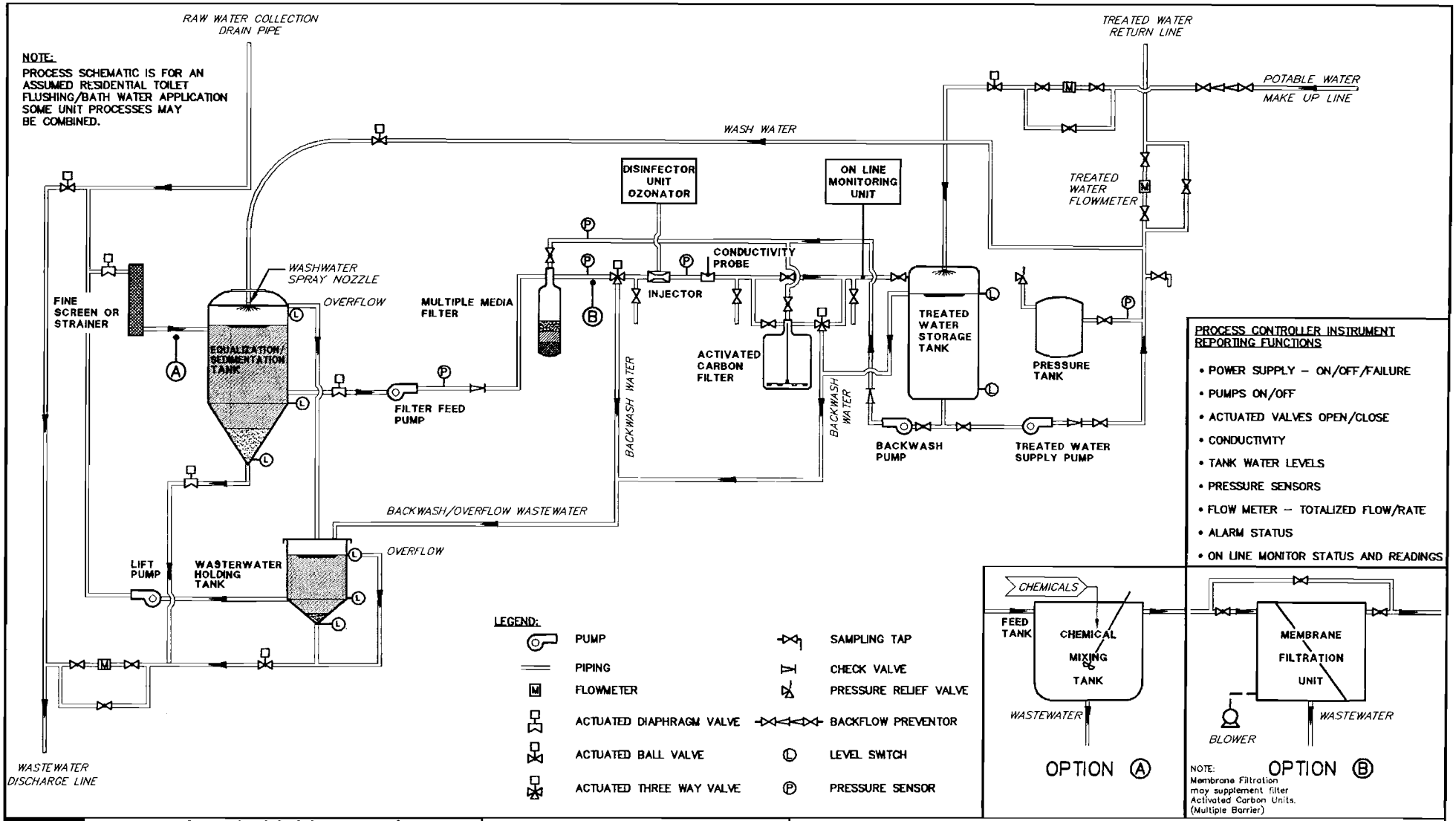
- equipment component units;
- direction of flow in all streams;
- reuse process train / waste streams;
- chemical addition points;
- sampling points;
- valves, sensor and other devices;
- instrumentation and reporting functions; and
- pumps.

All drawings should be stamped by a professional engineer.

3.3 Specifications

Detailed technical specifications should be provided for all process, instrumentation, and transmission system equipment components. The specifications should outline the type of equipment, model numbers, size, type and quality of process materials and chemicals required as well as any additional information required to undertake a complete review of the water reuse system.

Equipment performance results and supporting research data should also be provided. The manufacture may be required to supply evidence of the feasibility of the process, component or device for its intended use.



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ENGINEERS ARCHITECTS AND PLANNERS

CMHC SCHL

WATER REUSE SAMPLE PROCESS DIAGRAM

APPENDIX A

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APPENDIX B

PROPOSED BRITISH COLUMBIA PLUMPING CODE AMENDMENT

BC PLUMBING CODE AMENDMENT

Submitted by
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#1-1131 Collinson Street
Victoria, BC V8V 3C2

Recycled Waste Water Systems

References: AWWA Manual M24 (Dual Water Systems)
NSF Standard No. 41 (Relating to Wastewater Recycle/Reuse and Water Conservation Devices)

Definitions

Dual Water Systems - plumbing distribution systems employing both potable and non-potable water in keeping with the principles of AWWA Manual M24 (Dual Water Systems).

Recycled Waste Water - water recovered from black and grey water sources that has been treated and disinfected through a process certified under NSF Standard number 41 (Relating to Wastewater Recycle/Reuse and Water Conservation Devices) to remove the contaminants to a level acceptable to the *authority having jurisdiction* to permit re-use in non-potable applications.

Text

1. **Design of Recycled Waste Water Systems:**

   a. All systems employing the use of *recycled waste water* shall be designed and stamped by a member of the Association of Professional Engineers and Geoscientists of BC or be of a pre-approved design acceptable to the *authority having jurisdiction.*

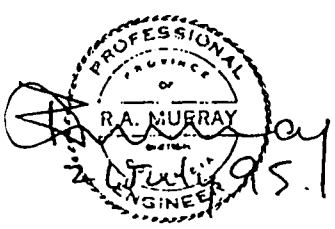
   b. Plans and specifications for the installation of *dual water* or *recycled waste water* systems shall be submitted to the *authority having jurisdiction*

2. **Installation of Recycled Waste Water Plumbing Systems:**

   a. Installation of *Recycled Waste Water Systems* shall be completed only by a person holding:

      (1) a BC tradesman's qualification certification as a plumber, or

      (2) be an indentured apprentice supervised by a journeyman possessing a BC tradesman's qualification certification as a plumber.



3. Testing:

a. In addition to the requirements of Section 3.7 Testing of Potable Water Systems, *Recycled Waste Water* systems shall also be subjected to testing to ensure it is free of contaminants as specified by the *authority having jurisdiction.*

b. *Recycled Waste Water* shall be effluent from a treatment plant certified under NSF Standard No. 41 and shall meet the discharge criteria for contaminants as specified by the *local, regional and provincial authorities having jurisdiction.*

4. **Connections to Potable Water Systems:**

a. *Recycled Waste Water* systems shall not be connected to a potable water system

5. **Materials**

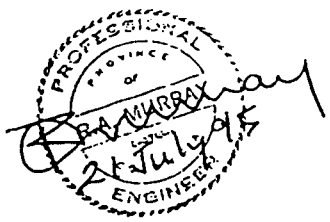
a. All materials employed in the distribution of recycled water shall conform to the requirements of Section 2 of the BC Plumbing Code.

6. **Identification:**

a. All piping and fixtures employed in the distribution of recycled water shall be marked in such a manner as to minimize the risk of mistakenly taking the water as being potable. Marking shall be permanent, distinct and easily recognized.

b. All piping shall be marked "RECYCLED WATER - UNSAFE FOR DRINKING" at intervals not exceeding 30 cm.

c. All valves, fixtures and appurtenances shall be colour coded or otherwise marked to differentiate reclaimed water from potable water. Valves, fixtures and appurtenances shall be marked with the following label (or equivalent acceptable to the *authority having jurisdiction*):



d. Where hose bibs are provided on potable and *recycled waste water* systems, differential sizes shall be used to preclude the interchange of hoses. Hoses used in the distribution of recycled waste water shall be identified as per paragraph 6a through 6c. Once used for the distribution of recycled waste water, hoses shall not be subsequently used for the purposes of potable water distribution.

