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Canadian Council of Ministers of the Environment | Le Conseil canadien des ministres de l'environnement

Notice of Consultation on the Draft
Canada-wide Strategy for the Management of Municipal Wastewater Effluent

October 22, 2007

The Canadian Council of Ministers of the Environment (CCME) is pleased to present the consultation materials for the draft Canada-wide Strategy for the Management of Municipal Wastewater Effluent. As a result of consultations held with a broad range of stakeholders over winter 2006/07, a large number of comments were received. Using these comments, CCME has completed the draft Strategy and is seeking a final review of the Strategy with stakeholders. Comments on the consultation materials are welcome until January 31, 2008. At this time CCME will consider any comments submitted by stakeholders prior to finalizing the Strategy and submitting it to ministers for approval.

All consultation materials are available for download from the CCME website (http://www.ccme.ca) or through your local Development Committee member. Included with the consultation materials is a listing of all comments received over winter 2006/07 with a disposition table of how stakeholder comments were considered and managed. A Development Committee contact list is also posted on the CCME website. You may submit your feedback by mail, e-mail or fax to the CCME Secretariat at the contact information listed below, or to any Development Committee member. Comments and suggestions should be received at CCME no later than January 31, 2008.

CCME encourages all interested organizations and individuals to provide comment. When considering the proposals in the Strategy, please note the following:

- The detailed economic plan is Technical Supplement 1. This is the first time this document has been available for review by the public.
- The concept of financial sustainability relative to implementation of the National Performance Standards is new, and its definition is still being considered by CCME. Please provide any input as to how financial sustainability should be defined and what factors or variables should be considered.
- Please note the options identified for stakeholder review and comment in Technical Supplement 2 (section 9) on determining the priority associated with combined sewer overflows.

Please forward all correspondence to the attention of:

Jennifer Vigano
Programs Coordinator
Canadian Council of Ministers of the Environment
360 - 123 Main Street
Winnipeg MB, R3C 1A3

Fax: 204.948.2125
E-mail: jvigano@ccme.ca

Thank you and we look forward to receiving your comments.

123 Main St. Suite 360
Winnipeg, Manitoba R3C 1A3
Tel (204) 948-2090
Fax (204) 948-2125

123 rue Main, bureau 360
Winnipeg (Manitoba) R3C 1A3
Tél (204) 948-2090
Téléc (204) 948-2125

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Canada-wide Strategy for the Management of Municipal Wastewater Effluent

DRAFT

September 2007

Table of Contents

List of Tables

List of Figures

Technical Supplements (under separate cover)

1. Economic Plan Supporting the Canada-wide Strategy for Managing Municipal Wastewater Effluent
2. Environmental Risk Management – Framework and Guidance
3. Environmental Risk Management – Standard Method and Contracting Provisions for the Environmental Risk Assessment
4. Model Sewer Use Bylaw
5. Glossary

Part A Preamble

Municipal wastewater consists of sanitary waste collected in sewers from Canadian households, as well as wastewater from industry, commercial establishments and institutions. Municipal wastewater effluent typically contains human and other organic waste, nutrients, pathogens, microorganisms, suspended solids, and household and industrial chemicals not removed by the treatment process. In some cases, urban runoff or storm water is collected with sanitary waste in combined sewers, adding different substances to municipal wastewater.

The risks posed to environmental and human health are reduced by treating wastewater before it is discharged. There are more than 3,500 municipal wastewater facilities in Canada with treatment processes that range from no treatment at all or just screening to state-of-the-art technologies. More than 3 trillion litres of treated effluent are discharged each year into Canada's surface waters.

In many sewer systems, stormwater run-off is collected in the same pipes as wastewater (combined sewers). During wet weather events like rainstorms and spring snowmelt, the volume flow in the combined sewers often exceeds the hydraulic capacity of the system, resulting in wastewater and stormwater being released directly into the environment from combined sewer outfalls or combined sewer overflows.

Wastewater facilities commonly have bypasses that are used during wet weather events to avoid wastewater back-up into basements and onto streets. The flow is then deliberately redirected and discharged into the receiving environment without treatment. These effluent releases are referred to as sanitary sewer overflows.

Generally, wastewater facilities are able to reduce the levels of some substances in the effluent and remove others through treatment. However, even the best available technology is often not capable of reducing or eliminating all substances. In short, wastewater effluent may contain a range of substances which impact environmental and human health in a variety of ways.

Added to these challenges is aging infrastructure. Many existing wastewater facilities have operated for decades and are in need of repair and upgrading.

In order to address these issues, CCME has developed a Canada-wide strategy for managing municipal wastewater effluent. CCME's objective with the Strategy is for Canada's water quality and quantity to be managed sustainably.

The *Canada-wide Strategy for the Management of Municipal Wastewater Effluent* addresses issues related to governance, wastewater facility performance, effluent quality and quantity, and infrastructure needs in a way that provides consistency and clarity to the wastewater sector across Canada while ensuring funding for improved treatment is managed in an equitable and sustainable way. The Strategy seeks to improve the protection of environmental and human health.

The Strategy addresses municipal wastewater effluent from wastewater facilities, including combined sewer overflows. It does not cover discharges from separate storm water facilities, septic tank discharges to infiltration facilities, air emissions or effluent reuse. While the management of biosolids also falls outside the scope of the Strategy, CCME recognizes that improved wastewater management will increase the quantity of biosolids produced. The estimated capital costs of the Strategy therefore include increased capacity for handling biosolids.

The Strategy applies to wastewater facilities owned by municipalities, communities (including aboriginal), federal and other government entities, and facilities on federal and aboriginal lands. The Strategy refers to owners of wastewater facilities, which includes all of the above.

The Strategy is comprised of strategic elements including risk assessment, national performance standards, governance, an economic plan and compendium of technical supplements which direct and assist regulators and wastewater facility owners in implementing the Strategy.

Part B Key Elements of the Strategy

The *Canada-wide Strategy for the Management of Municipal Wastewater Effluent* establishes a set of objectives with timelines and deliverables so that:

> Owners will have regulatory clarity in managing municipal wastewater effluent under a harmonized framework that is both protective of human health and the environment and supported by a sustainable funding strategy.

In order to achieve this goal, the Strategy focuses on three outcomes:
1. Environmental and human health protection are improved.
2. Owners have clarity about the way municipal wastewater effluent is managed and regulated.
3. Funding to improve treatment of municipal wastewater is managed in an equitable and sustainable manner.

The standards, objectives and other requirements contained within the Strategy are considered a minimum to be adhered to; jurisdictions may maintain or impose more stringent limits. Jurisdictions may also include additional requirements in their legislation, regulations or policies for existing, upgraded and new facilities in order to provide an appropriate level of environmental and human health protection and to protect sensitive and significant ecosystems.

Facility size, which considers effluent flow and the presence of industrial input in the effluent, is an important consideration in the implementation of the Strategy. The requirements for a particular wastewater facility will vary depending on its size and the characteristics of the receiving environment. Definitions of facility sizes are provided in the definitions in Part E below.

The Strategy includes a method to determine the level of risk posed by a wastewater facility to environmental and human health. The level of risk—high, medium or low—is determined by the characteristics of both the effluent and the receiving environment.

Figure 1 offers a simplified conceptual overview of the Strategy. It indicates the next steps to take if a particular requirement is not met. If a requirement is met, the wastewater facility continues to monitor its effluent and address all other requirements. The timing and implementation of each element described is based on risk and supported by a funding strategy to be discussed later in this document. The details of the Strategy are elaborated below and in the Technical Supplements.

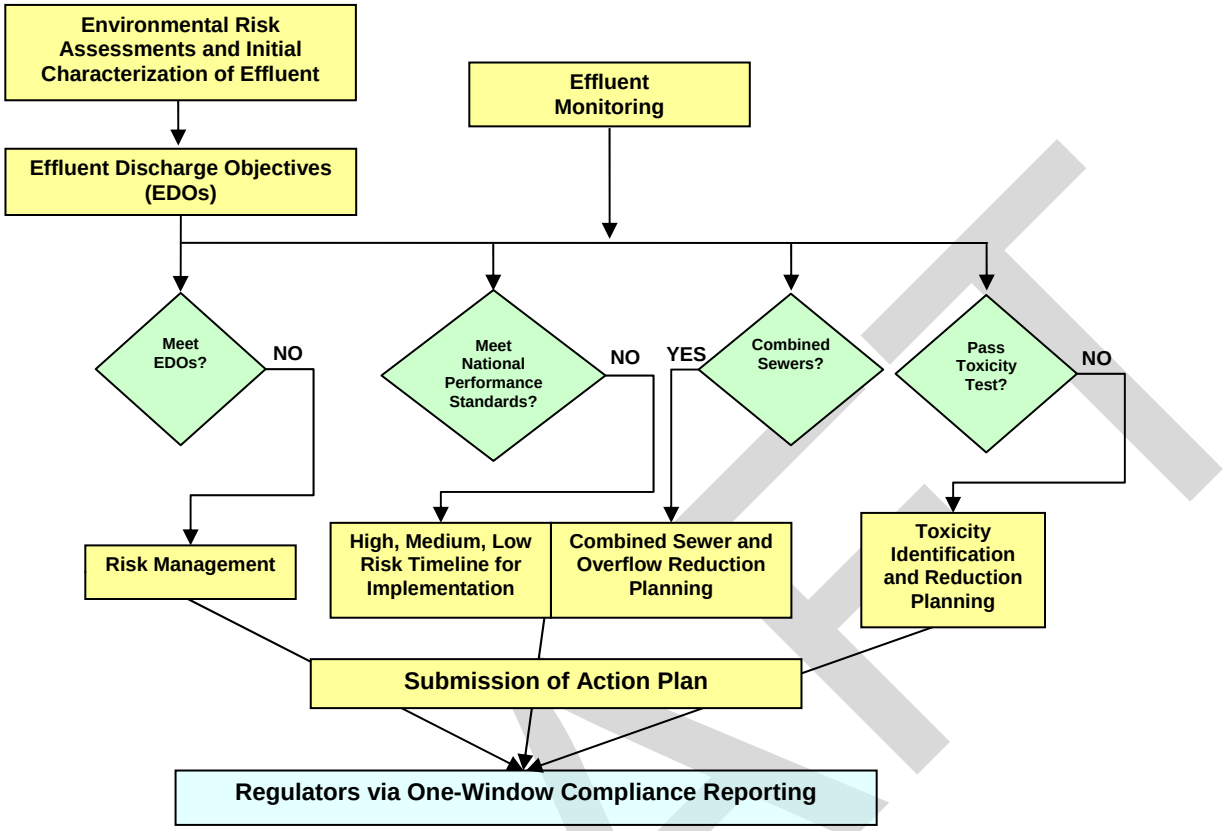

Figure 1. Overview of the Canada-wide Strategy for Managing Municipal Wastewater Effluent

The text below describes the intended outcomes of the Strategy. Table 1 that follows provides the objectives for each element and how and when they will be implemented. Table 2 provides a summary of the deliverables and timelines.

Outcome 1
Environmental and human health protection are improved.

The protection of environmental and human health is an important part of environmental management. Municipal wastewater effluent contains a broad range of substances and has a potentially broad range of impacts on environmental and human health. To prevent or minimize these impacts and improve the protection of environmental and human health, the Strategy outlines criteria for risk-based environmental assessments, National Performance Standards, combined sewer overflows, monitoring, and coordination of research and information dissemination.

1.1 Risk Assessments

The risk assessment process considers, at minimum, the *Canadian Environmental Quality Guidelines* or jurisdictional equivalent to establish site-specific Environmental Quality Objectives for the receiving environment and, subsequently, Effluent Discharge Objectives for the discharge(s). The process starts with characterization of the quality of the effluent discharged to determine which substances are of concern. The end result is a risk-based decision-making process where effluent discharge requirements can be adjusted depending on risk. A standard method for completing environmental risk assessments is provided in Technical Supplement 3.

1.2 National Performance Standards

The Strategy sets National Performance Standards for Carbonaceous Biochemical Oxygen Demand ($CBOD_5$), Total Suspended Solids (TSS) and Total Residual Chlorine (TRC). These National Performance Standards are the minimum performance requirements for effluent quality from all municipal, community and government wastewater facilities that discharge effluent to surface water. These standards do not apply to sanitary or combined sewer overflows nor to facilities located in geographic location where cold or artic conditions impede treatment. Section 1.2.1 below discusses considerations for artic conditions.

The National Performance Standards will be incorporated into each jurisdiction's regulatory framework. The federal government will include these standards in a regulation it intends to develop under the authority of the *Fisheries Act*.

While the National Performance Standards will apply to all facilities, implementation of these standards will be based on risk, available funding and financial sustainability of municipalities. For each existing wastewater facility that does not already meet the National Performance Standards, the implementation timeline to achieve the National Performance Standards will be based on risk criteria that reflect characteristics of both the discharge and the receiving environment. The risk criteria use readily available, objective information to calculate a level of risk – high, medium or low – that corresponds to the overall timeline – 10, 20, 30 years – established for implementation. Definitions of the risk criteria are included in Technical Supplement 2.

1.2.1 Considerations for Arctic Conditions

Due to the extreme climatic conditions and remoteness of Canada's arctic, alternative performance standards for arctic conditions will be proposed within five years. This time will allow further investigation of the constraints associated with meeting the National Performance Standards in the arctic. Availability of data is a limiting factor in establishing performance standards for arctic conditions at this time. *Arctic* is defined in Part E of the Strategy.

1.3 Site-Specific Effluent Discharge Objectives

Site-specific environmental risk assessments of the receiving environment, where municipal wastewater effluent is discharged, will guide the development of site-specific Effluent Discharge Objectives for substances found in wastewater effluent, including those which are not covered by National Performance Standards. The substances are listed in Technical Supplement 3. Jurisdictions will use the results of these assessments to set more stringent discharge requirements for those parameters already covered by National Performance Standards, where appropriate.

Jurisdictions will manage their own Effluent Discharge Objectives. Effluent Discharge Objectives for federal facilities will be established in a similar manner as for provincial/territorial facilities. If Effluent Discharge Objectives are not achieved, actions need to be taken and a risk management decision must be made to improve the quality of the effluent discharge. The first actions considered are to look for opportunities to reduce the discharge of substances at the source, and/or look for opportunities to improve the wastewater facility or its operation.

1.4 Combined Sewer Overflows and Sanitary Sewer Overflows

For wastewater facilities with combined sewers, the risks posed by overflows can be in some cases more important than those posed by the release of effluent from the main wastewater facility. The potential risks posed by overflows relate to the type and duration of the specific wet weather event and the location of the actual outfalls. Typically, these outfalls were designed to avoid the immediate risks related to back up into basements and onto streets, rather than the risks posed to the receiving environment. The Strategy

recognizes the need to integrate their management with an approach that includes wastewater effluent from wastewater facilities.

Currently, no Canadian jurisdiction allows the construction of new combined sewers, although existing ones may be replaced or rehabilitated. The primary objective of overflow management is to reduce the impact of existing combined sewer and sanitary sewer overflows on surface waters. Measures to achieve such reductions include:

- Separating sanitary and storm sewers, where possible, or managing flow to capture the first flush.
- Eliminating sanitary sewer overflows through corrective measures.
- Prohibiting discharge upstream of designated areas.
- Incorporating design features into developments which prevent an increase in overflow frequency.

Other site-specific objectives may be determined by the jurisdiction. Data collection is a priority for improving future combined sewer and sanitary sewer overflow management.

1.5 Monitoring

All wastewater facilities are required to monitor their effluent discharge in accordance with the requirements outlined in Technical Supplement 2. Effluent discharged as a result of a sanitary or combined sewer overflow is not subject to these monitoring requirements. Requirements for monitoring the effluent from combined sewer overflows will be determined on a site-specific basis. Environmental monitoring at a watershed level should provide confirmation that the environment is protected.

1.6 Toxicity

All medium, large and very large wastewater facilities are required to complete whole effluent acute and chronic toxicity testing in accordance with Technical Supplement 2. The toxicity of effluent discharges will be measured at the end of pipe. If the effluent fails a toxicity test, action must be taken to identify and correct the cause of the toxicity through source controls and/or treatment improvements. If the toxicity is due to ammonia, then the capacity of the receiving environment to assimilate the ammonia loadings will determine if ammonia reduction is required. The process for managing toxicity is outlined in Technical Supplement 2. Toxicity testing may be required on a site-specific basis for small and very small facilities where a risk has been identified by the jurisdiction or owner.

1.7 Reduction at Source

Reducing substances at their source is an important aspect of the Strategy. While wastewater facilities can treat some substances, many more can only be partially treated or cannot be treated at all. Source control activities at the production, importation, use and disposal stages reduce the discharge of specific substances to the environment and play an important role in protecting sewer systems, the public and property against hazardous substances potentially released to sewers.

1.8 Regulatory Reporting

The results of monitoring activities will be reported to the jurisdiction.

1.9 Science and Research

Currently in Canada, a significant amount of research is being conducted on municipal wastewater effluent issues. To better coordinate research and disseminate information within the municipal wastewater effluent sector, an independent national wastewater research coordination committee is needed. Such a committee would keep track of who is researching what, what has already been done and what the key research priorities should be in the future. For instance, persistent organic pollutants, bioaccumulative substances, personal care products and pharmaceuticals may be introduced into source water through wastewater discharges. Scientific research has been undertaken to link these substances

with human health or environmental effects. There is a need to further investigate these and other emerging wastewater issues.

Outcome 2
Owners have clarity about the way municipal wastewater effluent is managed and regulated.

Successful implementation of the *Canada-wide Strategy for the Management of Municipal Wastewater Effluent* requires a clear and consistent regulatory framework across Canada. While the elements under Outcome 1 address the protection of human and environmental health, they also contribute to regulatory clarity by establishing clear and consistent requirements for all wastewater facilities across Canada. To ensure clarity, the Strategy also provides a governance model which harmonizes source control activities and releases of municipal wastewater effluent to surface water.

2.1 Governance

The Strategy provides a framework for harmonizing the regulatory requirements applicable to the management of municipal wastewater. Harmonizing the regulatory requirements will result in greater regulatory clarity for the sector by defining the roles and responsibilities of jurisdictions and owners of wastewater facilities.

Harmonization will be based on the following principles. Jurisdictions will:

- Recognise their respective regulatory authorities and responsibilities.
- Eliminate overlaps and fill gaps.
- Recognize the need for baseline National Performance Standards and long term investments in wastewater infrastructure.
- Ensure continuous improvement in managing municipal wastewater effluent.

A one-window approach to governance will be established so operators and facility owners deal with a single regulatory agency. As part of this approach, regulatory requirements for source controls (sewer use bylaw and other instruments) and releases to surface waters (National Performance Standards, Effluent Discharge Objectives) will be harmonized.

The Strategy will be implemented through policy and legislative changes in all jurisdictions. Provincial and territorial governments will amend applicable policies and legislation. The federal government intends to develop a regulation specific to municipal wastewater effluent under the authority of the federal *Fisheries Act*. To clarify the roles and responsibilities of jurisdictions and regulated entities, formal agreements will be negotiated between the federal and provincial governments and the Yukon. In the Northwest Territories and Nunavut, an agreement will be developed between the jurisdictions, taking into account the regulatory role of the various water boards. These agreements will also address one window reporting, and the implementation of the National Performance Standards and site-specific standards, within the established timelines.

2.2 Public Reporting

Wastewater facilities will report annually, at a minimum, to the public on the results of monitoring related to the National Performance Standards and on any Effluent Discharge Objectives applicable to the facility.

Outcome 3
Funding to improve treatment of municipal wastewater will be managed in an equitable and sustainable manner.

Successful implementation of the Strategy requires that funding be managed in an equitable and sustainable manner. Meeting the National Performance Standards and other elements in the Strategy will come with a significant price tag. Over 30 years, depending on inflation, the estimated capital costs range from $7.5 billion to $ 9.3 billion. The estimated non-capital costs (e.g., environmental risk assessment) range from $2.8 billion to $3.8 billion. In total, the estimated capital and non-capital costs to meet the National Performance Standards over 30 years range from $10.3 billion to $13.1 billion. Based on the Strategy's timelines, the majority of the costs will be incurred within the first 10 to 20 years; this is when most high and medium risk facilities will be required to meet the National Performance Standards.

It is difficult to estimate the cost for combined sewer overflows, as such cost estimates for combined sewer overflows are not provided. It is recognized that in some cases, combined sewer overflows could have greater environmental and public health impacts than treated wastewater effluent; therefore, it is necessary to consider the impacts of the discharges from both the combined sewer and the effluent from wastewater facilities. In cases, where it is not possible to reduce impacts from both discharges from combined sewer overflow and the wastewater facility, priority should be given to reduce impacts from the discharge with the higher risk. In cases where owners are required to reduce the risks and impacts from combined sewer overflows, funding may be directed to resolve issues associated with these overflows first, before focusing on meeting the National Performance Standards.

The current range of wastewater treatment methods employed across Canada reflects past funding priority in Canadian jurisdictions. It is unclear how much funding has been allocated to wastewater projects in the past, as many system owners have not employed full cost accounting practices. However, Statistics Canada figures show $14 billion[1] has been invested on water and wastewater infrastructure in Canada since 2000 (neither the breakdown between water and wastewater investments nor the source of the funding is indicated). Infrastructure Canada reports that since 2000, at least $2.9 billion[2] has been spent by federal, provincial, territorial and municipal governments on wastewater infrastructure projects including treatment plants, collection systems and associated components and works through federal-provincial programs alone. The limited information available on current funding levels indicates that implementing the Strategy will require a higher level of financial commitment to wastewater infrastructure compared to historic levels.

The wastewater sector is just one of many competing for infrastructure funding. All orders of government will need to recognize wastewater infrastructure as a priority if the Strategy is to be implemented successfully. The funding announced in the 2007 Federal Budget, which will establish new cost-share contribution programs for infrastructure and extend the Gas Tax Fund to 2014, is a start in this direction.

The recommendations below will help make the Strategy more economically achievable.

1. Funding Principles

The following funding principles should inform funding programs and decisions:

a) Emphasize economic, environmental and social sustainability and be consistent with applicable community, regional or broader jurisdictional plans.

[1] *Capital and Repair Expenditures, Actual, Preliminary Actual and Intentions – 2803*, Table 029-0008, Statistics Canada
[2] Through federal-provincial-municipal programs cost-share, each committed at least $960 million towards wastewater infrastructure investment.

- *Economic sustainability*: Options that are economically sustainable support proper infrastructure asset management, with an emphasis on full cost accounting, full cost recovery and municipal accounting systems that ensure that funding for wastewater infrastructure is not directed to other municipal purposes.
- *Environmental sustainability*: Options that are environmentally sustainable support stewardship of the resource, conservation, appropriate watershed management and source water protection.
- *Social sustainability*: Options that are socially sustainable support the protection of human health and well-being and should not adversely impact one community or segment of a community more than another.

b) Be flexible and take into consideration local, provincial and territorial factors, including the fiscal and human resource capacity of municipal wastewater services providers.

c) Promote opportunities for municipalities to self-fund, including the implementation of innovative financing arrangements and schemes that may include private sector involvement.

d) Take into account risk to help inform the appropriateness of the options considered.

2. Funding Mechanisms: Municipal-based Approaches

- Own-source revenues should be used to the maximum extent possible.
- Wastewater utilities should be managed so they are sustainable economically, environmentally, and socially.
- Owners should be encouraged to use best management practices and existing tools (e.g., Infraguide) in order to implement proper infrastructure management (e.g., up-to-date asset inventories, state of good repair, focus on lifecycle approach, etc.).
- Full cost recovery should be implemented to the extent that funding at local levels makes it possible. Where not possible to fully fund the necessary capital investment, rates should be maximized keeping in mind affordability and sustainability. To help all jurisdictions assess affordability, a model is included in Appendix C of Technical Supplement 1.
- Alternative finance and service delivery mechanisms should be explored to the extent possible.
- Owners should be encouraged to make wastewater infrastructure a high priority and use existing and future funding programs including the federal Gas Tax Fund and provincial equivalents.

3. Funding Mechanisms: Senior Government Assistance

- Senior government assistance should consider and encourage the use of best management practices, full cost accounting, full cost recovery and sewer use by laws.
- Funding should consider the financial capacity and fiscal constraints faced by owners of small and very small facilities. Senior governments should also consider other means of assistance to these owners (e.g., planning, capacity building).
- Senior governments should make wastewater infrastructure a high priority under existing and future infrastructure funding programs as a means to implement the Strategy.
- Senior governments should consider establishing financing mechanisms to assist municipalities in accessing low cost financing, thereby potentially increasing the number of municipalities that have the capacity to borrow, and enabling those municipalities that have the capacity to fund investments to spread the investment cost over a number of years (e.g., the use of revolving funds like the Green Municipal Funds).

A more detailed economic analysis is found in Technical Supplement 1.

Table 1. Timelines and deliverables of the Canada-wide Strategy

Element	Objectives	Timelines & Deliverables
Risk Assessments and Site-specific Effluent Discharge Objectives	Conduct site-specific environmental risk assessments that include initial characterization and consider the characteristics of the receiving environment and effluent quality. Develop site-specific Effluent Discharge Objectives based on results of environmental risk assessments.	Within 5 years, all facilities will complete an environmental risk assessment and establish site-specific Effluent Discharge Objectives per the standard method outlined in Technical Supplement 3. High risk facilities will be the highest priority for completion of environmental risk assessments. A one-year initial characterization will be completed as part of the environmental risk assessment. An environmental risk assessment may be completed either for a single discharge or at a watershed level for all discharges.
National Performance Standards	Establish National Performance Standards for all facilities for the following substances: • Carbonaceous Biochemical Oxygen Demand ($CBOD_5$): a maximum of 25 mg/L based on a periodic average. • Total Suspended Solids (TSS): a maximum of 25 mg/L based on a periodic average. • Total Residual Chlorine (TRC): a maximum of 0.02 mg/L based on a periodic average.	All new and upgraded facilities will meet National Performance Standards immediately. Existing facilities: • High risk facilities will meet the National Performance Standards within 10 years. • Medium risk facilities will meet the National Performance Standards within 20 years. • Low risk facilities must meet the National Performance Standards within 30 years. The National Performance Standards will apply to all facilities. Implementation of the National Performance Standards will be based on risk, available funding and financial sustainability of municipalities/communities. Where: • combined sewer overflows are present, • the wastewater facility does not meet the National Performance Standards, and • the effluent from a combined sewer overflow has a greater impact on environmental and human health than the treated effluent discharged from the wastewater facility. An owner may apply to address combined sewer overflows first and extend their compliance timeline with the National Performance Standards to a maximum of 30 years. The site-specific details will be approved in an action plan by the jurisdiction.

Element	Objectives	Timelines & Deliverables
	Establish performance standards for wastewater facilities in Canada's arctic.	The Northwest Territories, Nunavut and the federal government will undertake research to develop performance standards for wastewater facilities in the arctic. Research will be conducted within 5 years to identify factors that affect performance of lagoons and wetlands in arctic conditions and how they can be improved. The following are the interim measures for Canada's arctic wastewater facilities: • Monitoring of wastewater effluent quality and reporting to jurisdictions will be implemented immediately. • Standards referenced in current permits will be retained.
Combined Sewer Overflows and Sanitary Sewer Overflows	Reduce the impact of combined sewer and sanitary sewer overflows by meeting national overflow standards.	Effective immediately, combined sewer overflows will not increase in frequency due to development. Within 5 years: • Combined sewer overflow and sanitary sewer overflow events will be recorded. • No combined sewer overflow will be discharged during dry weather, except during spring thaw and emergencies. *[Note: Dry weather is defined as any time where flows in combined sewers are not affected by runoff generated by storm events.]* • Floatable materials will be removed where feasible. *[Note: Every combined sewer overflow structure should at least be equipped with a baffle or a screen that can separate floatable materials from discharge.]* • Everything that can be done with existing equipment will be done to limit overflows. • Long term plans to reduce overflows and capture substances will be in place, and based on achieving overflow objectives.
Monitoring	Regularly monitor effluent quality for compliance with National Performance Standards and Effluent Discharge Objectives.	Within 1 year, all facilities will begin to monitor effluent quality. Wastewater facilities must monitor for compliance with the National Performance Standards and Effluent Discharge Objectives as identified in Technical Supplement 2. The jurisdiction will determine who is responsible for conducting compliance monitoring. All sample analyses for both the National Performance Standards and all Effluent Discharge Objectives will be completed by an accredited laboratory.

Element	Objectives	Timelines & Deliverables
	Monitor for impacts in the receiving environment.	Within 5 years, a mechanism will be developed for jurisdictions to monitor the receiving environment at a watershed level.
	Monitor effluent quality for toxicity.	All medium, large and very large wastewater facilities will complete whole effluent acute and chronic toxicity testing. Toxicity testing requirements and the process for managing toxicity failure are outlined in Technical Supplement 2. Toxicity testing may be required on a site-specific basis for small and very small facilities where a risk has been identified by the jurisdiction or owner.
Regulatory Reporting	Report monitoring results regularly to jurisdictions.	Within 1 year, all facilities will begin to report the results of monitoring requirements to jurisdictions.
Science and Research	Set up a national wastewater committee representing the municipal wastewater effluent sector to support coordinated research and information-sharing.	Within 2 years, Environment Canada will lead a process to engage a diversity of organizations within the municipal wastewater effluent sector, to investigate and determine the feasibility of setting up an independent national wastewater research coordination committee.
	Investigate different levels of treatment and investigate occurrence, removal and impacts of emerging compounds such as pharmaceuticals, personal care products and persistent organic pollutants and their human and environmental effects.	Within 5 years, develop a targeted research program to identify the human health and environmental impacts of emerging compounds such as pharmaceuticals, personal care products and persistent organic pollutants, and investigate different types of treatment techniques, including source control, for their removal from wastewater.
Harmonized Regulatory Framework for Sources and Releases	Harmonize regulatory requirements for source controls and releases to surface waters. Establish a one-window approach to governance so operators and facility owners deal with a single regulatory agency. Harmonize regulatory requirements for source controls (sewer use bylaw and other instruments) and releases to surface waters (National Performance Standards, Effluent Discharge Objectives and formal agreements).	Within 3 years, jurisdictions will incorporate requirements into their respective regulatory frameworks and develop implementation plans. Within 3 years, jurisdictions will establish bi-lateral federal-provincial and federal-territorial agreements. For the Northwest Territories and Nunavut, an agreement on governance issues in these territories will be developed among the jurisdictions, taking into account the regulatory role of the various water boards.
Reduction at Source	Implement source control activities: Substance-based approaches will be designed to reduce or eliminate specific substances, or to reduce or eliminate problematic waste groups.	Effective immediately, jurisdictions will work to reduce substances at the source. Following the completion of site-specific environmental risk assessments, the need for national risk management instruments using the authority of the *Canadian Environmental Protection Act (1999)* to manage the risks associated with chemicals that are not

Element	Objectives	Timelines & Deliverables
		treatable, and to control the use of substances or products, will be determined. Jurisdictions will evaluate the applicability of these instruments on an on-going basis.
	Sector-based approaches will be designed for the public or private sectors operating industrial, commercial or institutional facilities.	For sector-based approaches, some action has already been taken (e.g., mercury from the dental industry). Sectors will continue to be evaluated for sector-based approaches to reduce substances at their source.
	Wastewater facility management approaches will address the use and management of the sewer system as a whole.	A model sewer use bylaw has been developed and is included in Technical Supplement 4 to provide guidance to municipalities when implementing source control activities for substances discharged to sewer systems. Integrated water management frameworks and water management strategies have been developed or are being developed in jurisdictions across Canada. Additional water management instruments applicable to wastewater can be used to improve water use and efficiency in Canada (e.g., Infraguide).
Public Reporting	Report annually to the public, at a minimum, on monitoring results related to National Performance Standards and Effluent Discharge Objectives applicable to the wastewater facility.	Within 5 years, all owners of facilities will meet public reporting requirements.
Jurisdictional Capacity and Resource Assessment	Establish a baseline of the ability of owners to undertake full cost accounting, join a regional system to mitigate cost increases and identify other challenges.	Within 6 years, owners will estimate the actual costs of implementation of the Strategy. Jurisdictions will continue to examine the on-going costs of implementing the Strategy. Within 6 years, jurisdictions will develop their investment priorities based on the full estimated costs of implementing the Strategy.
Full Cost Accounting	Obtain clear funding needs for implementing the Strategy, based on site-specific factors.	Within 3 years, jurisdictions will establish the requirements and provide the tools (affordability model, etc.) needed to implement the Strategy. Municipalities will implement full cost accounting in accordance with Public Sector Accounting Board.
Identify and commit to funding mechanisms and financial tools	Provide access to sustainable and achievable funding mechanisms to owners to meet the risk-based timelines (high, medium or low).	Within 1 year, senior levels of government should consider establishing a specific short-term funding mechanism for high risk facilities to complete the environmental risk assessment, including initial characterization. Within 6 years, senior governments should consider other means of assistance to owners of small and very small facilities (e.g., planning, capacity building).

Element	Objectives	Timelines & Deliverables
		After the environmental risk assessment is completed, alternative finance and service delivery mechanisms should be explored to the extent possible. On an on-going basis, senior governments should establish and maintain financing mechanisms to help municipalities access low cost financing, thereby potentially increasing the number of municipalities that have the capacity to borrow, and enabling those municipalities that have the capacity to fund investments to spread the investment cost over a number of years (e.g., the use of revolving funds such as the Green Municipal Funds).
Economic Information Management and Reporting	Improve transparency and communication through better tracking, monitoring and reporting of costs and funding committed to wastewater treatment.	Owners should report accurately and publicly their current level of wastewater expenditure, the value of their wastewater asset base and the multi-year investment needed for their wastewater system. Senior governments should explore the establishment of a mechanism to collect and report information on the value of the wastewater infrastructure asset base and associated infrastructure expenditures on a national basis.

Table 2. Summary of Timelines and Deliverables

Deliverables	Timelines (Years)							
	1 to 5					6 to 10	11 to 20	21 to 30
	1	2	3	4	5			
Risk Assessments and Site-specific Effluent Discharge Objectives								
All facilities complete an environmental risk assessment and establish site-specific Effluent Discharge Objectives.								
National Performance Standards								
Jurisdictions establish timelines for existing facilities to meet National Performance Standards and to complete environmental risk assessments.								
Arctic wastewater facilities monitor and report wastewater effluent quality to jurisdictions. Standards referenced in current permits are retained.								
Northwest Territories, Nunavut and the federal government undertake research to develop performance standards for wastewater facilities in the arctic.								
Owners may apply to address combined sewer overflows before meeting National Performance Standards and extend their compliance timeline for the National Performance Standards to a maximum of 30 years. Site-specific details are approved in an action plan by the jurisdiction.								
Existing high risk facilities meet the National Performance Standards.								
Existing medium risk facilities meet the National Performance Standards.								
Existing low risk facilities meet the National Performance Standards.								
All new and upgraded facilities meet the National Performance Standards.								

Deliverables	Timelines (Years)							
	1 to 5					6 to 10	11 to 20	21 to 30
	1	2	3	4	5			
Combined Sewer Overflows and Sanitary Sewer Overflows								
Combined sewer overflows do not increase in frequency due to development.								
Combined sewer overflow and sanitary sewer overflow events are recorded.								
No combined sewer overflow is discharged during dry weather, except during spring thaw and emergencies.								
Floatable materials are removed where feasible.								
Everything that can be done with existing equipment is done to limit overflows.								
Long term plans to reduce overflows and capture substances are in place, based on achieving overflow objectives.								
Monitoring								
All facilities begin to monitor effluent quality as identified in Technical Supplement 2.								
A mechanism is developed to monitor the receiving environment at a watershed level.								
Regulatory Reporting								
All facilities begin reporting the results of monitoring requirements to jurisdictions.								
Science and Research								
Environment Canada leads a process to engage a diversity of organizations within the municipal wastewater effluent sector to investigate and determine the feasibility of setting up an independent national wastewater research coordination committee.								
Harmonized Regulatory Framework for Sources and Releases								
Jurisdictions incorporate requirements into their respective regulatory frameworks and develop implementation plans.								
Jurisdictions establish bi-lateral federal-provincial and federal-territorial agreements. For the Northwest Territories and Nunavut, an agreement on governance issues in these territories is developed which takes into account the regulatory role of the various water boards.								
Reduction at Source								
Every effort is made to reduce substances at the source.								
Sectors are evaluated for approaches to reduce substances at their source.								
Municipalities consider the model sewer use bylaw when implementing source control activities for substances discharged to sewer systems.								
Water management instruments applicable to wastewater are used to improve water use and efficiency.								
The need for national risk management instruments using the authority of the *Canadian Environmental Protection Act (1999)* is determined. Jurisdictions evaluate the applicability of these instruments on an on-going basis.								
Public Reporting								
All facilities meet public reporting requirements.								
Jurisdictional Capacity and Resource Assessment								
Municipalities estimate the actual costs of implementation of the Strategy.								
Jurisdictions develop their investment priorities based on the full estimated costs of implementing the Strategy.								
Jurisdictions continue to examine the on-going costs of implementing the Strategy.								

Deliverables	Timelines (Years)							
	1 to 5					6 to 10	11 to 20	21 to 30
	1	2	3	4	5			
Full Cost Accounting								
Municipalities implement full cost accounting in accordance with the Public Sector Accounting Board.								
Jurisdictions establish the requirements and provide the tools needed to implement the Strategy.								
Funding Mechanisms and Financial Tools								
Senior levels of government consider establishing a specific short-term funding mechanism for high risk facilities to complete the environmental risk assessment, including initial characterization.								
Owners identify the extent to which they are able to apply full-cost pricing to defray investment costs.								
Owners identify the extent to which alternative forms of financing are available.								
Owners and provinces prioritize wastewater infrastructure funding required from recent increases/extensions to existing shared federal, provincial, territorial and municipal programs.								
Senior levels of government consider one-time funding for revolving loan funds (e.g., Green Municipal Funds).								
Senior governments consider other means of assistance to small and very small municipalities (e.g., planning, capacity building).								
Senior governments establish and maintain financing mechanisms to help municipalities access low cost financing.								
Alternative finance and service delivery mechanisms are explored.								
Economic Information Management and Reporting								
Municipalities report accurately (and publicly) their wastewater capital and operating expenditures, the value of their wastewater asset base and the multi-year investment needed in their wastewater system.								
Senior governments explore establishing a mechanism to collect and report information on the value of the wastewater infrastructure asset base and associated infrastructure expenditures on a national basis.								

Part C Management

1.1 Implementation

CCME recognizes that the requirements of the Strategy will not be met overnight. Implementation will require long-term planning on the part of each individual jurisdiction and owner. While the Strategy includes implementation timelines and deliverables, it is up to each jurisdiction to determine how it will go about meeting these.

Where the owner of a facility is subject to the *Notice Requiring the Preparation and Implementation of Pollution Prevention Plans for Inorganic Chloramines and Chlorinated Wastewater Effluents* under the *Canadian Environmental Protection Act*, 1999, the implementation timeline for the National Performance Standard of 0.02 mg/L TRC would be December 31, 2010, notwithstanding the timeline calculated by the risk criteria.

1.2 Review

Within 5 years of signing the Strategy, CCME will assess progress on the implementation of the Strategy. At that time an assessment will be completed to determine whether revisions are needed to the Strategy.

The assessment will include a review of the economics and the latest science, especially on emerging substances associated with municipal wastewater effluent.

1.3 Reporting on Progress

Progress towards meeting the requirements of the Strategy will be reported to CCME Ministers and Canadians every five years.