7. Location:

a. *Recycled Waste Water* outlets shall not be located where they may discharge into fixtures used for a purpose related to the preparation, handling or dispensing of food, drink, or products that are intended for human consumption except as prescribed in Appendix A (A-7.3.2)

b. Potable and *recycled waste water* mains shall be separated as far apart as conditions permit, both horizontally and vertically. Special encasement shall be placed around *recycled waste water* lines at all points where they cross over, under or closely parallel to potable water lines.

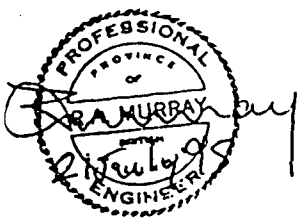
c. Special encasement shall be placed around *recycled waste water* piping in the vicinity of food handling or preparation areas.

d. Unencased *Recycled Waste Water* piping shall not be located:

(1) where food is prepared in a food processing plant,

(2) above food handling equipment,

(3) above a non-pressurized *potable* water tank, or



(4) above a cover of a pressurized *potable* water tank.

e. Adequate means of notification shall be provided to inform the public that reclaimed water is being used. Such notification shall include the posting of conspicuous warning signs with proper wording of sufficient size to be clearly read.

8. **Contamination Prevention:**

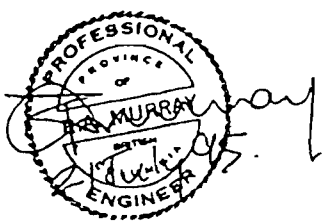
a. Every residence or facility served by a *recycled waste water* system shall have fitted on the potable water system a backflow prevention device consisting of a reduced pressure backflow prevention device or a double check valve assembly, depending on the degree of potential hazard. The back flow protection device shall conform to the standards listed in section 2.9.9.(1).

9. **Operation of Valves:**

a. All *recycled waste water* valves shall be of the type that can only be operated by authorized personnel

In addition, Section 7 should be amended to include the following exclusion:

This section does not apply to *Recycled Waste Water* Systems



APPENDIX C

STANDARDS AND GUIDELINES

Guidelines for Canadian Drinking Water Quality

Sixth Edition

Canada

Table 1
New, Revised and Reaffirmed Guidelines for Chemical and Physical Parameters

Parameter	Guideline (mg/L)	Previous Guideline (mg/L)
atrazine + metabolites	IMAC 0.005	IMAC 0.06
chloramines	MAC 3.0	None
cyanide	MAC 0.2	MAC 0.2
dichloroethylene, 1,1-	MAC 0.014	None
iron	AO ≤0.3	AO ≤0.3
sulphide (as H_2S)	AO ≤0.05	AO ≤0.05
tetrachloroethylene	MAC 0.03	None
trihalomethanes (total)	IMAC 0.1	MAC 0.35
vinyl chloride	MAC 0.002	None

4.3 Summary of Guidelines

Guidelines for all chemical and physical parameters, including all new, revised and reaffirmed guidelines, are listed in Table 2.

Table 2
Summary of Guidelines for Chemical and Physical Parameters[1]

Parameter	MAC (mg/L)	IMAC (mg/L)	AO (mg/L)
aldicarb + metabolites	0.009		
aldrin + dieldrin	0.0007		
arsenic		0.025	
atrazine + metabolites		0.005	
azinphos-methyl	0.02		
barium	1.0		

Table 2 (cont'd)

Parameter	MAC (mg/L)	IMAC (mg/L)	AO (mg/L)
bendiocarb	0.04		
benzene	0.005		
benzo[a]pyrene	0.000 01		
boron		5	
bromoxynil		0.005	
cadmium	0.005		
carbaryl	0.09		
carbofuran	0.09		
carbon tetrachloride	0.005		
chloramines	3.0		
chloride			≤250
chlorpyrifos	0.09		
chromium	0.05		
colour			≤15 TCU[2]
copper[3]			≤1.0
cyanazine		0.01	
cyanide	0.2		
diazinon	0.02		
dicamba	0.12		
dichlorobenzene, 1,2-	0.20		≤0.003
dichlorobenzene, 1,4-	0.005		≤0.001
dichloroethane, 1,2-		0.005	
dichloroethylene, 1,1-	0.014		
dichloromethane	0.05		
dichlorophenol, 2,4-	0.9		≤0.0003
dichlorophenoxyacetic acid, 2,4- (2,4-D)		0.1	

Table 2 (cont'd)

Parameter	MAC (mg/L)	IMAC (mg/L)	AO (mg/L)
diclofop-methyl	0.009		
dimethoate		0.02	
dinoseb	0.01		
diquat	0.07		
diuron	0.15		
ethylbenzene			≤0.0024
fluoride	1.5		
glyphosate		0.28	
iron			≤0.3
lead[3]	0.010		
malathion	0.19		
manganese			≤0.05
mercury	0.001		
methoxychlor	0.9		
metolachlor		0.05	
metribuzin	0.08		
monochlorobenzene	0.08		≤0.03
nitrate	45[4]		
nitrilotriacetic acid (NTA)	0.4		
odour			Inoffensive
paraquat (as dichloride)		0.01[5]	
parathion	0.05		
pentachlorophenol	0.06		≤0.030
pH			6.5-8.5[6]
phorate	0.002		
picloram		0.19	
selenium	0.01		

Table 2 (cont'd)

Parameter	MAC (mg/L)	IMAC (mg/L)	AO (mg/L)
simazine		0.01	
sodium			≤200
sulphate			≤500
sulphide (as H_2S)			≤0.05
taste			Inoffensive
temperature			≤15°C
terbufos		0.001	
tetracholoroethylene	0.03		
tetrachlorophenol, 2,3,4,6-	0.1		≤0.001
toluene			≤0.024
total dissolved solids (TDS)			≤500
trichloroethylene	0.05		
trichlorophenol, 2,4,6-	0.005		≤0.002
trifluralin		0.045	
trihalomethanes (total)		0.1	
turbidity	1 NTU[7]		≤5 NTU[3,7]
uranium	0.1		
vinyl chloride	0.002		
xylenes (total)			≤0.3
zinc[3]			≤5.0

Notes:
1. Summary paragraphs for all the parameters in this table may be found in Section 4.6.
2. TCU = true colour unit.
3. At the point of consumption.
4. Equivalent to 10 mg/L as nitrate-nitrogen.
5. Equivalent to 0.007 mg/L for paraquat ion.
6. No units.
7. NTU = nephelometric turbidity unit.

4.4 Parameters without Guidelines

Since 1978, a number of parameters have been identified as not requiring a numerical guideline. Table 3 lists these parameters. The reasons for parameters having no numerical guideline include the following:

- currently available data indicate no health risk or aesthetic problem (e.g., calcium);
- data indicate the compound, which may be harmful, is not registered for use in Canada (e.g., 2,4,5-TP) or is not likely to occur in drinking water at levels that present a health risk (e.g., silver); or
- the parameter is composed of several compounds for which individual guidelines may be required (e.g., pesticides [total]).

Table 3
Parameters without Guidelines[1]

Parameter	Parameter
ammonia*	pesticides (total)
asbestos*	phenols
calcium*	phthalic acid esters (PAE)
chlordane (total isomers)	polycyclic aromatic hydrocarbons (PAH)[2]
DDT	radon[3]
endrin	resin acids
gasoline and its organic constituents*	silver*
hardness*	tannin
heptachlor + heptachlor epoxide	temephos
lignin	total organic carbon
lindane	toxaphene
magnesium*	triallate
methyl-parathion	trichlorophenoxyacetic acid, 2,4,5-(2,4,5-T)
mirex	trichlorophenoxypropionic acid, 2,4,5-(2,4,5-TP)

Notes:
1. Summary paragraphs for parameters marked with an asterisk may be found in Section 4.6.
2. Other than benzo[a]pyrene.
3. A summary paragraph for radon may be found in Section 5.5.

SUGGESTED GUIDELINES FOR WATER REUSE[1]

Type of Water Reuse	Degree of Treatment	Reclaimed Water Quality[2]	Reclaimed Water Monitoring	Setback Distances[3]	Comments
Urban Reuse All types of landscape irrigation (e.g., golf courses, parks, cemeteries), vehicle washing, toilet flushing, use in fire-protection systems and commercial air-conditioners, and other uses with similar access or exposure to the water	Secondary[4] Filtration[5] Disinfection[6]	• pH = 6-9 • ≤ 10 mg/L BOD[7] • ≤ 2 ntu[8] • No detectable fecal coliform/100 mL[9,10] • 1 mg/L Cl_2 residual (min.)[11]	• pH - weekly • BOD - weekly • Turbidity - continuous • Coliform - daily • Cl_2 residual - continuous	• 50 ft (15 m) to potable water supply wells	• At controlled-access irrigation sites where design and operational measures significantly reduce the potential of public contact with reclaimed water, a lower level of treatment, e.g., secondary treatment and disinfection to achieve ≤ 14 fecal coliform/100 mL, may be appropriate. • Chemical (coagulant and/or polymer) addition prior to filtration may be necessary to meet water-quality recommendations. • The reclaimed water should not contain measurable levels of pathogens.[12] • Reclaimed water should be clear, odourless, and contain no substances that are toxic on ingestion. • A higher chlorine residual and/or a longer contact time may be necessary to assure that viruses and parasites are inactivated or destroyed. • A chlorine residual of O.5 mg/L or greater in the distribution system is recommended to reduce odours, slime, and bacterial regrowth.
Restricted Access Area Irrigation Sod farms, silviculture sites, and other areas where public access is prohibited, restricted, or infrequent	Secondary[4] Disinfection[6]	• pH = 6-9 • ≤ 30 mg/L BOD[7] • ≤ 30 mg/L SS • ≤ 200 fecal coliform/100 mL[9,13,14] • 1 mg/L Cl_2 residual (min.)[11]	• pH - weekly • BOD - weekly • SS - daily • Coliform - daily • Cl_2 residual - continuous	• 300 ft (90 m) to potable water supply wells • 100 ft (30 m) to areas accessible to the public (if spray irrigation)	• If spray irrigation, SS less than 30 mg/L may be necessary to avoid clogging of sprinkler heads.
Agricultural Reuse - Food Crops Not Commercially Processed[15] Surface or spray irrigation of any food crop, including crops eaten raw	Secondary[4] Filtration[5] Disinfection[6]	• pH = 6-9 • ≤ 10 mg/L BOD[7] • ≤ 2 ntu[8] • No detectable fecal coliform/100 mL[9,10] • 1 mg/L Cl_2 residual (min.)[11]	• pH - weekly • BOD - weekly • Turbidity - continuous • Coliform - daily • Cl_2 residual - continuous	• 50 ft (15 m) to potable water supply wells	• Chemical (coagulant and/or polymer) addition prior to filtration may be necessary to meet water-quality recommendations. • The reclaimed water should not contain measurable levels of pathogens.[12] • A higher chlorine residual and/or a longer contact time may be necessary to assure that viruses and parasites are inactivated or destroyed. • High nutrient levels may adversely affect some crops during certain growth stages.

SUGGESTED GUIDELINES FOR WATER REUSE[1] Continued

Type of Water Reuse	Degree of Treatment	Reclaimed Water Quality[2]	Reclaimed Water Monitoring	Setback Distances[3]	Comments
Agricultural Reuse - Food Crops Commercially Processed;[15] Surface Irrigation of Orchards and Vineyards	Secondary[4] Disinfection[6]	• pH = 6-9 • ≤ 30 mg/L BOD[7] • ≤ 30 mg/L SS • ≤ 200 fecal coliform/100 mL[9,13,14] • 1 mg/L Cl_2 residual (min.)[11]	• pH - weekly • BOD - weekly • SS - daily • Coliform - daily • Cl_2 residual - continuous	• 300 ft (90 m) to potable water supply wells • 100 ft (30 m) to areas accessible to the public (if spray irrigation)	• If spray irrigation, SS less than 30 mg/L may be necessary to avoid clogging of sprinkler heads. • High nutrient levels may adversely affect some crops during certain growth stages.
Agricultural Reuse - Nonfood Crops Pasture for milking animals; fodder, fibre, seed crops	Secondary[4] Disinfection[6]	• pH = 6-9 • ≤ 30 mg/L BOD[7] • ≤ 30 mg/L SS • ≤ 200 fecal coliform/100 mL[9,13,14] • 1 mg/L Cl_2 residual (min.)[11]	• pH - weekly • BOD - weekly • SS - daily • Coliform - daily • Cl_2 residual - continuous	• 300 ft (90 m) to potable water supply wells • 100 ft (30 m) to areas accessible to the public (if spray irrigation)	• If spray irrigation, SS less than 30 mg/L may be necessary to avoid clogging of sprinkler heads. • High nutrient levels may adversely affect some crops during certain growth periods. • Milking animals should be prohibited from grazing for 15 days after irrigation ceases. • A higher level of disinfection, e.g., to achieve≤ 14 fecal coliform/100 mL, should be provided if this waiting period is not adhered to.
Recreational Impoundments Incidental contact (e.g., fishing and boating) and full body contact with reclaimed water allowed	Secondary[4] Filtration[5] Disinfection[6]	• pH = 6-9 • ≤ 10 mg/L BOD[7] • ≤ 2 ntu[8] • No detectable fecal coliform/100 mL[9,10] • 1 mg/L Cl_2 residual (min.)[11]	• pH - weekly • BOD - weekly • Turbidity - continuous • Coliform - daily • Cl_2 residual - continuous	• 500 ft (150 m) to potable water supply wells (minimum) if bottom not sealed	• Dechlorination may be necessary to protect aquatic species of flora and fauna. • Reclaimed water should be nonirritating to skin and eyes. • Reclaimed water should be clear, odourless, and contain no substances that are toxic on ingestion. • Nutrient removal may be necessary to avoid algal growth in impoundments. • Chemical (coagulant and/or polymer) addition prior to filtration may be necessary to meet water-quality recommendations. • The reclaimed water should not contain measurable levels of pathogens.[12] • A higher chlorine residual and/or a longer contact time may be necessary to assure that viruses and parasites are inactivated or destroyed. • Fish caught in impoundments can be consumed.

SUGGESTED GUIDELINES FOR WATER REUSE[1] Continued

Type of Water Reuse	Degree of Treatment	Reclaimed Water Quality[2]	Reclaimed Water Monitoring	Setback Distances[3]	Comments
Landscape Impoundments Aesthetic impoundments where public contact with reclaimed water is not allowed	Secondary[4] Disinfection[6]	• ≤ 30 mg/L BOD[7] • ≤ 30 mg/L SS • ≤ 200 fecal coliform/100 mL[9,13,14] • 1 mg/L Cl_2 residual (min.)[11]	• pH - weekly • SS - daily • Coliform - daily • Cl_2 residual - continuous	• 500 ft (150 m) to potable water supply wells (minimum) if bottom not sealed	• Nutrient removal processes may be necessary to avoid algal growth in impoundments. • Dechlorination may be necessary to protect aquatic species of flora and fauna.
Construction Uses Soil compaction, dust control, washing aggregate and making concrete	Secondary[4] Disinfection[6]	• ≤ 30 mg/L BOD[7] • ≤ 30 mg/L SS • ≤ 200 fecal coliform/100 mL[9,13,14] • 1 mg/L Cl_2 residual (min.)[11]	• pH - weekly • BOD - weekly • SS - daily • Coliform - daily • Cl_2 residual - continuous		• Worker contact with reclaimed water should be minimized. • A higher level of disinfection, e.g., to achieve≤ 14 fecal coliform/100 mL, should be provided where frequent worker contact with reclaimed water is likely.
Industrial Reuse Once-through cooling	Secondary[4]	• pH = 6-9 • ≤ 30 mg/L BOD[7] • ≤ 30 mg/L SS • ≤ 200 fecal coliform/100 mL[9,13,14] • 1 mg/L Cl_2 residual (min.)[11]	• pH - weekly • BOD - weekly • SS - daily • Coliform - daily • Cl_2 residual - continuous	• 300 ft (90 m) to areas accessible to the public	• Windblown spray should not reach areas accessible to the public.
Recirculating cooling towers	Secondary[4] Disinfection[6] (chemical coagulation and filtration may be needed)	Variable, depends on recirculation ratio		• 300 ft (90 m) to areas accessible to the public • May be reduced if high level of disinfection is provided	• Windblown spray should not reach areas areas accessible to the public. • Additional treatment by user is usually provided to prevent scaling, corrosion, biological growths, fouling, and foaming.
Other Industrial Uses Depends on site-specific use					