1.4 Administration

The Strategy will be implemented by each jurisdiction upon signing of the Strategy by that jurisdiction's representative.

Part D Future Work

It recognized that managing municipal wastewater effluent impacts other aspects of environmental protection. As a result, additional work is recommended in the following areas:

- Wastewater residuals including biosolids
- Education
- Storm water
- Incentive programs
- Climate change and air pollution
- Innovations (i.e., innovative/alternative technologies)

Part E Definitions

Arctic
The term *arctic* is still under discussion by the Development Committee. Considerations to date in defining arctic include number of growing degree days, mean annual near surface ground temperature, temperature and number of ice-free days.

Combined Sewer
A sewer intended to receive both sanitary waste and storm water.

Combined Sewer Overflow
A discharge from a combined sewer system when the hydraulic capacity of the system has been surpassed due to rainfall and/or snow melt events.

Effluent Discharge Objectives
The establishment of concentrations and load limits at the end of the wastewater discharge pipe in order to protect all water uses in the receiving water. Concentration, load or toxicity units that should be met at the municipal wastewater effluent discharge to adequately protect the receiving environment. Effluent Discharge Objectives are obtained through an environmental risk assessment methodology using the principles of assimilative capacity and mixing zone, in conjunction with Environmental Quality Objectives (see Technical Supplement 3).

Environmental Risk Assessment
A procedure that will enable the establishment of Effluent Discharge Objectives for substances of concern. This process will take into account the characteristics of the site-specific receiving environment. The environmental risk assessment includes a one-year period where a facility will characterize its effluent (initial characterization). A description of the process for both initial characterization and the environmental risk assessment is found in Technical Supplements 2 and 3.

Existing Facility
Existing collection system, on or before the signing of the Strategy, with a discharge to surface water (with or without treatment).

Facility Size

Very Small Facility
Facility discharge is less than 500 m^3 per day on an annual average, based on facility design capacity. Where the actual discharge meets or exceeds design capacity, the actual flow will be used. Under this category, only residential input is considered. Very small facilities receiving industrial input must meet the requirements of Medium sized facilities.

Small Facility
Facility discharge is greater than 500 m^3 per day (m^3/day) but less than 2,500 m^3/day on an annual average, based on facility design capacity. Where the actual discharge meets or exceeds design capacity, the actual flow will be used. Under this category, only residential input is considered. Small facilities receiving industrial input must meet the requirements of a Medium sized facility.

Medium Facility
Facility discharge is greater than 2,500 m^3/day and less than 17,500 m^3/day on an annual average, based on facility design capacity. Where the actual discharge meets or exceeds design capacity, the actual flow will be used. All discharge types are considered. Small and Very Small facilities with industrial input are considered to be Medium facilities.

Large Facility
Facility discharge is greater than 17,500 m^3/day and less than 50,000 m^3/day on an annual average, based on facility design capacity. Where the actual discharge meets or exceeds design capacity, the actual flow will be used. All discharge types are considered.

Very Large Facility
Facility discharge is greater than 50,000 m^3/day on an annual average, based on facility design capacity. Where the actual discharge meets or exceeds design capacity, the actual flow will be used. All discharge types are considered.

Financing
The use of financial instruments (e.g., loans, bonds, etc.) as a means to obtain immediate funding for a project. Financing is a subset of funding.

Funding
The act of providing the resources (funds) for a project. Used to refer to the range of mechanisms that are used to pay for wastewater infrastructure investments.

High Risk
See Technical Supplement 2

Jurisdiction
All provincial, territorial and the federal governments in Canada, as well as the territorial water boards as regulators of the wastewater sector.

Low Risk
See Technical Supplement 2

Medium Risk
See Technical Supplement 2

Municipality
As identified in a jurisdiction's local government or municipal legislation. For the purposes of the Strategy, the term municipality encompasses municipalities, communities (including First Nations and Métis communities) and federal entities.

Municipal Wastewater Effluent
Wastewater discharged to surface water from a collection or treatment system by an owner. Wastewater is a mixture of liquid wastes comprised primarily of domestic or sanitary sewage that may also include wastewater from industrial, commercial and institutional sources. It comprises end-of-pipe discharges and overflows, including combined sewer overflows and sanitary sewer overflows, but does not include separate storm water discharges. Septic tank discharges to infiltration systems are not included.

Owner
A municipality, a community including aboriginal community, or a federal or other government entity, that owns a wastewater facility. It also includes owners of wastewater facilities situated on federal or aboriginal land.

Sanitary Sewer Overflow
A discharge of untreated or raw wastewater to the environment that occurs on an infrequent basis.

Substance
Chemical substance or any other parameter associated with wastewater, including carbonaceous biochemical oxygen demand, total suspended solids, temperature, pH, pathogens, etc.

Upgrade
Further development of existing infrastructure which results in expanded throughput capacity. Does not include the addition of disinfection.

Wastewater Facility
Any works for the collection or treatment and release of wastewater or any part of such works. Includes engineered wetlands and those with natural elements considered as design components.

Wastewater Lagoon
A wastewater treatment system that consists of one or more designed and engineered surface impoundments, including enhancement of natural features, where biological and physical treatment of wastewater occurs, but does not include mechanical aeration systems that are employed to keep all the solids in suspension.

Ministers' Signature Block

CCME

Canadian Council of Ministers of the Environment | Le Conseil canadien des ministres de l'environnement

Technical Supplement 1

Canada-wide Strategy for the Management of Municipal Wastewater Effluent

Economic Plan Supporting the Canada-wide Strategy for the Management of Municipal Wastewater Effluent

June 2007

Table of Contents

List of Tables

Appendices

1. Introduction

1.1 Economics and Funding Task Group

The Canadian Council of Ministers of the Environment (CCME) is developing a Canada-wide Strategy for the management of municipal wastewater effluents (hereafter, 'the Strategy'). A main feature of the Strategy will be a harmonized regulatory framework for the management of municipal wastewater effluents, including proposed national performance standards and a collectively agreed-to approach for implementation and timelines.

These new standards will require significant investments and upgrades to existing wastewater infrastructure. As a result, in May 2006 CCME's Deputy Ministers recognized the economic and funding issues associated with the implementation of the Strategy as key to its success. Consequently, Deputy Ministers established the Economics and Funding Task Group (hereafter the 'task group') to address the issues related to costs and options for funding.

The core purpose of the task group is to provide input to the developing Strategy to contribute to its achievement from an economic and funding standpoint. The work of the task group will complement the background economic work of the Development Committee developing the Strategy and contribute to the development of a feasible Strategy acceptable to ministers.

The task group has compiled information related to the costs associated with implementation of the Strategy. This information focuses on the incremental costs, the fiscal capacity of large versus small municipalities to deal with these costs, the costs associated with facilities with a higher environmental risk and the priority given to these projects within jurisdictions. This information is foundational and vital in order to identify efficient and effective funding mechanisms. The task group will use this information to identify potential funding options for various facility types to implement the Strategy within reasonable time frames.

1.2 Structure of the Economic Plan

In addition to the background above, section 1 outlines the funding principles upon which the Economic Plan was developed. Section 2 examines wastewater capital expenditures by federal, provincial, territorial and municipal governments since 2000. A look ahead and future funding in the context of federal programs is discussed. Section 3 focuses on the estimated capital and non-capital costs to jurisdictions to implement the strategy. This section also addresses those costs which cannot be determined at this time. Section 4 highlights the funding considerations that must be taken into account in order to ensure that available funds are utilized in an efficient manner to implement the Strategy. The final section presents a summary and analysis of the information presented and the recommendations of the task group, given information presented.

1.3 Funding Principles

Funding and financing are two words often used interchangeably. For the purposes of the Economic Plan they will be defined separately. Funding is the act of providing the resources (funds) for a project, while financing is specifically defined as the use of financial instruments (e.g., loans, bonds, etc.) as a means to obtain immediate funding for a project. Financing is therefore a subset of funding. The term funding will be used throughout the Economic Plan to refer to the range of mechanisms that are used to pay for wastewater infrastructure investments.

Funding principles were established as a means of clarifying the overarching goals that the Economic Plan will facilitate. These serve as the framework within which the considerations of section 4 are taken into account. Options for funding should:

a) emphasize economic, environmental and social sustainability and be consistent with applicable community, regional or broader jurisdictional plans

    - Economic sustainability: Options that are economically sustainable support proper infrastructure asset management, with an emphasis on full cost accounting, full cost recovery and municipal accounting systems that ensure that funding for wastewater infrastructure is not directed to other municipal purposes;
    - Environmental sustainability: Options that are environmentally sustainable support stewardship of the resource, conservation, appropriate watershed management and source water protection;
    - Social sustainability: Options that are socially sustainable support protection of human health and well-being, and should not adversely impact one community or segment of a community more than another;

b) be flexible and take into consideration local, provincial and territorial factors, including the fiscal and human resource capacity of municipal wastewater services providers;

c) promote opportunities for municipalities to self-fund, including the implementation of innovative financing arrangements and schemes that may include private sector involvement; and

d) take into account risk to help inform the appropriateness of the options considered.

2. Wastewater Funding in Canada

2.1 Historic Funding

Wastewater infrastructure is one of many priorities competing for infrastructure funding. Municipalities own and are responsible for the operation of about 70% of wastewater infrastructure (including collection systems, wastewater facilities and combined sewers). The majority of funding for wastewater infrastructure is therefore provided directly by municipalities and recovered by revenues generated either through their rate base or from service charges. Supplemental funding for wastewater systems are often provided by federal, provincial and territorial governments.

Statistics Canada reports that approximately $14 billion has been spent in Canada on water and wastewater infrastructure by municipalities since 2000, with $2.7 billion of this representing spending intentions for 2007; however, the breakdown between water and wastewater spending is unknown. Additionally, it is unclear whether municipalities have accurately reported funding that was also provided by federal and provincial/territorial governments.

Related to the above, actual spending on wastewater infrastructure on a national basis has proven very difficult to determine. While most provincial and territorial governments can provide accurate accounts of their spending in this sector, the capacity to account for spending at the municipal level – the single greatest funding source of wastewater infrastructure – varies greatly between jurisdictions. In addition, many municipalities do not report on spending on wastewater infrastructure separately from drinking water infrastructure. Consequently, an accurate picture of annual or multi-year spending on wastewater infrastructure at a national level cannot be provided at this time, which makes it difficult to quantify the

gap between current spending and that needed to manage the added requirements proposed under the Strategy.

Anecdotal evidence from many municipalities and the Canadian Water and Wastewater Association indicates that funding for wastewater infrastructure is insufficient, indicating the existence of a deficit in funding for wastewater infrastructure, as with other infrastructure sectors. As a result, it can be reasonably assumed that, the infrastructure requirements imposed by the Strategy will be mostly in addition to existing levels of expenditure. Therefore, a substantial increase in the level of investment in wastewater infrastructure will probably be necessary to meet the requirements of the Strategy. It should be noted however, that this may be mitigated somewhat where normal course, planned municipal spending includes the construction of a new wastewater treatment facility or the replacement of an existing facility within the proposed timelines of the Strategy. Based on data from Statistics Canada[1], wastewater facilities in general, are one of the most advanced infrastructure sectors, in terms of age. In 2003, the average age of municipally owned wastewater treatment facilities was 16.9 years, with 58% of existing municipal stock nearing the end of its useful life of 29 years. While it is impossible to verify with any accuracy the impact that this will have on the costs of the overall Strategy, it does indicate that in a significant number of municipalities the cost of the requirements to upgrade to the new proposed standards may be incremental to the cost the municipality would be incurring in any event to replace or renew their existing stock.

Since 2000, the federal government has instituted a number of cost shared contribution programs for infrastructure. Funding provided under these programs has focused on addressing a number of municipal infrastructure priorities; however, a significant amount has been committed to wastewater infrastructure – both collection and treatment systems. In total, just under $960 million in federal funding has been provided to wastewater infrastructure from 2000 to date. This funding is generally matched by provincial, territorial and municipal governments resulting in investments of $2.88 billion in wastewater infrastructure over the past seven years leveraged from federal-provincial programs alone. Federal infrastructure program funding figures represent only a portion of actual investments in wastewater infrastructure, as provinces, territories and most significantly, municipalities make many more investments that are not reflected through an analysis of federal infrastructure programs. This does not include funding provided under the federal Gas Tax Fund, provincial funding programs and other funding mechanisms used by municipalities which may also be used to support wastewater infrastructure. As a result, these figures should represent only small portion of overall expenditures in the wastewater infrastructure sector since 2000. In addition, it should be noted that Statistics Canada data indicates that in the early to mid-1990s there was significant investment in wastewater infrastructure, which may explain the seeming lack of emphasis in funding relative to other infrastructure sectors in more recent expenditure data.

2.2 Potential Future Funding

In respect of potential future funding, the Government of Canada's 2007 Budget announced $16 billion in new infrastructure funding commitments. As a result, proposed federal support for infrastructure pursuant to the 2007 Infrastructure Plan will total $33 billion over the next seven years (2007/08 to 2013/14). With respect to wastewater infrastructure a few aspects of the 2007 federal Budget commitment are particularly notable:

- An estimated $17.6 billion in base funding for municipalities was provided, which includes $8 billion to extend the Gas Tax Fund for another four years (2010/11 to 2013/14).
- $8.8 billion for the Building Canada Fund with spending allocated among provinces and territories on an equal per capita basis. As indicated in the Budget, this funding will be used to support

[1] Reference - *The Age of Public Infrastructure in Canada*, Statistics Canada Analysis in Brief Series, January 30, 2006

investments in the core national highway system, large-scale projects such as public transit and sewage treatment infrastructure, and small-scale municipal projects such as cultural and recreational facilities.

- $2.275 billion over seven years in equal per jurisdiction funding. Pursuant to this commitment, each province and territory will be provided an additional $25 million per year to support investments in national priorities throughout the country.

The federal Budget 2007 commitments, which are over a 7 year timeframe, will have particular implications in respect of the early time frame for the Strategy. As will be noted in Section 3, over half of the capital costs of upgrades will be incurred in the first 10 years of the Strategy. As a result, there is significant overlap between the required capital spending and the implementation of this new infrastructure funding. Because wastewater infrastructure will be eligible under the federal government's Infrastructure Plan, it provides a potential source of funding for the Strategy through a combination of cost-shared programs and transfers that could, with appropriate cost matching by provincial, territorial and municipal governments, assist many municipalities in meeting the capital costs of required upgrades.

Historically, projects funded under the federal cost shared programs have been identified jointly with provinces, territories and municipalities, in accordance with priorities established in each jurisdiction. It is important that all jurisdictions look carefully at the funds available through these programs and the amounts that will have to be spent in the coming years to upgrade wastewater systems as agreed to under the new Strategy (as outlined in section 3). Each jurisdiction will then have to assess their priorities for federal infrastructure funding given that there will be competing demands for these funds.

3. Jurisdictional Costs

All orders of government – federal, provincial, territorial and municipal – will need to bear the costs of implementation of the Strategy. These costs include both the capital costs to upgrade wastewater facilities to meet the proposed national performance standards, as well as non-capital costs (e.g. studies, monitoring) that would be required to implement the Strategy.

There are both capital and non-capital costs that have not been considered in the Economic Plan, although they are within the scope of the Strategy. These costs will be discussed in more detail later in this section:

- Some costs are related to site-specific conditions that cannot be predicted with any certainty (e.g., collection systems).
- Costs which are are expected to arise as the Strategy evolves in future years (e.g., combined sewer overflows, additional treatment).

The Strategy is limited in scope and therefore the costs are estimated and discussed only for facilities that are subject to the Strategy. Some costs are therefore beyond the scope of this document.

- The Strategy does not apply to facilities other than those discharging to surface water; therefore there are no costs presented for systems discharging to the subsurface or via evaporation.
- Costs that are related to the operation and maintenance of wastewater facilities (aside from directly related non-capital costs, such as monitoring costs, as indicated above) are not included.
- Administrative costs for federal, provincial territorial and municipal governments are also outside the scope of both the Strategy and the Economic Plan.

3.1 Capital Costs to Meet the Proposed National Performance Standards

The Strategy proposes that wastewater facilities meet proposed national performance standards of 25 mg/L for 5-day carbonaceous biochemical oxygen demand, 25 mg/L for total suspended solids, and 0.02

mg/L for total residual chlorine. There are a significant number of facilities across Canada which will require upgrading to meet these standards. Those wastewater facilities which currently do not meet the proposed national performance standards or do not meet the proposed standards consistently due to physical deterioration of the wastewater facility, facility capacity or original facility design, will require upgrading to achieve these standards consistently.

Where a wastewater facility is located in a municipality where combined sewer overflows are an issue, a decision will be made as to which is the higher environmental priority: ensuring the facility meets the proposed national performance standards within the identified timeframe, or addressing the environmental impact of the combined sewer overflows. Where it is determined that addressing the combined sewer overflows are the higher priority, funding may need to be directed towards combined sewer overflows prior to developing or upgrading wastewater facilities to meet the proposed national performance standards.

Upgrading a wastewater facility to meet the proposed national performance standards will likely create a concurrent need to increase the biosolids management capacity of the facility; therefore, the capital costs presented for meeting the proposed national performance standards for carbonaceous biochemical oxygen demand and total suspended solids includes a biosolids component. In addition, there are systems currently employing chlorination for disinfection of effluent which would need to retrofit either dechlorination or ultraviolet irradiation equipment to meet the proposed national performance standard for total residual chlorine. The capital costs identified in tables 3.1 and 3.2 below are based on either a CCME costing template and/or actual jurisdictional cost estimates.

Ranking of capital projects is necessary in order to apportion available funds to cover capital costs over the implementation timeframe of the Strategy. A national level preliminary ranking of need to meet the proposed national performance standards based on level of treatment and broad environmental risk was used to rank upgrades in order of priority (see Appendix A). For example, under this methodology, a wastewater facility with primary treatment discharging to a sensitive receiving environment would receive “high priority” for upgrading whereas a secondary wastewater facility discharging to a large receiving environment with little sensitivity would receive “low priority” for upgrading. This preliminary ranking was used to estimate the required capital funding flow over the implementation period of the Strategy.

3.2 Non-Capital Costs to Implement the Strategy

An important component of the Strategy is an initial characterization of effluent and an environmental risk assessment which are used to ultimately establish site-specific effluent discharge objectives for harmful substances. High-risk facilities will be required to complete the initial characterization and environmental risk assessment first. Based on the results of the initial characterization and environmental risk assessments for these facilities, a refined method/program for both initial characterization and environmental risk assessments will be developed for all medium and low risk facilities. These one-time costs will be incurred during years 1-5 of the Strategy and are estimated to total (real costs) $113 million for the effluent characterization and $63 million for the environmental risk assessments. Some municipalities may have completed an environmental risk assessment which will be considered equivalent to the requirements of the environmental risk assessment under the Strategy which would reduce the overall costs in this area.

Monitoring is an important part of the Strategy. Estimated annual costs (real costs) for compliance monitoring and toxicity testing are estimated at $59 million for all facilities.

Environmental monitoring at a watershed level will be required in all jurisdictions. The process for environmental monitoring will be determined in years 1-5 under the strategy. Environmental monitoring costs will begin to be incurred in years 6-10. It is estimated that the costs for environmental monitoring will be $185 million over every five years.

3.3 Summary of Costs

The estimated total capital costs (including inflation) to achieve compliance with the proposed national performance standards across Canada have been identified for both a 30 year implementation timeframe and a 20 year implementation timeframe.

Over 30 years, depending on inflation, the estimated capital costs range from $7.5 billion to $ 9.3 billion, and the non-capital costs range from $2.8 billion to $3.8 billion. In total, the range of capital and non-capital costs over 30 years ranges from $10.3 billion to $13.1 billion.

Over 20 years, depending on inflation, the estimated capital costs range from $7.3 billion to $8.8 billion, and the non-capital costs range from $2.3 billion to $2.8 billion. In total, the range of capital and non-capital costs over 20 years ranges from $9.9 billion to $12.1 billion.

Table 3.1. Summary of Estimated Costs over a 30 Year Implementation Period at 2% and 4% Inflation

30-Year Implementation (nominal – 2% inflation)	**Years 1-5**	**Years 6-10**	**Years 11-20**	**Years 21-30**
Capital Investment	$0 (a)	$3,760,000,000	$3,727,000,000	$22,000,000
Non Capital Investment (b)				
Initial Characterization (c, d)	$118,000,000	$0	$0	$0
ERA (e)	$66,000,000	$0	$0	$0
Annual Monitoring (f)	$307,000,000	$339,000,000	$788,000,000	$960,000,000
Environmental Monitoring (g)	$0	$32,000,000	$75,000,000	$91,000,000
Sub total Non Capital Investment	$491,000,000	$371,000,000	$863,000,000	$1,051,000,000
Totals	$491,000,000	$4,131,000,000	$4,590,000,000	$1,073,000,000
30-year Total	**$10,285,000,000**			

See table notes below

30-Year Implementation (nominal – 4% inflation)	**Years 1-5**	**Years 6-10**	**Years 11-20**	**Years 21-30**
Capital Investment	$0 (a)	$4,313,000,000	$4,962,000,000	$36,000,000
Non Capital Investment (b)				
Initial Characterization (c, d)	$122,000,000	$0	$0	$0
ERA (d)	$68,000,000	$0	$0	$0
Annual Monitoring (f)	$320,000,000	$389,000,000	$1,049,000,000	$1,552,000,000
Environmental Monitoring (g)	$0	$37,000,000	$100,000,000	$147,000,000
Sub total Non Capital Investment	$510,000,000	$426,000,000	$1,149,000,000	$1,699,000,000

Totals	$510,000,000	$4,739,000,000	$6,111,000,000	$1,735,000,000
30-year Total	**$13,095,000,000**			

Table Notes
a. Some facilities will build or upgrade in the first five years of the strategy. These costs would then be reduced from subsequent time periods within the Strategy.
b. For the purposes of cost estimation for the non-capital costs, it is assumed there are a total of 3500 wastewater facilities in Canada, of which approximately 80% are small (2800) and 20% are large (700).
c. Initial characterization is linked to the ERA. Some facilities have completed an assessment equivalent to the environmental risk assessment; therefore they will not be required to complete this work again.
d. Initial characterization is a one time cost [(2800 *$16,000) + (700*$98,000) + inflation]
e. ERA is a one time cost [(2800 *$3,500) + (700*$14,000) + inflation].
f. Annual monitoring costs are $57,000,000 per year [(2800 *$4,000/year) + (700*$69,000/year) + inflation]
g. Costs for environmental monitoring will be incurred once every 5 years starting at year 6 of implementation [(2800 *$3,500/5 years) + (700*$250,000/5 years) + inflation]

Table 3.2. Summary of Estimated Costs over a 20 Year Implementation Period at 2% and 4% Inflation

20-Year Implementation (nominal – 2% inflation)	**Years 1-5**	**Years 6-10**	**Years 11-15**	**Years 16-20**
Capital Investment	$0 (a)	$3,760,000,000	$3,542,000,000	$19,000,000
Non-Capital Investment (b)				
Initial Characterization (c, d)	$118,000,000	$0	$0	$0
ERA (e)	$66,000,000	$0	$0	$0
Annual Monitoring (f)	$307,000,000	$339,000,000	$374,000,000	$413,000,000
Environmental Monitoring (g)	$0	$212,000,000	$234,000,000	$259,000,000
Sub total Non Capital Investment	$491,000,000	$551,000,000	$608,000,000	$672,000,000
Totals	$491,000,000	$4,311,000,000	$4,150,000,000	$950,000,000
20-year Total	**$9,902,000,000**			

See table notes below

20-Year Implementation (nominal – 4% inflation)	**Years 1-5**	**Years 6-10**	**Years 11-15**	**Years 16-20**
Capital Investment	$0 (a)	$4,313,000,000	$4,477,000,000	$27,000,000
Non Capital Investment (b)				
Initial Characterization (c, d)	$122,000,000	$0	$0	$0
ERA (e)	$68,000,000	$0	$0	$0
Annual Monitoring (f)	$320,000,000	$389,000,000	$473,000,000	$576,000,000
Environmental Monitoring (g)	$0	$244,000,000	$269,000,000	$361,000,000
Sub total Non Capital Investment	$510,000,000	$633,000,000	$742,000,000	$937,000,000
Totals	$510,000,000	$4,946,000,000	$5,704,000,000	$973,000,000
20-year Total	**$12,133,000,000**			

Table Notes
a. Some facilities will build or upgrade in the first five years of the strategy. These costs would then be reduced from subsequent time periods within the Strategy.
b. For the purposes of cost estimation for the non-capital costs, it is assumed there are a total of 3500 wastewater facilities in Canada, of which approximately 80% are small (2800) and 20% are large (700).
c. Initial characterization is linked to the ERA. Some facilities have completed an assessment equivalent to the environmental risk assessment; therefore they will not be required to complete this work again.
d. Initial characterization is a one time cost [(2800 *$16,000) + (700*$98,000) + inflation]
e. ERA is a one time cost [(2800 *$3,500) + (700*$14,000) + inflation].
f. Annual monitoring costs are $57,000,000 per year [(2800 *$4,000/year) + (700*$69,000/year) + inflation]
g. Costs for environmental monitoring will be incurred once every 5 years starting at year 6 of implementation [(2800 *$3,500/5 years) + (700*$250,000/5 years) + inflation]

Note that actual implementation costs will likely be higher than the estimated costs in Tables 3.1 and 3.2 above due to site specific factors and the accuracy of the available information.

In addition to the above costs, it is estimated an additional $225 million in capital investment costs will be incurred for First Nation on reserve and federal (e.g. prisons, national parks) wastewater facilities. These costs are not incorporated into the tables above as they are monies which will be incurred solely by the federal government.

3.4 Additional Considerations

There are a number of costs which may arise during the implementation of the Strategy which may be subject to significant variation as the Strategy is implemented. These include site-specific treatment costs, combined sewer overflows and sewage collection systems.

Site-Specific Treatment Costs

The purpose of the environmental risk assessment component of the Strategy is to identify the presence of harmful substances in municipal wastewater effluent and determine whether or not the wastewater facility will need to take action to reduce substance levels in effluent to protect the receiving environment. It is not possible to accurately forecast in advance how many facilities will need to take action, which substances will be detected at levels of concern and the exact nature of the actions needed to reduce the substances levels at affected facilities. This makes it difficult at this time to estimate with any certainty the costs that would arise from full implementation of effluent discharge objectives at affected facilities across Canada. It is anticipated that the environmental risk assessment-related costs will be clearer after the first five years of implementation.

What can be expressed in a general sense at this time is that the overall costs across Canada could be significant. If a harmful substance is present in effluent at levels above the effluent discharge objectives, the Strategy requires the wastewater facility to take action to meet its effluent discharge objectives by either controlling the source of the substance or by upgrading the sewage treatment process.

Source control is the preferred method to address the majority of substances. This could involve imposition of sewer use controls through a municipal sewer use bylaw and/or targeted best management practices which could be used by industrial, commercial and institutional users who discharge to the sewer system. There are costs to the municipality associated with imposing sewer use controls including enforcement. There are also costs which would need to be borne by users, including on-site treatment, to pre-treat their effluent to a level prescribed in the sewer use bylaw.

For specific harmful substances, treatment is the only viable option for reducing levels in effluent to meet effluent discharge objectives. The most significant substance in this regard is ammonia, which is generated naturally by the breakdown of sewage. Upgrading wastewater facilities to allow for

nitrification to reduce ammonia content is a major cost. For example, estimated costs for a medium-sized facility to upgrade to nitrification could range from $6 to $20 million. These costs will be better known after the first five years of implementation of the Strategy. It is difficult to predict how many facilities will need to upgrade to nitrification across Canada at this time.

Combined Sewer Overflows

Many major cities in Canada have older portions of their city serviced by combined sewers which carry both sewage and storm water. Combined sewers are widely recognized as being major contributors to water pollution in all provinces as heavy storm water flows exceed the capacity of the combined sewer and the sewer overflows into the environment, dumping untreated sewage at many locations, some of which are close to recreational and other sensitive areas. The Strategy proposes requirements which will initiate action to address the impact of combined sewer overflows across Canada. While these requirements include the completion of a pollution control plan, monitoring of overflow events and floatables control where feasible, if a municipality determines that the impact of a combined sewer overflow is a greater environmental risk than the current quality of the treated effluent, it may propose actions to address the impacts of the combined sewer overflow first, prior to meeting the proposed national performance standards. This could include a capital investment in managing its combined sewers before it upgrades its wastewater facility. Estimates of the costs to meet these requirements have not been completed. While the monitoring costs associated with combined sewer overflows are significantly less than the capital costs, it is likely that the capital cost of meeting a reasonably protective control standard for combined sewer overflows across Canada in the future will be several billions of dollars.

Sewage Collection Systems

The collection systems which convey sewage to wastewater facilities are outside the scope of the Strategy; however, inflow and infiltration into sewer mains can contribute significantly to sanitary sewer flow during storm events and play a significant role in sanitary sewer overflows and bypasses. The general commitment in the Strategy to eliminate bypassing of raw sewage may lead to the need for capital spending on sewer system upgrades, which cannot be predicted at this point of the Strategy's development. This would need to be addressed in a future update of the Strategy.

4. Funding Considerations

Funding for capital infrastructure projects will be one of the most significant factors in the success of the Strategy as envisioned by CCME. This section provides a brief overview of some of the conclusions that can be drawn from sections 2 and 3 above, and examines the various funding options available for improvements to municipal wastewater infrastructure in the context of various provincial/territorial and municipal considerations that may impact the effectiveness of certain funding options in particular regions. This section considers both existing and alternative funding arrangements for municipal wastewater and concludes with an analysis of the suitability and applicability of each in the Canadian context.

Based on sections 2 and 3, above, a number of conclusions can be drawn that will assist in the determination of the availability of funding options. From section 2 it is apparent that although there has been significant expenditure in respect of wastewater infrastructure, an accurate amount of spending by all levels of government cannot be provided, primarily because of the lack of a consistent reporting mechanism for expenditures at the municipal level, separate from that of drinking water infrastructure. Section 3 indicates that costs will vary depending on the timeline of implementation and the inflation rate over that period of time; however, under both options it is clear that regardless of the timeline, the costs over the first 10 years will be the same and over 50% of the total capital costs will likely be incurred

within the 6-10 year timeframe, based on a preliminary risk ranking assessment performed by the task group. As a result, the estimated capital costs of upgrading the higher risk facilities for during years 6 to 10 of the implementation of the strategy are between $5.26 and $6.14 billion. Of the remaining capital funding, practically all of it is required in years 11-15 (under a 20 year implementation period), or 11-20 (under a 30 year implementation period). Only a very small proportion of funding will be required in the last years of the implementation of the Strategy (less than 1% under all scenarios). This indicates that the capital costs of the Strategy will be loaded towards the early and mid periods of implementation.

With respect to the mid-period of implementation of the Strategy (years 11-15 for 20 years and 11-20 for 30 years), funding would likely be assisted by the 30 year implementation period. Although the overall costs are higher over a 30 year implementation period, the year over year costs may be more manageable for all orders of government over the 30 year implementation period ($459-611 million per year over 10 years, as opposed to $830 million-$1.2 billion per year over five years). As the highest risk facilities will be dealt with in years 6-10 of the strategy, the economic considerations of a longer implementation period for medium risk facilities may outweigh the environmental benefits.

The success of the Strategy clearly depends to a large extent upon the availability of suitable funding options for municipalities for the implementation of the provisions for the Strategy. It is clear that not all options are applicable or practical in all situations and for all municipalities. Many of the options can or should be combined; however, to reduce the financial burden on a municipality and each may represent a partial solution to issue of funding for capital projects.

4.1 Jurisdictional Considerations

Federal

The federal government is, generally speaking, the smallest player in respect of direct responsibility for the construction and operation of wastewater infrastructure. The federal government has direct responsibility only in limited circumstances: (1) on federally owned lands (such as military facilities owned by the Department of National Defence); and, (2) on First Nations reserves. Despite this relatively limited direct responsibility, federal actions can have implications regarding the wastewater effluent requirements in all jurisdictions, primarily through regulations under the *Fisheries Act*, which limit the deposit of deleterious substances in waters.

Provincial/Territorial

Like the federal government, provincial and territorial governments also do not own the majority of wastewater facilities. They are directly responsible, however for licensing these facilities and setting the effluent treatment levels.

Generally speaking, the effectiveness of the various funding mechanisms at the provincial and territorial level is influenced by a variety of factors. The geography of the province or territory, particularly the presence of sensitive watersheds such as those in Alberta and Saskatchewan which do not drain to the sea, or may be at risk because of multiple user demands and somewhat limited resources, can influence the level of treatment required and thus the scale and cost of a municipal wastewater project. As well, the size of municipalities within the province and territory has an effect as small, scattered population centres tend to have limited tax bases, making the large-scale funding that may be required by municipal wastewater effluent challenging. Such conditions also do not lend themselves to the regionalization of services and the limited tax base may make debt financing and public-private-partnership arrangements less attractive to potential investors than those in larger centres. Finally, the fiscal means of a particular provincial or territorial government may dictate its ability to offer grants, contributions or other transfers to the municipal and regional levels of government.

Municipal

Municipalities own and are responsible for the maintenance of the vast majority (70%) of wastewater facilities in Canada. They are subject to federal, provincial and territorial legislation and standards in respect of the operation of the infrastructure.

The suitability or appropriateness of different funding mechanisms varies most according to the characteristics of the municipality involved. When determining whether a particular mechanism for funding or financing of wastewater treatment upgrades required under the Strategy is applicable, a number of characteristics have been identified. These relate to the ability of the municipality to self-fund or finance a project, as well as the impact environmental risk assessment has on the timeline within which a municipality has to implement changes to their wastewater treatment systems. The key six factors identified are : (1) size of the community; (2) potential to increase the existing rate base; (3) whether sustainable asset management practices are in place; (4) financial position of the municipality; (5) the growth prospects within the community; and, (6) the environmental risk assessment ranking of the municipality.

Size of Community

The Strategy indicates that very large and large communities are likely to receive a higher risk ranking as a result of the volume of municipal wastewater effluent produced. From a financial perspective, these same communities can generally also be expected to have greater ability to raise revenues from within their own constituency. This ability may be reduced when looking at medium, small or very small communities. This factor can be influenced by the timelines within which the community is operating, as well as the asset management practices that are in place, both of which are discussed below.

Flexibility of Rate Base

The wastewater rate structures within individual municipalities vary widely across the country. Those that have rate structures do not often support the full life cycle cost of operation, maintenance, rehabilitation, potential expansion and eventual capital replacement of the municipalities wastewater infrastructure system. Indeed, many Canadians pay less for wastewater services than they do for other utilities such as cable, phone, electricity or heating. As a result, the rate base may be artificially low in many municipalities with a corresponding flexibility to be increased. These increases in rate bases can be used to generate additional financial revenues that can, in turn, be used to create reserves or to service debt to cover the cost of wastewater treatment upgrades.

Sustainable Asset Management

Sustainable asset management focuses on ensuring that the real costs of the infrastructure asset are accounted for and are used as the foundation on which to base cost recovery and to establish user rates. This helps reduce life-cycle costs and improve system performance. In order to establish sustainable asset management practices in respect of their wastewater infrastructure, municipalities must have a reliable inventory of their wastewater assets, including the age, expected life span and current state of repair of the asset. Sustainable asset management should include long term capital planning that reflects expected growth, as well as recognition of the eventual need to substantively rehabilitate or replace the asset. This must be accompanied by financial planning practices that ensure that the costs of the long-term capital plan are identified and that there is a mechanism in place to address these costs.

Municipal Financial Position

The financial situation of the individual municipality is critical to its ability to access external financing opportunities. Municipalities with strong balance sheets, high bond ratings and low borrowing charges have greater flexibility to access financial markets for loans or other debt financing mechanisms. The ability of municipalities to access debt financing mechanisms is also impacted by provincial and territorial

legislation, which may set limits on the amount of debt that an individual municipality can carry. This is often established as a ratio to municipal revenues or reserves.

Community Growth Prospects
Communities that are growing or that have stable populations have more flexibility in terms of their capacity to raise revenues through own-sources. In growing communities in particular, this can include development charges as well as other mechanisms discussed above. Growing communities, as with all communities, also have a particular responsibility to implement demand side management and system optimization mechanisms to increase conservation and reduce the costs associated with infrastructure expansion and upgrades. Communities that are declining will have a correspondingly reduced capacity to raise own-source revenues as they are faced with a declining rate base. In addition, senior governments (senior governments include federal, provincial and territorial governments) may be less inclined to prioritize investments in infrastructure assets that the community cannot afford to operate or maintain over the long term.

Environmental Risk Ranking and Timelines
The Strategy will establish clear criteria by which each facility will be able to asses its level of risk and hence, the priority and the timelines within which a particular municipality must implement upgrades to their wastewater treatment system to meet the proposed national performance standards. Municipalities that are identified as having a high environmental risk will be required to meet the proposed national performance standards set out in the Strategy within 10 years from the start of implementation. As one of the factors in determining risk is the volume of municipal wastewater effluent produced, it is expected that many large facilities may have a higher risk ranking. As a result, these facilities will likely have less time to plan, and raise their own source revenues, and because of the size of the facility, may have higher costs. Facilities that are identified as medium risk will have up to 20 years to meet the proposed national performance standards, and low risk facilities will have up to 30 years to meet the proposed national performance standards. The lower risk communities will have longer timeframes to plan for the infrastructure upgrades required, this may provide them with additional flexibility to develop and implement strategies to address associated costs.

4.2 Funding Sources and Mechanisms

Innovative Transportation Revenues/Incentives (i.e., Gas Tax Fund)

This type of funding involves a portion of provincial fuel taxes or other revenues (i.e., tolls, license fees) being redistributed to municipalities for the funding or maintenance of road infrastructure. The federal government's Gas Tax Fund is an example of this type of mechanism, although it is important to clarify that the amount of the Fund is a notional amount that has been established in advance and is not directly linked to the gas tax revenues collected by the federal government in a particular year. The Gas Tax Fund was extended to 2014 in the Government of Canada's 2007 Budget. Important features of the Gas Tax Fund include that it is "bankable" and can be used as a mechanism to create a reserve or as a mechanism to repay loans or leverage additional financing. The Gas Tax Fund encourages small municipalities to pool funding and could be used as a mechanism to support regional schemes.

One of the major drawbacks, however, of this form of funding, generally speaking, is that depending on how funding is allocated, small municipalities may not receive enough money individually to fund larger scale projects such as wastewater facilities. Additionally, although this form of funding provides a sustainable source of funds to municipalities, it does so only so long as the federal or provincial partner continues to maintain the program.

Depending on allocation amount received by municipalities, this mechanism will work best in situations where there are longer time horizons for creating a reserve. While it will be most effective in larger

communities because of the expected higher allocation amounts, it can also be applicable to smaller communities particularly if regional schemes are initiated. Over the shorter term, the Gas Tax Fund can be used to leverage financing for all communities, to various degrees, as it is a guaranteed income stream until 2009.

Government Service Partnerships

Also referred to as "regionalization of services," these arrangements encourage governmental partnerships particularly between neighbouring municipalities to achieve economies of scale to lower capital and administrative costs and/or ongoing maintenance and operational costs. This would be an effective mechanism for medium and small communities within reasonable proximity of each other. Regionalization schemes are quite adaptive; for example, municipalities could save money by sharing their human resources, thereby saving money to put toward a wastewater facility. There are, however, significant initial costs to organizing Government Service Partnerships. In addition, they are only applicable where geography and location make them a possibility.