SUGGESTED GUIDELINES FOR WATER REUSE[1] Continued

Type of Water Reuse	Degree of Treatment	Reclaimed Water Quality[2]	Reclaimed Water Monitoring	Setback Distances[3]	Comments
Environmental Reuse Wetlands, marshes, wildlife habitat and stream augmentation	Variable Secondary[4] and Disinfection[6] (min.)	Variable, but not to exceed: • ≤ 30 mg/L BOD [7] • ≤ 30 mg/L SS • ≤ 200 fecal coliform/100 mL [9,13,14]	• BOD - weekly • SS - daily • Coliform - daily • Cl_2 residual - continuous		• Dechlorination may be necessary to protect aquatic species of flora and fauna. • Possible effects on groundwater should be evaluated. • Receiving water quality requirements may necessitate additional treatment. • The temperature of the reclaimed water should not adversely affect the ecosystem.
Groundwater Recharge By spreading or injection into nonpotable aquifers	Site specific and use dependent Primary (min.) for spreading Secondary[4](min.) for injection	Site specific and use dependent	Depends on treatment and use	• Site specific	• Facility should be designed to ensure that no reclaimed water reaches potable water supply aquifers. • For injection projects, filtration and disinfection may be needed to prevent clogging.

SUGGESTED GUIDELINES FOR WATER REUSE[1] Continued

Type of Water Reuse	Degree of Treatment	Reclaimed Water Quality[2]	Reclaimed Water Monitoring	Setback Distances[3]	Comments
Indirect Potable Reuse Groundwater recharge by spreading into potable aquifers	Site specific Secondary[4] and disinfection[6] (min.). May also need filtration and/or advanced wastewater treatment [16]	• Site specific • Meet drinking water standards after percolation through the vadose zone	Includes, but not limited to, the following: • pH - weekly • Coliform - daily • Cl_2 residual - continuous • Drinking water standards - quarterly • Other[17] - depends on constituent	• 2000 ft (600 m) to extraction wells • May vary depending on treatment provided and site-specific conditions	• The depth to groundwater (i.e., thickness of the vadose zone) should be at least 6 ft (2 m) at the maximum groundwater mounding point. • The reclaimed water should be retained under-ground for at least 1 year prior to withdrawal. • Recommended treatment is site-specific and depends on factors such as type of soil, percolation rate, thickness of vadose zone, native groundwater quality, and dilution. • Monitoring wells are necessary to detect the influence of the recharge operation on the groundwater. • The reclaimed water should not contain measurable levels of pathogens after percolation through the vadose zone.[12]
Groundwater recharge by injection into aquifers	Secondary[4] Filtration[5] Disinfection[6] Advanced wastewater treatment	Includes, but not limited to, the following: • pH = 6.5 - 8.5 • ≤ 2 ntu[8] • No detectable fecal coliform/100mL[9,10] • 1 mg/l Cl_2 residual (min.)[11] • Meet drinking water standards	Includes, but not limited to , the following: • pH - daily • Turbidity - continuous • Coliform - daily • Cl_2 residual - continuous • Drinking water standards - quarterly • Other[17] - depends on constituent	• 2000 ft (600 m) to extraction wells • May vary depending on site-specific conditions	• The reclaimed water should be retained under-ground for at least 1 year prior to withdrawal. • Monitoring wells are necessary to detect the influence of the recharge operation on the groundwater. • Recommended quality limits should be met at the point of injection. • The reclaimed water should not contain measurable levels of pathogens at the point of injection.[12] • A higher chlorine residual and/or a longer contact time may be necessary to assure virus inactivation.

Type of Water Reuse	Degree of Treatment	Reclaimed Water Quality[2]	Reclaimed Water Monitoring	Setback Distances[3]	Comments
Indirect Potable Reuse Continued Augmentation of surface supplies	Secondary[4] Filtration[5] Disinfection[6] Advanced wastewater treatment	Includes, but not limited to, the following: • pH = 6.5 - 8.5 • ≤ 2 ntu[8] • No detectable fecal coliform/100mL[9,10] • 1 mg/l Cl_2 residual (min.)[11] • Meet drinking water standards	Includes, but not limited to , the following: • pH - daily • Turbidity - continuous • Coliform - daily • Cl_2 residual - continuous • Drinking water standards - quarterly • Other[17] - depends on constituent	• Site specific	Recommended level of treatment is site specific and depends on factors such as receiving water quality, time and distance to point of withdrawal, dilution and subsequent treatment prior to distribution for potable uses. The reclaimed water should not contain measurable levels of pathogens.[12] A higher chlorine residual and/or a longer contact time may be necessary to assure virus inactivation.

Source: USEPA (1992).

1 These guidelines are based on water reclamation and reuse practices in the US, and they are especially directed at states that have not developed their own regulations or guidelines. While the guidelines should be useful in many areas outside the US, local conditions may limit the applicability of the guidelines in some countries.

2 Unless otherwise noted, recommended quality limits apply to the reclaimed water at the point of discharge from the treatment facility.

3 Setback distances are recommended to protect potable water supply sources from contamination and to protect humans from unreasonable health risks due to exposure to reclaimed water.

4 Secondary treatment processes include activated sludge processes, trickling filters, rotating biological contactors, and many stabilization pond systems. Secondary treatment should produce effluent in which both the BOD and SS do not exceed :30 mg/L.

5 Filtration means the passing of wastewater through natural undisturbed soils or filter media such as sand and/or anthracite.

6 Disinfection means the destruction, inactivation, or removal of pathogenic microorganisms by chemical, physical, or biological means. Disinfection may be accomplished by chlorination, ozonation, other chemical disinfectants, UV radiation, membrane processes, or other processes.

7 As determined from the 5-day BOD test.

8 The recommended turbidity limit should be met prior to disinfection. The average turbidity should be based on a 24-h time period. The turbidity should not exceed 5 ntu at any time. If SS is used in lieu of turbidity, the average SS should not exceed 5 mg/L.

9 Unless otherwise noted, recommended coliform limits are median values determined from the bacteriological results of the last 7 days for which analyses have been completed. Either the membrane filter or fermentation tube technique may be used.

10 The number of fecal coliform organisms should not exceed 141100 mL in any sample.

11 Total chlorine residual after a minimum contact time of 30 minutes.

12 It is advisable to fully characterize the microbiological quality of the reclaimed water prior to implementation of a reuse program.

13 The number of fecal coliform organisms should not exceed 800/100 mL in any sample.

14 Some stabilization pond systems may be able to meet this coliform limit without disinfection.

15 Commercially processed food crops are those that, prior to sale to the public or others, have undergone chemical or physical processing sufficient to destroy pathogens.

16 Advanced wastewater treatment processes include chemical clarification, carbon adsorption, reverse osmosis and other membrane processes, air stripping, and ion exchange.

17 Monitoring should include inorganic and organic compounds, or classes of compounds, that are known or suspected to be toxic, carcinogenic, teratogenic, or mutagenic and are not included in the drinking water standards.

NSF BASIC CRITERIA C-9

FOR
EVALUATION OF SPECIAL PROCESSES, COMPONENTS, OR DEVICES USED IN TREATING WASTEWATER

SECTION 1. GENERAL

1.0 SCOPE: These criteria cover the requirements for special processes, components, or devices used in handling, treatment, or disposal of wastewater. These criteria shall be used to evaluate special processes, components, or devices not covered by other NSF standards or criteria. It is considered impractical to specify the parameters for all pertinent tests which could apply to the various types of equipment. Provision is made for the manufacturer to suggest applicable evaluation parameters with supportive data (see Appendix A).

1.1 MINIMUM REQUIREMENTS: Variations from these minimum requirements may be permitted when they make the process, component, or device equally resistant to corrosion, wear, and physical damage, or if they provide equal operation and performance. Variations shall be accepted prior to use. Devices with components covered under existing NSF standards shall comply with those applicable requirements.

1.2 ALTERNATE MATERIALS: If the specific materials are mentioned, other materials equally satisfactory may be permitted.

1.3 CRITERIA REVIEW: A complete review of these criteria shall be conducted at least every five years to keep the requirements consistent with new technology. These reviews shall be conducted by representatives from the public health, industry, and user groups of NSF Joint Committee on Wastewater Technology.

SECTION 2. DEFINITIONS

PROCESSES, COMPONENTS, OR DEVICES

2.0 APPURTENANT DEVICE: A component of a total or unit process (diffuser, chemical feed pump, chlorinator, etc.).

2.1 TOTAL PROCESS: A process receiving raw wastewater and discharging a treated effluent. Types of total processes may be classified as:

2.1.1 Biological;

2.1.2 Chemical;

2.1.3 Mechanical;

2.1.4 Other or combinations of the above.

2.2 UNIT PROCESS: A single step in the total treatment process (comminution, screening, aeration, sedimentation, chemical precipitation, vacuum filtration, centrifugation, incineration, chlorination, etc.).

2.3 ACIDITY: The quantitative capacity of aqueous solutions to react with hydroxyl tons expressed as milligrams per liter (mg/L) of calcium carbonate.

2.4 ALKALINITY: The quantitative capacity of aqueous solutions to neutralize acids, a property imparted by carbonates, bicarbonates, hydroxides, and occasionally borates, silicates and phosphates expressed as mg/L of calcium carbonate.

2.5 AMMONIA NITROGEN (NH_3-N): All the nitrogen in wastewater which exists as ammonium ion or in the equilibrium $NH_4+ \quad NH_3+H^+$.

2.6 CHEMICAL OXYGEN DEMAND (COD): A measure of the oxygen-consuming capacity of organic and inorganic matter present in wastewater expressed as mg/L.

2.7 CHLORINE DEMAND: The difference between the amount of chlorine added to wastewater and the amount of residual chlorine remaining at the end of a specified contact period expressed as mg/L.

2.8 CHLORINE RESIDUAL: A measure of the amount of chlorine remaining in wastewater after a specific contact period.

2.9 DISSOLVED OXYGEN (DO): The oxygen dissolved in wastewater, expressed as mg/L.

2.10 DRAINABILITY: A measure of the dewatering characteristics of sludge.

2.11 FECAL COLIFORMS: Aerobic and facultative anaerobic, gram-negative, nonspore-forming, rod shaped bacteria, distinguished from nonfecal coliforms by incubation at 44.5°C.

2.12 FIVE-DAY BIOCHEMICAL OXYGEN DEMAND (BOD_5): The quantity of oxygen used in the biochemical oxidation of organic matter in five days at 20°C under specified conditions, expressed as mg/L.

2.13 HEAD LOSS: The difference between total heads at two points in the hydraulic system, expressed in feet (m) of water.

2.14 METHYLENE BLUE ACTIVE SUBSTANCE (MBAS): A blue salt formed when methylene blue complexes with anionic surfactants.

2.15 MOISTURE CONTENT: The quantity of water in sludge filter cake or screenings, expressed as percent of wet weight.

2.16 NITRATE NITROGEN (NO_3-N): The end product in the oxidation of ammonia or organic nitrogen.

2.17 NITRITE NITROGEN (NO_2-N): An intermediate product in the oxidation of ammonia or organic nitrogen, or reduction of nitrate.

2.18 pH: The logarithm of the reciprocal of the hydrogen-ion concentration.

2.19 PHOSPHATES (PO_4): Acid salts containing phosphorus, expressed as PO_4.

2.20 PRESSURE (P): The total load or force applied to a unit area of surface, expressed in pounds per square inch (psi) (kPa).

2.21 SENSITIVITY LEVEL: The lowest concentration that can be detected and quantified by a test method.

2.22 SETTLEABLE SOLIDS: Solids which settle during a preselected period of time, expressed as milliliters per liter of sample after 30 minutes of settling time (mL/L/30 min).

2.23 SLUDGE VOLUME INDEX (SVI): Ratio of the volume in mL of sludge settled in 30 minutes from a 1,000 mL sample of mixed liquor to the concentration of suspended solids in mg/L multiplied by 1,000.

2.24 SUSPENDED SOLIDS (SS): Solids in wastewater which can be removed readily by standard filtering procedures in a laboratory, expressed in mg/L.

2.25 TEMPERATURE (T): The measure of the thermal state of a substance with respect to its ability to communicate heat to its environment, expressed in degrees centigrade (°C).

2.26 TOTAL COLIFORMS: All aerobic and facultative anaerobic, gram-negative, nonspore-forming, rod shaped bacteria that ferment lactose with gas formation within 48 hours at 35°C; all bacteria that produce a dark purplish-green colony with metallic sheen within 24 hours following incubation by the membrane filter technique used for typical coliform identification.

2.27 TOTAL ORGANIC NITROGEN (TON): All of the nitrogen combined in organic molecules such as proteins, amines, and amino acids.

2.28 TOTAL SOLIDS (TS): The sum of dissolved and undissolved constituents in wastewater, expressed in mg/L.

2.29 VOLATILE SUSPENDED SOLIDS (VSS): The percent of total suspended solids in wastewater which are lost on ignition of the dry suspended solids at 550 ± 50°C.

SECTION 3. MATERIALS

3.0 GENERAL: Materials used in the construction of processes, components, or devices must be structurally sound under operating conditions. They shall withstand exposure to the use environment, including corrosive action of chemicals used.

3.1 DURABILITY: Materials shall be durable and withstand normal stresses during shipping, installation, and operation.

SECTION 4. DESIGN AND CONSTRUCTION

4.0 GENERAL: Processes, components, or devices shall be fabricated to perform their intended function when installed and operated according to the manufacturer's instructions. They shall not be adversely affected by the use environment. Processes and appurtenant devices shall be fabricated to present no hazardous or unsafe condition when operated according to the manufacturer's instructions.

4.1 SERVICEABILITY: Component parts subject to malfunction or wear shall be accessible for repair or replacement.

4.2 CHEMICAL REQUIREMENTS: The manufacturer shall supply, on a confidential basis, a detailed description of types and quantities of any chemicals required for the operation when presented for evaluation. In lieu of specific quantity requirements, the manufacturer may submit a test methodology for determining chemical requirements.

4.3 ELECTRICAL EQUIPMENT: Electrical equipment shall be protected with safety devices (overload interrupting devices, fuses, etc. and shall comply with appropriate National Electrical Manufacturers' Association (NEMA), American National Standards Institute (ANSI), and/or Underwriters Laboratories (UL) requirements. Equipment shall be capable of installation in compliance with the National Electrical Code. Electrical component parts shall be covered by the manufacturer's limited warranty (see Item 5.4).

4.4 MECHANICAL COMPONENTS AND SYSTEMS: Mechanical components and systems shall be provided with personnel safeguards, and be protected against damage or impairment of efficiency for all normally anticipated operating conditions. Mechanical component parts shall be covered by the manufacturer's limited warranty (see Item 5.4).

SECTION 5. INSTRUCTIONS AND INFORMATION

5.0 GENERAL: A complete installation and operation manual (including a basic description of process fundamentals, design data, complete drawings and specifications) shall be provided by the manufacturer with the application for evaluation.

5.1 INSPECTION AND MAINTENANCE: A manual (including instructions for any required inspections, accessibility, and maintenance operations) shall be provided by the manufacturer with the application for evaluation.

5.2 ENERGY REQUIREMENTS: The manufacturer's engineering data and literature shall specify the energy sources and requirements for proper operation of processes, components, or devices or any auxiliary system.

5.3 PARTS LIST: The manufacturer shall provide a parts list with each process, component, or device. Parts shall be listed by number, letter or symbol, and identified by the same designation on a photograph, print, or illustration with the same designation.

5.4 LIMITED WARRANTY: The manufacturer shall provide at least a two-year limited warranty, from date of installation, covering all parts and materials. See sample limited warranty in Appendix B (see also Items 4.3 and 4.4).