Regionalization of services can assist smaller communities in relatively close geographic proximity by allowing them to realize savings and pool risk. Over the short term it can help improve access to financing and over the long term can improve the sustainability of the asset. Regionalization will likely not be of assistance for high risk situations where upgrades are mandated within the 5 years.

Strategic Budget Allocations

This arrangement involves a portion of a tax bill or rate bill being set aside in a special fund. These monies are invested and interest reinvested in order to create a dedicated fund for certain types of capital needs. This type of fund could be created by most municipalities regardless of size, although it is limited by the length of time required to accumulate sufficient funds for a major project such as a wastewater facility. However, to shorten this lag time, the funds in a Strategic Budget Allocation could be combined with a bankable transfer such as the Gas Tax Fund.

This framework can be applicable to municipalities in many situations; however, it is best suited to longer timeframes to allow for the capital fund to be built up. It will work better if associated with life cycle cost accounting to ensure adequate amounts are being set aside but will often face skepticism from members of the public regarding the need for such allocations.

Full Cost Recovery

Full cost recovery can be achieved through a "cash needs basis" or a "utility model," approach that identifies the cost of providing drinking water to consumers and recouping the full cost of delivery of the service, including operation, maintenance, and eventual replacement. The "utility model," full cost recovery involves charging rates to users of the utility that reflect the full cost of delivery of the service, including operation, maintenance, rehabilitation and eventual replacement. Full cost accounting is a necessary precursor to full cost recovery. Full cost recovery requires full life cycle cost or accrual accounting for the particular infrastructure as a precursor. It is notable that the Public Sector Accounting Board announced on March 6, 2007 that it would be instituting a new standard for the government sector in terms of the accounting for tangible capital assets. This new standard for full cost or accrual accounting is required to be in place for all local governments for fiscal years starting on or after January 1, 2009.

Full cost recovery, may be viewed as fair as it is the users of the utility who pay in proportional to the amount of the service that they consume. Although full cost recovery has been implemented in Canada previously for municipal wastewater (Kelowna, British Columbia, Saskatoon, Saskatchewan and Edmonton, Alberta all have full cost recovery sewer utility charges), organizing such a funding system can be complicated and may have substantial initial costs.

This can be applied to many municipalities; however, for some small systems it may be prohibitive to implement full cost recovery due to the inability of a small tax base to support the potentially high full cost of wastewater infrastructure. It is generally best suited to longer timeframes. Ultimately, full cost recovery is the most desirable option of funding most wastewater infrastructure as it is open, transparent, accountable and sustainable.

Debt Financing - Bonds, Loans, State Revolving Loan Funds, Securitization Funds

Bonds or loans can be used to finance infrastructure. In both cases the financial situation of the municipality is the main factor regarding the success of the instrument; if a municipality is not rated or has a poor bond rating, bonds may be unavailable and/or interest rates on loans may be very high. As there can be full cost recovery associated with many municipal wastewater systems the rates charged to users can be adjusted to include the cost of borrowing through the bond or loan, providing a guaranteed source of revenue to repay the bond or loan.

A revolving loan fund involves an initial grant from either the federal or provincial government, along with a percentage match contributed by the municipal government. The municipality controls the fund and the federal or provincial partner contributes an ongoing yearly grant that decreases in amount over time. State established revolving loan funds have the advantage of lower rates of interest (as the municipality controls the flow of money into and out of the fund) and can have broad applicability to both small and large municipalities. This type of funding is sustainable and flexible with respect to the conditions of repayment, refinancing, and type of project funded. Indeed, the existence of a potentially dedicated revenue stream through municipal wastewater rates can be utilized to repay funding. The federal Green Municipal Funds are an example of a revolving loan fund that currently exists for municipal infrastructure.

Securitization funds use repackaged loans to sell securities which entitle the owner of the securities to repay a portion or the total amount of a loan. The loans are pooled and the cash flow from the loans is used to pay the interest and principle on the securities. Under this type of funding mechanism, individual municipalities or regional districts may borrow money together and guarantee each other's debt. However, despite the fact that securitization funds can provide long-term financing at low rates, small municipalities may not be able to handle the financial burden. In addition, securitization funds may not be applicable in the wastewater sector since investors may not feel that their investments are diversified in a securitization fund which provides funds to only one type of project.

These mechanisms can be good options for shorter timeframes and where the financial status of the municipality will support lower interest and/or bond rates. This is more often the case for larger municipalities. A poor municipal financial position can also be somewhat offset through the provision of loan guarantees by higher orders of government. The existence of a potentially dedicated revenue stream through municipal wastewater rates can be utilized to repay funding and this could also potentially be combined with revenues through the Gas Tax Fund.

Public Private Partnerships

There are different types of public private partnership arrangements: public-private partnerships; build, own and operate; build, operate and transfer; and private finance initiatives. Some of these arrangements involve private sector financing only, while others focus on the building and operating of the asset, with some of those including maintenance and replacement. Most public private partnership arrangements include provisions that the asset reverts to public ownership at the end of the contract. Public private partnership arrangements have numerous advantages: creativity and the level of expertise and innovation will be increased, costs to governments can be lessened, the private sector is better able to handle more debt than most municipalities, and the arrangement can involve a maintenance phase for which total life

cycle costs will be considered. However, this type of mechanism may present some risks to the public that must be appropriately managed. In addition, it is usually only successful if a fair, open and transparent selection process is used in the development of the public-private partnership and in the selection of the private sector partners.

These are generally applicable to very large facilities in large communities, but smaller communities may also benefit from different public private partnership arrangements, particularly under regionalization schemes. Public private partnerships can also be utilized to address high risk facilities that have a shorter timeframe for implementation. Public private partnerships will work best if accompanied by appropriate life cycle accounting and full cost recovery, as the cost recovery allows a dedicated revenue stream, which particularly enables public private partnership arrangements in respect of wastewater treatment.

Grants and/or Contributions

Grants and contributions from federal or provincial governments are non-repayable and can have different levels of conditionality and different eligibility criteria. Grants have been used extensively in Canada to fund services but tend to have significant costs associated with the application process and are an unpredictable funding resources as the priorities of the federal or provincial governments dictate the amount of funds devoted to grant programs. At the federal level, grants are generally not used to support infrastructure development.

Contributions are normally associated with higher levels of conditionality and are cost shared with other orders of government, as they are usually a "contribution" to a specific project or for a specific reason. Existing federal infrastructure programs are contribution programs such as the *Canada Strategic Infrastructure Fund* and the *Municipal Rural Infrastructure Fund*. Funding is subject to the terms of the Contribution Agreement signed and funding is normally audited to ensure all funding conditions are met. In addition, funding under federal contribution agreements are normally made in the form of reimbursements for eligible costs that the project proponent has incurred.

Grants and contributions could be used for all types of municipalities. They would be particularly applicable to the high- risk facilities that are faced with shorter timeframes, or small municipalities that are unable to fund or finance capital works projects on their own. In order to avoid the funding becoming viewed as an ongoing subsidy and a reward for poorer asset management practices, funding would have to be accompanied by appropriate conditionality (i.e. full life cycle cost accounting and, preferably, recovery).

Additional information on these funding sources and mechanisms is found in Appendix B.

5. Summary and Recommendations

It is difficult to ascertain an accurate estimate of total expenditure on wastewater infrastructure as spending for water and wastewater is usually reported together, especially by municipalities. Since 2000, at least $2.88 billion[2] has been spent by federal, provincial, territorial and municipal governments on wastewater infrastructure through federal-provincial programs alone, although it is anticipated that this number is much higher. Statistics Canada figures show $14 billion[3] has been invested on water and wastewater infrastructure in Canada since 2000, although neither the breakdown between water and wastewater investments nor the source of the funding is indicated.

[2] In federal-provincial-municipal programs cost-share, each committed $960 million towards wastewater infrastructure investment.

[3] Reference – *Capital and Repair Expenditures, Actual, Preliminary Actual and Intentions – 2803*, Table 029-0008, Statistics Canada

There will be costs to all jurisdictions to implement the strategy. Over 30 years, depending on inflation, the estimated capital costs range from $7.5 billion to $ 9.3 billion, and the non-capital costs range from $2.8 billion to $3.8 billion. In total, the range of capital and non-capital costs over 30 years ranges from $10.3 billion to $13.1 billion. Over 20 years, depending on inflation, the estimated capital costs range from $7.3 billion to $8.8 billion, and the non-capital costs range from $2.3 billion to $2.8 billion. In total, the range of capital and non-capital costs over 20 years ranges from $9.9 billion to $12.1 billion.

At this time the task group recognizes that these costs are incomplete due to the lack of site specific details regarding infrastructure upgrades and that additional costs will arise as the Strategy is implemented (e.g., the above estimates do not include financing costs). In addition, while the difference between current expenditures in wastewater and the cost of implementation of the Strategy cannot be estimated accurately, based on limited information, existing spending on wastewater infrastructure is not enough to cover the cost of maintenance, replacement and expansion of existing stock at current treatment standards. As a result, it would appear that the large proportion of the estimated capital costs of implementation of the Strategy are additional to existing expenditure levels. This may be mitigated somewhat, as a result of the normal lifecycle replacement of existing wastewater treatment infrastructure assets. As noted in Section 2, based on Statistics Canada data, a significant portion of existing municipal wastewater infrastructure stock is nearing the end of its expected lifespan and will need to be replaced within the timelines of the Strategy. This indicates that for a significant number of municipalities the costs of treatment to the new proposed standards would be incremental to the costs that would have been incurred anyway in the replacement of their existing facilities. It is impossible, however, to estimate with any accuracy the actual impact this will have on the costs of the Strategy.

Funding for capital infrastructure projects will be one of the most significant factors in the success of the Strategy. There are a number of considerations for each jurisdiction when considering funding of wastewater infrastructure that may impact the effectiveness of certain funding options in particular regions. The success of the Strategy also depends upon the availability of suitable funding to municipalities to implement the provisions for the Strategy. While it is clear that not all options are applicable or practical in all situations and for all municipalities, many of the options can or should be combined to reduce the financial burden on a municipality and each may represent a partial solution to issue of funding for capital projects.

Implementation of the Strategy will require a higher level of financial commitment to wastewater infrastructure compared with historic levels. Wastewater infrastructure is just one of many sectors competing for infrastructure funding and all orders of government will be required to prioritize wastewater infrastructure if the Strategy is to be implemented successfully. The funding announced in the 2007 Federal Budget, which will establish new cost-shared contribution programs for infrastructure and extends the Gas Tax Fund to 2014, provides an opportunity for governments to do this.

Based on the economic considerations, both the 20 and 30 year timeframes are feasible, provided all orders of government make funding of wastewater a high priority. The funding committed by the federal government through its Budget 2007 Infrastructure Plan will be implemented over the coming year and, for most programs and transfers outlines, can be used to fund wastewater treatment infrastructure. The federal funding commitment overlaps significantly with the planned first 10 years of the Strategy, and it is notable that is during this timeframe that the majority of the capital costs will be incurred. As a result, if wastewater infrastructure is appropriately prioritized over this timeframe, there should be sufficient funding, assuming appropriate cost-matching by provincial, territorial and municipal governments, to address the capital costs of upgrades to the high risk facilities.

As indicated above, the majority of the costs will be incurred within the first 10 years of implementing the Strategy, regardless of the timeframe chosen. It should also be noted that because of the predicted cash flow requirements over the 11-15 versus the 11-20 year timeframe for upgrades to medium risk facilities, the 30 year timeframe may be more easily accommodated from a fiscal perspective. In addition, the longer timeframe will have the added benefit of increasing the availability of funding options, many of which can be more easily accessed over a longer timeframe. At a minimum, within 20 years, both high and medium risk facilities are required to meet the proposed national performance standards. Should a 30-year implementation period be chosen, the last 10 years would address the low risk facilities. Based on the small amount of estimated capital costs for these facilities, they are few in number. In addition, where a municipality will address issues with its combined sewer overflows prior to meeting the national performance standards, funding for combined sewer overflows will likely be required. A 30-year implementation timeframe would provide these municipalities with greater financial and planning flexibility to address combined sewer overflow issues and still meet the proposed national performance standards within the 30 years.

Balancing the above considerations, inflation will result in higher overall costs over a 30 year time frame and the environmental benefits will be realized at a slower pace (ten years later), which may be considered by Canadians to be too long a timeframe for realization of the environmental benefits.

There is no consensus within the task group on a recommendation for a particular implementation timeframe. Both timelines are feasible and there are advantages and disadvantages associated with both 20- or 30-year implementation timeframes.

5.1 Recommendations

The following recommendations will assist in making the Strategy more economically achievable:

Funding Principles

1. The following funding principles should inform funding programs and decisions.

a) emphasize economic, environmental and social sustainability and be consistent with applicable community, regional or broader jurisdictional plans

- Economic sustainability: Options that are economically sustainable support proper infrastructure asset management, with an emphasis on full cost accounting, full cost recovery and municipal accounting systems that ensure that funding for wastewater infrastructure is not directed to other municipal purposes;
- Environmental sustainability: Options that are environmentally sustainable support stewardship of the resource, conservation, appropriate watershed management and source water protection;
- Social sustainability: Options that are socially sustainable support protection of human health and well-being, and should not adversely impact one community or segment of a community more than another;

b) be flexible and take into consideration local, provincial and territorial factors, including the fiscal and human resource capacity of municipal wastewater services providers;

c) promote opportunities for municipalities to self-fund, including the implementation of innovative financing arrangements and schemes that may include private sector involvement; and

d) take into account risk to help inform the appropriateness of the options considered.

Current Expenditure on Wastewater Infrastructure

1. All orders of government need to place a high priority on wastewater infrastructure in order to ensure access to funding programs.

Costs of the Strategy

1. The initial effluent characterization and environmental risk assessment are required in years 1-5 are an imperative part of the Strategy. A phased approach – high risk facilities will complete the initial characterization and environmental risk assessment first – may be taken to carrying out the initial characterization and the environmental risk assessment. Senior governments should consider establishing a specific short-term funding mechanism for this initial part of the Strategy.

2. During the first 6 years, as a part of implementation plan development, municipalities must estimate the actual costs of implementation of the Strategy, based on site-specific factors and the proposed national guidelines for the implementation of the Strategy.

3. Jurisdictions should continue to examine the on-going costs of implementing the Strategy. For example, administrative costs, CSOs, upgrades, etc.

4. Each jurisdiction should complete a jurisdictional implementation plan, including a capacity and resource assessment on the ability of municipalities to undertake full cost accounting, join a regional system to mitigate cost increases and identify other challenges. This will allow all jurisdictions to prioritize investments based on more complete information.

Funding Mechanisms

Municipal-based Approaches

1. Own-source revenues should be used to the maximum extent possible.

2. Wastewater utilities should be managed so they are sustainable economically, environmentally, and socially.

3. Municipalities should be encouraged to use best management practices and existing tools (e.g. Infraguide) in order to implement proper infrastructure management (e.g. up-to-date asset inventories, state of good repair, focus on lifecycle approach, etc.).

4. Full cost accounting should be implemented by all municipalities as required by the Public Sector Accounting Board.

5. Full cost recovery should be implemented to the extent that funding at local levels makes it possible. Where not possible to fully fund the necessary capital investment, rates should be maximized keeping in mind affordability and sustainability. To assist all jurisdictions in assessing affordability, a model is available in Appendix C.

6. Alternative finance and service delivery mechanisms should be explored to the extent possible.

7. Municipalities should be encouraged to make wastewater infrastructure a high priority and utilize existing and future funding programs including the federal Gas Tax Fund and provincial equivalents.

Senior Governments Assistance (federal, provincial and territorial governments)

1. Senior government assistance should consider and encourage best management practices, full cost accounting, full cost recovery and municipal sewer use by laws.

2. Funding should consider the financial capacity and fiscal constraints faced by small and very small municipalities.

3. Senior governments should also consider other means of assistance to small and very small municipalities (e.g., planning, capacity building).

4. Senior governments should make wastewater infrastructure a high priority under existing and future infrastructure funding programs as a means to implement the Strategy.

5. Senior governments should consider establishing financing mechanisms to assist municipalities in accessing low cost financing, thereby potentially increasing the number of municipalities that will have the capacity to borrow, and enabling those municipalities that have the capacity to fund investments to spread the investment cost over a number of years (e.g., the use of revolving funds like the Green Municipal Funds).

Economic Information Management

1. Better tracking, monitoring reporting of costs and funds committed to wastewater treatment are needed by municipalities. Municipalities should report accurately (and publicly) their current level of wastewater expenditure, the value of their wastewater asset base, and the multi-year investment needed in their wastewater system.

2. The possible establishment of a mechanism to collect and/or act as a repository of information on the value of the wastewater infrastructure asset base and associated infrastructure expenditures on a national basis (e.g., Statistics Canada) should be considered. Information collected should include separate statistics on the level of water versus wastewater utility expenditures by private, municipal, provincial, territorial and federal sources. Economic information should be included in the overall approach to one-window reporting under the Strategy.

Implementation

1. Implementation of these recommendations should include:
   a. Initial Characterization and an environmental risk assessment will be completed for high risk facilities first, with all remaining facilities to follow.
   b. Identify the municipal-financial capacity: the capacity of a municipality to address the problems, if any).
   c. Jurisdiction implementation plan based on a and b.
   d. Formation of a national municipal wastewater effluent management committee to provide guidance on the various elements of the Strategy during its implementation, to coordinate future work, to review the Strategy, to report on progress in implementing the Strategy and to manage emerging wastewater issues.

Appendix A National Ranking for Capital Funding Priorities for Wastewater Systems Template

Municipality	Population	Level of Treatment	*Value*	Receiving Environment		*Value*	Overall Value*	*Estimated Cost of Upgrading - per facility ($,000)*	*Number of Similar Facilities*	Total Estimated Cost ($,000)
				Proximity to higher risk uses	*Receiving Watercourse Concern*					Includes biosolids
		Preliminary Treatment Primary Treatment Secondary Treatment Sewage Lagoons			Proportion of flow and location of discharge					

This preliminary ranking was used to estimate the required capital funding flow over the implementation period of the Strategy: 1-5 years, 6-10 years, 11-20 years and 21-30 years. Each jurisdiction filled in the template for those facilities which would require upgrading as a result of the Strategy or for those municipalities which would require a wastewater facility as a result of the Strategy. A value, based on current information, was estimated for all categories above for each facility and a total identified. Priority to rank capital projects was based on the following values:

- High Priority – those facilities with an overall value greater than 25.
- Medium Priority – those facilities with an overall value between 11 and 24.
- Low Priority – those facilities with an overall value 10 and less.

Overview

The purpose of this template, that can be applied to all Canadian wastewater facilities, is to develop a national level preliminary ranking of need, based on the level of treatment and the receiving environment. The template is developed in response to the proposed National Performance Standards for 25mg/L five-day carbonaceous biochemical oxygen demand ($CBOD_5$) and total suspended solids (TSS) of 25mg/L, and 0.02 mg/L for total residual chlorine (TRC). Other discharge options, such as the 50 - 50mg/L $CBOD_5$ and TSS, are not being considered in this ranking method.

The template does not address risk from acute toxicity due to ammonia and the related need for upgrades to nitrification, as the strategy does not mandate action to eliminate acute toxicity at the end of pipe associated with ammonia. Nor does the template address risk associated with other harmful pollutants, as these are site specific contaminants whose occurrence cannot be assessed in all systems at this time, and which in any case are largely managed through source control activities (e.g. sewer use controls) rather than infrastructure upgrades.

The various levels of treatment are assigned a value or range of values based on the potential for that system to meet discharge standards. The poorest performance is achieved through preliminary treatment therefore it is assigned the highest number of 30. Primary treatment is that much more efficient that it is assigned a range of values from 24 to 27 depending on how well the system is operating. Secondary treatment produces considerably better results than primary, so it is assigned the weighting of 9 to 15 depending on the system operation. Tertiary treatment is assigned a 0 weighting as this level of treatment

is expected to meet the performance standards. The definitions of the various treatment levels, as well as the definitions applied to the risk to downstream users and watercourse sensitivity, are provided below.

Level of Treatment

The level of treatment will be assigned a value. Higher values will be assigned to treatment processes that are less effective in protecting the receiving watercourse. For example, a system that only provides primary treatment will receive a higher value than a system that provides secondary treatment. Values were determined in a manner that would create a distinct separation between the levels of protection provided to the receiving water course. Providing a range of values allows for consideration for a system's level of sophistication and its ability to reduce the impact of discharges to the receiving watercourse. More sophisticated systems would be assigned a lower score because of the extra level of protection afforded to the receiving watercourse.

Preliminary Treatment: Preliminary treatment involves screening, shredding or grinding for the purpose of removing coarse solids such as sticks, rags and other debris from the incoming wastewater. The purpose of preliminary treatment is to protect downstream treatment components such as pumps and reduce maintenance or operational problems. Preliminary treatment is a common first step to all wastewater facilities. These systems will not consistently meet the proposed National Performance Standards for $CBOD_5$ and TSS referred to above.

Primary Treatment: Primary treatment follows preliminary treatment and involves the use of primary devices that allow flows to be reduced and for solids to settle due to gravity. Commonly, sedimentation tanks that detain flows for 2 to 6 hours to allow settleable solids to settle and be drawn off for separate solids treatment. Typical BOD5 and TSS removal rates in primary treatment are 30% and 60%, respectively. On stand alone primary treatment, primary effluents can be treated with chemical disinfection prior to release. Primary treatment can also be enhanced using chemicals in which inorganic or organic flocculants are introduced into the wastewater to help improve the effluent quality over primary treatment alone. These systems will not consistently meet the proposed National Performance Standards for $CBOD_5$ and TSS referred to above.

Secondary Treatment: Secondary treatment follows primary treatment and is specifically designed for the removal of biodegradable organic matter (in solution or suspension) and the removal of suspended solids. Secondary treatment can include nutrient removal. Compliance standards are commonly set at 25 mg/L to allow for operational variations. The physical, chemical and biological processes in the process design may also fortuitously (not by design) remove other trace contaminants at unpredictable levels. The activated sludge treatment process is the most widely used form of secondary treatment in Canada and the world due to its versatility and relatively low cost. Properly designed and operated, these systems should consistently meet the proposed National Performance Standards for $CBOD_5$ and TSS referred to above.

Sewage lagoons: Sewage lagoons are a type of secondary treatment and one of the more common biological treatment processes used in Canada principally due to low cost and simplicity of operation. Effluent quality from lagoon systems varies depending on the type, size and configuration of the treatment cells (i.e. anaerobic cells, facultative cells and storage cells) and operational mode (i.e., seasonal or continuous discharge mode). A lagoon system with several months of storage capacity, such as systems with once a year discharge, can consistently produce very good effluent quality if the biological activity is not hindered. Recognizing that effluent quality varies with the size, type, configuration and retention time, a range of effluent quality can be achieved for $CBOD_5$ of 5 to 25 mg/L and for TSS of 10 to 30 mg/L. Compliance standards are commonly set higher to allow for operational variability.

While some lagoons consistently produce effluent with $CBOD_5$/TSS levels under 25 mg/l, not all lagoons across Canada are able to consistently meet the proposed limits (Comment: Unless one of the strategy's

proposed exceptions to the 25/25 limits for small and very small systems is adopted - this remains as an outstanding decision for the DC to make). This may be especially true for continuously discharging lagoons that would have to meet 25/25 based on a quarterly or monthly average of regular test results. Continuous or intermittent discharge lagoons not capable of consistently meeting a 25/25 limit would need upgrading consisting of a post-lagoon treatment step prior to discharge to remove excess $CBOD_5$ and TSS (e.g. roughing filters).

Tertiary Treatment: The additional treatment needed to remove suspended, colloidal, and dissolved constituents remaining after conventional secondary treatment. In Canada this term can refer to physical processes that further remove suspended solids, such as sand filtration. Tertiary treatment may include biological processes for removal of nutrients. Typical tertiary effluent $CBOD_5$ and TSS values are 5 and 5 mg/L, which meet the proposed National Performance Standards of 25mg/L for BOTH $CBOD_5$ and TSS.

Receiving Environment

This parameter considers the combination of the proximity of the outfall to higher risk uses, and the sensitivity of the receiving watercourse or waterbody. In terms of the location of the wastewater discharge to that of other activities in the watercourse, a higher rating would be assigned to a higher risk scenario where the discharge is just upstream from potential direct human contact, or a drinking water treatment plant or fishery. An example of a moderate risk is where a wastewater discharge is near a recreational use like canoeing, fishing or wading (no direct human contact or general aquatic consideration). A low risk would be an instance where there is little or no activity downstream where wastewater discharge would have an adverse affect on downstream users. Receiving watercourse concern considers the ability of that watercourse to assimilate the discharge from the wastewater treatment system. This is not a quantitative measure but is rather a subjective evaluation of impact of the discharge on the receiving watercourse.

Proximity to Higher Risk Uses:

Low Risk: Discharge located at such a distance whereby it is unlikely to have any impact on a highly sensitive downstream use (e.g. drinking water intake, aquaculture) at any time of the year.
No highly sensitive uses downstream.

Medium Risk: Discharge located at a distance where there is potential impact on a highly sensitive downstream use for at least part of the year. Discharge located in close enough proximity to a less sensitive uses (e.g. beach) where it is likely to have an impact for at least part of the year.

High Risk: Discharge located in close enough proximity to a highly sensitive use whereby it is likely to have an impact for at least part of the year.

Receiving Environment Sensitivity:

Low Risk: Discharge to rivers/streams where the discharge flow represents a minor proportion of the overall stream flow (at baseflow conditions) downstream of the discharge point. Discharge to off-shore areas of lakes or marine waters where presence of currents and/or distance of discharge from shore provides significant dispersion and dilution of effluent and a buffer for shallow aquatic environments.

Medium Risk: Discharge to rivers/streams where the discharge flow represents a moderate proportion of the overall stream flow (at baseflow conditions) downstream of the discharge point. Discharge to near-shore area of a lake or marine waters where there are significant currents present to promote dispersion and dilution of effluent. Discharge to off-shore area of a lake or marine waters where distance provides a buffer for shallow aquatic environments.

High Risk: Discharge to rivers/streams where the discharge flow represents a significant proportion of the overall stream flow (at baseflow conditions) downstream of the discharge point. Discharge to a lake at a near-shore location with no significant currents able to disperse and dilute effluent.

Receiving Environment Values

The values applied to the receiving environment category are dependent on the combination of the high, medium and low factors assigned to the receiving environment components of proximity to high risk users and watercourse sensitivity. The values are assigned as follows:

Proximity to higher risk uses	Watercourse Sensitivity	Value
High	High	10
High	Medium	8
High	Low	6
Medium	High	6
Medium	Medium	5
Medium	Low	3
Low	High	5
Low	Medium	2
Low	Low	1

Appendix B Funding Mechanisms for Municipal Wastewater Infrastructure Projects in Canada

FUNDING MECHANISM	GENERAL INFORMATION	SUSTAINABLE OR ONE TIME?	REPAYMENT REQUIRED? Y/N Why?	EXAMPLE OF LOCATION WHERE USED
ALTERNATIVE				
Sponsorships	Private contributor or group provides significant donations or strategic funding arrangements to a municipality in exchange for some form of public recognition through advertising, signage, or other. Not a very common form of funding.	One Time.	No repayment required, although the contributor must be acknowledged.	This type of funding has been used in Okotoks, Alberta in the development of open spaces and recreational areas, but does not seem to be very prevalent among Canadian municipalities. Winnipeg is pursuing corporate sponsorships for municipal parks to help cover O&M costs.
Innovative Transportation Revenues and Incentives	Generally involves an agreement in which a portion of provincial or federal fuel or gas taxes collected at gas pumps is redistributed to municipalities towards funding the construction or O&M associated with road infrastructure or other infrastructure projects. Other examples include road tolls, advertising fees along major routes or bus shelters and local road improvement with community funding partnerships. Refer also to "Special Levies" Funding Mechanism below. May be some difficulties in determining how to allocate funds to the municipalities. Those with smaller populations may not receive adequate funds for large projects. Municipalities may also have to follow terms and conditions set by provincial or federal levels of government, which could limit their control on how the funds are used.	Generally sustainable as long as the source of revenue or the incentive is maintained.	No.	Through the New Deal for Cities and Communities the federal government will flow the gas tax funds through the provinces and territories, which will in turn be allocated according to the municipalities as per federal-provincial and federal-territorial bilateral agreements. The funds will be directed towards projects involving public transit, water and wastewater management, solid waste and community energy systems. Calgary, Edmonton and Grande Prairie in Alberta also have a similar program that redistributes provincial fuel taxes.
Government Service Partnerships	Alternative form of service delivery which can take place in the form of inter-municipal, provincial-municipal, or federal-municipal partnerships. Also referred to as "regionalization" of services. Can be ideal for	Sustainable given that the partnership for the delivery of these services is ongoing.	N/A	Regionalized services have been used in Canada, including Annapolis County in Nova Scotia where a regionalized service agreement with other towns is used to manage solid waste

FUNDING MECHANISM	GENERAL INFORMATION	SUSTAINABLE OR ONE TIME?	REPAYMENT REQUIRED? Y/N Why?	EXAMPLE OF LOCATION WHERE USED
	small, rural, neighboring communities. Advantage may include a savings in administrative costs and a higher level of service. May be some substantial start-up costs.			and transit.
Strategic Budget Allocations (Funds)	This method involves strategically setting aside certain monies collected from a portion of a tax bill or a portion of a rate bill into a special fund. The fund is then invested, and interest earned is re-invested, with the goal of having a special fund for certain types of capital for future needs. Can be applied to a diverse range of services, and can be appropriate for all sizes of communities. May encounter some skepticism from the public regarding the need for such allocations.	Sustainable.	No.	Reserve funds have been used in Surrey, BC., and Yellowknife, NWT. In Surrey a number of reserve funds have been used. In Yellowknife stabilization funds are used to maintain an adequate level of financial resources for infrastructure and to protect against reduced service levels or higher taxes.
Utility Models	Utility models are also known as "full-cost recovery models" and involve a charge and direct billing for system use and services. Typically, utility charges are charged for potable water, however since wastewater is a by-product of the use of water, the charge for wastewater can typically be collected with the water bill. This type of financing provides for full-cost recovery. This type of charge is normally dependent upon the amount of water used, and it should be considered that the amount of wastewater discharged to the system may not be equal to the amount of water used.	Sustainable.	N/A	In Kelowna, BC, the sewer utility charge for residential customers is made up of a monthly flat user rate and a parcel tax. Similar types of utility charges also exist in Saskatoon, and Edmonton.
BANK				
Bonds	In Canada, bonds can be sold for infrastructure at all three levels of government, although municipal bonds are less common. The borrower promises to repay the capital	One-Time financing.	Yes.	Bonds are commonly issued in both Canada and the United States. In the United States, bonds are more attractive as interest income is exempt from federal and/or state tax.

FUNDING MECHANISM	GENERAL INFORMATION	SUSTAINABLE OR ONE TIME?	REPAYMENT REQUIRED? Y/N Why?	EXAMPLE OF LOCATION WHERE USED
	value of the bond along with interest at a specified date. With tax-exempt bonds, the borrower can borrow funds at lower interest rates than regular rates. Since bonds can be immediate, the up-front financial burden on the public is reduced. Some drawbacks are that bonds can create high long-term costs for the public. Not good for communities that are not rated or do not have a good bond rating.			
Loans	Loans include loan agreements, loan guarantees and capital access programs (CAPS). The lender is a private sector company and the borrower is a province or municipality. For CAPS, the borrower and the lender make a payment into a loss reserve fund, and the payment is matched by the federal government, thereby reducing the lender's risk. Loans can be immediate and the up-front cost to the public will be reduced. May not be applicable to small, rural communities. Can pose a significant financial burden, and may be unstable as political and fiscal demands change.	One-Time financing.	The borrower pays back the loan with interest over time to the lender. A federal or provincial government may offer a loan with no interest.	Very common in Canada and the United States.
Revolving Loan Funds/State Infrastructure Banks	A revolving loan fund is set up when a higher level, or central level government provides an initial grant, and lower jurisdictions provide a percent match and oversee the administration of the fund. The lower jurisdiction can then lend and re-lend funds. The central government provides a yearly grant that declines over time. The administration of the fund is paid using interest income. Small communities may have some difficulties with repaying due to limited financial,	This is a sustainable financing mechanism, that provides for one time-funding of infrastructure projects	Yes. As recipients pay back the loans to the revolving funds, the central level government can make new loans to other recipients.	In the United States these are referred to as "State Infrastructure Banks", and are a popular way to finance water infrastructure, including the "Drinking Water State Revolving Fund" and the "Clean Water Revolving Fund". May have potential for wider application in Canada than in the US.

FUNDING MECHANISM	GENERAL INFORMATION	SUSTAINABLE OR ONE TIME?	REPAYMENT REQUIRED? Y/N Why?	EXAMPLE OF LOCATION WHERE USED
	technical, administrative and legal resources.			
Trust Funds	A percentage of tax revenues is dedicated to a specific investment area, thereby providing revenues for trust funds. Equitable if the source of revenue draws from users of the type of infrastructure that they support. (e.g. gas tax used to fund a highway infrastructure project.). Do not impose long-term costs on the public.	Sustainable.	No.	In the United States Trust Funds are useful for federal funding of highways and transit projects. In Canada, an example of a Trust Fund is the New Brunswick Environmental Trust Fund that supports projects in environmental conservation projects in New Brunswick.
Securitization Funds	Securitization is the process of repackaging loans and selling certificates, or securities, which entitle the owner to some or all of the repayment on the loans. The loans are pooled and the cash flows from the loans in the pool pay off the interest and principal on the securities. Allows municipalities to borrow together as a group and to guarantee each other's debts. May be beyond the capabilities of the poorest communities. Investors may want to diversify their portfolio and not provide loans for only one type of project.	One Time.	Yes.	Securitization loans have been used in the United States and Canada. For example the Toronto Atmospheric Fund to finance local initiatives related to global warming and to improve air quality in Toronto.
P3				
Public-Private Partnerships (P3s)	This financing arrangement increases the involvement of the private sector in public service delivery, and can range from minimal private-sector involvement to more comprehensive involvement. Can lower government costs. Private sector may be able to take on more debt. However, competitiveness of private companies may mean it is difficult to generate profit.	One-Time financing.	No repayment required, however, in return, the private partner receives payment according to certain standards of service as specified in the contract (i.e. fee, tariff or user charge).	Used in the United States, and becoming more common place in Canada and the world. Some examples of P3s used in Canada include: 1. The Town of Goderich, Ontario initiated a P3 for water and wastewater facilities, water distribution system and sewage collection system. 2. Construction of the Confederation Bridge in PEI 3. Ontario's 407 ETR toll highway
BOO (Build-	A type of P3 used in both	Refer to P3s	Refer to P3s	BOO mechanisms have been

FUNDING MECHANISM	GENERAL INFORMATION	SUSTAINABLE OR ONE TIME?	REPAYMENT REQUIRED? Y/N Why?	EXAMPLE OF LOCATION WHERE USED
Operate and Own)	developed and developing nations. With this type of mechanism, a private company or consortium of companies receives a concession to finance, build and operate a facility for a fixed period of time, after which ownership reverts back to the public sector.	above.	above.	used to build wastewater facilities in Canada and the United States. The City of Moncton used a BOO to build a drinking water treatment facility for the Greater Moncton Area. A provate company designed, built and operates and maintains the facility, while it is owned by the City of Moncton.
BOT (Build-Operate and Transfer)	A type of P3 used in both developed and developing nations. The private sector designs, finances, constructs, and operates the revenue-producing public projects, and, at the end of the pay-back period, turns the project back over to the community.	Refer to P3s above.	Refer to P3s above.	The Ambassador Bridge connecting Detroit, Michigan and Windsor, Ontario was built and is owned by a private consortium, which accepts all the risks associated with the construction, ownership and operation of the bridge.
Private Finance Initiative (PFI)	United Kingdom funding mechanism. Refer to P3s above.	Refer to P3s above.	Refer to P3s above.	Used in Britain, called PFIs but can also be referred to as PPPs. Since January 2003 the London Underground has been operated as a Public-Private Partnership (PPP), where all the infrastructure is maintained by private companies although the Underground (the London subway) is still owned and operated by Transport for London.
PUBLIC				
Transfer Payments	In Canada, transfer payments are made from the federal or provincial government levels to the provincial and municipal government levels. Transfers may be non-specific and unconditional or specific and conditional. Provide equality between regions of Canada. However, those paying for the infrastructure are not necessarily the ones using it.	One-time or multi-year financing. Not considered self-sustainable.	Repayment is not expected in Canada.	Very common in Canada. The federal government commonly issues transfer equalization payments between the provinces and territories in Canada.
Grants	Unconditional transfer of funds from the federal or provincial	One Time.	No	Grants have been used in Canada and the United States

FUNDING MECHANISM	GENERAL INFORMATION	SUSTAINABLE OR ONE TIME?	REPAYMENT REQUIRED? Y/N Why?	EXAMPLE OF LOCATION WHERE USED
	government levels to the provincial and municipal government levels, an individual or an organization which is not subject to being accounted for or audited but for which eligibility and entitlement may be verified or for which the recipient may need to meet pre-conditions. Can use grant funds to leverage additional funding. Grants limit the number of projects that can be supported.			
Contributions	Transfer of funds with conditions from the federal government to provincial and municipal governments, an individual or an organization. A contribution is a payment to an organization for specific purposes and costs meeting certain eligibility requirements and the terms of a Contribution Agreement. Contributions limit the number of projects that can be supported.	One Time.	No	At Infrastructure Canada, there are 4 funding programs: CSIF, ICP, MRIF and BIF.
Taxation	Taxes are used at all levels of governments to generate revenues. May not be sufficient and are not uniformly applied across all provinces. May be difficult to develop and set the appropriate rate.	Sustainable	No.	Very common in Canada and the United States.
USER BASED				
Special District Financing	Often used in combination with development charges to finance new infrastructure projects that will benefit directly those living in the area serviced by the new infrastructure. Primarily intended for financing of current operations and life-cycle renewal costs rather than for funding construction projects.	May be sustainable or one-time.	No.	Common in the United States.
Development Charges and Fees	In order to fund new infrastructure, municipalities will use a Development Charge instead of a property tax	May be sustainable or one-time.	No.	Canada has been using this financing mechanism for over 20 years. There are many examples included in the

FUNDING MECHANISM	GENERAL INFORMATION	SUSTAINABLE OR ONE TIME?	REPAYMENT REQUIRED? Y/N Why?	EXAMPLE OF LOCATION WHERE USED
	increase. May be difficult to develop and set the appropriate rate.			Alternative Funding Mechanisms document as part of the Best Practice by the National Guide to Sustainable Municipal Infrastructure.
Special Levies	Economic Instruments that ensure a funding source exists to cover needs that are difficult to fund through user pay, and for which there is a benefit in explicitly identifying them separately from the general tax levy. Typically, this method is accompanied by a special fund established by the municipality to manage the special levy revenue. Costs for establishing the level may be considerable, and may be inappropriate for smaller communities.	May be sustainable or one-time depending on if the special Levy is set up for a specific time period or is set indefinitely.	N/A	Has been used in the United States (Portland transit system), Australia (watershed protection), and Alberta (infrastructure replacement), Winnipeg (sewer and water), etc.

Appendix C Affordability Model

The Affordability Model will be available for use by federal, provincial, territorial and municipal governments. The model will be made available for download from the CCME website in both French and English.

CCME

Canadian Council of Ministers of the Environment | Le Conseil canadien des ministres de l'environnement

Technical Supplement 2

Canada-wide Strategy for Managing Municipal Wastewater Effluent

Environmental Risk Management: Framework and Guidance

September 2007

Table of Contents

Boxes

List of Figures

List of Tables

List of Acronyms

BOD_5	Biochemical Oxygen Demand
CAEAL	Canadian Association of Environmental Analytical Laboratories
$CBOD_5$	Five day Carbonaceous Biochemical Oxygen Demand
CCME	Canadian Council of Ministers of the Environment
CEAEQ	Centre d'Expertise en Analyse Environnementale du Québec
CEQG	Canadian Environmental Quality Guidelines
CSO	Combined Sewer Overflow
CWA	Clean Water Act (United States)
DO	Dissolved Oxygen
EDO	Effluent Discharge Objective
EQO	Environmental Quality Objective
I/I	Inflow and infiltration
LC50	Lethal Concentration for 50% mortality
MWWE	Municipal Wastewater Effluent
N	Nitrogen
NDEP	Nevada Division of Environmental Protection
NPDES	National Pollutant Discharge Elimination System
P	Phosphorus
POTW	Publicly Owned Treatment Works
SSO	Sanitary Sewer Overflow
TIE	Toxicity Identification Evaluation
TKN	Ammonia + organic nitrogen
TMDL	Total Maximum Daily Load
TRC	Total Residual Chlorine
TRE	Toxicity Reduction Evaluation
TSS	Total Suspended Solids
TU	Toxic Unit
US EPA	United States Environmental Protection Agency
WET	Whole Effluent Toxicity
WQG	Water Quality Guidelines
WQS	Water Quality Standards (United States)

1. Environmental Risk Management Model

Environmental risk management is a key element of the Canada-wide strategy for the management of municipal wastewater effluent (MWWE) (hereafter 'Strategy'). This document is a technical supplement to the Strategy, explaining its requirements in further detail. Where discrepancies appear between the Strategy and this technical supplement, the Strategy prevails.

1.1 Environmental Risk Management Framework

The environmental risk management framework set out in this document (see Figure 1) is a decision-making process that will help manage municipal wastewater effluent will help protect the environment and human health, while taking into account site-specific factors. The framework

- Identifies a list of substances of national concern and develops achievable and desirable performance standards for them.
- Integrates the characteristics of the site specific receiving environment into the development of these standards.
- Includes a risk-based decision-making process where performance standards can be adjusted depending on risk. The onus is on the discharger to demonstrate the absence of adverse effects.

The environmental risk management framework includes National Performance Standards (i.e., minimum discharge limits) for common substances. These Standards are applicable to all MWWE discharges in Canada and are achievable by commonly available technology. They are equivalent to what can be achieved with a minimum of conventional secondary treatment for five day carbonaceous biochemical oxygen demand ($CBOD_5$), total suspended solids (TSS) and total residual chlorine (TRC).

In some instances, the National Performance Standards may not achieve the effluent quality needed to avoid unacceptable risks to human and ecosystem health or to fishery resources. Thus, the framework includes an environmental risk-based approach that enables more stringent requirements than the National Performance Standards to be established, where needed, as well as discharge requirements for substances not covered by the National Performance Standards. The approach considers the characteristics and uses of the site-specific receiving environment.

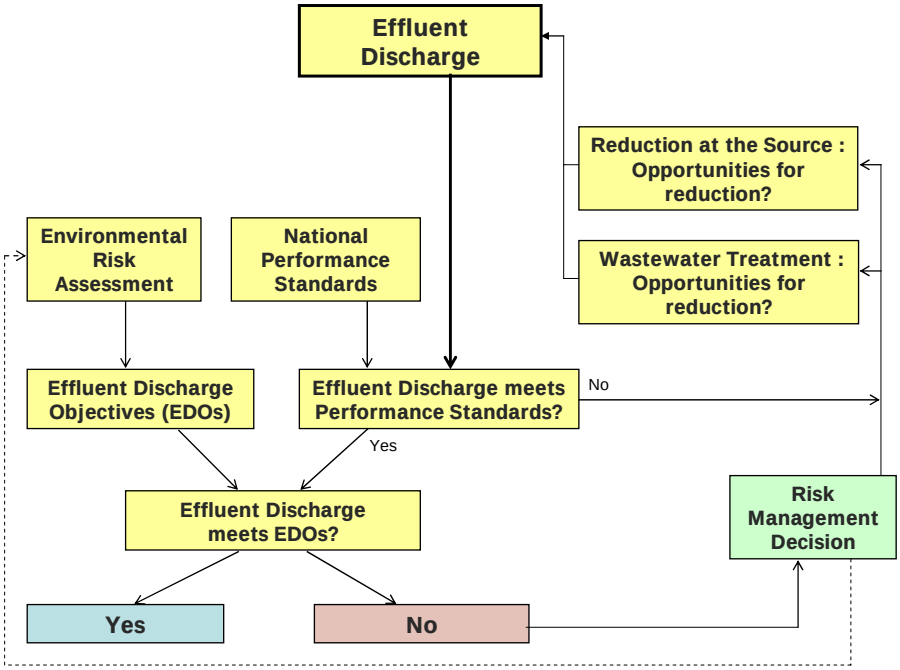

Figure 1. Environmental Risk Management Framework

The environmental risk management framework starts with the quality of the effluent discharge. The characteristics of the effluent are compared with the National Performance Standards. The quality of the effluent must meet the National Performance Standards. If it does not, the wastewater facility must look for opportunities to reduce the discharge of substances at the source and/or look for opportunities to improve the wastewater facility or its operation so the National Performance Standards can be achieved.

The effluent discharge is then compared with the effluent discharge objectives (EDOs) determined through the environmental risk assessment. If the effluent discharge meets all of its EDOs, no other actions are required as the environment is considered protected. If EDOs are not achieved, actions need to be taken and a risk management decision must be made to improve the quality of the effluent discharge. Again, the first actions are to look for opportunities to reduce the discharge of substances at the source and/or look for opportunities to improve the wastewater facility or its operation.

Once a facility has examined different opportunities to reduce the discharge of substances of concern in the effluent and has implemented improvements, the new effluent discharge is again compared with the EDOs. If the EDOs still have not been achieved, further improvements should be made. When the wastewater facility cannot improve its system for technical, financial, societal or other reasons, then a risk management decision may indicate nothing further can be done at the time. In such cases, EDOs become long-term goals that the wastewater facility must continue to strive to attain. EDOs will be reviewed when new information becomes available or when deemed necessary.

1.2 Using This Document

This document presents the general concepts of the environmental risk management framework. It is intended to provide information and guidance on the requirements identified in the Strategy and the implementation of the environmental risk management framework. It provides guidance on the environmental risk assessment process for single discharges in section 3 and at a watershed level in section 4. Guidance on effluent monitoring is provided in section 5, including the initial characterization

of effluent needed to determine which substances in the discharge are of concern. When substances of concern are not achieving EDOs, a risk management decision is needed. Guidance on risk management decisions is provided in section 6. Section 7 examines environmental monitoring. Combined and sanitary sewer overflow requirements and collection system information are found in section 8. Implementation timelines can be found in section 9.

Figures 2 and 3 identify where pertinent information about the different parts of the environmental risk management framework can be found within the Technical Supplement. Figure 2 describes the process to complete the environmental risk assessment and establish EDOs. Figure 3 describes effluent monitoring and what to do when the effluent discharge is not achieving the National Performance Standards or EDOs. The boxes on the left describe the process and the boxes on the right reference the relevant sections of the document where detailed information can be found.

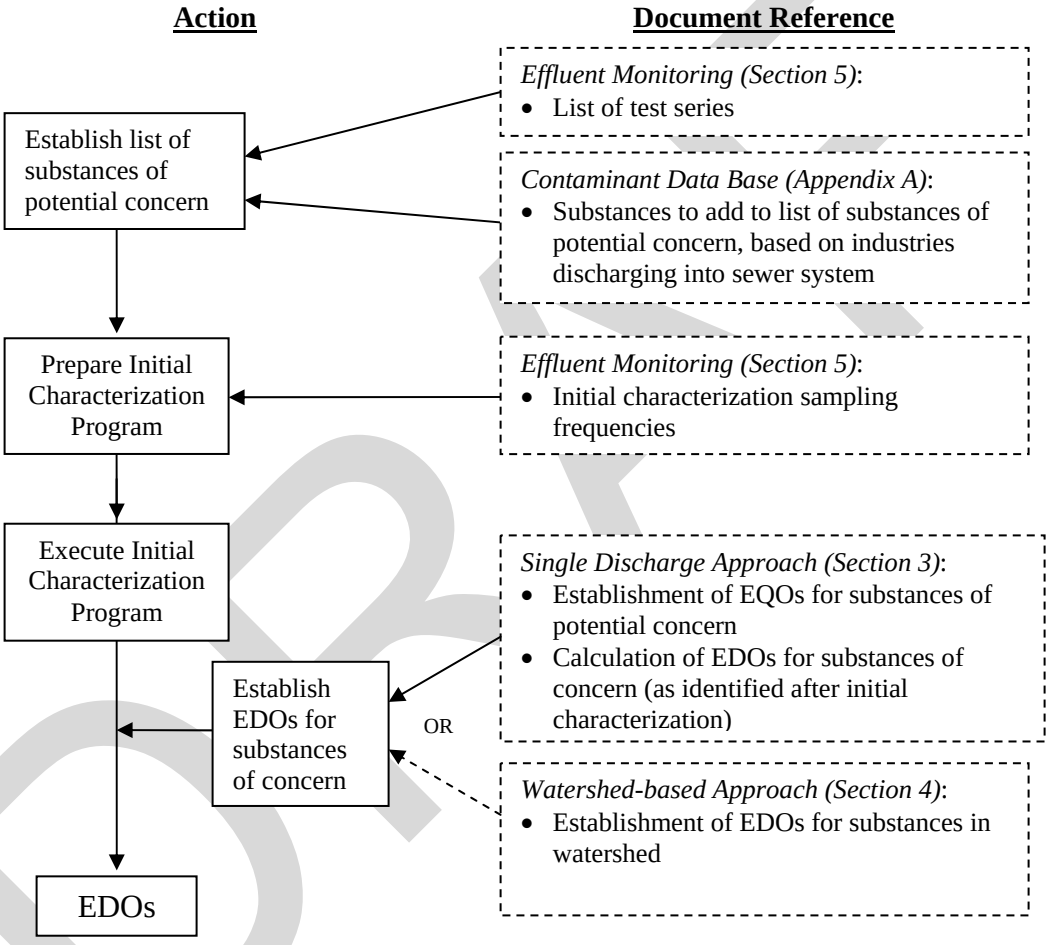

Figure 2. Environmental Risk Assessment

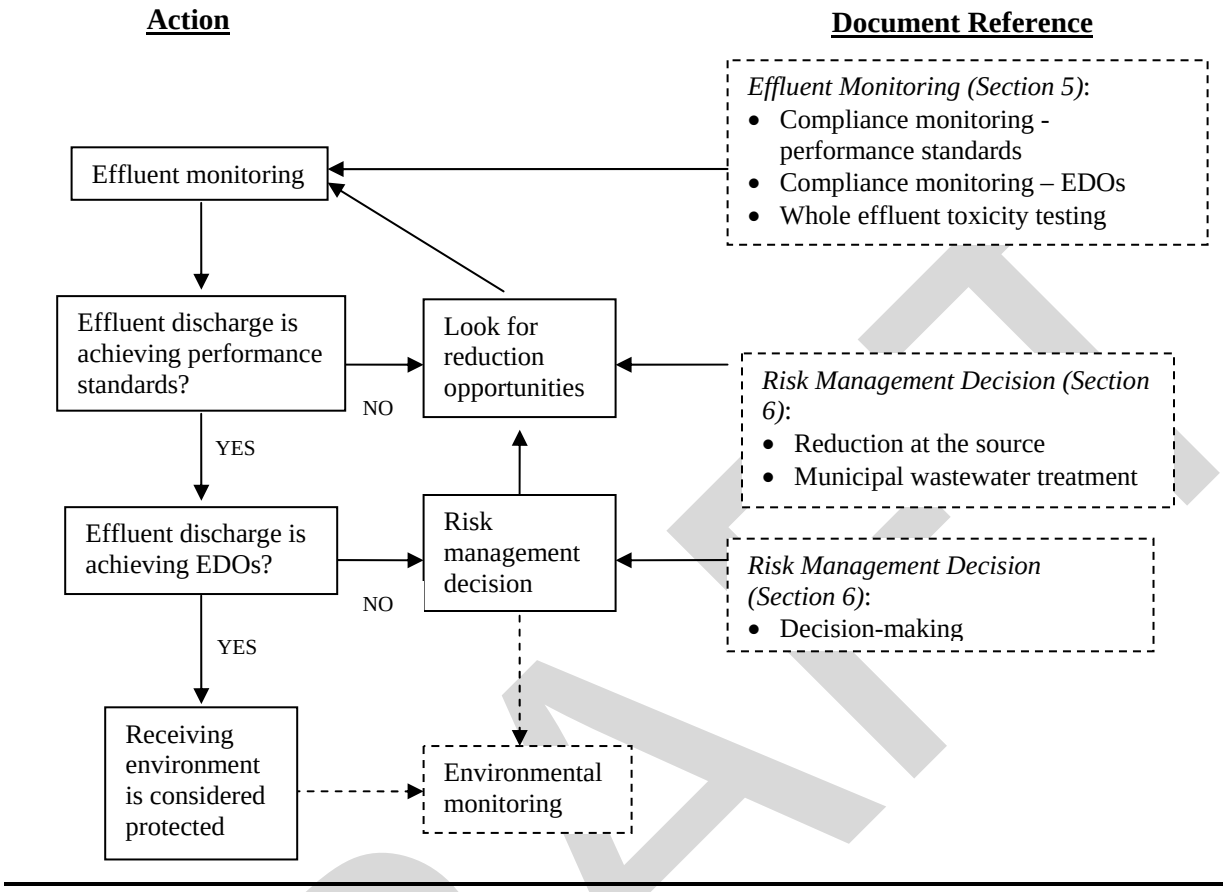

Figure 3. Effluent Monitoring and Risk Management Decision-Making

2. National Performance Standards

Two approaches can be used to develop discharge requirements or standards for MWWE: a technology-based approach and an environmental risk-based approach. The technology-based approach establishes performance standards based on technology selection and/or currently best available technology. The environmental risk-based approach establishes EDOs based on the level of protection for the receiving environment. Regulators have used both approaches or a combination of approaches to establish discharge requirements for MWWE.

Traditionally, performance standards have been set for biochemical oxygen demand (BOD_5) and TSS. The intent of a technology-based approach is to require a minimum level of treatment for MWWE based on available and proven treatment technologies. Technology-based approaches have been used to establish minimum acceptable standards for the reduction of other substances in MWWE. The physical and chemical strengths and limitations of a selected treatment technology could lead to discharges that do not meet or exceed EDOs derived by assessing acceptable risk to the environment.

Existing discharge requirements in each jurisdiction in Canada have been analyzed as a starting point for assessing achievable technology-based performance standards. A number of jurisdictions use secondary treatment, or produce an effluent quality equivalent to that achieved by secondary treatment, as part of

their regulatory requirements. Actual implementation, however, is sometimes done on a case-by-case basis.

For the Strategy, secondary treatment has been selected as the minimum level of treatment that all wastewater facilities should eventually achieve. This level of treatment is normally prescribed in permits, regulations, codes of practice and other authorizations, covering BOD_5 and TSS through effluent quality or discharge limits. TRC has also been selected for a National Performance Standard because of its toxicity to aquatic organisms and, more specifically, because it is added to the wastewater at the wastewater facility, making it easy to control or remove.

The National Performance Standards under the Strategy are:

- **25 mg/L** for **five day carbonaceous biochemical oxygen demand ($CBOD_5$);**
- **25 mg/L** for **total suspended solids (TSS);** and
- **0.02 mg/L** for **total residual chlorine (TRC).**

National Performance Standards must be met at the end-of-pipe as periodic averages (averages of at least four samples). TSS may exceed the National Performance Standard if exceedances are caused by algae. It should be noted that $CBOD_5$ is used instead of traditional total BOD_5 because of concerns about the effect of nitrogenous oxygen demand.

All new and upgraded wastewater facilities are required to meet the National Performance Standards immediately. Existing facilities will be required to meet the standards within a number of years, depending on the level of risk. Implementation of the National Performance Standards will be based on risk, available funding and financial sustainability. Additionally, jurisdictions may establish more stringent limits than the National Performance Standards.

Nutrients, pathogens and other substances will be addressed through environmental risk assessments (see sections 3 and 4).

2.1 Considerations for Canada's Arctic

The Strategy recognizes that Canada's arctic faces unique concerns due to its extreme climatic conditions and remoteness. Alternative National Performance Standards for arctic facilities will be proposed within five years. This extra time will allow further investigation of the constraints associated with meeting the National Performance Standards. A number of factors, such as ice-free-days, are being explored to determine which ones may affect the achievement of any proposed National Performance Standards. Data availability is a limiting factor.

The following interim measures will apply to Canada's arctic:

- A risk-based approach will continue to be used to manage municipal wastewater effluent. The standards in use in current permits in the arctic will be retained.
- Further research will be conducted within the next five years to identify the factors that affect performance of lagoons and wetlands in arctic conditions and how lagoons and wetlands can be improved.
- Once adequate information is available within the five year period, National Performance Standards for arctic conditions will be developed.

3. Environmental Risk Assessment – Single Discharge Approach

Establishing EDOs through environmental risk assessments (ERAs) is a key element of the framework, especially since National Performance Standards may not always sufficiently protect the environment. This section describes the framework proposed for developing MWWE discharge objectives using the environmental risk-based approach.

The requirements for completing an ERA are described in sections 3 and 4 below. In addition, a standard method (see technical supplement 3) has been developed to assist owners in completing an ERA. Some owners may have previously completed a site-specific assessment equivalent to the ERA required under the Strategy and should contact their jurisdiction to determine equivalency of process.

EDOs are expressed as concentrations and/or loads of substances in MWWE discharges that will ensure that environmental quality objectives (EQOs) are achieved in receiving waters outside of specified mixing zones. EQOs are concentrations of substances that are considered safe for aquatic life and for human uses that exist or should exist outside of mixing zones. An environmental risk assessment is done to establish EDOs, taking into account the characteristics of the site-specific receiving environment.

An ERA can be performed for a single discharge to establish its EDOs, or can be conducted at a watershed level (see section 4), or part thereof, to allocate loads for all discharges of the same substance through a watershed management plan. In both cases, the process starts with *Canadian Environmental Quality Guidelines* (CEQGs) or their provincial equivalent. Site-specific EQOs for the receiving environment are established first, with EDOs for the discharge(s) established second. Although a watershed-based approach is recommended, especially for nutrients, establishing EDOs for single discharges is still acceptable.

Box1. Canadian Environmental Quality Guidelines

CCME has established generic water quality guidelines in the *Canadian Environmental Quality Guidelines* (CEQGs). CEQGs,

…are nationally endorsed, science-based goals for the quality of atmospheric, aquatic, and terrestrial ecosystems. Environmental quality guidelines are defined as numerical concentrations or narrative statements that are recommended as levels that should result in negligible risk to biota, their functions, or any interactions that are integral to sustaining the health of ecosystems and the designated resource uses they support.

These generic guidelines are recommended for substances of national concern that are found in the ambient environment. As national benchmarks or indicators of environmental quality, they are intended to protect, sustain and enhance the quality of the Canadian environment and its many beneficial uses. In Canada, CEQGs provide a consistent basis for assessing water quality conditions and, consequently, the health of water resources. Guidelines developed by CCME have been adopted/adapted by provincial and territorial jurisdictions to serve as a cornerstone for water resources management and environmental protection.

Although CEQGs are broadly used within Canada and elsewhere to assess and manage water quality conditions, they should not be regarded as blanket values for national environmental quality. Variations in environmental conditions across the country have the potential to influence the applicability of these generic guidelines. Some jurisdictions have opted to develop guidelines outside the scope of the CCME mandate for particular substances of concern (e.g., BOD_5, certain pesticides) or for other specific uses in

their jurisdictions (e.g., fish consumption or shellfish harvesting). Guidelines developed by other jurisdictions, such as the United States Environmental Protection Agency (US EPA), may also be applied by provincial or territorial governments, if scientifically based (see section 3.2.2).

3.1 Completing an Environmental Risk Assessment

The goals of completing an ERA for a single discharge are two-fold:
(a) To determine the potential impact of MWWE in the receiving water; and
(b) To help limit substance concentrations and loads at the end of the discharge pipe in order to protect all uses of the receiving water.

EDOs are determined from:

- The characteristics of the receiving environment;
- Water quality guidelines for a specific substance or for whole effluent toxicity, or site-specific water quality objectives for the receiving water;
- The current, potential or designated uses of the water resource; and
- Other sources of substances in the watershed.

The characteristics of the receiving water body are defined by its intrinsic conditions (i.e., water quality and quantity)—independent of human-caused (anthropogenic) inputs—as well as by its vulnerability and assimilative capacity. For example, a small water body cannot assimilate a discharge or load similar to that of a large water body without having its water quality degraded, nor can a lake with a slow flushing rate assimilate a load comparable to that of a river with a high flow. The approach should account for these differences, as well as restrict discharges into a receiving environment whose assimilative capacity is already exceeded due to existing sources of the substance(s) of concern in the watershed or naturally high background concentrations.

EQOs for water are defined by CCME (1987) as numerical concentrations or narrative statements that establish the conditions necessary to support and protect the most sensitive designated use of water at a specified site. The EQOs for receiving water provide the basis for evaluating the risks of MWWE to human and ecosystem health or to fisheries resources.

EQOs can be determined using one of three approaches: a physical/chemical/pathogenic approach, a whole effluent toxicity (WET) approach, or a biological criteria or bioassessment approach. The relevant data inputs from these approaches, as well as several other variables (e.g., upstream water quality or background, critical low-flow periods in the receiving environment, effluent flow), are considered when developing the EDO. EDOs are developed to specify the concentrations/loads of substances in the effluent discharge that will result in achieving the corresponding EQOs in the receiving environment, at the edge of the mixing zone.

Independently, these three approaches are good predictive tools of unacceptable risks to human and ecosystem health. An integrated approach, however, builds on the limitations of the individual approaches and provides greater assurance of the risks being further minimized. Other advantages and limitations are discussed in detail in section 4.

Figure 4 illustrates the process of establishing science-based EDOs using a single discharge ERA approach.

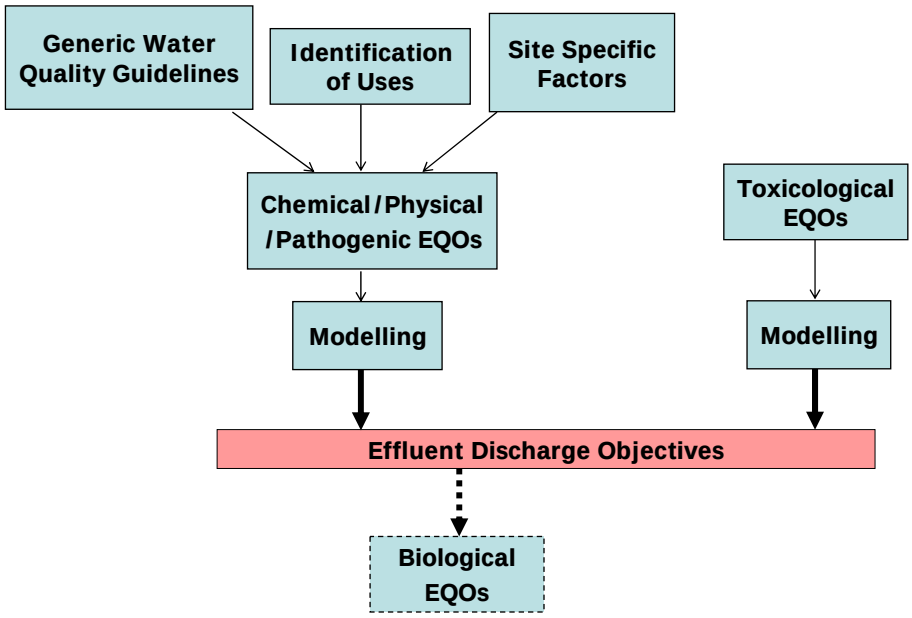

Figure 4. Environmental Risk Assessment - Single Discharge Approach

3.2 Environmental Quality Objectives

3.2.1 Water Uses

The first step in developing an EQO is to define all the uses of a particular water body; the derivation of EQOs is inherently tied to these uses.

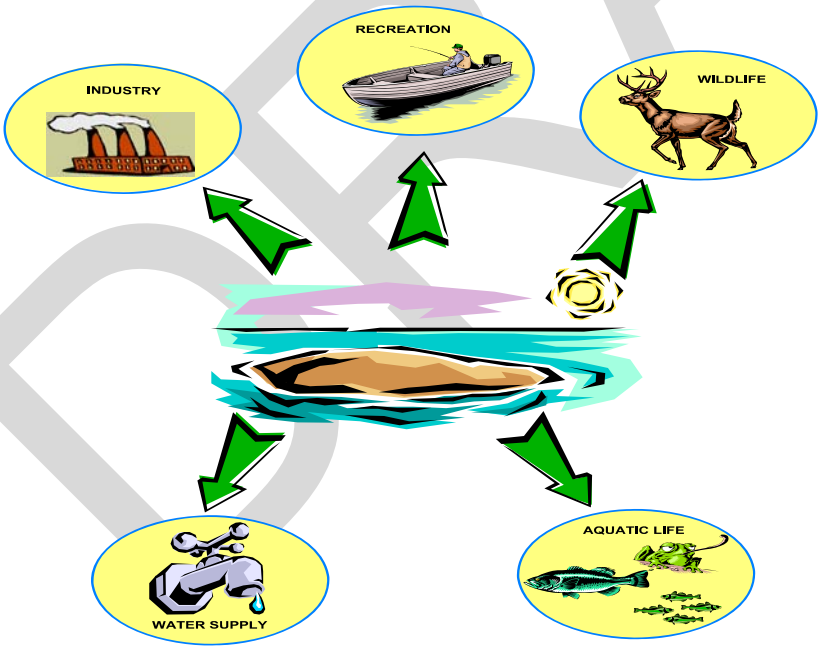

Figure 5. Beneficial Uses of Water

Box 2. Beneficial Uses of Water

Aquatic systems are valuable natural resources that support many beneficial uses. They are sources for drinking water, the foundation of fish and shellfish fisheries, the source of irrigation and livestock water for agriculture, the source of process water for various industrial activities, and places for both contact (e.g., swimming, wading) and non-contact (e.g., fishing, boating) recreational activities (see Figure 5). They also support broader ecosystem health, including the protection of aquatic life and wildlife.

Aquatic systems are also the receiving environment for the disposal of treated MWWE. Various effluent components have been linked to changes in aquatic habitats and species composition, decreases in biodiversity, the impaired use of recreational waters and fish and shellfish harvesting areas, and contaminated drinking water. Ultimately, these changes lead to a less prosperous economy, human health and environmental concerns, and a diminished quality of life.

3.2.2 Overview and Development of Environmental Quality Objectives

Generic guidelines may be modified for a specific location or area by considering the uses of the receiving water downstream from the discharge, other site-specific factors and toxicological criteria. The modification process results in EQOs, which are objectives to be met in the specific receiving environment. An EQO for a particular substance becomes an input to a model used to back-calculate an EDO that applies to the effluent discharge (end-of-pipe).

The condition of the receiving environment can be best characterized using a combination of approaches: chemical/physical/pathogenic, toxicological, and biological indicators. The physical/chemical/pathogenic approach describes the level of a particular substance of concern (i.e., pathogens, metals) that will not adversely impact water quality. The toxicological approach specifies the proportion of the effluent discharge that may enter the water body without toxicological impact. The biological approach describes the level of ecological integrity that must be maintained, using parameters such as diversity. Objectives for each of these approaches can be established to describe a desirable level of environmental quality or condition of the receiving environment. For all approaches, at no time should an EQO be established that will result in degradation of water quality.

EQOs within each approach can take many forms, including:

- Qualitative (or narrative) statements: for instance, Canada's *Fisheries Act*, 36(3) states "…no person shall deposit or permit the deposit of a deleterious substance …" while the United States *Clean Water Act* has requirements for waters that are commonly described as drinkable, swimmable, or fishable.
- Quantitative measures: physical/chemical/pathogenic water, tissue, or sediment quality guidelines (i.e., the concentration of a substance in water, tissue, or sediment); toxicological criteria (i.e., verified with toxicity tests on whole effluent or on ambient waters); or biocriteria (e.g., less than 30 per cent change in fish gonad size, population or community structure, or species diversity).

Each approach has strengths and weaknesses as a tool for characterizing water quality, as summarized in Table 1 at the end of this section. The primary purpose of this section is to explore how physical/chemical/pathogenic, toxicological, and biological objectives are developed and implemented in the assessment and characterization of environmental quality and, ultimately, the management of complex effluent.

Physical/chemical/pathogenic EQOs

This approach is intended to protect the quality of the receiving water by ensuring that environmental quality guidelines and/or objectives are met. It involves evaluating the discharge and its predicted effect

on the receiving water. Guidelines are the ideal tool for use in this approach because a standardized but flexible framework is used to develop generic or site-specific water, sediment and aquatic organism tissue residue guidelines for any Canadian context. These guidelines can support use-protection goals established in MWWE management and will demonstrate the environmental relevance of management decisions.

Site specific factors can limit the direct applicability of CEQGs as EQOs. These factors include elevated background levels of substances of concern (natural or due to past contamination), atypical levels of water quality variables that influence the bioavailability and/or toxicity of these substances, specific human or natural uses of the area, and sensitivity ranges of resident species (compared to species used to develop the CEQG). Therefore, it may be necessary to establish site-specific EQOs that account for such variations in environmental conditions.

Several provincial/territorial jurisdictions use physical/chemical/pathogenic EQOs to assess the potential for ecological effects in waters receiving effluent discharge. In Canada, the most commonly used EQOs are the CEQGs, although some jurisdictions have in place other EQOs developed independently to suit their specific environmental needs.

Development of site-specific EQOs

Site-specific EQOs are numerical concentrations or narrative statements that support and maintain a designated use at a specific site. Objectives are typically based on generic water quality guidelines (WQGs), which may be modified to account for local environmental conditions or other factors. For instance, if ambient levels of the substance of concern at the site exceed the generic WQG, the site would not adopt the generic national WQG as the EQO for that particular substance. Instead, the ambient level of the substance would become the EQO for the site. In this scenario, site-specific objectives would stipulate that water quality should not be degraded beyond the ambient level and that all practical measures should be taken to upgrade the water quality. Exceptions may be made on a case-by-case basis in areas where this is not practical or feasible.

Site-specific EQOs are derived using one of four procedures: the background concentration procedure, the recalculation procedure, the water effect ratio procedure, or the resident species procedure. A discussion of these methods is beyond the scope of this document (see CCME, 2003).

Toxicological EQOs

MWWE is a complex mixture that may contain unknown or unidentified substances for which guidelines do not exist. Little or no understanding of chemical interactions (e.g., synergism) in these mixtures makes it nearly impossible to precisely predict their collective environmental effect. WET tests can be used to determine the potential toxicity of chemical mixtures through short-term acute toxicity or long-term chronic toxicity tests on either end-of-pipe effluent or receiving environment media (i.e., water or sediments). WET tests are bioassays used to determine the degree of response of aquatic organisms, such as fish and *Daphnia*, exposed to an effluent. WET tests are generally conducted in laboratories, where effluent water is serially diluted and selected organisms are exposed to concentrations of effluent water for a predetermined period of time. Dilution water is either standard laboratory water or receiving water.

Two types of WET tests exist to qualify toxicity: acute and chronic. Acute tests allow screening for concentrations high enough to cause effects over a short exposure period. The 96-hour rainbow trout test is a standard acute WET test. The endpoint is commonly mortality, expressed as LC50, which is the concentration of effluent that is lethal to 50% of exposed organisms. Chronic tests are used to determine sublethal effects, such as inhibited growth or reproduction, over durations of seven or more days depending on the lifespan of the organism. Endpoints include lowest observable effects concentrations, no observable effects concentrations, and effects concentrations.

Toxic units (TUs) may be used to express EQOs, to calculate EDOs and to compare effluent toxicity to these EDOs. TUs are defined as the inverse of the sample fraction. They are obtained by expressing toxicity as a percentage of the sample (i.e., effluent) divided into 100. TUs are intuitive: the higher the number, the more toxic the effluent. For instance, an acute TU for an effluent is calculated as 100/LC50. If an LC50 for an effluent is calculated as 25%, the TU is 100/25 = 4. An LC50 of 100% would be converted to a TU of 1. Any test endpoint may be converted to a TU, but the toxicity of several samples may only be compared to TUs calculated from the same test endpoint and test duration. TUs should be designated as acute (TU_a) or chronic (TU_c) and cannot be directly compared.

EQOs may be expressed as effect (acute) or no effect (chronic) concentrations, or in TUs. They serve to protect aquatic life from the additive effect of all substances in the whole effluent. Such EQOs are implemented in the same way as EQOs derived from physical/chemical/pathogenic guidelines. TUs are used to express toxicological EQOs based on the following definitions. Samples are commonly considered acutely toxic when the TU_a is equal to or greater than 1. Chronic toxicity is defined as equal to or greater than 1 TU_c, based on a no effect level on reproduction or growth (n.b., measurements of chronic effect vary with jurisdiction, but should be expressed so that chronic toxicity does not exceed this no effect level). Therefore, the toxicological EQO is always 1 TU_a at the end-of-pipe, and 1 TU_c at the end of the allowed mixing zone. The acute toxicity EDO (acute WET) will be 1 TU_a at the end-of-pipe (without dilution); the chronic toxicity EDO will be calculated from 1 TU_c, and a dilution factor. The results of a chronic WET test are therefore compared to the expected dilution of the effluent in the receiving water to determine whether the EQO will be met.

The absence of toxicity, expressed in toxicity test results, is therefore also an EQO.

The advantage of implementing the WET approach is that it addresses the potential for additive, synergistic or antagonist toxicity effects and provides a level of direct protection for aquatic organisms from effluent discharge. WET tests are limited in their interpretation, however, as the direct toxicity of particular substances is not investigated and guidelines are not developed for the specific substances of concern. In some jurisdictions, WET testing is often incorporated into the permitting process.

Biological EQOs

When chemical, physical and biological integrity is protected and EQOs are not exceeded, ecological integrity should be preserved. Biological assessments, or bioassessments, are tools used to gauge ecological integrity. Biological EQOs are based upon biocriteria, which in turn are derived using bioassessments. Biological EQOs differ from toxicological EQOs in that they often focus on adverse effects at higher levels of organization, such as population and community structures, rather than toxicity effects in individuals, although the latter could be included. They are also the only EQOs that examine actual impacts on receiving waters.

Biological assessments are studies of biota carried out within an area exposed to MWWE discharges, as well as in reference areas unexposed to these discharges but having similar physical and chemical characteristics. Typically, significant differences between exposed and reference locations are used to determine the nature and severity of effects caused by the discharge. From a regulatory perspective, the principal indicator organisms are generally fish and benthos. Plants, algae and zooplankton are used to a lesser extent. Whenever impacts are observed, even though EDOs are being achieved, an ERA should be undertaken to establish new EDOs that will better protect the receiving environment. Criteria should focus on effects on higher trophic levels, with management decisions based on the level of effect (Kilgour *et al.*, 2005). Specifically, conditions that may indicate impairment of the fish community are warning-level effects that may or may not be associated with the exceedance of EQOs, while unacceptable effects occur when measurable effects show a trend that surpasses the warning level. These effects require

identification of cause (Kilgour *et al.*, 2005). Several leading agencies have implemented biomonitoring in the receiving environment to more fully characterize environmental effects associated with industrial or municipal effluent.

Biocriteria are developed from bioassessments that integrate measures (indices) of the composition, diversity and functional organization of a reference aquatic community. The reference conditions are considered the foundation for biocriteria. Bioassessments are then conducted to determine if a water body is attaining its designated aquatic-life use. This is done by comparing the assessment results with the biocriteria. Biological EQOs are not universally used in Canada and no standard approach has been established. The CCME Water Quality Task Group has scoped out issues related to biocriteria and the report is available on the CCME website (www.ccme.ca). Once developed, provincial or CCME biocriteria could become the third pillar of EQOs (along with physical/chemical/pathogenic and toxicological objectives) to be used in the environmental risk management framework for MWWE.

Table 1. Capabilities and Limitations of Water Quality Evaluation Tools

Control Approach	Capabilities	Limitations
Physical/ chemical/ pathogenic guidelines	Human health protection, wildlife protection	Does not consider all toxics present
	Complete toxicology	Bioavailability not measured
	Straightforward treatability	Interactions of mixtures unaccounted for
	Fate understood	Complete analyses can be expensive
	Less expensive testing if only a few toxicants are present	Direct biological impairment not measured
	Prevents or predicts impacts	
Whole effluent toxicity	Aggregate toxicity	No direct human health or wildlife protection
	Unknown toxicants addressed	Incomplete toxicology (few species may be tested)
	Bioavailability measured	No direct cause-effect relationship established
	Accurate toxicology	No persistency or sediment coverage
	Prevents impacts	Ambient conditions may be different
		Incomplete knowledge of causative toxicant
Bioassessments	Measure actual receiving water effects	Critical flow effects not always assessed
	Historical trend analysis	Difficult to interpret impacts
	Assess level of ecological quality above standards	Cause of impact not identified
	Total effect of all sources, including unknown sources	No differentiation of sources
		Impact has already occurred
		No direct human health or wildlife protection
		Expensive and labour/time intensive

(Adapted from US EPA, 1991, and MENV, 2001)

3.3 Mixing Zone and Dilution Assessment

3.3.1 Definition of the Mixing Zone

A mixing zone, also called the initial dilution zone, is defined as “the area contiguous with a point source (effluent discharge site) or a delimited non-point source where the discharge mixes with ambient water

and where concentrations of some substances may not comply with water quality guidelines or objectives." A typical mixing zone is shown in Figure 6.

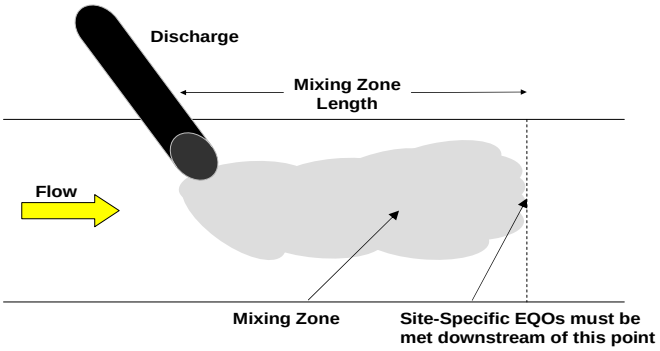

Figure 6. Conceptual Diagram of a Mixing Zone

Physical mixing zone

Many effluent discharges do not mix instantaneously with the receiving water, resulting in mixing zones adjacent to the outfall. The physical mixing zone may be defined as the area outside of which effluent and receiving waters have mixed completely. For a sufficiently large body of water, the physical process of mixing continues indefinitely and the physical mixing zone contains the area up to the point where there is virtually no measurable difference between receiving water and effluent mixed with receiver. In a river or stream, the physical mixing zone is the area within which the effluent discharge is not fully or completely mixed with the receiving water. It is possible that the plume may not occupy the entire width of the stream, although "complete" mixing over the entire depth and cross section of the river may occur at some distance further downstream. Beyond that point, the entire river flow is of similar make-up and hence no further mixing occurs. In a small lake, a sufficiently large discharge may mean that the whole lake is the physical mixing zone. The physical process of "mixing" also has two distinct phases: near field and far field mixing processes. Near field is where mixing is dominated by the effluent/outfall characteristics and is more controllable through design. Far field is where mixing is more dominated or controlled by ambient processes such as diffusion and wave action.