5.5 DATA PLATE: A permanent type plate shall be provided. The plate shall be inscribed and installed to be easily seen and understood, and be securely attached at a location normally visible following recommended installation. It shall include:

5.5.1 Name and address of manufacturer;

5.5.2 Model and serial number designation;

5.5.3 Design capacity or rated daily capacity, if applicable.

SECTION 6. PERFORMANCE EVALUATION METHOD

6.0 PREQUALIFICATION: Prior to performance evaluation, the manufacturer shall supply evidence of the feasibility of the process, component, or device for its intended use.

6.1 GENERAL TEST CONDITIONS: Performance evaluation shall be independent of design and construction. However, structural weaknesses, undesirable noise, and other environmental defects and failures during the test shall be reported in the test results.

6.1.1 The device shall be operated and maintained, or the process carried out, according to the manufacturer's instructions. If these instructions conflict with the provisions of Section 6, the provisions of the criteria shall apply. Records for frequency of maintenance shall be included.

6.1.2 All sample collection and analytical methods shall be those established in the 15th edition of *Standard Methods for the Examination of Water and Wastewater*, published by the American Public Health Association, except as otherwise specified.

6.1.3 The duration of the evaluation period shall be sufficient to insure that results are reliable and applicable to anticipated operating conditions. The length of the evaluation period shall be specified in the test report.

6.2 EVALUATION PARAMETERS: Evaluation parameters shall be determined by the Special Task Committee.

6.2.1 TOTAL PROCESS: Parameters for evaluating a total process may include:

- Alkalinity
- Dissolved Oxygen
- Nitrogen - Ammonia, Nitrite, Nitrate and/or Total Organic
- Oxygen Demand - Biochemical and/or Chemical
- pH
- Phosphates
- Suspended Solids
- Temperature
- Total and/or Fecal Coliform Densities

6.2.2 UNIT PROCESS: Parameters for evaluating a unit process may include:

- Chlorine - Demand and/or Residual
- Dissolved Oxygen
- Drainability
- pH
- Moisture
- Oxygen Demand - Biochemical and/or Chemical
- Solids - Total Suspended, Volatile and/or Settleable
- Temperature
- Total and/or Fecal Coliform Densities

6.2.3 APPURTENANT DEVICES: Parameters for evaluating appurtenant devices may include:

- Chlorine Demand - and/or Residual
- Dissolved Oxygen
- Drainability
- Head Loss
- Particle Size
- pH
- Response Time
- Sensitivity
- Total and/or Fecal Coliform Densities

6.2.4 APPLICATION INFORMATION: An application may be accompanied by suggested evaluation parameters, giving anticipated range of values, and citing as reference: published data, manufacturer's tests, and other valid source of information. Where possible, these suggested evaluation parameters shall follow the format of NSF standards or criteria. They shall include the basis for deviations from standards and criteria which relate to similar devices or processes.

6.2.5 REPORTS: The testing agency shall provide a report to the manufacturer that includes the test protocol and significant data showing the test results. Appropriate comments shall also be provided.

SCHEDULE 2

PERMITTED USES AND STANDARDS FOR RECLAIMED WATER (SECTION 13)

Reclaimed Water Category and Permitted Uses	Treatment Requirements[1]	Effluent Quality Requirements[2]	Monitoring Requirements[3]
UNRESTRICTED PUBLIC ACCESS			
URBAN - Parks - Playgrounds - Cemeteries - Golf Courses - Road Rights-of-Way - School Grounds - Residential Lawns - Greenbelts - Vehicle and Driveway Washing - Landscaping around Buildings - Toilet Flushing - Outside Landscape Fountains - Outside Fire Protection - Street Cleaning AGRICULTURAL - Aquaculture - Food Crops Eaten Raw - Pasture (no lag time for animal grazing) - Frost Protection, Crop Cooling and Chemical Spraying on Crops Eaten Raw RECREATIONAL[14] - Stream Augmentation - Impoundments for Boating and Fishing - Snow Making	Secondary[4] Chemical Addition[5] Filtration[6,2] Disinfection[7] Emergency Storage[1]	pH = 6 - 9 ≤ 10 mg/L BOD_5 ≤ 2 NTU[8] 2.2 fecal coli/100 mL[9,10] General[11,12]	pH - weekly BOD - weekly Turbidity - continuous Coliform[13] - daily (flow ≥ 5000 m^3/d) - weekly (flow < 5000 m^3/d)
RESTRICTED PUBLIC ACCESS			
AGRICULTURAL - Commercially processed food crops[15] - Fodder, Fibre, Seed Crops - Pasture[16] - Silviculture - Nurseries - Sod Farms - Spring Frost Protection - Chemical Spray - Trickle Drip Irrigation of Orchards and Vineyards - Aquaculture URBAN/RECREATIONAL[14] - Landscape Impoundments - Landscape Waterfalls - Snow Making (during production) CONSTRUCTION - Soil Compaction - Dust Control - Aggregate Washing - Making Concrete - Equipment Washdown INDUSTRIAL[20] - Cooling Towers - Process Water - Stack Scrubbing - Boiler Feed ENVIRONMENTAL[14,21] - Wetlands - Marshes - Stream Augmentation	Secondary[4] Disinfection[7]	pH = 6 - 9 ≤ 45 mg/L BOD_5 ≤ 45 mg/L TSS ≤ 200 fecal coli/100 mL[9,17,18] General[12,19]	pH - weekly BOD - weekly TSS - daily Coliform - weekly

≤ means less than or equal to ≥ means greater than or equal to > means greater than

APPENDIX 1 TO SCHEDULE 2:
EXPLANATORY NOTES

1 Reliability must be provided for all treatment processes as set out in schedule 10. For the unrestricted public access category emergency storage must also be provided as set out in section 13.

2 Effluent quality limits must apply to the reclaimed water at the point of discharge from the treatment facility. Sixty day storage after secondary treatment is acceptable in lieu of filtration provided the final effluent quality requirements are met.

3 Schedule 2 monitoring requirements are additional to and/or take precedence over the monitoring requirements set out in section 30 and schedule 7.

4 Secondary treatment processes include activated sludge processes, trickling filters, rotating biological contactors and many stabilization pond systems. Secondary treatment must produce effluent in which both the BOD and TSS do not exceed 45 mg/L and average 20 to 30 mg/L.

5 Chemical addition includes coagulant and/or polymer prior to filtration. Use is restricted to those coagulants and polymers shown to be non-toxic.

6 Filtration means the passing of secondary effluent through filter media such as sand, membranes, anthracite and/or other comparable filter media.

7 Disinfection means the destruction, inactivation or removal of pathogenic microorganisms by chemical, physical or biological means. Disinfection may be accomplished by chlorination, ozonation, other chemical disinfectants, UV radiation, membrane processes or other processes.

Turbidity limit shall be met prior to disinfection. The average turbidity must be based on a 24-hour time period. The turbidity must not exceed 5 NTU at any time. If TSS is used in lieu of turbidity, the average TSS must not exceed 5 mg/L.

9 Coliform limits are median values determined from the bacteriological results of the last 7 days for which analyses have been completed. Either the membrane filter or fermentation tube technique must be used.

10 The number of fecal coliform organisms must not exceed 14/100 mL in any sample.

11 Microbiological quality of the reclaimed water must be fully characterized prior to implementation of a reuse program. Reclaimed water must not contain measurable levels of pathogens. Reclaimed water must be clean, odourless, non-irritating to skin and eyes and must contain no substances that are toxic upon ingestion.

12 Agricultural (crop) limits must govern criteria for metals. High nutrient levels may adversely affect some crops during certain growth stages. Crop limits and season must govern nutrient application.

13 Coliform monitoring must be daily for all flows $\geq 5000\ m^3/d$. For flows $< 5000\ m^3/d$, coliform monitoring must be weekly unless quality limit exceeded, in which case monitoring must be daily until quality limit is in compliance. Ten tests must be conducted to demonstrate that the discharge is back in compliance and frequency can be reduced.

14 Dechlorination must be undertaken to protect aquatic species of flora and fauna. Nutrient removal may be necessary to limit algae growth in impoundments.

15 Commercially processed food crops are those that, prior to sale to the public or others, have undergone chemical or physical processing sufficient to destroy pathogens.

16 Milking animals must be prohibited from grazing for 6 days after irrigation ceases. Other cattle must be prohibited from grazing for 3 days after irrigation ceases unless the meat is inspected under the Federal Meat Inspection Program.