The size of the physical mixing zone is not fixed but varies over time with factors such as: effluent flow rate and concentration, design of the outfall, ambient properties (depth, velocity, density, etc.) and concentrations of the substances in both the receiving environment and the effluent. Additionally, the size of the physical mixing zone also may differ for each contaminant because the mixing process itself may differ for different parameters (e.g., some substances may decay over time while others may be conservative).

Allocated mixing zone

In some circumstances, smaller mixing zones that are a portion of the physical mixing zone may be allocated. For instance, they may be allocated to determine if ambient guidelines are met, for the calculation of the assimilation capacity of a water body and for back calculation to an EDO. The allocated mixing zone may be set by regulators. It differs from the physical mixing zone because its purpose is to calculate reasonable assimilative capacity for the effluent discharge, rather than to allow the entire dilution capacity of the stream or lake to be used for the calculation of complete mixing. For the purposes of this document, the simplified term 'mixing zone' is used from this point forward. It refers to the allocated mixing zone.

Mixing zones are the areas in which the initial dilution of the effluent occurs and concentrations of some substances may not comply with EQOs (which are generally based on preventing chronic effects). The mixing zone is an area of acceptable, but not acutely toxic, impact that does not affect the overall quality of the receiving water. In general, the integrity of the water body as a whole is protected even if EQOs are exceeded within the mixing zone, as long as the effluent does not cause significant mortality inside the zone and respects the EQOs at the edge of the zone.

Mixing zones are considered for the EDO calculation because some assimilation of the substance occurs in the water body. Dilution is considered because, for the most part, the immediate concentration of a substance at the end-of-pipe will not be an adequate representation of the concentration of the substance in the water body as a whole. For instance, for the most part, aquatic life will not be exposed to the concentration of the substance in the pipe but rather to the receiving waters mixed with effluent. Similarly, for the most part, humans will be exposed at the site of a particular use, such as recreation, rather than at the end-of-pipe. This means that comparing concentrations at the end-of-pipe to long term guidelines for aquatic or human health may be too conservative. Mixing zones are therefore allocated so long term guidelines, in the form of EQOs, will be applied to protect specific water uses under realistic conditions. The mixing zones may be used to back calculate from the EQOs to EDOs that will estimate the assimilative capacity of the water body. Where a mixing zone is allowed, the EDO represents the maximum concentration and load of a substance, or the WET, in the point-source effluent that will enable receiving water to meet the EQO at the edge of the allocated zone.

The mixing zone must meet certain requirements in order to prevent inappropriate impacts on the receiving waters. In no case should the mixing zone impair the water body as a whole. Mixing zones should not be used as a replacement for adequate treatment. Dilution is not treatment. To prevent inappropriate impacts, mixing zones may vary from one water body to another, due to factors such as the speed of the mix. Mixing zones may also vary in the same water body from one water use to another. For instance, the mixing zone for a use closer to the end-of-pipe would not extend as far as the mixing zone for a swimming zone located farther away. Finally, the allocation of a mixing zone varies from one substance to another: degradable substances are allowed to mix in a portion of the receiving water, whereas toxic, persistent and bioaccumulative substances are not allowed in a mixing zone (EDOs will match EQOs). This is because no dilution is allowed for persistent, toxic and bioaccumulative substances such as chlorinated dioxins, PCBs, and mercury. In addition, no mixing zone may be allocated where other circumstances, such as the requirement for greater protection of certain water uses, exist. Mixing zones are only considered for treated and monitored effluent, not for spills or for voluntary or accidental discharges.

3.3.2 Criteria for Allocating the Mixing Zone

The following general criteria, adapted from those established by CCME (1996), are recommended for allocating a mixing zone:

- The dimensions of a mixing zone should be restricted to avoid adverse effects on the designated uses of the receiving water system (i.e., the mixing zone should be as small as possible).
- The mixing zone should not impinge on critical fish or wildlife habitats (e.g., spawning or rearing areas for fish, over-wintering habitats for migratory water fowl).
- Conditions outside the mixing zone should be sufficient to support all of the designated uses of the
- A zone of passage for mobile aquatic organisms must be maintained.
- Placement of mixing zones must not block migration into tributaries.
- Changes to the nutrient status of the water body as a result of an effluent discharge should be avoided; eutrophication or the presence of toxic blooms of algae are unacceptable impacts.
- Mixing zones for adjacent wastewater discharges

receiving water system.

- Mixing zones must not be established such that drinking water intakes are contained therein.
- Wastewaters that are discharged to the receiving water system must not be acutely toxic to aquatic organisms.
- Conditions within the mixing zone should not cause acute toxicity to aquatic organisms.
- Conditions within a mixing zone should not result in the bioconcentration of substances of concern to levels that are harmful to the health of organisms, aquatic-dependent wildlife, or humans.
- No mixing zones should be allocated for persistent, toxic and bioaccumulative substances.

should not overlap.

- Mixing zones should not unduly attract aquatic life or wildlife, thereby causing increased exposure to substances of potential concern.
- Mixing zones should not be used as an alternative to reasonable and practical pollution prevention, including wastewater treatment (pollution prevention principle).
- Accumulation of toxic substances in sediment to toxic levels should not occur in the mixing zone.
- Adverse effects on the aesthetic qualities of the receiving water system (e.g., odour, colour, scum, oil, floating debris) should be avoided.

Prevention of acute toxicity within the mixing zone

The mixing zone should not have an adverse effect on aquatic life beyond its borders. EQOs are therefore applied at the edge of the zone to assess stress and sublethal effects.

Acute toxicity to organisms passing through the mixing zone should also be prevented, as this constitutes an unacceptable impact. To prevent significant mortality inside the zone, acute toxicity (defined by greater than 50 per cent mortality) should not occur at end-of-pipe. In order to protect passing organisms from acute toxicity, undiluted effluent should pass an LC50 test; in other words, it should not exceed $1TU_a$. This may be expressed as:

$$EDO < 1TU_a$$

Ammonia is the only substance for which an exception may be made if the EDO is surpassed (see section 5). If the effluent fails the acute toxicity test and ammonia is determined to be the cause, the EDO will remain in place but no immediate action will be required unless the CCME water quality guideline for unionized ammonia is exceeded at the end of the mixing zone.

3.3.3 Restrictions on Mixing Zone Dimensions

The spatial dimensions allocated to the dilution should be restricted in order to protect the water body as a whole. This may be achieved through physical/spatial restrictions or a restriction of the flow allocated for the mixing of the effluent into the receiving water. The dimensions serve to delineate where the EQOs would be attained and therefore where the dilution factor should be estimated, in order to back calculate from the EQO to the EDO.

Although mixing zones vary from time to time, regulators have fixed some default limits to simplify the process. These limits are for critical conditions of an environment. For streams, critical conditions imply low flows. Jurisdictional mixing zone limits may be preferentially consulted, however default limits are suggested (see below).

The limits of the mixing zone are defined for the following three categories of aquatic environments based on their physical characteristics: streams and rivers; lakes, reservoirs and enclosed bays; and

estuarine and marine waters. In all cases, the limits for each aquatic environment may be modified to account for site-specific characteristics, such as the existence of a particular water use that requires more protective measures. Where several limits are in place, the first one to be reached sets the maximum extent of the mixing zone allowed for the dilution assessment.

For each category of aquatic environment, default physical limits and dilution factors are suggested. These may be used where jurisdictional limits are not in place. In the case of ammonia, the default values must be used. Phosphorus and fecal coliforms are not allocated any maximum dilution. For phosphorus, a case-by-case analysis may be necessary to address particular conditions of a receiving environment, such as the meeting of salt and fresh water masses. For fecal coliforms, the location of the water use must be considered and protected by the limits of the mixing zone.

Streams and rivers

Streams and rivers are water bodies with continuous or intermittent flows that do not present a natural density gradient. In this type of environment, the critical conditions of the effluent and receiving environment mixing generally correspond to periods of lowest water flow.

The fraction of flow allocated to the mixing zone in a river depends on the extent to which mixing occurs. Small discharges into rivers of non-turbulent flow will not mix with the entire stream flow for considerable distances. At the opposite end of the spectrum are very turbulent small streams and effluent-dominated streams. Here, large amounts of effluent discharge into a small stream of low flow. In these situations, full mixing occurs but the mitigating effects of dilution are minimal. In intermittent streams, a mixing zone is not allocated and the EDOs are set as equivalent to the EQOs. However, in some cases, the jurisdiction may decide to apply the mixing zone where the stream empties into a larger, year-round receiving body of water (see section 6.1).

When a discharge mixes slowly with receiving waters (for instance, in large rivers with laminar flow), complete mixing will not be reached in a short distance. It could take many kilometres before a plume is completely dispersed through the receiving waters to the point that no distinction can be made between the mixed water and the receiving water. Without a limit on the length of the zone allowed for mixing, high concentrations of substances may stay in a portion of the water body for long distances. To protect aquatic life and water uses inside the mixing zone, the zone allowed for the dilution of the effluent should be limited by a length (e.g., 100 m, 300 m, at the site of the water use). The dilution assessment is then done by modeling or by using a dilution ratio (see below). A length of 100 m may be used as a default value.

When a discharge mixes rapidly with receiving waters (for instance, in small streams with turbulent flow), the complete mix will occur within a short distance. The full stream flow may dilute the effluent before any length limit to the dilution is reached. However, one hundred per cent of the stream flow should not be allocated to a single discharge in order to allow for future development and to maintain a zone of passage for fish, among other considerations. Only a portion of the stream flow should be allocated for mixing. The dilution factor used to calculate the EDO should be based on a limited portion of the stream flow (e.g., 25%, 33%, 50%). Some jurisdictions have defined a default percentage value to be used. This percentage could be reduced in situations where multiple discharges use a stream. A default value of 33% of the critical low flow may be used. Normally, these percentages are based on a low flow period such as a seven-day low flow with a ten year return period.

As mentioned previously, the dilution of an effluent is not treatment. In large rivers, where dilution may be very high (e.g., St. Lawrence River, Saguenay River), it is difficult to take the presence of all the discharges to the river into account. Even if the concentrations of substances are not measurable individually because of the dilution factors, the summation of all the loads discharged may result in

deleterious concentrations of substances in some compartment of the environment. Therefore, a maximum dilution is allocated. This default maximum dilution would be 1 in 100 for streams and rivers.

Jurisdictions have likely already defined limits to the dilution allowed for mixing zones. These jurisdictional limits should be used. However, the default values must be used to define the limits of the mixing zone for ammonia, and may also be used as default limits where jurisdictional limits are not in place. These default values are summarized below.

1. The mixing zone does not exceed 100 metres in length.
2. The mixing zone does not exceed 33% of the stream or river flow, at a low flow of 7Q10 (seven-day low flow over 10 years). The percentage of the stream flow allocated to the mixing zone is termed the fraction of flow (ff), which is used in the following equation:

$$Dilution\ \ factor = \frac{effluent\ \ flow}{(ff) \times streamflow + effluent\ \ flow}$$

   where $(\mathrm{ff}) \leq 33\%$.
3. The maximum dilution factor allowed for effluent discharges in rivers and streams is 1:100.

Lakes, reservoirs and enclosed bays

Lakes, reservoirs and enclosed bays are especially sensitive to the addition of substances. Their hydrodynamics generally favor slow effluent mixing and long retention times which may prolong the presence of substances in the entire body of water.

The default length allocated to the mixing zone is 100 m, in any direction, for the dilution assessment. In all cases, this length may be modified to reflect existing jurisdictional limits, or for optimal protection of water uses.

As with rivers and streams, mixing zones limits must be respected to protect the water uses of the receiving environment. For lakes and enclosed bays, the default dilution factor allowed for the calculation of EDOs for discharges is a maximum of 1 in 10. This default value should be used for ammonia. For other substances, jurisdictional values may be used.

In some circumstances, while the dilution factor allocated by the jurisdiction may be 1 in 10 for calculating the EDO for attaining the EQO, jurisdictions may also include a minimum dilution factor in order to allow a discharge into a lake. This requirement for a minimum dilution factor, such as 1 in 20, may occur because lake mixing is very slow and retention time is long. The minimum dilution factor is included under these conditions to prevent acute toxicity in the mixing zone. The 1 in 10 dilution factor is used as a maximum for EDO calculation because substances may build up over the long term, leading to chronic toxic conditions for aquatic life.

Estuarine and marine waters (other than enclosed bays)

Estuaries and marine waters are characterized by the presence of currents that fluctuate in intensity and direction (e.g., under the influence of tides). Determining effluent mixing in estuaries and marine waters is often complex because the hydrodynamics are influenced by the inflow of fresh water, wind intensity and direction, the depth of the water, the nature of the substrate and the stratification of the water column.

A thorough understanding of the mixing zones of estuarine or marine waters may be obtained by hydraulic modeling and/or the use of tracer studies. As for lakes and rivers, default limits may be adopted by a jurisdiction. For all substances except phosphorus and fecal coliforms, the default limits of the

mixing zone are delineated by whichever of the following is more restrictive: a maximum radius of 100 m from the discharge point or a maximum dilution of 1 in 100.

Mixing zone models
Mixing zones should be thoroughly evaluated to ascertain whether the integrity of the water body as a whole is intact. A mixing zone assessment, which predicts the dilution process of the substance through a mixing zone, is recommended for situations in which the effluent does not mix rapidly or completely with the receiving waters (US EPA, 1996).

Mixing zone assessment models vary in complexity. The simplest is a basic equation that estimates the dilution predicted during the first phase of discharge-induced mixing and the distance from the outlet at which the EQO is attained under worst-case conditions (US EPA, 1991). More detailed modeling is necessary where there is a dispute over proximity to spawning grounds or overlapping plumes. Several mixing zone assessment computer models, such as PLUME and CORMIX, are available through the US EPA (1991) for this purpose; however, they require a user with knowledge of mixing concepts and model input substances.

Mixing zone assessments based on empirical measurements should supersede those based on modeling calculations.

3.4 Determining the Need for Effluent Discharge Objectives

EQOs are desired characteristics or benchmarks that, if attained, will protect all water uses for a particular water body. Once EQOs have been developed, the next step is to assess whether EDOs are required. EDOs should be implemented in situations where it is projected or calculated that EQOs may be exceeded at the edge of the mixing zone. This is referred to as an assessment of "reasonable potential."

EDOs provide guidance on the desired characteristics of the effluent discharge, thereby preventing substances in excess of EQOs to exist beyond the mixing zone. The general approach for deciding whether an EDO is necessary involves predicting concentrations in the receiving environment by characterizing the effluent and considering site-specific factors. Predicted concentrations are then compared with those specified by the EQOs. Depending on the characteristics of the site, the effluent discharge and the specific EQOs, EDOs may be based on EQOs developed for WET, for physical/chemical/pathogenic substances, or both.

To predict the toxicity of an effluent in receiving waters, the effluent must be characterized. Initial characterization of the effluent, as described in section 5, will determine which substances are of concern for that particular facility.

Water quality models may be used to predict whether the effluent will cause levels of substances of potential concern to exceed EQOs in the receiving environment. While more detailed water quality models exist (see section 3.5.2), the simplest water quality model uses a basic mass-balance approach to determine the concentration of either a specific substance or whole effluent in the water, after dilution. This approach assumes a complete mixing of the effluent in the receiving water and allows the resultant substance concentration/load to be calculated such that, after dilution:

The resulting load of a substance at the edge of the mixing zone	=	**the load of the substance in the effluent**	+	**the background load of the substance in the stream**

Where:
load = flow x concentration

This basic mass-balance equation is presented as:

$$Q_r C_r = Q_d C_d + Q_s C_s$$

Where:
Q_d = effluent discharge flow (m^3/s)
C_d = substance concentration in discharge (µg/L or TU)
Q_s = background stream flow above point of discharge (m^3/s)
C_s = concentration of substance in stream above point of discharge (µg/L)
Q_r = resultant stream flow after point of discharge, or $Q_d + ff\ Q_s$ (m^3/s)
C_r = resultant concentration after point of discharge (µg/L or TU)

This equation may be rearranged to calculate the resultant concentration of discharge in the stream after mixing and dilution as:

$$C_r = \frac{C_d Q_d + C_s Q_s}{Q_r}$$

When modified to account for the (*ff*) (see section 3.3.2 and Figure 7), the equation becomes:

$$C_r = \frac{C_d Q_d + ff\,(Q_s C_s)}{Q_d + ff\,(Q_s)}$$

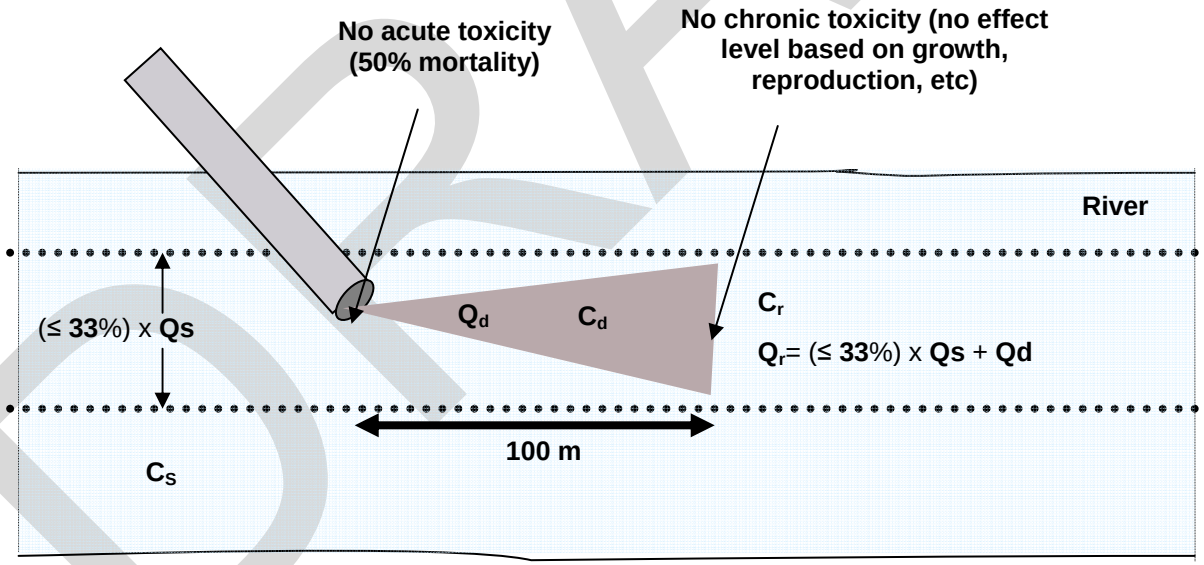

Figure 7. The Mass-balance Equation

To determine reasonable potential, the highest value observed throughout the characterization period or a worst-case projection (e.g., high effluent discharge) is used to calculate the resultant in-stream concentration. An EDO should be developed if reasonable potential is demonstrated by a resultant concentration in excess of the EQO. The US EPA (1991) should be referenced for details on the statistical method used to address uncertainty in effluent data.

3.5 Developing Effluent Discharge Objectives

EDOs represent the maximum concentration and load of the substance at the end-of-pipe that will enable the receiving water to meet the EQOs at the edge of the mixing zone. From the established EQOs, EDOs must be calculated, using a model that integrates site-specific factors, such as design stream and effluent flows, background concentration levels in the receiving environment, dilution capacity in the mixing zone, and so on. Mass-balance and water-fate-and-transport models are used to establish a quantitative relationship between the substance concentration/load and the receiving water quality. EDOs should be calculated for all substances, WET and uses where reasonable potential of exceeding the EQO is demonstrated. The general principles are outlined below.

EDOs calculated from chemical/physical/pathogenic EQOs are concentrations and/or loads of substances in the effluent that will enable the receiving water to meet the EQOs at the edge of a mixing zone. Mixing zones are discussed in section 3.3.1.

An acute toxicity criterion of not more than 50% mortality is applied at the end-of-pipe. This limit normally prevents significant mortality anywhere in the receiving environment. A mixing zone is considered when establishing chronic toxicity EDOs, meaning that no noticeable chronic effects should show beyond the mixing zone. No mixing zone is allowed for persistent toxic and bioaccumulative substances. Other mixing zones are calculated based on the location and occurrence of drinking water intakes and specific activities such as shellfish harvesting and swimming, among others.

EDOs for new discharges are calculated in the same way as for existing discharges (i.e., based on EQOs and available dilution), but with estimated effluent characteristics. Wastewater facilities should be designed to achieve EDOs or to come as close as possible.

Since end-of-pipe concentrations and WET will vary from day to day for a number of reasons, statistical analyses should be performed to determine which effluent requirements are conservative enough to assure, with a minimum level of confidence, that the EDOs are being achieved. This means that discharge limits should be lower than EDOs. The lower the sampling frequency, the lower the discharge limits have to be to achieve the same level of confidence that EDOs are being met.

To help with establishing statistically-based discharge limits, the US EPA published a *Technical Support Document for Water Quality Based Toxics Control* (1991). Some provinces also have guidance documents based on the US EPA method.

3.5.1 Background Concentration of a Substance

The background concentration of a substance—the concentration that naturally occurs upstream from a point-source discharge—should be established prior to determining the EDO. The choice of which water quality model to use to derive the EDOs will be influenced by the availability of receiving environment and effluent data sets. Where receiving environment information is limited, steady-state models may be used. In this case, available receiving environment monitoring data may be used to estimate worst-case, steady-state conditions. When large datasets are available, a more sophisticated model, such as a dynamic one, may be selected. These models allow information on background levels of a substance detected over a certain time period to be incorporated.

To satisfy data requirements, monitoring may be recommended at a location upstream of a discharge point. Provinces and territories have monitoring networks that may be consulted first, as generic quality data are usually available for the most important rivers and streams. For toxics, data from specific studies are available for some water bodies. Default values are defined and used by jurisdictions. The extent of the information on background concentrations will also depend on the designated uses of the receiving

waters. Stringent monitoring may be necessary in areas where multiple discharge points exist in the watershed.

3.5.2 Selecting an Appropriate Model

A representative model is selected based on site-specific characteristics, substances and effluent characteristics. Site-specific characteristics include stream and effluent flows, background concentrations in the receiving environment and dilution capacity in the mixing zone. The level of sophistication required is also an important consideration. Simplified modeling approaches, such as steady-state modeling, require limited data and computing resources. Sophisticated methods, such as dynamic models, have detailed requirements, but are preferred because they provide more accurate estimates than the more stringent worst-case scenario estimates provided by simplistic methods. Where sophisticated modeling tools and resources are not available, however, simplistic approaches are acceptable.

Based on these considerations, both steady-state and dynamic water-transport models may be applied.

Steady-state models

Steady-state modeling is a simplistic method commonly used to ensure the basic protection of water quality. Less data and resource intensive than more sophisticated methods, it assumes complete mixing and constant conditions for effluent input, background levels in receiving water, design stream flow and environmental conditions (i.e., temperature). The disadvantage of steady-state models is that they can be too conservative when using worst-case scenarios in their calculations. In reality, however, the receiving water and effluent are variable. These scenarios consist of restrictive conditions under which the guidelines should be met, such as high effluent discharge of the substance of concern and projected background concentrations. The use of worst-case conditions at a steady state provides a level of protection that should allow the EQO to be attained even when actual substance levels vary.

Development of EDO equations for chemical substances using steady-state models

The premise of the steady-state model is the mass-balance equation (section 3.4). This equation can be rearranged, as shown below, to calculate the EDO (in concentration) that will not exceed the EQO in downstream receiving waters:

$$Q_d C_d + Q_s C_s = Q_r C_r$$

becomes

$$C_d = \frac{Q_r C_r - Q_s C_s}{Q_d}$$

The resulting equation may be further modified to take into consideration only the fraction of the background stream flow that is designated for the mixing zone:

$$C_d = \frac{C_r(Q_d + ff \cdot Q_s) - ff \cdot Q_s C_s}{Q_d}$$

This equation may be used to determine the EDO. The concentration of a chemical in the effluent, C_d, represents the EDO where C_r (the resultant concentration in the stream after mixing of effluent discharge) is given the value of the EQO:

$$\text{EDO(conc)} = \frac{\text{EQO} \cdot (Q_d + ff \cdot Q_s) - ff \cdot Q_s C_s}{Q_d}$$

and

$$\text{EDO(load)} = \text{EDO(concentration)} \cdot Q_d$$

This basic steady-state model assumes that dilution is the only mitigating factor; however, steady-state models can be adapted to include processes such as degradation or sorption of the substance (US EPA, 1991). The EDO may be expressed as the substance concentrations/loads at the effluent discharge that will result in a concentration/load at the edge of the mixing zone (C_r) that will not exceed the EQO.

Development of EDO equations for WET using steady-state models
The same equations may be used to determine a chronic WET EDO:

$$C_d = \frac{C_r(Q_d + ff \cdot Q_s) - ff \cdot Q_s C_s}{Q_d}$$

To develop an EDO from WET-based EQOs, toxicity units (defined in section 3.2.2) should be used. The EQO and EDO should be expressed as chronic toxic units, because exposure at the edge of the mixing zone is predicted to be chronic. The background toxicity of a receiving water body is assumed to equal 0. The EDO is represented by C_d, where:

$$\text{EDO} = \frac{\text{EQO}(Q_d + ff \cdot Q_s)}{Q_d}$$

To prevent chronic toxicity at the edge of the mixing zone, the WET-based EQO may be defined as $1TU_c$:

$$\text{EQO} \leq 1TU_c$$

This specifies that no chronic effects should result from exposure to the effluent, after dilution, at the edge of the mixing zone. Taking this into account, the equation:

$$\text{EDO(conc)} = \frac{\text{EQO} \cdot (Q_d + ff \cdot Q_s) - ff \cdot Q_s C_s}{Q_d}$$

may be rewritten as

$$EDO = 1TUc \frac{(Q_d + ff \cdot Q_s)}{Q_d}$$

where the EDO is expressed in TU_cs.

The acute WET EDO is equivalent to the acute WET EQO, as it should be met directly at the end-of-pipe. Therefore, the acute WET EDO = 1 TU_a.

Dynamic modeling
Dynamic modeling may be applied where sufficient information exists to account for the variability of environmental substances and stream and effluent flow. These methods calculate a complete probability distribution that an EQO will be exceeded in receiving waters. Dataset requirements are more rigorous than for steady-state modeling, but may be more accurate. An additional advantage of dynamic modeling methods is that they determine the effluent concentration frequency distribution required to attain the EQO. The EDO may be easily selected from this output. The dynamic models used by the US EPA

include continuous simulation, Monte Carlo simulation, and log-normal probabilistic dilution (US EPA, 1996).

Continuous simulation models use time series input data to predict receiving water quality concentrations in the same chronological order as the input data (US EPA, 1996). They offer several advantages over steady-state models. Rather than provide a single, worst-case scenario estimate, continuous simulation models incorporate the variability and interaction of pH, flow, temperature and substance discharge over time. In addition, long simulation times can prevent the initial conditions used in the model from affecting the interpretation of fate and transport processes (US EPA, 1991).

Monte Carlo simulations involve the random selection of sets of input data for use in repetitive model runs to predict the probability distribution of receiving water quality concentrations (US EPA, 1996). Unlike the continuous simulation model and the log-normal dilution method, the Monte Carlo simulation does not require a time series for model input data or a specific statistical distribution (US EPA, 1991).

The log-normal probabilistic dilution model predicts the probability distribution of receiving water concentrations from the log-normal probability distributions of input variables. This method is not dependent on time-series data and is practical, as in-stream water quality data are often log-normally distributed. The US EPA (1991) presents these models in greater detail.

The output of the dynamic modeling method is the predicted substance load/concentration allocated to the point source under certain conditions that will not exceed the EQO after dilution and mixing.

3.5.3 Intermittent Discharge Lagoons

For lagoon systems that discharge only when lagoons are emptied, typically once or twice per year, the same approach to selecting and using a model as described above is used, even though discharges do not occur all year. Chronic toxicity data can be obtained within a relatively short period of time (chronic toxicity tests typically last only one week). However, the selection of the low flow condition is different since the discharges typically do not occur during the driest periods of the year. The low flow conditions to be used are those that occur during the months when discharges occur (usually during the spring and/or fall).

Box 3. Case Study – Effluent Discharge Objectives

The following simple case study demonstrates the steps that may be followed in developing EDOs.

Aquatic-life Use Designation

Assume that a MWWE discharges into a water body with an aquatic-life use designation in which there are no protected spawning or nursery grounds for fish and no species at risk. The water body is not a source of drinking water nor does it have recreational uses. Monitoring information identifies copper as a substance of concern in the MWWE discharge.

Development of a Physical/Chemical/Pathogenic Effluent Discharge Objective

A chemical/physical/pathogenic EQO is determined using a generic guideline for copper: a CEQG for the Protection of Aquatic Life of 2 to 4 µg/L depending on water hardness. Since the water hardness of the receiving body is 120-180 mg/L ($CaCO_3$), the CEQG for copper is 3 µg/L. The site's EQO for the purpose of protecting aquatic life from chronic exposure to copper is therefore 3 µg/L.

Implementation of the EQO

The EQO is applied at the edge of the mixing zone. Therefore, to protect aquatic life, copper levels at the edge of the zone should not exceed 3 µg/L.

Development of the EDO

The EDO is developed next. It estimates the highest level of copper that may be present in the effluent at the point of discharge and still not exceed the EQO of 3 µg/L at the edge of the mixing zone.

An appropriate model must be selected to determine the EDO based on the level of sophistication required, the characteristics of the stream and effluent flows and the background concentration and dilution capacity. For the purposes of this example, a basic steady-state model, considering dilution as the only mitigating factor, is used. This model consists of the modified mass-balance equation previously presented:

$$EDO = \frac{EQO \cdot (Q_d + ff \cdot Q_s) - ff \cdot Q_s C_s}{Q_d}$$

Assume that the background concentration of copper in the stream is 0.70 µg/L, that the design flow of the stream is 5.5 m^3/s, and that mixing occurs with 33% of the receiving stream before the 100 m mixing zone limit is reached. For a discharge flow of 0.04 m^3/s, and using 33% of the design flow of the stream, the effluent does not exceed the maximum 1:100 dilution factor. Therefore, the maximum effluent concentration of copper at the point of discharge that will ensure the receiving waters meet the EQO of 3.0 µg/L at the edge of the mixing zone will be:

$$EDO = \frac{3.0 \cdot (0.04 + 0.33 \cdot 5.5) - 0.33 \cdot 5.5 \cdot 0.70}{0.04}$$

EDO (conc) = 107.3 µg/L

EDO (load) = (107.3 µg/L) (10^{-9} kg/µg) (0.04 m^3/s) ($10^3 L/m^3$) (86400 s/d)
= 0.37 kg/d

Therefore, the EDO for copper for this MWWE discharge is 107 µg/L in concentration and 0.37 kg/d in load.

Development of an Effluent Discharge Objective Based on Whole Effluent Toxicity Testing

Although the substances of concern were identified for the effluent, the additive toxicological properties of the effluent should also be determined. This involves WET testing.

Assume that acute and chronic tests are conducted. The effluent passes the 96-hr LC50 rainbow trout test, with less than 50 per cent mortality observed after exposure to the whole effluent. The effluent therefore meets the objective of no acute toxicity at the end-of-pipe (assuming that the rainbow trout test is the only one required). A value of 75 per cent effluent is reported for a 14-day growth, no observable effects concentration, with fathead minnow.

Implementation of the EQO

The chronic WET-based EQO at the edge of the mixing zone should not exceed 1.0 TU_c.

Developing the EDO from a WET-test derived EQO
To develop an EDO from a chronic WET EQO, the simple steady-state model is again selected. Stream flow and discharge flow remain the same. The background level of effluent is given a value of 0. The EQO is defined as 1 TU_c. The EDO is calculated as:

$$EDO = 1TUc\frac{(Q_d + ff \cdot Q_s)}{Q_d}$$

$$EDO = 1TUc\frac{(0.04 + 0.33 \cdot 5.5)}{0.04}$$

$$EDO = 46\ TU_c$$

Toxic units
To determine whether the chronic toxicity surpasses the EDO, the no-effect or low effect concentration (depending on jurisdiction) is determined through WET tests with the most sensitive species. The no-effect concentration is converted to TUs:

$$TUc = \frac{100}{75}$$

Effluent $TUc = 1.3$

The EDO for the MWWE discharge is 46 TU_cs. The chronic testing in this example does not surpass the EDO and will, therefore, meet the EQO:

46 TU_c > 1.3 TU_c

As a result, the MWWE discharge will meet both the objective for toxicity at the end-of-pipe and the EQO at the edge of the mixing zone.

3.6 Summary

The following is a brief summary of the steps involved in developing EDOs:

1. Identify the uses of the receiving waters. Check the substance database and determine which substances are of potential concern for the discharging industries (see section 5).
2. To preserve designated water uses, determine the EQOs for the substances of potential concern. For instance, to protect aquatic life, a chronic toxicological EQO should be established as $1TU_c$ and applied at the edge of the mixing zone. EQOs should also include physical/chemical/pathogenic substances.
3. Perform an initial characterization of the effluent (see section 5). Identify which substances have a reasonable potential to exceed the EQOs at the edge of the mixing zone. Perform a mixing zone assessment.
4. Establish EDOs for the substances of concern and the chronic WET EDO by back calculating from the EQOs. An acute WET-based EDO should also be established for the effluent, such that acute toxicity in the mixing zone does not exceed $1TU_a$ (e.g., a 96-hour rainbow trout test).

EQOs specify the desired level of water quality for a water body receiving a MWWE discharge. This protects the designated uses of the water body. The following may be used to develop EQOs for receiving waters: the physical/chemical/pathogenic guideline approach, the toxicological approach and/or the biological approach.

The physical/chemical/pathogenic guideline approach may be used to develop an EQO for a specific substance or pathogen. Physical/chemical/pathogenic EQOs may be developed from CEQGs, national guidelines that are adaptable to site-specific considerations. The toxicological approach addresses the toxicity of the whole effluent. WET testing may be used to protect aquatic life from chronic effects and to prevent acute toxicity, defined by 50% mortality, at end-of-pipe. The biological approach addresses the potential impacts of effluent exposure on the ecosystem as a whole. It is currently under development.

Once a suite of physical/chemical/pathogenic and toxicological EQOs have been developed to protect a water body at a point-source discharge, the need to develop EDOs should be determined. EDOs should be developed for each EQO where reasonable potential for EQO exceedance is predicted. In many cases, the EDO calculation will consider the mixing zone, an allocated area in which excursions from the EQO may occur as the effluent mixes with receiving waters. Where a mixing zone is allocated, the EDO should be calculated so the EQO is met at the edge of the zone. EDOs are calculated using mixing zone assessments and water quality models, which vary in complexity.

Attaining the EDO in the MWWE discharge at the end-of-pipe should prevent exceedances of the EQO in receiving waters and protect existing water uses. Biological assessments should be performed periodically to verify that biological integrity is protected.

4. Environmental Risk Assessment – Watershed Approach

MWWE discharges are often one of several sources of pollutant loadings influencing the quality of water bodies. The need to recognize the other users of the water and to integrate MWWE into the total loadings of the watershed is an important new perspective for MWWE management.

When viewed as part of a broader management system, MWWE management allows for innovative and more cost effective approaches to pollutant reduction. The watershed approach follows the same basic steps to environmental risk assessments the single discharge approach, but the geographic scope, water quality objectives and participation of stakeholders are broader.

4.1 Background

Canada's traditional and current approach to managing MWWE involves assessing each facility on an individual (single discharge) basis. Regulatory controls for discharges are normally applied through a permit system. Requirements may differ between provincial and territorial jurisdictions and are further varied among municipalities. As a result, MWWE discharges are evaluated and managed on an individual basis depending on their specific location and the applicable requirements.

Due to intensified farming practices and the rapid increase in worldwide population over the last 50 years, the cumulative impacts of MWWE discharges have escalated, raising concerns. In order to address these cumulative impacts, various jurisdictions have adopted a "systems approach" to managing MWWE discharges. The new trend steers away from the current fragmented approach of managing MWWE discharges on an individual basis and towards managing discharges holistically throughout the watershed. A review of trends in watershed management in the United States, United Kingdom, France, Australia

and New Zealand indicates that managing water resources on a watershed basis is a widely accepted concept in many developed countries.

This section presents the rationale, guiding principles and the when and how for using a watershed approach. It also gives examples of successful implementation of the approach and its associated benefits.

4.2 What is a Watershed Approach?

A watershed approach is tailored to the site-specific circumstances evident in the watershed. It may include:

- Synchronized permits within a basin for several MWWE discharges.
- Synchronized permits within a basin for MWWE and other point source discharges.
- Water quality-based effluent limits developed using a multiple-discharge modeling analysis.
- Permits which include provisions for non-point dischargers which help meet environmental water quality objectives.

The ultimate goal of the watershed permits approach is to issue permits that consider the conditions of the entire watershed and address the diverse sources of substances within it, not just individual point source discharges.

4.3 When to Use a Watershed Approach

A watershed approach can be used to manage all substances. It simply formalizes a process to allocate a loading limit and assign parts of that limit to known inputs into the system. This approach is highly recommended when targeting substances such as nutrients, because they travel great distances in a watershed and impact larger geographic areas than other substances (such as metals). The levels of these kinds of substances may not be at acutely toxic at the end of the discharge pipe, but over time, and often in concert with other inputs, they can cause unacceptable changes to the receiving environment, such as eutrophication.

A watershed approach is also suggested for managing discharges that meet the following criteria:

- MWWE and other point sources clustered geographically close together.
- MWWE discharges that are impacting downstream users.
- High loadings from agricultural sites.

The approach is also suggested when the assimilative capacity of the receiving water has been reached from one MWWE discharge which has not dissipated before the next water intake.

4.4 Benefits of a Watershed Approach

Because the watershed approach examines the many upstream influences on water quality (other MWWE, other point sources, agricultural loadings, storm water management areas), it has a number of administrative and cost benefits:

- Decision-making between point sources with respect to priority and level of reduction of discharges is optimized.
- Cost for improved water quality is reduced by considering non-point sources.
- Monitoring costs can be reduced due to coordination.
- Public awareness and support is increased.
- Subtle and chronic problems such as cumulative effects can be addressed.

4.5 Guiding Principles

Various principles support a watershed approach to address the increasing cumulative impacts from MWWE discharges. These principles are guided by core environmental values of long-term sustainability and the protection of the natural environment. They are grounded in the development of sound management techniques that are supported by research and science.

Guiding principles:

- MWWE will be managed within the context of watershed water quality objectives.
- Watershed objectives will be set by the water users and managers who regulate the inputs into the water system.
- In establishing the individual discharge limits, the inputs of upstream users and the requirements of downstream users will be considered.
- Source control efforts will benefit from discussion with users, i.e., industries.

4.6 Determining Effluent Discharge Objectives Using a Watershed Approach

This process of developing EDOs for a watershed uses the mass-balance approach to determine appropriate loadings of substances. However, it extends the scope of the loadings beyond one MWWE discharge to include several discharges, storm water discharge areas and non-point sources.

The steps involved in developing a watershed approach are to:

1. Determine the scale and boundaries of the proposed watershed (or portion thereof) where water quality goals will be set and identify existing watershed programs to co-ordinate with and/or build on.
2. Assemble water managers and water users or expand existing watershed management bodies.
3. Establish watershed objectives with water managers and water users. Within these objectives, define key substances of concern, either single substances or critical substances of concern.
4. Measure substance inputs from point and non-point sources.
5. Develop management options and action plans while considering all point and non-point loadings. Identify areas requiring strict load management. Make sure allocations take into account the individual mixing zones within the watershed.
6. Establish permit limits for the watershed, for each contributor and substance.
7. Conduct annual monitoring and feedback to objectives.

4.7 Integrating the Single Discharge and Watershed Approaches

Whether the single discharge or watershed approach is applied, the same basic steps are used to determine the EDOs:

1. Characterize the environment.
2. Set environmental objectives.
3. Characterize the pollutant sources.
4. Set effluent discharge objectives.

The scope of investigation/interaction differs between the watershed and single discharge approaches; the two processes are easily integrated. Figures 8 and 9 illustrate the additional considerations used in the watershed approach. Essentially, the single discharge approach can be easily expanded to include aspects of the watershed approach, with the following advantages:

- Sources are managed from “up the watershed” as well as “up the pipe.”
- Other point and non point sources (other plants, storm sewers, farm run–off) are integrated.

- A broader range of water users is included in setting objectives. These users can include:
  - other municipalities,
  - industrial, agricultural and recreational users,
  - water managers,
  - monitoring agencies.

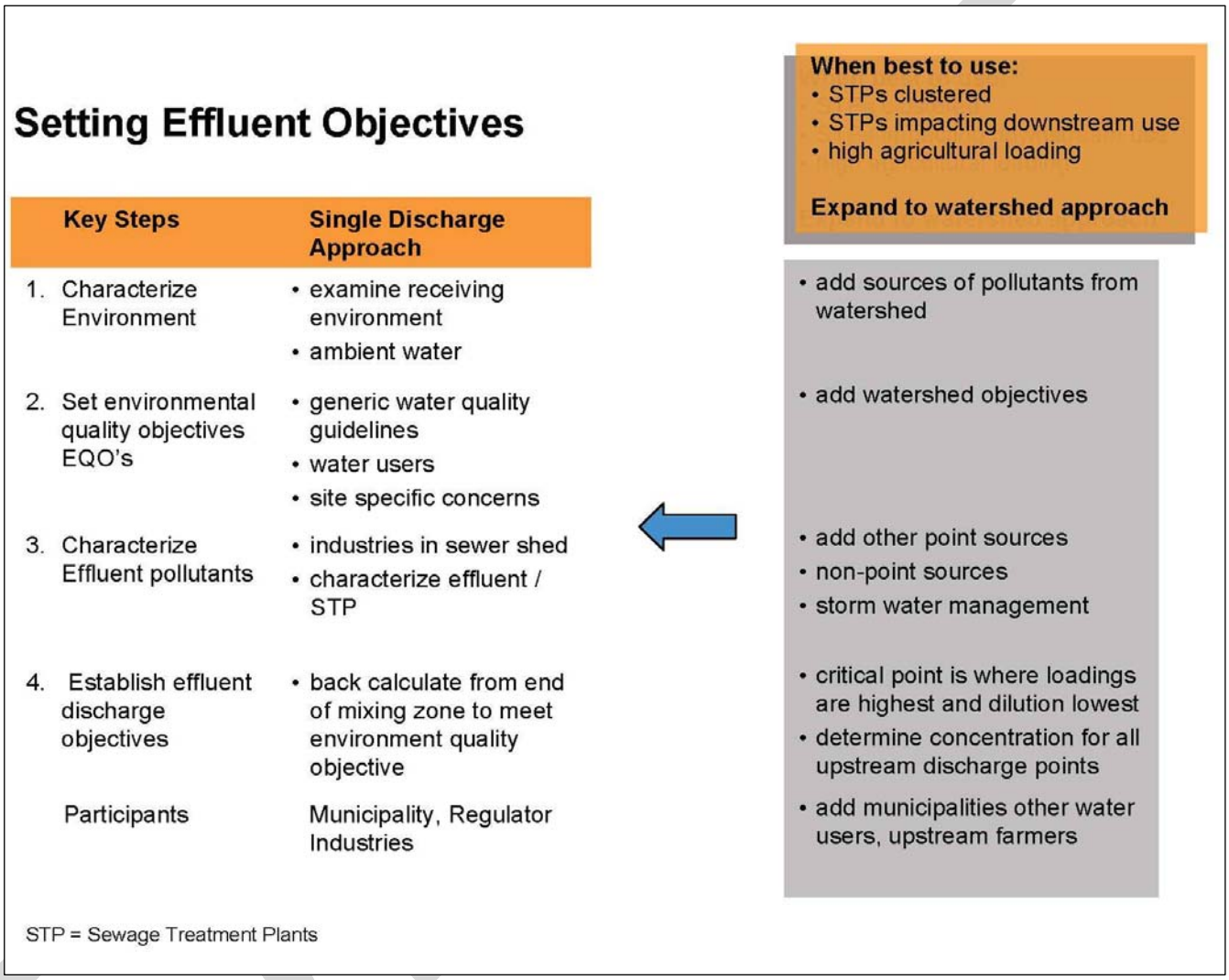

Figure 8. Setting Effluent Discharge Objectives

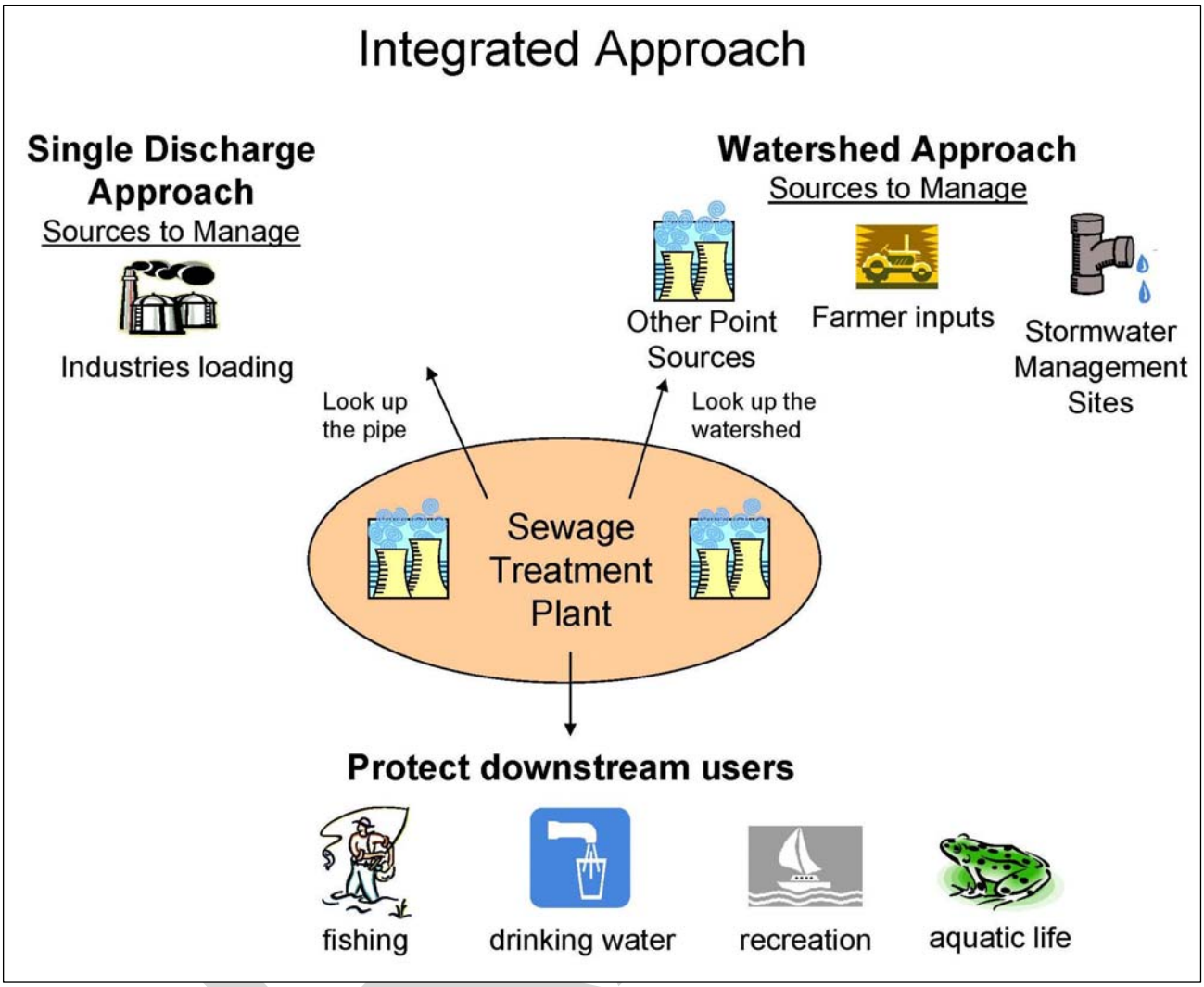

Figure 9. An Integrated Approach

4.8 Implementation and Examples

A watershed approach allows greater flexibility in meeting water quality objectives than a single discharge approach. It includes several factors so costly plant upgrades are only one of several options to improve water quality. Three variations on watershed management of pollutants are examined below:

1. US EPA – Total Daily Maximum Load
2. Watershed Management for Several Plants
3. Water Quality Trading

4.8.1 US EPA – Total Maximum Daily Load

Over the last 20 years, the United States has actively participated in watershed-based management. It has substantially reduced pollutant discharges into the nation's air, lakes, rivers, wetlands, estuaries, coastal waters and ground water. These successes have been achieved primarily by controlling point sources of pollution.

The United States' total maximum daily load (TMDL) approach to setting effluent objectives accounts for all loadings into a water body. The objective of a TMDL approach is to allocate allowable loads among all of the substance sources throughout a watershed so appropriate control measures can be implemented and water quality standards achieved. If they are not achieved, a water body can be declared impaired under section 303(d) of the *Clean Water Act*. The maximum amount of a substance a body of water can accommodate without becoming impaired is called the total maximum daily load (TMDL). All organizations within a watershed can trade pollution credits to either offset a greater than allocated pollution discharge or to gain reward from an especially clean operation.

One example of a US initiative that is supporting watershed management is the modification of requirements to the National Pollutant Discharge Elimination System (NPDES) permit program. The NPDES permit program allows states to reorient programs on a watershed basis and have short-term backlogs on NPDES permit reviews without penalty. This flexibility gives states time to synchronize the re-issuance of major and minor permits within a watershed. By managing NPDES permits on a watershed basis, all discharge permits can be coordinated and the most efficient and equitable allocation of pollution control responsibility can be made.

Box 4. Watershed Approach – Truckee River

In recent years, the Truckee River flowing from Lake Tahoe, California, into Nevada's Northern Basin, has seen heavy growths of aquatic weeds and benthic algae caused by high nutrient loads and low flows. Plant respiration and decaying biomass have decreased dissolved oxygen (DO) levels in the river. In response to these problems, the Nevada Division of Environmental Protection (NDEP) developed the *Truckee River Strategy*, a plan to coordinate the activities of the agencies involved in restoring the quality of the Truckee River and Pyramid Lake. The strategy includes timetables for numerous non-point source control projects, such as storm water permitting, wetlands treatment systems, pasture improvements, riparian restoration and landowner education. As part of the strategy, NDEP used DSSAM III, a water quality model, to develop nitrogen, phosphorus, and total dissolved solids TMDLs for the Truckee at Lockwood, Nevada. The TMDLs for total nitrogen, total phosphorus and total dissolved solids were approved in March 1994 by the US EPA. These TMDLs include load allocations for non-point and background sources and one waste load allocation for the major point source discharger in the basin, the Truckee Meadows Wastewater Reclamation Facility. The Truckee River TMDLs provide quantitative goals for the improvement of water quality in the basin.

4.8.2 Watershed Management of Several Dischargers

When several wastewater facilities release effluent into a watershed, they can collaborate in setting effluent limits for one substance (phosphorus) to ensure watershed objectives are met.

Box 5. Watershed Approach – Grand River Conservation Authority

The Grand River Conservation Authority, as a coordinating body, undertakes monitoring and modeling of dissolved oxygen, nitrogen and phosphorus. Reports of monthly loadings are made regularly to the Water Management Committee which decides on the effluent limits to ensure protection of downstream users. The number of water intakes and wastewater treatment plants serving various populations can be seen in Figure 10. The Regional Municipality of Waterloo, which is responsible for nine plants within the watershed, plans to develop a wastewater master plan which will direct growth to the wastewater treatment plants with the most cost efficient operations and least environmental impact.

The Grand River Conservation Authority's watershed management strategy involved collaborating with water management agencies and six municipalities situated along the Grand River. Due to the sensitivities

of dissolved oxygen (DO) to temperature in the river, phosphorus management was identified as a priority. The original basin study of the Grand River set an objective of maintaining the DO at not less than 5 mg/L, 55% of the time.

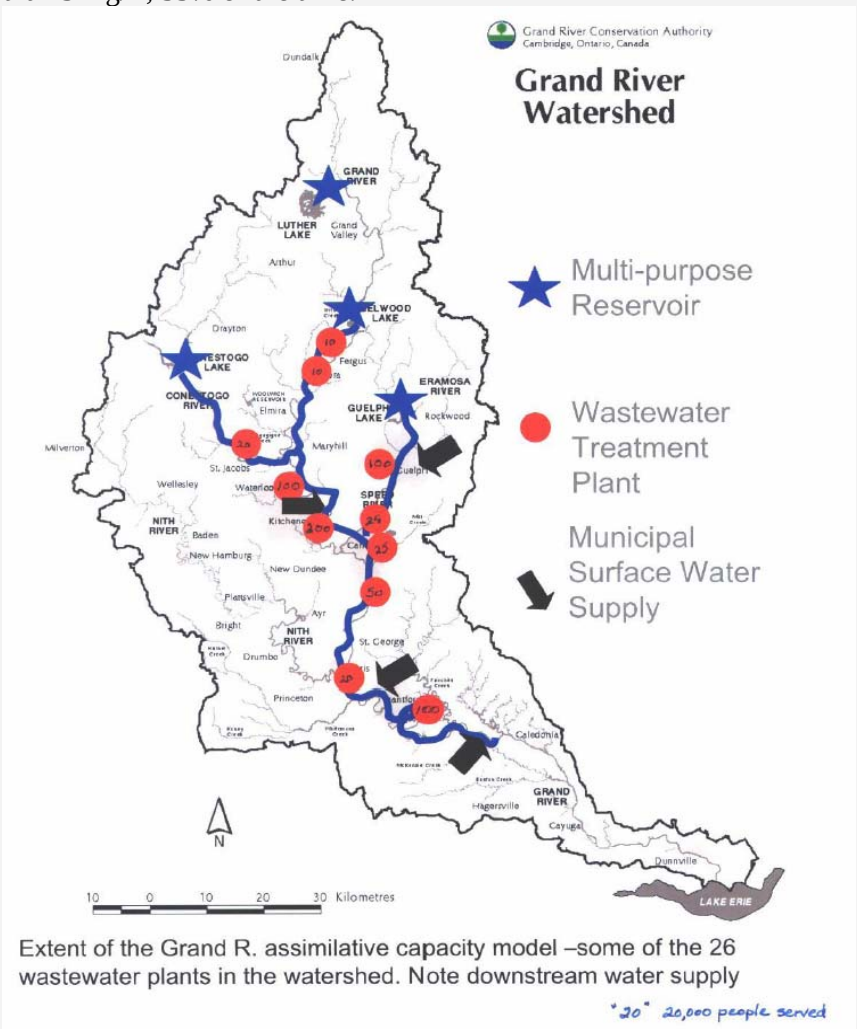

Figure 10. Grand River Watershed (used with permission of the Grand River Conservation Authority)

4.8.3 Water Quality Trading

In January 2003, the US EPA began recognizing the practice of trading pollutant loads between point sources or mixing point and non-point sources when it issued a *Water Quality Trading Policy*. The policy recognizes the costs and benefits of the program which encourages states and tribes to "develop and implement water quality trading programs for nutrients, sediments and other pollutant where opportunities exists to achieve water quality improvements at reduced costs."

Trading works best when the following conditions apply:

- A driver exists which motivates wastewater facilities to seek pollutant reductions.
- Sources have significantly different costs associated with pollutant reductions.
- Necessary levels of substance reduction are not so large that all sources must be reduced.
- Jurisdictions are willing to be innovative.

Water quality trading allows dischargers to take advantage of treatment efficiencies and various economies of scale leading to a more cost-effective achievement of water quality goals. In the US,

estimated cost savings for the regulated community ranges from hundreds of millions to billions of dollars.

Box 6. Watershed Approach – Lake Simcoe

The local municipality of Lake Simcoe recently had to address demands to increase its urban area to accommodate a growing population. It was calculated that the proposed new development would contribute an additional phosphorus (P) load of 20 kg/year. As its local wastewater facility was already operating at maximum efficiency and its Certificate of Approval required the facility to maintain existing phosphorus loadings entering the watercourse, management action was required. After undertaking an engineering cost-benefit study to evaluate the costs of upgrading the plant, it was determined that the cost would be $500,000, or $25,000/kg P/year.

The municipality decided to approach the Lake Simcoe Region Conservation Authority to assess if a phosphorus trade was feasible. First, they determined whether sufficient opportunities existed for urban storm water retrofit trades within the sub-watershed to ensure that the water quality of the local watercourse would not be further degraded. Then, the trading option was evaluated using a trading ratio of 8:1, based on a unit cost phosphorus reduction of $2,500/kg for storm water retrofits. In other words, for every kg of P allowed to be discharged by the plant, 8 kg would need to be reduced from urban runoff through storm water control best management practices. The total cost to the municipality for the trade would therefore be:

8 (trading ratio) X 20 (kg P to trade) X $2,500 (cost/kg P)

= $400,000

Savings: about $100,000 and reduction of an additional 140 kg of phosphorus per year from entering the local watercourse and Lake Simcoe.

Box 7. Watershed Approach – South Nation

The village of Winchester in North Dundas Township was under a development freeze pending an increase in water supply and expansion of their wastewater facilities. The village consulted with the Ontario Ministry of the Environment (MOE) and realized that policy requirements did not allow any new phosphorus discharges into the South Nation River. The village council passed a resolution to conduct a Phosphorus Management and Water Quality Environmental Assessment in December 2002. The environmental assessment included:

1. An assessment of the current situation and future conditions.
2. Options for treatment.
3. Public consultation.
4. Preferred options for environmental, economic and social reasons.

Based on the environmental study report, the proposed resolution included an expansion of the wastewater facility and a reduction of phosphorus (P) from non-point sources. The cost to reduce phosphorus was calculated to be $300/kg P removed. Phosphorus reductions would be administered through the existing Clean Water Program. The cost was calculated based on program experience and was dependent on the amount of phosphorus to be removed as approved by the MOE. The new phosphorus loading was projected to be 160 kg from the treatment plant with an offset ratio of 4:1. The calculation for removal was:

160 kg P (discharge) X 4 (offset ratio)
= 640 kg P

640 kg of phosphorus was to be removed from non-point source projects.

The cost was calculated as follows:

640 kg P (offset target) X $300/kg P (Clean Water Program Delivery Costs)
= $192,000

This project was supported by the province and funded over 5 years. Annual reports are submitted to the MOE as part of the certificate of approval reporting requirements until total monies are spent and the offset load is accounted for.

Box 8. Watershed Approach – Lake Dillon, Colorado

Studies determined in the early 1980s that excessive phosphorus discharge was accelerating algae growth, causing low dissolved oxygen levels in Dillon Reservoir, 70 miles west of Denver, Colorado. Data collection and modeling results indicated that about half of the anthropogenic phosphorus loads entering the reservoir were contributed by point sources, mainly from four wastewater facilities. The other half were from non-point sources, primarily individual septic systems and urban runoff. The State of Colorado estimated that in order to maintain the health of Lake Dillon, the amount of phosphorus coming from the four major wastewater facilities would need to be reduced. Rather than having to upgrade their own facilities, the plants were offered the option of implementing controls for existing urban non-point sources. Cost studies showed that wastewater facilities could achieve the same overall reductions in phosphorus for half the cost if they concentrated on non-point sources rather than solely on their own emissions.

The EPA approved a trade ratio of 2:1 so enough phosphorus would be reduced in the basin to allow the wastewater facilities and new non-point-sources to grow given estimated population growth.

The Frisco Sanitation District wastewater facility decided to address non-point source storm water runoff of phosphorus into the lake. The district built storm water control structures to guide the surface runoff back underground. Approximately 50 to 70 per cent of the phosphorus was removed as the water filtered through the pipes. The number of credits gained from this project was set equal to the amount of phosphorus removed, determined by monitoring the flow and concentration of incoming and outgoing water—an example of a direct measurement of non-point source effluent discharge. The District was offered phosphorus credits for its non-point source reduction by the Colorado Water Control Commission. The District needed only a few of the phosphorus credits allocated to it annually and donated its surplus credits to offset increased phosphorus discharges associated with the construction of a new town golf course. Here, trading allowed further development while still improving lake water quality. The example of Dillon Reservoir demonstrates that it is possible to directly measure non-point source loads and, in addition, that trading does not necessarily need a tangible cash transaction for cost savings to occur.

Box 9. Watershed Approach – New Hamburg

New Hamburg's wastewater facility had to address environmental concerns associated with phosphorus effluent discharges, as it had recently reached its maximum allowable limit. The cost to increase treatment at the plant would have been approximately $1000/kg P reduced. The municipality decided to take an

alternate approach and target non-point sources through a water quality program which offers incentives for local landowners to control the phosphorus discharging into the surface waters. The cost of this program was $85/kg P reduced, a significant savings over traditional treatment upgrades.

4.9 Potential Challenges

As with any approach used in the management of MWWE, various barriers need to be acknowledged when implementing a watershed-based approach:

1. **Accurate measurement of non-point source discharges.** Approaches commonly used to tackle this barrier include the use of site-specific modeling or the use of monitoring/sampling stations to measure non-point dischargers.
2. **Legal implications of upgrades.** Users who make investments may feel they own the resultant loading reductions.
3. **Lack of sustainable funding.** Strategies for addressing sustainable funding issues include user pays/polluter pays models.
4. **Excessive bureaucracy and politics.**
5. **Weak environmental legislation.** Challenges include inadequate penalties for environmental violations and a lack of national water quality standards and guidelines.
6. **Lack of up-to-date watershed data and useful decision-support tools.**
7. **Lack of technical expertise.** This includes a lack of expertise to tackle the biophysical, social and economic complexities of watershed management.
8. **Resistance to change.** The prevailing focus is typically on a supply-oriented biophysical approach rather than a conservation/efficiency approach.
9. **Unrealistic expectations.** Stakeholders may demand immediate results.

4.10 Future Directions

Water management bodies (Conservation Authorities in Ontario, the BC Watershed Stewardship Alliance, Saskatchewan Watershed Authority, Organismes de basins versants in Quebec*)* currently provide direction for water management. However, many of these agencies focus on water quantity rather than looking at water quality from a watershed perspective.

Operating and coordinating programs on a watershed basis makes good sense for environmental, financial, social and administrative reasons. Because a watershed-based approach puts choice and control in the hands of those who directly manage the watershed, actions are based on shared information and a common understanding of the roles and priorities of the stakeholders involved. It allows managers from all levels of government to better understand the cumulative impacts of various human activities and determine the most critical problems within each watershed. This encourages decision-making in areas where information is available and promotes analysis and scientific verification in areas where information is incomplete.

A watershed-based approach raises environmental awareness and promotes public support. Both acute and chronic effects can be effectively dealt with. Most importantly, managing MWWE from a watershed perspective ensures the most cost effective methods for improving water quality are examined.

5. Effluent Characterization and Monitoring

This section offers guidance on characterizing and monitoring MWWE to determine:

- Which substances in MWWE are of concern (initial characterization).

- If the MWWE complies with the National Performance Standards and other site-specific discharge limits.
- If the MWWE is achieving its EDOs.

It also offers guidance on sampling, preservation and testing procedures and standards, as well as responses to toxicity test failures.

Wastewater facilities are classified into five categories based on annual average daily flow rates, as presented in Table 2.

Table 2. Facility Size Categories

Facility Size	**Flow (m^3/d)**
Very Small	≤ 500
Small	> 500 – 2,500
Medium	> 2,500 – 17,500
Large	> 17,500 – 50,000
Very Large	> 50,000

Very small and small facilities which have industrial input associated with MWWE flow are classified as medium size facilities. Wastewater facilities may be reclassified from medium to small or very small if pre-treatment of the industrial input before it is discharged to the sewer produces an effluent quality comparable to domestic wastewater or better, or if the industrial input is removed from the sewer. Industrial input is defined as non-domestic process water from the industry categories specified below that together exceeds 5% of total dry weather flow:

- Resource exploration and development (e.g., mining, forestry, oil and gas)
- Manufacturing/ fabrication
- Processing (including food)
- Marine or air transport (including container cleaning)
- Landfill leachate
- Hospitals and laboratories (but not nursing stations)

Process water from any industry from another category may also be designated as industrial input by a jurisdiction when there is reasonable potential that it may adversely affect the wastewater facility's operation or capacity to meet discharge requirements or EDOs.

5.1 Initial Characterization of Effluent

A one year initial characterization of the effluent discharge will determine which substances are of concern for the particular wastewater facility and will therefore need EDOs (see section 3). Initial characterization of MWWE is the first step in conducting the environmental risk assessment (ERA) (see sections 3 and 4). A standard test series as listed in Table 3, plus measurement of other substances associated with industrial or commercial activities that discharge into the sewer system, must be included in this initial characterization (see Appendix A for more detail). Substances of concern are those that are present in the MWWE discharge at concentrations with "reasonable potential" to exceed EQOs at the edge of the mixing zone. Once the substances of concern are identified, based on initial characterization results, they should be added to the MWWE regular monitoring program so improvements can be monitored. Discharge limits should also be established, whenever possible or practical.

All samples for effluent characterization must be taken at the discharge, before the effluent enters surface waters.

Table 3. Test Groups for Wastewater Characterization

Test Group*	**Parameters**
C-01A Selected major ions	Fluoride
	Nitrate
	Nitrate + Nitrite
C-02C	Total Extractable Metals and Metal Hydrides, full range
C-04D	COD
C-06	Organochlorine Pesticides
C-06	PCBs
C-07	PAHs
C-14	Cyanide (total)
C-15	pH
C-16	Volatile Organic Compounds
C-19	Mercury
C-25	Phenolic compounds
Tests must be done by an accredited lab.	
* Test group code of the Canadian Association for Environmental Analytical Laboratories. Labs listed at www.CAEAL.ca.	

For continuous discharges, the monitoring frequency for each wastewater facility size is listed in Table 4. Samples are 24-hour composites. Continuous discharges include regular discharges from batch treatment processes, such as a sequencing batch reactor, that discharge on a frequent and regular basis. For intermittent discharges in each size classification, two samples should be taken during each discharge period: one sample near the start of the discharge period and one near the end. For facilities with more than one discharge per year, each discharge should be sampled but the number of tests required should not be more than that required for continuous discharges for the same size facility.

Table 4. Monitoring Frequencies for Initial Characterization (1 year), Continuous Discharge

Facility Size	**TRC[1] (or dechlorination agent)**	**$CBOD_5$, TSS, Pathogens and Nutrients[2]**	**Test Series/Substance**	**Acute Toxicity**	**Chronic Toxicity**
Very Small	Daily	Monthly	n/a	n/a	n/a
Small	Daily	Monthly	n/a	Quarterly	Quarterly
Medium	Daily	Every two weeks	Quarterly	Quarterly	Quarterly
Large	Twice per day	Weekly	Quarterly	Monthly	Monthly
Very Large	Three times per day	Daily (5-7 days/week)	Quarterly	Monthly	Monthly

[1] If chlorine is used in the wastewater facility
[2] Nutrients include ammonia, TKN (ammonia + organic N) and total phosphorus. Temperature and pH must also be measured to determine the level of toxicity of ammonia.

All test series and substances associated with industrial or commercial activities must be completed for each effluent from medium, large and very large facilities over a one year period as shown in Table 4. Very small and small facilities with industrial input are classified as medium facilities and are required to

conduct initial characterization of the effluent as per the requirements of a medium facility. Additional information on potential substances in wastewater may be found at http://www.epa.gov/safewater/swp/sources1.html and http://cfpub.epa.gov/npdes/pretreatment/pstandards.cfm#categorical.

Since very small and small facilities typically represent a small risk, they are not required to complete the series of tests required for larger facilities. In these facilities, the risks usually relate to nutrients (TKN [ammonia, organic N], nitrate and nitrite, total phosphorus) and pathogens. Therefore, very small and small facilities are required to monitor these substances to determine if EDOs will be required. In some situations, site-specific risk factors may increase the risk. Such factors include the presence of sensitive areas in the nearby receiving water (e.g., fish spawning areas, water intakes, recreational usage, fishing, shellfish harvesting areas) and cumulative impacts from other nearby sources. Where these risks are present, an initial characterization of effluent for substances other than nutrients and pathogens should be conducted in order to confirm the nature of any risk posed by even very small facilities.

Initial whole effluent toxicity testing is included in the monitoring for all but very small facilities. Each sample should be flow-weighted and composite in nature, taken during days of full commercial and industrial activity when the wastewater facility is operating normally and effluent is being discharged. Days with flows strongly affected by storm or thaw events should be avoided. Samples for all three types of tests (National Performance Standards, EDOs for individual substances and toxicity) should be collected at the same time at the outfall or discharge point. An owner may use existing information, collected within the previous three years, to satisfy all or part of this requirement, provided that no major change has occurred in the wastewater system in the intervening period. Major changes include the addition of significant lengths of new sewers, the addition of major new industrial discharges to the sewer system, or alterations or upgrades to the treatment system.

Toxicity testing assesses the integrated effect of the wide variety of substances in an effluent. It must include a minimum of two species, to address different trophic levels, for both acute toxicity and chronic toxicity. Recommended acute toxicity tests use rainbow trout and *Daphnia magna* as test species and use either single concentration or multiple concentration test methods. Chronic toxicity tests include both fathead minnow and *Ceriodaphnia dubia* as standard test organisms (see Appendix B for the recognized methods for each recommended test). Other chronic tests may be used, with prior approval of the jurisdiction, to replace the ones listed above or as additional tests when required by site-specific conditions.

Every ten years, or earlier at the discretion of the jurisdiction, an evaluation must be done to determine if significant change that may affect effluent quality has occurred in the wastewater system. If so, the facility must redo the initial characterization of its effluent. If the effluent's character has changed, new or modified EDOs may need to be developed.

5.2 Compliance Monitoring – National Performance Standards

MWWE discharge characteristics must be compared with the National Performance Standards through effluent compliance monitoring. When National Performance Standards are not achieved, wastewater facilities must look for opportunities to reduce the discharge of substances at the source and/or improve the facility or its operation so the standards can be achieved. MWWE may not be diluted to achieve National Performance Standards or any other discharge limit.

All monitoring samples are taken at the discharge, before the effluent enters surface waters.

5.2.1 Continuous Discharge Facilities

Compliance with the National Performance Standards must be continuous and therefore requires regular and continuous monitoring. Table 5 identifies the minimum monitoring frequencies for National Performance Standard substances.

Table 5. Minimum Compliance Monitoring Frequencies for National Performance Standards, Continuous Discharge

Facility Size	TRC[1] (or dechlorination agent)	TSS and $CBOD_5$	Period for calculation of periodic averages[4]
Very Small	Daily	Monthly[2]	Quarter
Small	Daily	Monthly[2]	Quarter
Medium	Daily	Every 2 weeks	Quarter
Large	Twice per day	Weekly	Month
Very Large	Three times per day	Daily[3]	Month

1: TRC or the dechlorination chemical that is used. Only required if chlorine is used in the wastewater facility.
2: May be reduced to quarterly for existing lagoons, in which case averaging period would be annual.
3: 5 – 7 days per week.
4. For compliance with the National Performance Standards for $CBOD_5$ and TSS. Period is based on facility size and does not change for facilities that may have a higher monitoring frequency.

TRC is monitored only if chlorine or chlorine compounds are used in the treatment process. It must be measured on site, owing to its rapid degradation. If dechlorination is also practiced, the dechlorination substance may be monitored; measuring any residual amount of the dechlorination substance considered to be equivalent to no TRC present. In addition to monitoring the dechlorination substance, monitoring for TRC should take place periodically using a method that measures down to at least 0.05 mg/L to confirm the test results with the dechlorination substance.

Effluent flow from each outfall must also be monitored each day to calculate the total volume of effluent discharged each day and the annual average flow. Flow may be monitored with a system that takes continuous measurements or by using a method that meets generally accepted engineering principles, such as standard methods for measuring liquid flow in open channels or measuring fluid flow in closed conduits. These standard methods are published by the International Organization for Standardization. Flow monitoring equipment should be accurate to within 15% of the measured flow and should be calibrated at least once per year.

5.2.2 Intermittent Discharge Lagoons

For lagoon systems that discharge only when lagoons are emptied, typically once or twice per year, one sample is required during each discharge period. The sample must be taken during the last half of the discharge period and analysed for TSS, $CBOD_5$ and, if chlorination is practised, TRC or the dechlorination chemical used. For discharge periods of more than one month, samples should be taken every two weeks, with at least 5 days between samples.

As with continuous discharge facilities, effluent flow from each outfall must be monitored each day during which effluent is discharged in order to calculate the total volume of effluent discharged each day and the annual average flow. Flow may be monitored with a system that takes continuous measurements or by using a method that meets generally accepted engineering principles, such as standard methods for measuring liquid flow in open channels or measuring fluid flow in closed conduits. These standard methods are published by the International Organization for Standardization. Where wastewater is trucked rather than piped, flow may be estimated using generally accepted engineering principles.

5.3 Monitoring of Effluent Discharge Objective Substances

Based on the initial characterization results and the ERA, EDOs are established for certain substances on a site-specific basis (see sections 3 and 4 for details). All substances with mean effluent values over 80% of the EDO value must be monitored. Monitoring frequency would not necessarily be the same for all substances since some substances are very expensive to measure and/or analytical expertise may not be available locally. Monitoring requirements are specified in site-specific regulatory instruments (e.g., permits, certificates, licenses, regulations) issued by the jurisdiction.

If test results for a substance are consistently less than 80% of the EDO value, the monitoring frequency for that particular substance can be reduced when the regulatory instrument is periodically reviewed or the instrument allows it. Should the effluent discharge quality (periodic average) subsequently exceed 80% of the EDO, the monitoring frequency must return to the initial, more frequent one. On the basis of at least twenty consecutive results spread over at least one year that measure less than 80% of the EDO value, monitoring for that substance can be eliminated. Every ten years, or earlier at the discretion of the jurisdiction, an evaluation must be done to determine if significant change has occurred in the wastewater system that may affect effluent quality. If so, the facility must return to the initial monitoring frequency. Reduced monitoring frequencies or elimination of monitoring cannot be applied to phosphorus, ammonia and pathogens.

When all EDOs are being achieved, no other action is required since the environment is considered to be protected. Otherwise, risk management is needed (see section 6).

5.4 Toxicity Testing

Medium to very large facilities, including very small and small facilities with industrial input, must conduct acute and chronic toxicity tests on an ongoing basis. The same requirements apply to both continuous and intermittent discharges. Toxicity testing may also be required on a site-specific basis for small and very small facilities where a risk has been identified and regulatory authorities incorporate the requirement into their regulatory instrument. Toxicity test samples must be collected at the end-of-pipe as either composite samples or as grab samples. Samples must be taken at least three weeks apart for monthly testing and at least two months apart for quarterly testing.

For acute toxicity testing, either the single concentration or multiple concentration rainbow trout test following method EPS 1/RM/13 and *Daphnia magna* test following method EPS 1/RM/14 is required. Test failures are defined as effluent at 100% concentration that kills more than 50% of the test organisms during the specified test period.

For chronic toxicity testing, the fathead minnow test following method EPS 1/RM/22 and *Ceriodaphnia dubia* test following method EPS 1/RM/21, both using serial dilutions, are required. Test failures are defined as observed chronic effects during the specified test period and a result, expressed in TU_Cs, higher than the chronic WET EDO. Toxicity testing species and minimum testing frequencies are presented in Table 6.

Table 6. Toxicity Testing

Facility Size	Acute Toxicity Tests	Acute Toxicity Testing Frequency	Chronic Toxicity Tests	Chronic Toxicity Testing Frequency
Very Small	n/a	n/a	n/a	n/a
Small	n/a	n/a	n/a	n/a
Medium	-Rainbow trout -*Daphnia magna*	Quarterly	-Fathead minnow -*Ceriodaphnia dubia*	Quarterly
Large	-Rainbow trout -*Daphnia magna*	Quarterly	-Fathead minnow -*Ceriodaphnia dubia*	Quarterly
Very Large	-Rainbow trout -*Daphnia magna*	Monthly	-Fathead minnow -*Ceriodaphnia dubia*	Monthly

The test methods for acute and chronic testing are listed in Appendix B.

When the effluent has been found to be non-toxic for a particular toxicity test over the previous 12 months for continuous discharge facilities or over four discharge periods for intermittent discharge facilities (i.e., no failed test), the facility can reduce its frequency for that test. Medium facilities can reduce the frequency of toxicity testing to quarterly tests once every three years. For large and very large facilities, toxicity testing frequency can be reduced to quarterly testing every second year and quarterly testing every year, respectively. If the effluent fails a test during any period of reduced toxicity testing frequency, the facility must return to the testing frequency set out in Table 6 until the effluent is again non-toxic over 12 months of testing for continuous discharge facilities or over four discharge periods for intermittent discharge facilities.

The first year of toxicity testing can occur during the initial characterization phase (see section 5.1).

Further work is needed to determine when a species can be eliminated from regular toxicity testing. Conditions which may allow for the elimination of a test species may include when the test has 20 consecutive passes spread over at least one year.

Every ten years, or earlier at the discretion of the jurisdiction, an evaluation must be done to determine if significant change has occurred in the wastewater system that may affect effluent quality. If significant change has occurred, the facility must return to the initial species and frequencies, as described in Table 6.

5.5 Sampling and Analytical Testing Methods

Sampling should be done by qualified personnel and in accordance with ISO 5667-10, *Water quality – Sampling - Part 10: Guidance on sampling of waste waters* or another recognized guidance document. Except for substances like fecal coliforms or TRC, where instantaneous samples are necessary, effluent samples should be 24 hour composite samples preferably collected proportional to flow. For lagoons or other very long hydraulic retention treatment processes, instantaneous grab samples can be accepted if it is demonstrated that the quality of the wastewater does not change during the day. Samples for the National Performance Standards, EDOs and toxicity testing should be collected at the same time insofar as possible.

Effluent from a wastewater facility must be sampled upstream of the point where the effluent enters the receiving water body and downstream of any treatment process, including disinfection. Sample handling,

preservation and testing should be done in accordance with the most recent edition of the *Standard Methods for the Examination of Water and Wastewater*, or other recognized standards. All testing should be done by an accredited laboratory (CAEAL, Canadian Association of Environmental Analytical Laboratories, or CEAEQ, Centre d'Expertise en Analyse Environnementale du Québec).