17 The number of fecal coliform organisms must not exceed 800/100 mL in any sample.

18 Worker contact with reclaimed water must be minimized. A higher level of disinfection to achieve ≤ 14 fecal coli/100 mL must be provided where frequent worker contact with reclaimed water is likely.

19 Setback distance to potable water well must be ≥ 30 m. Windblown spray must not reach areas accessible to the public.

20 Consult recommended water quality limits for make-up water. Additional treatment by user is usually provided to prevent scaling, corrosion, biological growths, fouling and foaming.

21 If chlorine is used as a disinfectant then dechlorination is necessary to protect aquatic species of flora and fauna. The use of alternative disinfection methods is recommended. Possible effects on groundwater must be evaluated. Receiving water quality requirements may necessitate additional treatment. The temperature of the reclaimed water must not adversely affect the ecosystem.

APPENDIX D

SAMPLE WATER REUSE APPLICATION FORM

CMHC SCHL
Helping to house Canadians

SAMPLE APPLICATION FOR APPROVAL OF A WATER REUSE SYSTEM

This application form is intended for information/educational purposes. The form presents some common information requirements which may be required for the evaluation and approval of a water reuse system by respective Approval Authorities. The application is formatted primarily for a small residential water reuse system. Questions concerning the use or acceptance of this application form should be directed to the local Authority having Jurisdiction.

CMHC makes no claim concerning the completeness or use of this form. Water Reuse system proponents and Approval Authorities may modify the form to suit their own requirements. It is hoped this Application Form will facilitate an understanding of the issues and information requirements associated with the proper design and operational requirements for a water reuse system.

Instructions

1. A complete application submission consists of the following:
   - (a) Complete and sign application form (Owner, Designer, Municipality);
   - (b) Complete and attach agreements and statements as may be required by the Authority having Jurisdiction;
   - (e) Attach supporting documentation, design reports, specifications and plans; and
   - (f) Include any additional information which may be required.
2. Information which may be submitted in this application or accompanying this application shall not be considered confidential and may be made available to the public upon request and will be subject to the Freedom of Information Act and release of such information may be made without further notice to you.
3. Approval of this application shall be subject to Terms and Conditions as may be deemed appropriate by the Approval Agency.

1. Applicant / Owner

Name (attach proof if an incorporated body)		Company
Address (Include street number, concession, lot, etc.)		City / Province
Postal Code	Telephone Number	Fax Number

Is the Applicant / Owner (include attachments to this application as may be necessary):

Owner of the System?	☐ Yes ☐ No	If No attach name and address of Owner of the works.
Operating Authority?	☐ Yes ☐ No	If No attach name and address of Operating Authority.
Owner of the Property?	☐ Yes ☐ No	If No attach name and address of Land Owner.

2. Contact for Technical and Design Information

Name / Title / Company		
Address		City / Province
Postal Code	Telephone Number	Fax Number

3. Laboratory Testing Company (Company to be used for Water Quality Testing)

Name / Title / Company		
Address		**City / Province**
Postal Code	**Telephone Number**	**Fax Number**

4. System Site Location (Address, Municipality)

Same as Applicant/Owner ☐ or specify below

5. Water Reuse System Classification and Intended Use

A. The Proposed System Use is Intended for:

☐ Private Residential Use (Single Dwelling) ☐ Multiple Residential Use

☐ Public Use ☐ Other Use please specify _____

B. Number of Dwelling Units _____

C. The System Process/Design as Submitted for Approval is:

☐ System Design Pre-approved by Authority having Jurisdiction

☐ Experimental / Research System

☐ System Design by Professional Engineer

☐ System Design by Others, specify _____

D. The water reuse system is to be used for:

Potable (Drinking water or food handling/preparation water) ☐ Yes ☐ No

Non Potable Uses:

☐ Toilet Flushing ☐ Irrigation / lawn watering ☐ Fire Protection ☐ Washing / Bathing

☐ Recreational Use ☐ Environmental Use (i.e. habitat enhancement)

☐ Other, specify _____

6. System Description (description of the process design and equipment to be attached)

A. Source of Raw Water

☐ Rain Water ☐ Wastewater specify (light greywater / greywater / blackwater) _____

☐ Ground Water ☐ Surface Water specify source _____

☐ Treated Water ☐ Other specify _____

B. Raw Water Quality Testing Results Available

☐ Yes (Attach Test Results) ☐ No, Provide Explanation Below

C. Proposed Unit Treatment Process (Indicate Applicable Processes)

☐ Screening ☐ Sedimentation ☐ Filtration ☐ Disinfection

☐ Other Treatment Processes (reverse osmosis, microfiltrations, ultrafiltrations, advance treatment process) specify

_____

D. Is the Water Reuse System Connected to:

☐ Public Watermain, ☐ Private Water Supply System ☐ Not applicable, explain

Specify Reason (i.e. emergency backup or other) _____

_____

E. Transmission / Distribution / Plumping

Describe Water Reuse Transmission System (Dual Systems, etc.)

7. Additional Approvals Obtained

A. Pre consultation with Approval Agency	☐ Yes (specify below)	☐ No	
B. Municipal Consultation (where applicable)	☐ Yes (specify below)	☐ No	☐ Not Applicable (Specify Reasons)
C. Public Consultation	☐ Yes (specify below)	☐ No	

D. List any other environmental approvals/permits applied for:

_____

_____

8. Schedule

A. Estimated Start of Construction (M/Y):
B. Estimated Start of Operation (M/Y):

9. Cost Estimate

A. Cost of Treatment System and Installation:
B. Cost of Transmission / Distribution System or Retrofits:
C. Life Expectancy of System (years):
D. Annual Operation and Maintenance Cost:
E. Annual Monitoring and Reporting Cost:
F. Cost Estimate for System Removal and Decommissioning:

10. Supporting Information (provide a list of all information included with the application form)

Supporting Information	Attached
A. Pre-application consultation with Approval Authority	☐ Yes ☐ No
B. Description of proposed works	☐ Yes ☐ No
C. Environmental Study	☐ Yes ☐ No
D. Hydrogeological Report	☐ Yes ☐ No
E. Design Brief / Report / Engineering Study	☐ Yes ☐ No
F. Plans	☐ Yes ☐ No
G. Distribution System Details	☐ Yes ☐ No
H. Equipment Specifications	☐ Yes ☐ No
I. Water Use Patterns, Hydraulic and Process Calculations	☐ Yes ☐ No
J. Raw water quality analysis	☐ Yes ☐ No
K. Treated Water Quality (Objective/Criteria/Guidelines)	☐ Yes ☐ No
L. Operations & Maintenance Manual	☐ Yes ☐ No
M. Contingency Plan in case of Emergency Failure	☐ Yes ☐ No
N. Supporting Data on System Performance	☐ Yes ☐ No
O. Other attached information, specify:	☐ Yes ☐ No

11. On-Site Wastewater Disposal System (if applicable)

A. Provide details on the wastewater disposal system, if applicable.

B. Discharge connection to a Municipal Sewage Collection System ☐ Yes ☐ No
(if no provide additional details below).

C. Briefly describe the on-site wastewater disposal system and site conditions (soils, climate, groundwater and topography - use attachments for additional details where necessary).

12. Monitoring Program

Describe specific testing, observations and monitoring to be performed. Provide details on objective, parameters to be tested, methodology, frequency and duration. Use additional attachments where necessary.