The test to determine the $CBOD_5$ of an effluent is described in subsections 5210A and 5210B, with the inhibition of nitrification, of *Standard Methods for the Examination of Water and Wastewater*, 21st Edition, 2005, published jointly by the American Public Health Association, the American Water Works Association and the Water Environment Federation, as amended from time to time. An equivalent test method required by or authorized under the law of the province or territory where the wastewater facility is located may also be used. The quantity of $CBOD_5$ should be measured in an unfiltered sample.

The test to determine the presence and quantity of TSS in effluent is described in subsections 2540A to 2540E of *Standard Methods for the Examination of Water and Wastewater*, 21st Edition, 2005, published jointly by the American Public Health Association, the American Water Works Association and the Water Environment Federation, as amended from time to time. An equivalent test method required by or authorized under the law of the province or territory where the wastewater facility is located may also be used.

The test to determine the presence and quantity of TRC in effluent is the applicable method described in subsections 2350A to 2350B of *Standard Methods for the Examination of Water and Wastewater*, 21st Edition, 2005, published jointly by the American Public Health Association, the American Water Works Association and the Water Environment Federation, as amended from time to time. An equivalent test method required by or authorized under the law of the province or territory where the wastewater facility is located may also be used.

Where an effluent is chlorinated and subsequently dechlorinated, the effluent may be tested for the dechlorination substance instead of TRC since any excess or presence of the dechlorination substance is indicative of complete dechlorination and the absence of residual chlorine. The test method for the dechlorination substance must be a standard method.

5.6 Toxicity Failures and Toxicity Reduction Evaluation

5.6.1 Toxicity Test Failure

When a facility fails a toxicity test, it is required to determine and correct the cause of the failure through a Toxicity Reduction Evaluation (TRE). A TRE is a site-specific study conducted in a stepwise fashion to achieve this end. A TRE may be as simple as reviewing the treatment plant operations and effluent chemistry and making minor adjustments, or may involve a more complicated series of laboratory investigations and extensive corrective measures. The first step in the TRE is a requirement to immediately (within 5 days) conduct another toxicity test using the same species that failed the first test. The second test must be a multiple concentration test in order to provide additional information on the nature and cause of the toxicity. If the second test passes, the cause may be transient and thus difficult to identify. A third multiple concentration test, with sampling one week after the second test was started, is required. If both the second and third tests pass, the facility can return to its regular testing frequency set out in Table 6. If either the second or third test fails, further TRE activities must be undertaken.

A generalized process on the implementation of a TRE is shown in Figure 11 and explained in more detail in the text that follows.

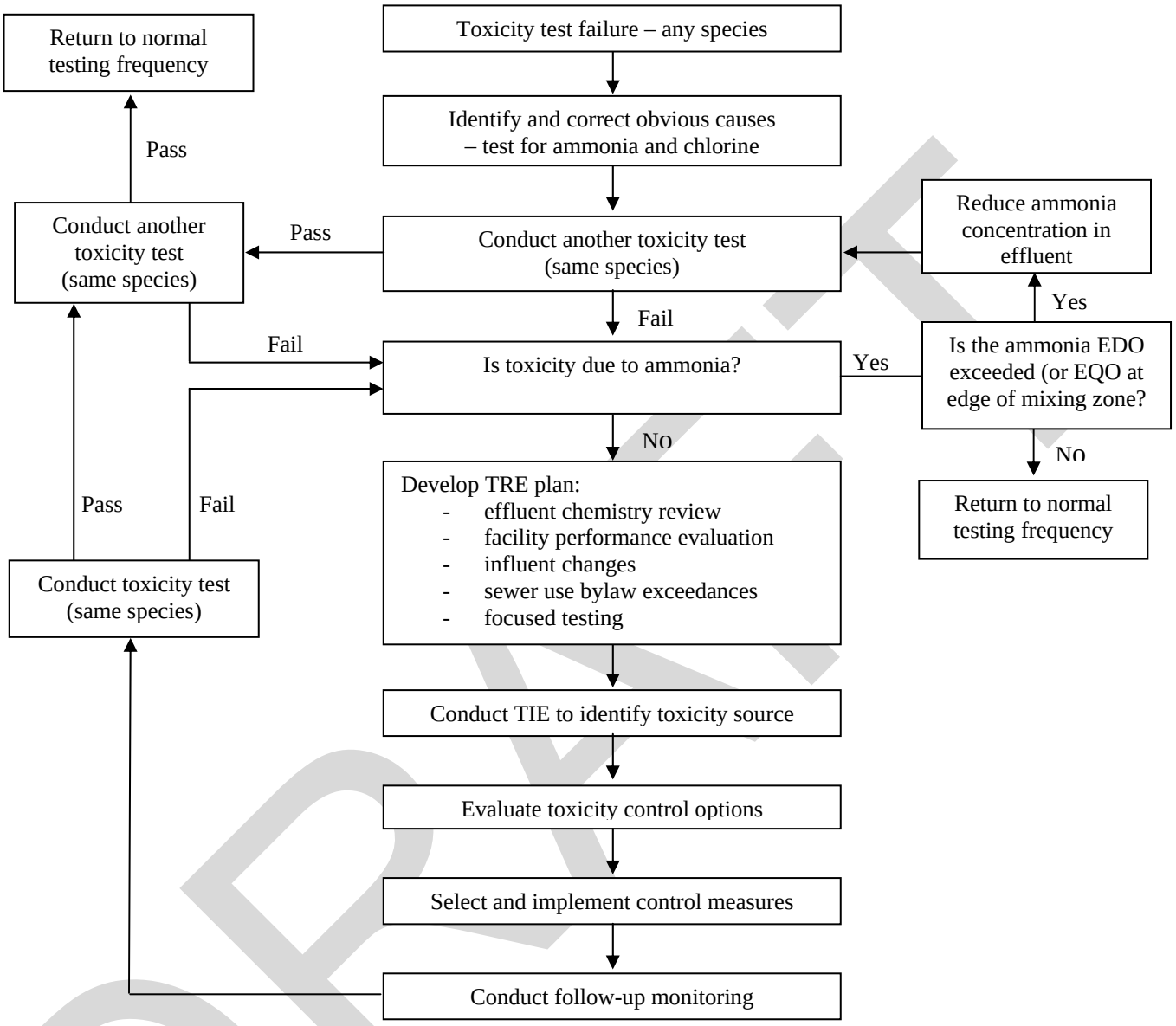

Figure 11. TRE Process

5.6.2 Initial Toxicity Reduction Evaluation Response

Following the first toxicity test failure, the facility should review available data to determine if there is a readily apparent cause for the failure(s), such as a malfunction or a change in the influent. The operator should have data on system operations, flow rates, unusual or upset conditions, or other information that may quickly and easily identify the cause and suggest corrective action(s). It is prudent to sample and analyze the toxicity samples for TRC and ammonia since the data may assist in quickly confirming or ruling out the most common causes of toxicity. Subsequent toxicity tests may confirm that the effluent is no longer toxic (the facility may return to the testing frequency in Table 6) or may be used to further investigate the cause of the toxicity. If the cause is not apparent from available data or the corrective action(s) is (are) not successful in eliminating the cause of the toxicity, further investigation is warranted.

5.6.3 Ammonia as a Potential Toxicant

Ammonia is commonly associated with acute toxicity in MWWE. Since fish are more sensitive than invertebrates to ammonia, their response is assessed most often in investigations of ammonia toxicity.

If not already available, the wastewater facility should determine the concentration of ammonia (total ammonia expressed as nitrogen) in, and the pH of, the effluent during the rainbow trout acute lethality test exposure. Referencing these values to the curve in Figure 12 (abstracted from Environment Canada's *Guideline for the Release of Ammonia Dissolved in Water Found in Wastewater Treatment Plants*) will indicate if ammonia is a likely cause for concern with the effluent. The ammonia concentration (y) corresponding to any pH (the points on the curve) may also be calculated using the following equation:

$$y = 306132466.34 \times (2.7183^{(-2.0437 \times pH)})$$

If the concentration-pH data point falls on or above the threshold concentration curve, the effluent is considered to contain an acutely toxic concentration of ammonia (i.e., the effluent ammonia concentration is above the estimated LC50 at the pH of the exposure). Since the curve was developed using pH-adjusted data, such an ammonia concentration would be high, and the wastewater facility may wish to consider actions to reduce the ammonia concentration to a non-acutely toxic level. If the concentration-pH data point falls below the threshold concentration curve (in the shaded area), the effluent may not contain an acutely toxic concentration of ammonia.

In either case, the wastewater facility must then evaluate the impact of ammonia on the receiving water body by checking the chronic toxicity at the end of the allocated mixing zone. This may be done by comparing the ammonia concentration at the end of the mixing zone (by theoretical modeling from the measured ammonia concentration or by actual sampling) to the applicable water quality guideline (such as the *Canadian Water Quality Guidelines*) for ammonia. This may already be calculated as the EDO for ammonia, which is applicable at the end-of-pipe. If the ammonia concentration at the end of the mixing zone is below the water quality guideline or if the EDO is met, there is no concern for chronic toxicity and the discharge is acceptable with respect to ammonia. If the ammonia concentration is above the water quality guideline or if the EDO is exceeded, there is concern for chronic toxicity and actions must be taken to reduce the ammonia concentration in the effluent such that there is no chronic toxicity at the end of the mixing zone.

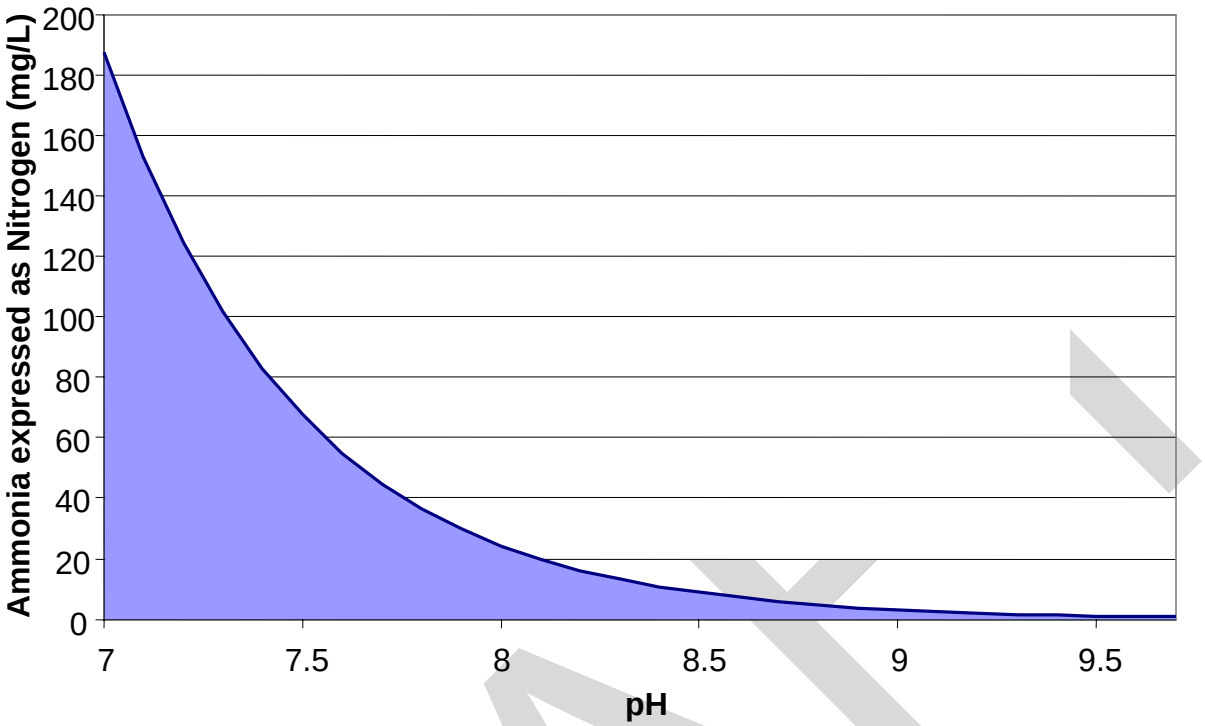

Figure 12. Threshold Acute Concentration of Ammonia versus pH

5.6.4 Subsequent Toxicity Reduction Evaluation Response

If the toxicity of the effluent cannot be attributed to a cause or source in a preliminary investigation, further efforts are required. The following general steps may be taken when developing and implementing a TRE plan:

- Evaluate the operation and performance of the wastewater facility to identify and correct treatment deficiencies contributing to effluent toxicity (e.g., operational problems, chemical additives, incomplete treatment).
- Review effluent chemistry for likely toxicants.
- Carry out a laboratory Toxicity Identification Evaluation (TIE) to characterize, identify and confirm the toxicant(s).
- Trace the effluent toxicant(s) and/or toxicity to its sources.
- Evaluate, select and implement toxicity reduction methods or technologies to reduce effluent toxicity to an acceptable level.

The cause of the toxicity failure may be obvious, such as an operational failure in the wastewater facility or a marked change in the influent. Analysis of the facility performance logs or data should provide some insight into this kind of cause. If there is no obvious cause for the toxicity failure, the facility should consider whether it has sufficient information on the duration and magnitude of the toxicity to pose a reasonable opportunity to identify the cause. Additional chemical and toxicological sampling should be undertaken as soon as possible to better detail the magnitude and frequency of the toxicity and to help identify the toxicant. This may be a formal TIE or somewhat less formal as long as progress is made towards improved effluent quality.

It is not feasible to detail a universal work plan leading to specific TIE or TRE activities. Each case is unique and decisions on an appropriate approach should be made by individuals experienced in the application of these tools. Further guidance can be obtained from the US EPA publication *Toxicity*

Reduction Evaluation Guidance for Municipal Wastewater Treatment Plants (available at http://cfpub.epa.gov/npdes/docs.cfm?document_type_id=1&view=1&program_id=13&sort=date_published). However, it is incumbent on wastewater facilities to develop a plan that presents a probable chance of identifying the toxicant(s) within a reasonable time period and to initiate actions to reduce the toxicity to an acceptable level as quickly as possible. Results from initial TRE activities should provide direction for subsequent testing and activities. Regular compliance monitoring with respect to National Performance Standards and EDOs must be continued during the development and implementation of a TRE program.

Intermittent or ephemeral toxicity may be difficult to identify and therefore to correct. In these cases, modifications to normal TIE and TRE procedures may be required in an attempt to identify and reduce the toxicity.

Where an effluent has failed a toxicity test and the owner has embarked on a TRE program, and even when an obvious cause of toxicity has been identified and corrected, the owner must conduct toxicity tests at least at the frequency indicted in Table 6 for at least one year after the cause of toxicity has been corrected, in order to confirm that the correction has been effective. Toxicity tests should be conducted as soon as possible after corrective measures have been taken. The effect of the corrective measures should be observable in the effluent.

In cases where the effluent continues to fail toxicity tests, all tests should be conducted using the multiple concentration (LC50) approach in order to follow the progression of the magnitude and the rate of reduction of the effluent toxicity.

5.7 Combined Sewer Overflows

Combined sewer overflow (CSO) events must be recorded in order to assess the frequency and severity of overflows. There should be no dry weather flow. Flows may be monitored for frequency of flow through simple mechanical measures that clearly indicate flow has occurred and that are reset quickly after a storm event. Where possible and feasible, the volume of a CSO should be recorded or estimated using more sophisticated methods and equipment, starting with major CSOs or those causing the greatest concern. The data should be recorded, along with information on storm event and snowmelt event occurrence (dates) and severity (rainfall), in order to help design any required mitigation of CSOs. Further guidance can be obtained from the US EPA publication *Combined Sewer Overflows Guidance for Monitoring and Modeling* (available at http://www.epa.gov/npdes/pubs/sewer.pdf).

6. Risk Management Decision-Making

This section offers guidance on how to make environmental risk management decisions when MWWE discharges are not meeting EDOs. The risk management decision process described below is directed at the main effluent discharge, but can be adjusted for use with CSOs and sanitary sewer overflows (SSOs).

Since risk management decisions are based on the level of risk, wastewater facilities need to determine the level of risk posed by an exceedance. An EDO exceedance does not necessarily mean the receiving environment is in immediate danger. Rather, risk is related to the magnitude and frequency of exceedances. Monitoring in the receiving environment (water quality, biota, etc.) or of drinking water quality (for EDOs related to drinking water objectives) can be used to determine the real impacts of EDOs not being achieved. EDOs are objectives and should not automatically be translated into discharge requirements.

6.1 Risk Management Decision Process

When an EDO is exceeded, efforts must be made to reduce the discharge of the substance of concern (or frequency/volume of overflows) as much as possible, by looking for opportunities to reduce it at one or more stages of the wastewater system: sources, collection, and treatment. Owners should determine:

- The severity and frequency of the exceedance.
- The source of the excess contaminant (or the cause of excess overflow frequency/volume).
- The mechanisms available to reduce the contaminant discharge and their cost.
- The feasibility of using these mechanisms (i.e., is the technology available and at a reasonable cost).
- The side effects from using the corrective measure (effects on biosolids, effects on meeting other discharge limits, etc.).

Facility owners should also consider the relative importance of the substance in the wastewater discharge compared to other contributors in the watershed; the wastewater discharge could be comparatively insignificant. When upstream concentrations are already high, the discharge may be allowed at concentrations equivalent to upstream concentrations. This situation could conversely indicate that no new discharge should be allowed in the watershed and that a watershed plan should be established.

In sewage dominated streams (i.e., when the effluent flow represents the total flow of the immediate receiving stream for more than 90% of the year), the jurisdiction could decide to apply the mixing zone where the stream empties into a larger, year round receiving body of water. This is likely the worst-case situation, as any flow in the intermittent stream will augment dilution of the effluent. Remember that compliance monitoring for the National Performance Standards takes place at the end of the discharge pipe.

Risk management decisions must also consider funding possibilities and availability, societal values and stakeholder input (see Figure 13). Owners should determine what internal and external funding sources are available to address the costs of reduction measures and to determine if the costs and measures are socially acceptable. Internal funding sources include tax rates or user fees based on full cost accounting.

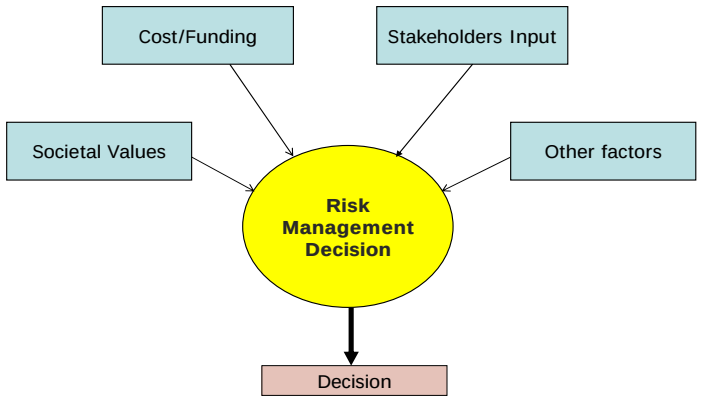

Figure 13. Risk Management Decisions

The analysis leading to risk management decisions is site-specific and cannot be specified in detail. The various factors involved in it are suggested above but the exact mechanism of how they are used, what weight each one carries, etc., must be left to discussion between the owner and the people the facility serves, and between the owner and the regulatory authorities. As a general rule, though, owners should address higher risks first.

After the analysis, facility owners have two options:

1. Implement contaminant reduction measures (see discussion on reductions later in this document):
   - After reduction measures are in place, compare the discharge quality to the EDO to ensure that measures have been effective. If the EDO is still not achieved, another risk management decision is needed. This process is repeated until all the EDOs are achieved.
2. Establish interim discharge limit(s):
   - Revisit the environmental risk assessment and the derivation of the EQO and EDO to ensure the EDO is still valid.
   - Establish interim discharge limit(s) for substance(s), based on risk and available/affordable technology.
   - Periodically review the discharge limit(s), available technology and funding possibilities, in order to lower discharge limits to the EDO(s) as soon as feasible.

The first option is preferred, but in some cases the owner may not, with reasonable effort, be able to further improve the wastewater quality for technical, financial, societal or other reasons. A risk management analysis may indicate that nothing more can be done at the time. In these cases, the jurisdiction may specify an interim discharge limit in a permit. The EDO then becomes a long term goal that the owner must always strive to attain. The interim discharge limit must be reviewed periodically in order for it to be reset as soon as possible to a level as close as possible to the EDO.

All permitting authorities should have an instrument, such as a renewable permitting system, for periodically reviewing effluent discharge limits and improving progress toward EDOs. In the United States, for example, all MWWE discharges are required to have a permit under the National Pollutant Discharge Elimination System (NPDES). NPDES permits are typically issued at five-year intervals on a site-specific basis, taking into consideration the impact of the proposed discharge on the quality of the receiving water relative to the state Water Quality Standards (Minnow Environmental, 2005). Effluent limits, monitoring conditions, standard and special conditions are specified in the NPDES permit. Special conditions may include special studies, additional monitoring, pollution prevention, compliance schedules and other conditions related to the National Pretreatment Program, sewage sludge, combined sewer and sanitary sewer overflows, and separate storm sewer systems. For more information on the NPDES, see: http://cfpub.epa.gov/npdes/.

6.2 Reduction at the Source

Controlling substances at their source is usually the best solution, where practical. Preventing substances from entering the sewer system or treating small quantities of concentrated wastewater is simpler and less costly than treating large quantities of a dilute wastewater. Preventing substances from entering the sewer system means these substances won't wind up in the MWWE, in the sludge, in air emissions or in overflows, and won't affect treatment performance or worker safety at the wastewater facility.

Controlling sources of pollution can be done in a number of ways, including: substance prohibition, pollution prevention programs (P2 plans), sector control programs, use of the 'Local Limits' methodology developed by the US EPA, sewer use by-laws, demand side water reductions (water conservation), and public education (see Figure 14). A model sewer use bylaw has been prepared as a tool to support municipalities in implementing the Strategy (see Technical Supplement 4). Further details on controlling sources of pollution are described in *Source Control Tools* (Marbek, 2006), *Wastewater Source Control* (InfraGuide, 2003) and briefly in the sections that follow.

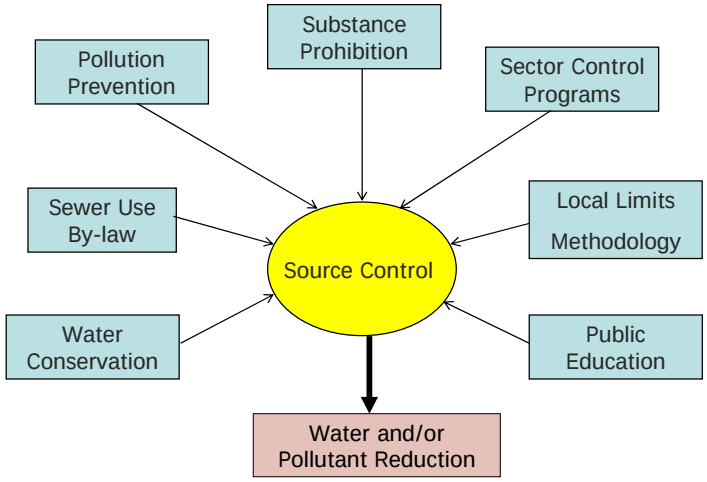

Figure 14. Reduction at the Source

Substance Prohibition
Under the *Canadian Environmental Protection Act (1999)*, the Canadian government can prohibit or restrict the use of substances that are considered toxic under the Act. Provincial, territorial and municipal governments can also restrict the use of substances within their jurisdictions, where they have the authority to do so.

Pollution Prevention Programs
Pollution prevention programs encourage industry, businesses, institutions and the public to eliminate, minimize or reduce sources of pollution, including those going into the wastewater collection system. Approaches that anticipate and prevent the generation of contaminants are preferred over other reduction methods such as treatment, reuse and recycling. The goal is to make pollution prevention the strategy of choice for protecting the environment and improving economic competitiveness.

CCME (1993) has developed the following principles to guide pollution prevention:

- All Canadians are individually and collectively responsible for the quality of the environment and should be involved in pollution prevention wherever they have the opportunity to do so.
- Prevention activities and associated costs should be borne by the producers of contaminants and waste.
- All jurisdictions should cooperate to harmonize their individual approaches to prevention.
- Voluntary action, regulation and economic instruments all have important, and often complementary, roles to play in pollution prevention. All approaches for prevention should be considered, with a view to using the most effective approach, or combination of approaches. Voluntary actions will be encouraged.
- Prevention should be considered at the earliest possible point in the development of any concepts, plans, policies, products, projects or processes.
- Pollution prevention planning should be a continuing process, incorporating opportunities for improvement on an ongoing basis, such as new scientific and technological developments.
- Prevention should apply throughout the entire life-cycle of a product.
- An ongoing effort should be made to ensure that prices better reflect the full costs of pollution (full cost accounting), in order to understand the real benefit of prevention.
- Full use should be made of pollution prevention opportunities to achieve greater domestic and international competitiveness.

All methods of source control should begin with and incorporate the principles of pollution prevention.

Sector Control Programs
Sector control programs target specific sectors that cause pollution and examine potential strategies for eliminating or reducing their contaminant discharges in wastewaters. Because specific sectors that contribute significant contaminant loads are targeted, early action is possible in a clean-up program. Since all industries within that sector are subject to the same controls and it is at the discretion of the producer to select the best method to achieve results, there is no competitive disadvantage for industries within the jurisdictions covered by the controls. Information on clean-up technologies specific to the sector can be cost shared and/or specifically developed for the particular waste reduction requirements. An example of this type of program is the pulp and paper sector's efforts to eliminate or reduce pollution from its wastewater stream, which was adversely affecting the receiving waters and aquatic life.

Local Limits
The US EPA has developed a National Pretreatment Program to prevent contaminants that pass through, interfere with, or are otherwise incompatible with publicly owned treatment works (POTWs) from discharging to sewers. A local pretreatment program is required for all POTWs with:
- Design flow > 5 million gallons/day (MGD) (18 900 m^3/d)
- Design flow < 5 MGD, with significant industrial users

Three types of standards apply to discharges to sewer:
- Prohibited Discharges (general prohibitions)
- Categorical Standards (technology based – divided into 35 industrial sectors)
- Local Limits (take into account site-specific factors)

Local limits are developed by POTWs to protect their operations and to ensure that their discharges comply with state and federal requirements. These limits are necessary when greater control over industrial discharges is needed than provided by the general prohibitions and categorical standards. Factors to be considered when developing local limits include:
- The POTWs efficiency in treating wastes
- The POTWs history of compliance with permit limits
- The receiving water body's condition
- Water quality standards that are applicable to the receiving water body
- The POTWs retention, use and disposal of sludge
- Worker health and safety concerns

Since the local limits methodology was developed to better control industrial users and is designed to take local conditions into consideration, it could be useful and readily adaptable to Canadian conditions. Pretreatment standards and limits, and a manual entitled *Local Limits Development Guidance*, can be found on the US EPA's website: http://cfpub.epa.gov/npdes/pretreatment/pstandards.cfm#local

Public Education
Public education is an essential component of all source reduction programs and is an effective means of reducing quantities of wastewater on its own. Public education programs need to be directed at all wastewater generators (residential, commercial, industrial and institutional) and to address both the quantity and quality of wastewater.

Wastewater quality can be improved and quantity reduced by implementing the three "R's" of pollution reduction: reduce, replace and recycle. Environmentally responsible procurement programs, such as the Environmental Choice Program[1] and Gippers Guide to Environmental Purchasing,[2] can help consumers

[1] Available at www.environmentalchoice.com

and organizations select less toxic substances as substitutes in their use of cleaners and chemical processes, and water-saving fixtures and appliances that generate less wastewater.

Educational programs promote environmentally-friendly consumption and disposal habits through outreach activities that target audiences through radio, television, newspapers and magazines, the Internet, flyers, posters, newsletters, environmental and community groups, and schools and universities.

Water Conservation
Water conservation can reduce the demand for expanding wastewater facilities and improving the effectiveness of existing treatment operations by concentrating wastewater, making it easier to treat. It can also reduce the occurrence of sewer overflows.

Individuals and organizations can reduce the amount of water they use by replacing existing fixtures and appliances with water-conserving ones (e.g., toilets, taps, shower heads, dishwashers, washing machines). Industries can review processes to save, substitute, reuse or redirect uncontaminated water away from the sanitary sewer. By saving water, efficiencies are realized through reduced energy, water and wastewater collection and treatment costs.

Water conservation can be achieved by regulatory (bylaws, plumbing codes, CSA standards, etc.) and non-regulatory methods (public education, subsidies, incentives and user-fee schedules for water and wastewater treatment). Municipalities should implement a volume-based rate scheme and rates that reflect the true costs of water treatment and distribution, wastewater collection and treatment and other associated costs, to encourage water conservation.

Sewer Use Bylaws
Sewer use bylaws are an essential component of every wastewater source control program, but their success requires effective education, monitoring and enforcement programs (with penalties). They can limit the concentration and toxicity of wastewaters entering the system, prohibit discharge of some contaminants into the system, and require that users implement pollution prevention programs and pre-treat their wastewater. The City of Toronto has one of the most modern and comprehensive sewer use bylaws in Canada.[3] A model sewer use bylaw has been prepared as a tool to support municipalities in implementing the Strategy (see Technical Supplement 4).

Permitting and Wastewater Rates
Municipalities can establish permit systems for major sewer users where discharge-to-sewer limits can be set (maximum daily loads, flows, etc.). This measure is important not only to promote reduction, but also to prevent wastewater treatment upsets. Wastewater rates should also be charged to users based on volumes of discharge. Economic incentives not only encourage users to reduce, but promote a user-pay approach that ensures a fair allocation of treatment costs.

6.3 Municipal Wastewater Treatment

In many cases, wastewater facilities provide adequate treatment; however, when improvements are required, certain factors must be considered (see Figure 15).

[2] Available at www.pmac.ca/PDF/gipper.pdf
[3] Available at www.city.toronto.on.ca/legdocs/municode/1184_681.pdf

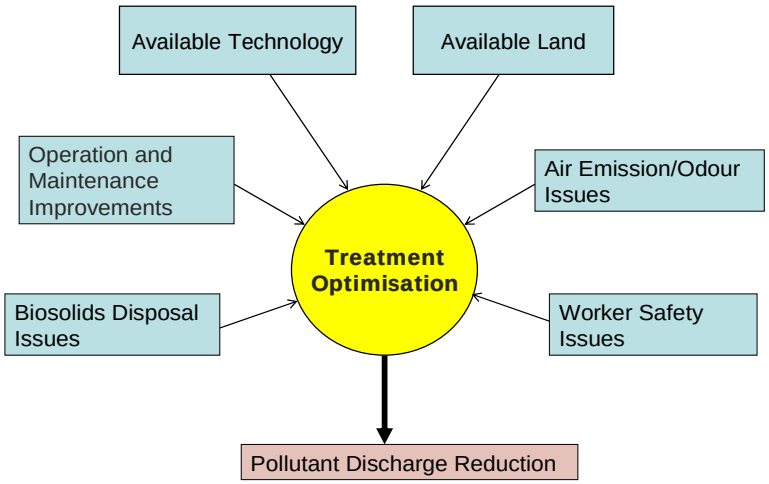

Figure 15. Factors to be Considered when Improving Wastewater Facilities

Wastewater facilities accelerate the natural process of degradation. Primary treatment is a physical process whereby solids are settled out of the system. Chemicals may be added to enhance the amount of solids that settle in a given period of time. Secondary treatment provides for biological degradation of particulate and dissolved wastes in wastewater. Tertiary treatment is any additional process, whether physical, biological or chemical, used on a site-specific basis to remove more of a particular contaminant and to address a specific risk. Often, a disinfectant such as chlorine or ultraviolet light is introduced as the final step to reduce the concentration of pathogenic organisms present in the effluent, thus protecting human and environmental health. Lagoon systems provide sufficient retention time for natural biodegradation to occur and can sometimes accomplish enough pathogenic organism reduction to meet EDOs without additional equipment. Wastewater facilities may also remove some of the additional contaminants (e.g., detergents, cleaners, solvents) deposited into sewers from households and from industrial, commercial and institutional sources, but they are incapable of removing many of the commercial and industrial wastes that are often discharged to the collection system. A report prepared by Hydromantis Inc. (2005) titled *Review of the State of Knowledge of Municipal Effluent Science and Research –Tasks 2 and 3*, provides additional information on wastewater treatment processes and what they can remove.

Where EDOs are exceeded, owners should first look at ways to improve the operation and maintenance of their existing wastewater facilities. For example, better chemical dosing, aeration or control of the treatment process can lead to additional removal of substances. Computer programs can help simulate operational modifications.

The InfraGuide titled *Wastewater Treatment Plant Optimization* (2003) provides an overview of an approach for optimizing existing facilities. *Optimization of Lagoon Operation* (2004) is a similar guide that deals specifically with lagoon facilities. Tools such as benchmarking practices and the ISO 14001 certification for environmental management can help bring about continuous improvement of wastewater facility operations. Further details can be found in the *National Water and Wastewater Benchmarking Initiative* and in a Water Environment Research Foundation report titled *Benchmarking Wastewater Operations: Collection, Treatment, and Biosolids Management* (1997). Hydromantis (2005) provides additional information on wastewater treatment quality control practices.

When operational and maintenance improvements (and efforts to reduce substances at the source) are insufficient, the owner must then investigate modifying the wastewater facility with available technology.

When further removal of suspended solids is needed, improvements could include adding filtration. When further removal of biochemical oxygen demand is needed, owners could consider additional aeration and residence time in the biological treatment unit. For further nutrient removal, it is generally necessary to add chemical precipitation for phosphorus removal, retrofit or add to an existing biological treatment system to provide for ammonia removal (nitrification) or install a tertiary treatment stage to reduce nitrogen and/or phosphorus levels.

Ammonia creates a unique site-specific issue because it is a nutrient (contributing nitrogen) for some organisms, but is toxic to fish at certain concentrations. Its toxicity is directly dependent on the pH and temperature of the receiving water, with critical conditions typically occurring in the summer period. Improved removal of ammonia can be achieved through the installation of secondary treatment with nitrification or retrofitting the existing secondary treatment system for additional nitrification. This can be done by providing media to which nitrifying bacteria can attach.

Additional wastewater treatment will generally create more solids and biosolids, which enhances the removal of metals and organics that tend to bind to solids. While this improves wastewater quality, appropriate disposal of contaminated solids and biosolids must be ensured to prevent degradation of other environmental media.

When modifications or additional treatment are considered, the different options have to be analyzed by a professional engineer to determine the costs, advantages and disadvantages of each. A description of this type of analysis is beyond the scope of this document.

Owners must take into account other impacts associated with the introduction of additional treatment, as well as the financial costs of improvements and the benefits of improved effluent quality. Issues associated with increased production of contaminated solids and biosolids, air emissions and odors, worker safety, and so on, must be considered. Owners should consider as many parameters as practicable when assessing the need for additional treatment.

7. Environmental Monitoring

Since mixing zone dilution factors are determined through the use of models, there may be some uncertainty within the model with respect to the actual environmental conditions. Therefore, once the MWWE discharge complies with the EDOs, a receiving environment monitoring program should be used to confirm modeling outcomes. Where differences are observed between model predictions and environmental monitoring results, the environmental risk assessment should be reviewed and model predictions adjusted.

The extent of environmental monitoring programs should be based on risk. For MWWE, the core risk elements can be identified as (1) sensitivity of the receiving environment, (2) size of the facility (flow of the effluent discharge) and (3) composition of the effluent. The proper design of a receiving environment monitoring program is a complex task which has not yet been completed. These details will be developed within 5 years.

8. Combined Sewer Overflows and Sanitary Sewer Overflows

Combined sewers are designed to carry both storm water and wastewater. They were popular in the 1800s when little or no treatment was required and populations were smaller. Currently, no jurisdiction in Canada allows new combined sewers or combined sewer extensions to be built. Today's combined sewers remain from times past. Unfortunately, they combine the worst aspects of the problems associated with

both wastewater and storm water. Wastewater contains domestic and industrial waste and therefore a large number of contaminants. Storm water is dilute but with very high volumes on an irregular basis. Because runoff volumes are high, large combined sewers are necessary to carry the storm water (and wastewater) away quickly to avoid flooding. Because the flows are so high and variable in combined sewers, interceptors and treatment plants cannot be designed for all storm or thaw events. Overflow structures and outfalls are located at strategic points within the sewer system to allow CSOs to occur when the capacity of the system is exceeded. Unless combined sewers are transformed into separate sewers, CSOs cannot be completely avoided.

Separate sanitary sewers convey only concentrated municipal wastewater, undiluted by extraneous water, to the wastewater facility. Because the wastewater is concentrated, treatment is very efficient. When the infiltration of groundwater and inflow of storm water (I/I) are kept low, flows are minimized and predictable, which makes facilities required to convey and treat the wastewater easy to design, dependable, smaller and cost effective. Correctly designed and constructed sanitary sewers should not have overflows. However, SSOs do occur from electrical or mechanical failure in pumping stations, blockage of sewers, or from I/I into the sanitary sewers. During storm events or high water table periods, old and poorly constructed and maintained sanitary sewers can experience problems with excess water in the sewer system.

Box 10. Inflow and Infiltration

Inflow is storm water that enters the sewer system directly from roof downspouts, area and driveway drains, foundation drains, manhole covers or connections from public storm drains. It should not occur in a separated sanitary sewer. Inflow normally results in a rapid increase to the sanitary sewer flow during storm events. Infiltration is groundwater or storm water that enters the sewer system through defects in pipes and manholes. Groundwater infiltration typically causes relatively slow, long-term increases in flow corresponding to seasonal changes in groundwater levels. Infiltration from storm water can be rapid as the water moves through the ground and into the pipe and manhole defects and breakages.

A framework similar to that used for effluent discharges can be used for CSOs and SSOs (see Figure 16), but since they occur periodically, EDOs for these are different. Narrative statements, rather than concentrations and/or loads, are more practical.

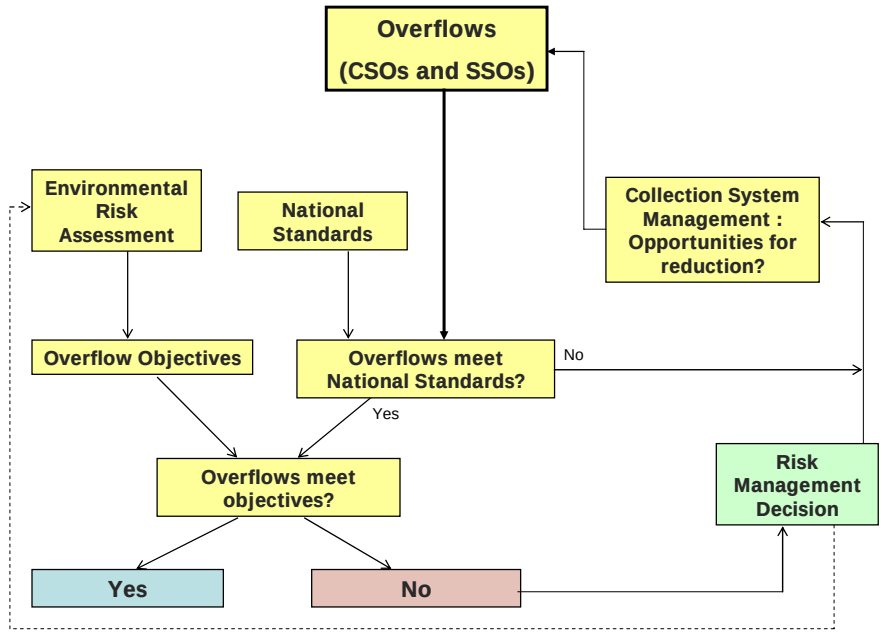

Figure 16. Environmental Risk Management Framework for CSOs and SSOs

8.1 Combined Sewer Overflow Reduction

Under the Strategy, three national overflow standards are suggested for CSOs:

a. No increase in CSO frequency due to development or redevelopment.
b. No CSO discharge during dry weather,[4] except during spring thaw and emergencies.
c. Floatable materials will be removed, where feasible.[5]

In addition to these standards, overflow objectives should be established to protect the beneficial uses of the receiving environment. For example, overflows should not occur upstream from designated areas such as fish spawning sites, beaches and drinking water intakes. Wastewater carrying industrial or hospital waste should not overflow either. Frequency, volume and/or treatment objectives should be set.