A. Water Quality Objectives

B. List Chemical Bacteriological Parameter to be tested and frequency of testing

C. Describe duration of monitoring program

D. Describe any additional tests to be performed as part of the monitoring program

E. Descirbe any additional details, equipment, which are integral to the program

13. Statement of Professional Engineer

I/We, the undersigned hereby declare that, to the best of my/our knowledge, the information contained herein and the information submitted in support of this application is complete and accurate and the water reuse system has been designed in accordance with all requirements of the Authority having Jurisdiction.	
Name	Title
Company	Address
Signature	Date

14. Statement of Municipality (where applicable or Responsible Authority)

I, the undersigned hereby declare on behalf of the Municipality / Responsible Authority that the Municipality / Responsible Authority has no objection to the water reuse system application and the proposed system conforms to Municipal / Responsible Authority requirements.	
Name	Title
Signature	Date

15. Statement of Owner

I/We, the undersigned hereby declare that I/We am the owner(s) of the proposed water reuse system and I/We have attached to this document supporting liability/operations/monitoring terms and conditions and agree to abide by these and any additional terms and conditions which may be requested by the Authority having jurisdiction prior to the construction/operation of the proposed system. I/We also agree that an Environmental Health Officer will have a right of access for the purpose of inspection, sampling and monitoring at all reasonable times. I/We also agree that in the event the property, where the water reuse treatment system is located, should be proposed for sale, that all prospective purchaser(s) of the property will be advised of the 'system' and that as a condition of sale, the purchaser will be required to agree to and sign the original proposal and submit a copy to the Authority having jurisdiction.	
Name	Title
Company	Address
Signature	Date

16. **ADDITIONAL APPLICATION DETAILS / SUPPORTING INFORMATION** (Use this space to provide any supplementary application details).

16. ADDITIONAL APPLICATION DETAILS / SUPPORTING INFORMATION.....continued

SAMPLE APPLICATION FOR APPROVAL OF A WATER REUSE SYSTEM
Instructions and Guide For Completing Application Form

The following information is provided to assist in completing the water reuse system application form. Information and conditions which may be considered for inclusion in a water reuse system agreement are presented at the end.

1. Applicant

Provide legal name of Owner or incorporation/partnership as may be applicable. Supporting documentation (proof of articles of incorporation, partnership declarations or certification) may be required.

2. Contact for Technical and Design Information

Provide the name of the contact for further technical and design information. The name of the technical contact would normally be the Professional Engineer who is responsible for the system design and who can make design changes if requested.

3. Laboratory Testing Company

In the event that system operation monitoring is to be performed by the owner in accordance with an agreed upon performance monitoring program, then the name of the laboratory testing company should be identified which meets laboratory certification requirements of the Authority.

4. System / Site Location

Identify the location where the water reuse system is to be installed and operated if different than the Owner(s)' address.

5. Water Reuse System Application, Classification and Intended Use

a. Identify the intended application for the water reuse system as either a public or private use and the building classification (residential dwellings or other building uses). For applications not associated with residential use, specify the intended application (i.e. commercial car wash, etc.).

b. Identify the number of dwelling units to be serviced by the system where the intended application is associated with residential use.

c. Identify whether the water reuse system process and design represents a Pre-approved design , an engineered system, a system design by others (i.e. manufacture) or is an experimental research system. If the system is intended for research then supporting research documentation and aims and objective of the research project should be provided in a separate attached report. For all other systems, Engineering reports and supporting manufactures specifications and equipment performance test literature should accompany the application.

d. Described the intended use of the system.

The approval of a water reuse system for direct potable use must clearly demonstrate the proposed system can comply with drinking water standards, is supported by all proposed users and regulatory agency, and a health effects study has been performed which provides a comprehensive assessment of water quality and human health risks which is acceptable to the local medical officer of health.

Uses associated with a non potable system should be identified. There may be more than one intended use of the system. A change in system use will likely require a subsequent review and approval as part of any system operation terms and conditions.

6. System Description

a. Identify the source of the raw / untreated water to be treated by the system.

b. Provide results of any raw / untreated water quality test parameter results. A series of test results may be required for parameters to be approved. The system designer should consult with the Authority for a list of water quality parameters to be tested. A list of important parameters is provided in this Guide. Test results any analysis would normally be provided in a Feasibility or Engineering Study Report.

c. Use the checklist to indicate the unit treatment process(es) being proposed. This information should be presented in greater detail on a treatment process diagram and described in a system design brief.

d. Indicate whether the system has a direct connection with a potable water supply system for emergency backup or make-up water requirements. Further details on the plumbing system should be addressed in the design brief to ensure there are adequate safeguards to prevent backflow or cross-connection between potable and non-potable plumbing systems. Where connections are proposed to a potable water system, indicate backflow prevention devices and safeguard to be employed. Backflow preventers should conform to Canadian Standards Association specifications with installation and testing performed by qualified installers.

e. Provide a brief description of the plumbing distribution system and indicate whether backflow preventers and /or other devices or tests are proposed to safeguard potable water system. Testing methods and devices to be used may be subject to approval in accordance with local building/plumbing code requirements.

7. Additional Approvals Obtained

It is recommended that the applicant consult with reviewing agencies, municipality and/or Approval Authority to discuss and confirm submission requirements, approvals and permits necessary for a water reuse system.

a. Indicate if there has been any pre consultation meetings with the Approval Agency. Indicate times and dates for Authority file reference purposes.

b. Indicate whether the applicant has had prior consultation(s) with the municipality or authority having jurisdiction. Where applicable indicate times and dates for authority follow-up or reference purposes.

c. Indicate if the affected public has been consulted about the project and the nature of consultations conducted. All system users should be adequately informed about the project and its impacts and associated health risks. All users should have an opportunity to voice any concerns. Times, dates and supporting documentation/statements should be provided and concerns documented as may be warranted.

d. List all environmental approvals and permit requirements which have been applied for. Where appropriate outline the status of any submission.

8. Schedule

Indicated the planned start date for system installation and the estimated date of system operation. System construction should not commence without first obtaining all necessary approval(s). System operation should not commence until all terms and conditions for system commissioning have been met.

9. Cost Estimate

a. System cost estimates should be prepared by a water reuse system designer who is familiar with treatment system design, equipment component costs and operational/maintenance costs. Cash or security performance provisions may be requested by the Approving Authority.

b. The total estimated cost of the treatment system components and installation should be provided together with the cost of any plumbing distribution system medications or retrofits.

c. The anticipate life expectancy of the system should be provided or where terms and conditions for approval outline a system approval expiry time, the approval expiry time limit should be indicated.

d. Annual system operational and maintenance costs should be provided. Additional details such as operational and maintenance procedures should be provided in an engineering study or design brief.

e. Annual monitoring and reporting costs should be based on the requirements contained in an approved monitoring program.

f. A cost estimate should be provided to decommission the system in the event of system failure or non compliance with monitoring terms and conditions associated with the system performance and reporting requirements.

10. Supporting Information

A checklist of supporting information and documentation is provided which may be required for the review and approval of a system. The checklist should be completed to indicate whether or not the supporting information and documentation has been provided as part of the application submission..

11. On-Site Wastewater Disposal System

Indicate whether effluent discharge from the water reuse system is connected to a municipal or communal sewer collection system. If the wastewater is to be discharged to a private sewage disposal system, the

proponent should provide additional information to describe the disposal system and associated site conditions as warranted.

12. Monitoring Program

Describe any specific testing and monitoring program to be followed or being proposed. Provide any additional details in attachments if necessary.

a. Details on water quality objectives (regulatory conformance requirements and/or system design objectives) should be outlined. Where the objectives have been established by existing regulatory policy documents or standards, the applicable standard should be indicated.

b. List the chemical / bacteriological parameters to be tested for and the testing frequency.

c. Describe the length and duration of the proposed monitoring program or monitoring program as required by regulatory authority.

d. Describe any additional tests or observations to be performed as part of the monitoring program either as part of the system commissioning and/or system operation as may be warranted.

e. Describe any additional details of the monitoring program such as protocols to be followed during emergency or performance non-compliance. Outline any additional system safeguards and/or controls which are integral to the monitoring program.

13. Statement of Professional Engineer

The Applicant should sign the statement indicating that, to the best of their knowledge, the information submitted in the application is complete and accurate.

14. Statement of Municipality or Responsible Authority (RA)

Where the applicant is not the municipality or responsible authority, the municipality/RA should indicate that the system as proposed conforms with Municipal/RA requirements and the Municipality/RA has not objection to the system as being proposed.

15. Statement of Applicant

The Applicant should sign the statement indicating that, to the best of their knowledge, the information submitted in the application is complete and accurate and the applicant agrees to abide by any terms and conditions required by the Approving Authority prior to system construction and operation. Further the applicant agrees that the Responsible Authority or Environmental Health Officer shall have right of access for the purpose of inspection/sampling/monitoring at all reasonable times.

The final condition in the applicant statement is to inform any future or prospective property owner of the system that as a condition of any sale, the purchaser agrees to abide by any of the water reuse system original approved terms and conditions.