Some provinces have general overflow objectives. Ontario's *Procedure F-5-5: Determination of Treatment Requirements for Municipal and Private Combined and Partially Separated Sewer Systems* asks for the capture and treatment of all dry weather flow plus 90% of volume resulting from wet weather flow above the dry weather flow, for a seven month period starting within 15 days of April 1. It also asks for the primary treatment of overflows, even for satellite wastewater facilities. Ontario also has specific beach protection objectives. These include no violation of the body contact recreational water quality objective at swimming and bathing beaches and no more than two overflow events per season (June 1 to September 30). British Columbia's *Municipal Sewage Regulation* specifies that no CSO should occur during storm or snowmelt events with less than a five year return period. It also asks for an average of 1% per year total volume reduction of CSOs and at least primary treatment of discharges. Quebec has site specific objectives, including no CSOs within 1 km of drinking water intakes or shellfish harvesting sites, no CSOs into or immediately upstream from fish spawning sites, and a maximum of one CSO per month in a continuous flow zone or one CSO per two months in an accumulation zone where human activities occur during periods where these activities occur.

[4] Dry weather is defined as any time where flows in combined sewers are not affected by runoff generated by storm events.
[5] Every CSO structure should at least be equipped with a baffle or a screen that can separate floatable materials from discharge.

Since facilities have no control over weather, frequency objectives may not be achieved every year. However, they should be achieved when comparing results obtained over a number of years.

The following steps are recommended to control CSOs:

1. Record CSO and SSO events.
2. Achieve the national overflow standards (see above).
3. Demonstrate at a facility level that everything that can be done with existing equipment is being done to limit CSO and SSO occurrences.
4. Develop a long term plan to reduce CSOs and SSOs and capture substances. The long-term plan should be based on achieving overflow objectives.

When overflow objectives are not achieved, wastewater facilities should consider several options in their long-term plans, including reducing overflows through sewer system separation and storage techniques, reducing substance release through treatment, and relocating outfalls (see Figure 17). Since the highest concentrations of substances in CSOs occur during what is called the "first flush" (the early part of a high rainfall event after a prolonged dry spell), as this is when many of the substances that have accumulated on the streets and in the sewers are washed away, it is particularly important to capture the early portions of CSOs.

Combined sewers should have CSO discharge limits (in the form of frequency and/or volume limits), or treatment requirements, as close as possible to established overflow objectives. Ontario's *Procedure F-5-5: Determination of Treatment Requirements for Municipal and Private Combined and Partially Separated Sewer Systems* and the *Combined Sewer Overflow Treatment Technologies Manual* (XCG Ltd, 2004), a report prepared for Environment Canada, have sections that can help owners prepare a long term CSO abatement plan. Long-term plans should establish priorities based on risk.

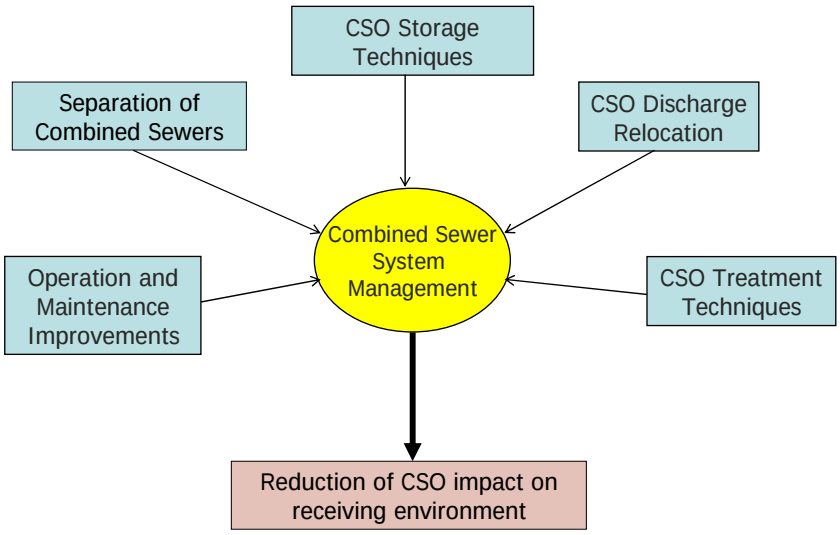

Figure 17. Combined Sewer System Management

8.1.1 Transformation to Separate Sewer System

The best way to reduce the occurrence of CSOs is to replace the combined sewer system with a separate sewer system. Most provinces encourage existing combined sewers to be transformed into separate systems. Even transforming part of the system is beneficial. Usually, the existing combined sewer becomes the storm water sewer since its capacity was designed for the larger storm water flows, and a

new sanitary sewer is built. However, in highly urbanized areas, sewer separation may not be advisable as storm sewers may also be highly contaminated.

8.1.2 Outfall Location

CSOs should have a well located outfall to get the wastewater out into water bodies where the contaminants will not be problematic. When an existing outfall is located in an area where it is having an impact on the receiving environment and overflow reduction efforts are insufficient, relocation of the outfall should be considered.

8.1.3 Storage Facilities

Small storm volumes are sometimes stored in oversized sewer lines, tanks or tunnels which discharge to the wastewater facility when the storm flows abate. Real time management tools exist to optimize the storage of the excess wastewater. Long term plans should start with modeling the sewer system so options can be simulated. Options should include in-pipe storage, storage tanks placed in strategic locations and real time management of these during different events.

8.1.4 Treatment Facilities

Treatment facilities for CSOs are physical-chemical due to the intermittent nature of the flows. Disinfection can be included in the facility. Facilities most often store the sludge and floatables removed during the storm event to be sent to the wastewater facility when the storm flows subside. The *Combined Sewer Overflow Treatment Technologies Manual* (XCG Ltd, 2004) can help owners select a CSO treatment technology.

8.1.5 US EPA Combined Sewer Overflow Control Policy

Published in 1994, the US EPA has a very comprehensive CSO control policy (59 *Federal Register* 18688). It is intended to provide guidance to permittees with CSOs, permitting authorities, state water quality standards authorities and enforcement authorities. This very comprehensive policy can be used by jurisdictions as a model to help develop their own CSO control policy, and owners and permitting authorities to help build long term CSO reduction plans required by the Strategy.

The policy's objectives include:

- Ensuring CSOs only occur as a result of wet weather, if at all.
- Bringing all wet weather CSO discharge points into compliance with the technology-based requirements of the Clean Water Act (CWA).
- Minimizing CSO impacts on water quality, aquatic biota and human health.

Its key principles are as follows:

- Clear levels of control that meet health and environmental objectives should be provided.
- Sufficient flexibility should be provided to municipalities, especially financially disadvantaged ones, to consider the site-specific nature of CSOs and to determine the most cost-effective means of reducing contaminants and meeting CWA objectives and requirements.
- A phased approach to implementation of CSO control should be allowed, considering financial capability.
- Water quality standards and their implementation procedures should be reviewed and revised to reflect site-specific wet weather impacts of CSOs when developing CSO control plans.

Under the policy, municipalities are obligated to implement the "Nine Minimum Controls" (see below) as soon as possible (initially by January 1, 1997) and to develop a long-term CSO control plan that will ultimately result in compliance with the requirements of the *Clean Water Act*. The nine minimum controls are the following (see US EPA, 1995):

1. Proper operation and maintenance programs for sewer system and CSOs

2. Maximum use of collection system for storage
3. Review and modification of pretreatment requirements to minimize CSO impacts
4. Maximization of flows to the POTW for treatment
5. Prohibition of CSOs during dry weather
6. Control of solid and floatable materials in CSOs
7. Pollution prevention
8. Public notification of CSO occurrences and impacts
9. Monitoring to characterize CSO impacts and efficacy of CSO controls

The minimum elements of a long-term CSO control plan are:

- Characterization, monitoring and modeling of combined sewer system
- Public participation
- Consideration of sensitive areas
- Evaluation of alternatives
- Cost/performance considerations
- Operational plan
- Maximizing treatment at the existing treatment plant
- Implementation schedule
- Post-construction compliance monitoring program

The permitting policy is implemented in two phases:

- Phase I permits – Requirements for Demonstration of Implementation of the Nine Minimum Controls and Development of the Long-Term CSO Control Plan.
- Phase II permits – Requirements for Implementation of a Long-Term CSO Control Plan.

8.2 Sanitary Sewer Overflow Elimination

Good design and construction techniques, combined with an adequate maintenance program, should ensure that SSOs are minimized. Corrective measures can be similar to those used for combined sewer systems or may involve rehabilitation of the sanitary sewer system so the problems with inflow and infiltration are corrected to the point where overflows from the system are avoided.

All SSOs should be monitored and reported. Since SSOs should not occur, the EDO is elimination through corrective measures. This may not always be possible in cases where inflow and infiltration problems are severe.

8.2.1 Inflow and Infiltration

Inflow and infiltration (I/I) related overflow reduction methods can be classified under two basic strategies or approaches. In the first strategy, I/I is accepted into the system and then accommodated by construction of relief sewers, storage, and/or additional pumping and treatment capacity, similar to combined sewer overflow control strategies. The second strategy involves using rehabilitation techniques to reduce the amount of I/I entering the sewer system and to eliminate I/I sources. Rehabilitation techniques include repair or replacement of defective sewer pipes and manholes and disconnection of inappropriate direct drainage connections to the sanitary sewer system.

Rehabilitation is the preferred overflow reduction method because it allows the sanitary sewer system to operate as it should, with no overflows and no degradation of wastewater treatment efficiency. However, some I/I problems are so severe that they require a combination of both of the above strategies. The extent to which each strategy is used is often determined by a technical and economic evaluation of all the possible alternatives and the available receiving environments. Usually a study needs to be done to document existing overflow locations, quantify the I/I flows and evaluate the capacity of the existing

facilities prior to determining the best overall strategy to correct I/I problems. The InfraGuide on I/I called *Infiltration/Inflow Control/Reduction for Wastewater Collection Systems* (2003) can help owners develop an I/I control/reduction program.

8.2.2 Inflow Rehabilitation Techniques

Eliminating inflows into the sanitary sewer generally means disconnecting inappropriate connections. Inflow problems can generally be corrected by (a) disconnecting inappropriate inflow sources and (b) rehabilitating manholes. Inappropriate inflow sources include storm drain laterals, roof and area drains and foundation drains directly connected to the sanitary sewer system. These sources are usually located during smoke testing, dye testing and field inspection. Their disconnection is usually inexpensive and the benefits substantial. Foundation drains and sump pumps connected to the sanitary sewer are redirected to either a surface drain or a storm drain. Rehabilitation of manhole frames and covers minimizes the surface water flowing into the manhole and generally involves plugging holes in the cover, sealing the lid between the frame and cover and raising manhole frames to minimize water getting to the covers.

8.2.3 Infiltration Rehabilitation Techniques

Infiltration correction can involve excavating and replacing sewers and manholes, sliplining sewers (sliding a flexible liner pipe into an existing sewer), cured in place pipe lining (inserting resin impregnated felt tube into pipe and cure in place) or chemical grouting (applied under pressure to fill voids in background sewer material). Service lateral corrections can be made using similar techniques. The InfraGuide called *Selection of Technologies for Sewer Rehabilitation and Replacement* (2003) provides municipalities with a method of selecting the best technologies available to rehabilitate or replace sections of their collection systems based on current practices and on local issues and conditions.

9. Implementation Timeline

9.1 National Performance Standards

For each existing facility that does not already meet the National Performance Standards, the implementation timeline to meet the Standards will be based on risk criteria that reflect characteristics of both the discharge and the receiving environment. The risk criteria use readily available, objective information to calculate a level of risk – high, medium or low – that corresponds to the overall timeline – 10, 20, 30 years – established for implementation.

A series of risk criteria have been developed, with various levels within each criterion being assigned a point value to indicate a relative level of risk. For any facility, the sum of the point values places the facility within a band that is assigned an overall risk level and to a corresponding time period to be in compliance with the National Performance Standards.

The risk criteria and point levels are shown in Table 7 and explained below.

Table 7. Criteria for Calculation of Risk Level for Facility Effluent

Facility Size (Flow)	Very small	5 points
	Small	10 points
	Medium	15 points
	Large	25 points
	Very large	35 points

$CBOD_5$/TSS (average)	>150/100	35 points
	50/50 to 150/100	20 points
	<50/50	5 points
	<25/25	0 points
TRC	chlorination, no dechlorination i.e. TRC >0.02 mg/L	10 points
Ammonia	Acutely lethal as per Figure 12	20 points
Receiving Environment	Open marine	5 points
	Marine port	10 points
	Lake, reservoir	20 points
	Enclosed bay, estuary	20 points
	River with bulk flow ratio >100	15 points
	River with bulk flow ratio 10 - 99	20 points
	River with bulk flow ratio <10	25 points

The point values for the five criteria in Table 7 are added to indicate an overall risk level and consequent implementation timeline for each facility to achieve the National Performance Standards. High risk (greater than 65 points) corresponds to an implementation timeline of 10 years. Medium risk (50 to 65 points) corresponds to an implementation timeline of 20 years. Low risk (less than 50 points) corresponds to an implementation timeline of 30 years.

Where the owner of a facility is subject to the *Notice Requiring the Preparation and Implementation of Pollution Prevention Plans for Inorganic Chloramines and Chlorinated Wastewater Effluents* under the *Canadian Environmental Protection Act*, 1999 (i.e. any person who owns a wastewater facility where the effluent released to surface water is greater than or equal to 5 000 m^3 per day, based on an annual average , and where the concentration of total residual chlorine in the effluent exceeds 0.02 mg/L in any sample, based on representative sampling), the implementation timeline for the National Performance Standard of 0.02 mg/L TRC is December 31, 2010, notwithstanding the timeline calculated by the risk criteria above.

9.1.1 Criteria Definition

Facility Size
This criterion is based on size category based on flow as set out in Table 2, including the consideration that small and very small facilities with industrial input are to be treated as medium facilities. It is assumed that a larger flow inherently poses greater risk, from the perspectives of both volume and likely chemical composition of the effluent.

Level of $CBOD_5$ and TSS
The levels correspond to effluent quality following no treatment (i.e., raw wastewater), primary treatment and advanced primary treatment. An additional level is included in this criterion for $CBOD_5$ and TSS levels below the National Performance Standards since a facility may still need to address other substances. If the $CBOD_5$ and TSS levels in the effluent fall into different levels in the criterion, the

higher of the two point values would be used. In all cases, average $CBOD_5$ and TSS values calculated as per sections 5.2.1 and 5.2.2 would be used.

TRC
If the effluent is chlorinated and not dechlorinated, the TRC value would be greater than 0.02 mg/L, the National Performance Standard. Facilities that chlorinate their effluent but do not dechlorinate it before discharge will be contributing chlorinated substances and residual chlorine, both of which are toxic, to the environment. Effluents that are dechlorinated or disinfected by means other than chlorination would not score any points under this criterion.

Acutely Lethal Concentration of Ammonia
The determination of acute lethality is made from the equation in section 5.6.3 and/or Figure 12. Concentrations of ammonia above the line in Figure 12 are considered to be acutely lethal.

Receiving Environment
Large and/or open bodies of water that are not rivers are subdivided into four groups: open marine; marine port (well flushing harbour with port development and the capacity to handle large ships); lakes and reservoirs; and enclosed bays and estuaries. For rivers, the bulk flow ratio is used to assess risk. Bulk flow ratio is the ratio of the average annual flow of the river to the average annual flow of the effluent. For intermittent discharges, the flows used would be those that occur during a typical discharge period. For some large rivers where the site more closely resembles a lake or enclosed bay, it may be more appropriate to use the lakes, reservoirs, enclosed bays and estuaries category to represent the level of risk.

9.2 Combined Sewer Overflows

Facilities with an overall CSO risk level higher than the risk level of the main effluent may work on CSOs first, and therefore delay work on meeting the NPS. The objective is to reduce the risk level associated with the combined sewer overflow at least as low as the risk level of the main effluent, before starting work on meeting the NPS. The facility must still achieve the National Performance Standards within the 30 year timeline of the Strategy.

Two approaches can be considered to determine whether CSOs are a higher priority than the wastewater facility's main effluent. The first approach consists of looking at every CSO location individually and determining which ones should be dealt with first, prior to dealing with the main effluent. The second one consists of looking at the CSO picture as a whole and determining if the overall CSO problem is at a higher risk level than the main effluent.

Once the level of risk is determined for the CSOs, it is then compared to the level of risk associated with the main effluent (see section 9.1). If the risk associated with the CSOs is greater than that posed by the main effluent, an action plan is developed by the owner addressing how both the CSOs will be managed and the National Performance Standards achieved within the 30 year timeline of the strategy. The action plan is then submitted to the jurisdiction for approval.

The Development Committee is currently considering the following two approaches as options to help determine the risk associated with CSOs. Based on input from stakeholders, one of these options will be included with the final Strategy.

9.2.1 Criteria for Calculation of Risk Level of Individual CSO Locations

This approach consists of looking at every single CSO location and determining which ones have an unacceptable impact on the receiving environment and its uses. Those that accumulate more points than

the main effluent are considered a higher risk and should be dealt with first, although the facility must still achieve the National Performance Standards within the 30 year timeline of the Strategy. Points are allocated based on Table 8. CSO units with treatment (solids removal or disinfection) should not be considered in this exercise.

Table 8. Criteria for Calculation of Risk Level of Individual CSO Locations

% of total dry weather flow found in sewer at this location (or % of combined sewer served at this location)	≥ 50%	30 points
	≥ 25%	20 points
	≥ 10%	10 points
	< 10%	5 points
Frequency of CSO events	Overflows during dry weather	50 points
	> 25 events/year	30 points
	> 15 events/year	20 points
	> 5 events/year	10 points
	5 events/year or less	0 points
Receiving environment affected uses - all that apply	Drinking water intake within 500 metres downstream	25 points
	Drinking water intake within 500 – 2 000 metres downstream	15 points
	Shellfish harvesting area or historic presence within 500 metres downstream	20 points
	Endangered species/fish spawning area within 500 metres downstream	10 points
	Recreational area within 500 metres downstream	20 points
	Recreational area within 500 – 2 000 metres downstream	10 points
	Fish consumption advisory	5 points

9.2.2 Criteria for Calculation of Overall Risk Level of CSOs

This approach consists of establishing a CSO risk level for the whole sewer system and determining whether this risk is higher than the one associated with the main effluent. It uses a CSO index that is obtained by calculation, using data obtained at each CSO location. The CSO index is obtained by following two steps. The first step consists of multiplying, for each CSO location, the fraction of the total dry weather flow that goes through the sewer at that location by the number of CSO events per year at that location. In the second step, all of these numbers are added up to obtain the index.

For example, a facility that has 2 overflow locations, one that carries 25% of the total dry weather flow and overflows 40 times per year, and another one that carries 50% of the dry weather flow and overflows 20 times per year, would obtain an index of : (0.25 x 40) + (0.50 x 20) = 20. (This criterion is likely a very rough estimate of the number of days of equivalent to total dry weather flow being discharged per year by CSOs, when considering a CSO event is one day in duration and the overflow is equivalent to the dry weather flow in the sewer. It is probably an overestimation, but a good index for comparative purposes). Once the CSO index has been calculated, points are allocated based on Table 9.

Table 9. Criteria for Calculation of Overall CSO Risk Level

CSO Index >100	75 points
CSO Index > 75	60 points
CSO Index > 50	50 points
CSO Index > 25	30 points

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Appendix A Database of the Sources of Contaminants in Municipal Wastewater

Currently under development.

Appendix B List of Acceptable Toxicity Test Methods

1. Biological Test Method : Reference Method For Determining Acute Lethality of Effluents to *Daphnia magna*. Environment Canada, 2000. EPS 1/RM/14 Second Edition.
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Technical Supplement 3

Canada-wide Strategy for the Management of Municipal Wastewater Effluent

Standard Method and Contracting Provisions for the Environmental Risk Assessment

September 2007

Table of Contents

List of Appendices

List of Tables

List of Figures

List of Tables

Acknowledgements

The Standard Method and Contracting provisions which follow were prepared for CCME by SENES Consultants Limited. The original documents have been modified to meet the needs of CCME. These provisions have not been developed to meet the needs of any particular municipality or community. Municipalities and communities should obtain proper legal advice before using any of the following provisions, for their own purposes.

List of Acronyms

BMP	Best Management Practice
$CBOD_5$	Carbonaceous Biochemical Oxygen Demand for 5 Days
CCME	Canadian Council of Ministers of the Environment
CEAEQ	Centre d'Expertise en Analyse Environnementale du Québec
CEQG	Canadian Environmental Quality Guidelines
CRM	Certified Reference Methods
DOC	Dissolved Organic Carbon
EC	Effects Concentration
EDO	Effluent Discharge Objective
US EPA	United States Environmental Protection Agency
EQO	Environmental Quality Objective
LC_{50}	Lethal Concentration
LMDL	Laboratory Method Detection Limit
LOEC	Lowest Observable Effects Concentration
MDL	Method Detection Limit
MWWE	Municipal Wastewater Effluent
NEL	No Effect Level
NOEC	No Observable Effects Concentration
NPE	Nonylphenol Ethoxylates
NPS	National Performance Standard
PCB	Polychlorinated biphenyls
QA	Quality Assurance
QC	Quality Control
SCC	Standards Council of Canada
TMDL	Total Maximum Daily Load
TRC	Total Residual Chlorine
TSS	Total Suspended Solids
TU	Toxic Unit
TU_a	Acute Toxic Unit
TU_c	Chronic Toxic Unit
WET	Whole Effluent Toxicity

PART A – Standard Method

Executive Summary

This document includes a step-by-step standard approach to ensure that the implementation of the environmental risk assessment is conducted in a consistent manner. Table ES-1 provides an outline of the activities to be performed by municipalities and approaches to be taken in developing an environmental risk assessment for a single or multiple MWWE discharges. The key aspect is the incorporation of specific actions into the framework which would allow a municipality to implement the environmental risk assessment.

Table ES 1. Activities and Approaches Taken in Developing an Environmental Risk Assessment

Activity by Municipality	**Approach**
REPORT SECTION 1 *Introduction*	**Present background and objective of the step-by-step standard method**
REPORT SECTION 2 *Establish the List of Substances of Potential Concern*	**Determine the list of substances of potential concern** **Step 2-1:** select generic list of substances of potential concern according to facility size **Step 2-2:** add substances associated with industrial discharges to the generic list
REPORT SECTION 3 *Prepare the Initial Characterization Program*	**Perform characterization of facility** **Step 3-1:** categorize facility size **Perform characterization of wastewater effluent** **Step 3-2:** select monitoring substances **Step 3-3:** select toxicity testing methods **Step 3-4:** determine sampling frequency **Step 3-5:** perform sample collection and analysis
REPORT SECTION 4 *Implement the Initial Characterization Program, including sampling, preservation and analytical requirements, according to substance*	**Follow protocols for analyses of MWWE**
REPORT SECTION 5 (SINGLE DISCHARGE) *Establish EDOs for Substances of Concern*	**Review the specific steps applicable to the MWWE to set EQOs, then EDOs for a single discharge** ***Determine EQOs:***

Activity by Municipality	**Approach**
	Step 5-1: define water uses **Step 5-2:** determine generic EQOs **Step 5-3:** characterize the receiving environment **Step 5-4:** determine site-specific EQOs **Step 5-5:** determine toxicological EQOs ***Determine the mixing zone and assess dilution:*** **Step 5-6:** review the definition of the mixing zones **Step 5-7:** evaluate criteria for allocating the mixing zone **Step 5-8:** determine restrictions on mixing zones and dilution allowed for mixing ***Determine EDOs:*** Mass-Balance Equations Steady-State Modelling Dynamic Modelling Follow the above framework. When appropriate, determine whether more modeling is required, or additional empirically derived values would be useful
REPORT SECTION 6 (MULTIPLE DISCHARGES) *Establish EDOs for Substances of Concern with the Watershed Approach*	**Review the specific steps applicable to the MWWE to set EQOs, then EDOs for the watershed, and thereafter determine water quality trading** ***Determine EQOs and EDOs:*** **Step 6-1:** build partnership **Step 6-2:** define scope of watershed planning effort **Step 6-3:** gather existing data and create inventory **Step 6-4:** identify data gaps and collect additional data **Step 6-5:** analyze data to characterize the watershed and pollutants sources **Step 6-6:** estimate pollutants loads **Step 6-7:** set objectives and identify load reductions **Step 6-8:** identify possible management strategies **Step 6-9:** evaluate options and select final

Activity by Municipality	Approach
	management strategies **Step 6-10:** design implementation program and assemble water plan **Step 6-11:** implement watershed plan and measure progress **Follow the above framework, and when appropriate, determine water quality trading:** **Step 6-12:** determine suitability of pollutant for trading **Step 6-13:** analyze the financial attractiveness of trading **Step 6-14:** establish the trading market infrastructure
REPORT SECTION 7 *Selection of Substances for Compliance Monitoring*	**Determine the list of substances for compliance monitoring** **Step 7-1:** selection of substances **Step 7-2:** selection of monitoring frequencies

Note:

EQOs, Environmental Quality Objectives
EDOs, Effluent Discharge Objectives
MWWE, Municipal Wastewater Effluents

1.0 Introduction

1.1 Background

Part of the Canada-wide strategy for the management of **Municipal Wastewater Effluent (MWWE)** is the development of an environmental risk assessment "standard method" to calculate **Effluent Discharge Objectives (EDOs)**. These EDOs represent concentrations / loads of substances in MWWE discharges that are expected to correspond to **Environmental Quality Objectives (EQOs)** in receiving waters, outside specified mixing zones. An environmental risk assessment can be performed for a single effluent discharge, or for multiple discharges, in which case it must consider concentrations / loads for all dischargers of the same substance as per a watershed management plan (including nutrients). In both cases, the process begins with the **Canadian Environmental Quality Guidelines (CEQGs)** and / or the Provincial Guidelines to establish site-specific EQOs, which subsequently are used to calculate EDOs for the discharger(s). Both freshwater and marine environment are to be considered into the standard method.

1.2 Standard Method Objective

In this document, the objective is to present a step-by-step standard methodology for MWWE, which establishes EDOs based on ensuring that EQOs are achieved in receiving waters, outside specified mixing zones.

1.3 A Step-by-Step Standard Method

To date, there has been a considerable amount of work conducted by the **Canadian Council of Ministers of the Environment (CCME)** aiming at developing an environmental risk assessment framework. The main task of this document is to translate that information into an easily accessible and consistent approach, or "framework" that can be implemented by **Municipal Wastewater Facilities (facilities)** across Canada. As presented in this document, the pertinent activities to conduct the environmental risk assessment and to establish EDOs are in the following order of sections (Figure 1-1), except for the last activity (i.e., Compliance Monitoring), which is presented thereafter:

- Establish the List of Substances of Potential Concern **(Section 2);**
- Prepare the Initial Characterization Program **(Section 3);**
- Execute Initial Characterization Program **(Section 4);**
- Establish EDOs from a Single Discharge Approach **(Section 5)**, or
- Establish EDOs from a Watershed Approach **(Section 6);**
- Selection of Substances for Compliance Monitoring **(Section 7).**

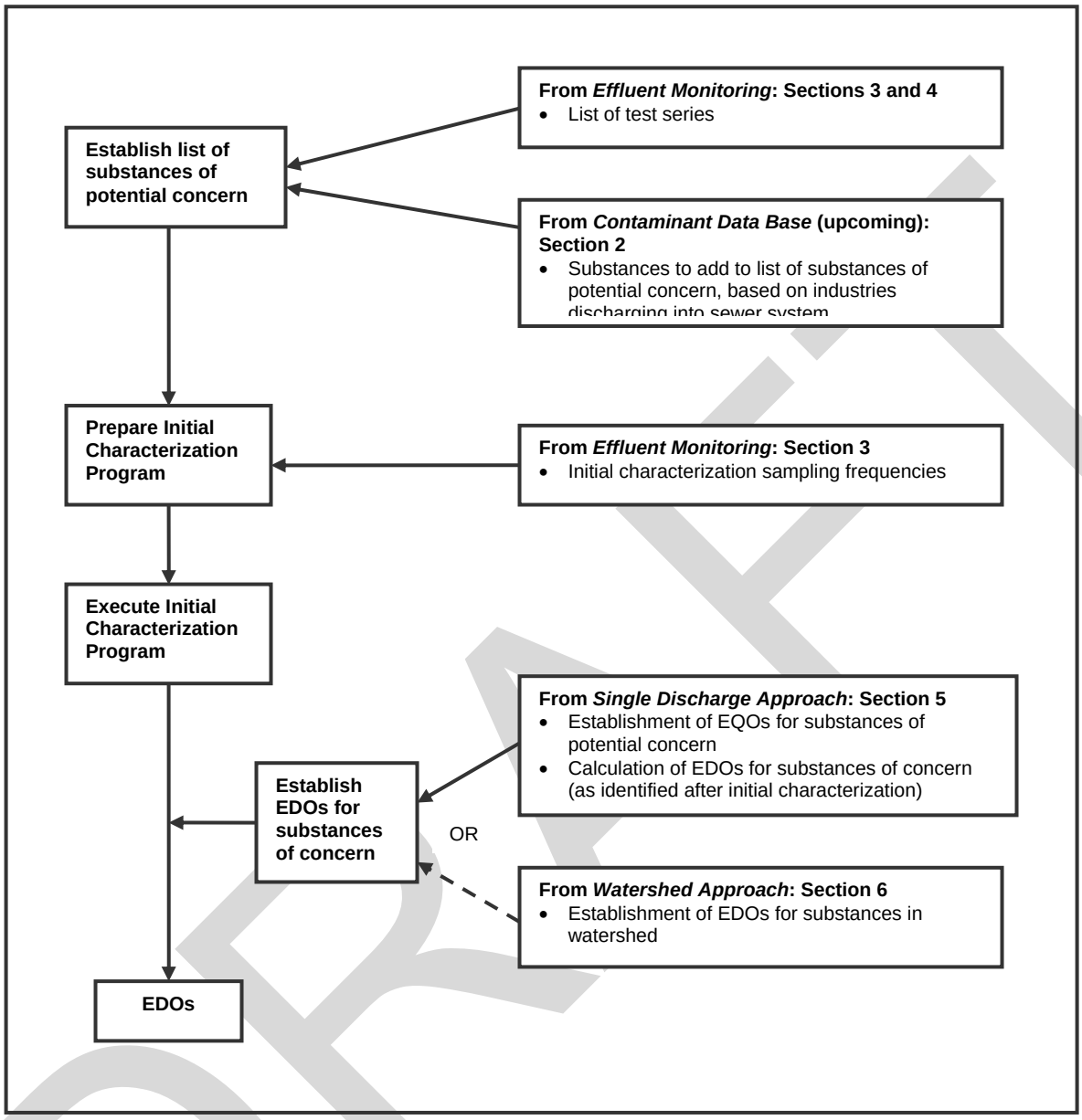

Figure 1-1. Pertinent Activities of an Environmental Risk Assessment

Facilities must meet the following **National Performance Standards (NPSs):**

- **Carbonaceous Biochemical Oxygen Demand ($CBOD_5$) for five days - 25 mg/L;**
- **Total Suspended Solids (TSS) - 25 mg/L; and**
- **Total Residual Chlorine (TRC) - 0.02 mg/L.**

It is of note that there might be different NPSs for the Arctic regions, which is to be determined by CCME.

If effluent discharge is not meeting the NPSs, opportunities for reduction are to be sought. Standards for other substances are set based on site-specific environmental risk assessments approach. Assimilative capacity in the receiving water and water uses downstream of the discharge will be considered in the

approach. Figure 1-2 describes effluent monitoring and what to do when the effluent discharge is not achieving performance standards or EDOs.

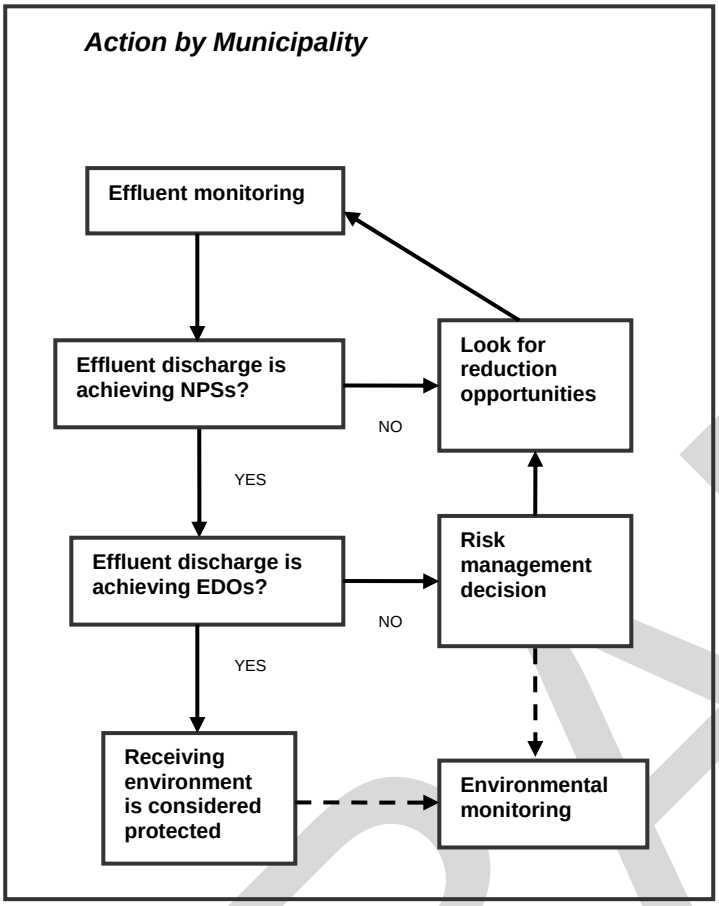

Figure 1-2. Effluent Monitoring and Risk Management Decision Making

2.0 Substances of Potential Concern

2.1 Introduction

MWWE contain grit, debris, suspended solids, pathogens, organic wastes, nutrients, and about 200 identified chemicals (EC 2001). $CBOD_5$ and TSS are the single largest constituents of MWWE. Primary treatment typically reduce $CBOD_5$ and TSS by 30% and 65% respectively (Metcalf and Eddy, 2003), whereas, secondary treatment is capable of reducing $CBOD_5$ and TSS by more than 80%. In 1999, releases of $CBOD_5$ and TSS from all Canadian facilities were estimated at 101,950 tonnes and 121,619 tonnes, respectively (EC 2001).

Nitrogen and phosphorus concentrations are an order of magnitude lower, with typical nitrogen concentrations in the 20–40 mg/L and phosphorus concentrations in the 7–15 mg/L range for primary treatment (EC 2001). In inland areas where eutrophication problems from phosphorus discharges have been widespread, tertiary treatment is often needed to reduce phosphorus concentrations to more benign levels (typically 1 mg/L or less, depending on the ecosystem characteristics that are exposed to the discharges).

Although microorganisms are found in large numbers in raw sewage, wastewater treatment is effective at reducing their numbers in effluents. Standard facilities with a well-functioning disinfection process can achieve a nearly 100% reduction in the number of microorganisms present in the final effluent. However, even with a 99% removal rate, 10,000–100,000 organisms per 100 ml may still remain in the treated effluent (EC 2001).

Aluminum and iron are the most abundant metals present as salts and are often used in the sewage treatment process. Other metals, including cadmium, copper, lead, zinc, manganese, molybdenum, and nickel, may be present at lower levels (CCME 2006a, EC 2001). Mercury, which is a metal of considerable environmental concern, may be present as well, although in trace quantities. Organic chemicals, such as polychlorinated biphenyls (PCBs), dioxins and furans, tetrachloroethylene and trichloroethylene, tend to be present at even lower levels than those of the metals. However, some of these contaminants can be toxic at low levels and can remain in the environment for very long periods of time. MWWE, together with stormwater runoff, overshadow direct industrial discharges as the dominant source of waterborne PCBs and mercury entering lakes Superior and Ontario, according to estimates for 1991 and 1992 (EC 2001).

Facilities must use an environmental risk assessment approach to set appropriate EDOs. This framework is to be used to set EDOs for all substances of potential concern (e.g., $CBOD_5$, TSS, TRC, nutrients, metals, pathogens and other chemicals) present in MWWE. A list of substances of potential concern has been established and can be found in Table 2-2.

2.2 Determine List of Substances of Potential Concern

The following steps are defined to obtain a list of substances of potential concern for MWWE.

Step 2-1: Select the Generic List of Substances of Potential Concern According to Facility Size

There is a list of conventional substances that all facilities must measure. This list is presented in Table 2-1. However, the list of substances of potential concern must be selected based on the size of the facility. More specifically, Table 2-1 presents the list of substances of concern for *very small* and *small* facilities. Note that *very small* and *small* facilities with industrial input should be considered as *medium* facilities. Table 2-2 presents the list of substances of concern for *medium*, *large* to *very large* facilities.

Table 2-1. List of Potential Substances of Concern for MWWE – Very Small and Small Facilities

Test Group	Substances
General Chemistry / Nutrients	Total Suspended Solids (TSS) Carbonaceous Biochemical Oxygen Demand ($CBOD_5$) Total Residual Chlorine (TRC) if chlorination is used Nitrate Nitrate + Nitrite Ammonia Total Phosphorus (TP) pH Temperature
Pathogens	*E.coli*

Table 2-2. List of Substances of Potential Concern for MWWE – Medium, Large and Very Large Facilities

Test Group	Substances
General Chemistry / Nutrients	Fluoride Nitrate Nitrate + Nitrite Ammonia Total Phosphorus (TP) Total Suspended Solids (TSS) Carbonaceous Biochemical Oxygen Demand ($CBOD_5$) Total Residual Chlorine (TRC) Chemical Oxygen Demand (COD) Cyanide (total) pH Temperature
Metals scan	Aluminum, barium, beryllium, boron, cadmium, chromium, cobalt, copper, iron, lead, manganese, molybdenum, nickel, silver, strontium, thallium, tin, titanium, uranium, vanadium, zinc as well as arsenic, antimony, selenium and mercury
Pathogens	*E.coli*
Organochlorine Pesticides	Alpha-BHC, endosulfan (I and II), endrin, heptachlor epoxide, lindane (gamma-BHC), mirex, DDT, methoxychlor, aldrin, dieldrin, heptachlor, a-chlordane and g-chlordane, toxaphene
Polychlorinated Biphenyls (PCBs)	Total PCBs
Polycyclic Aromatic Hydrocarbons (PAHs)	Acenaphthene, acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i,)perylene, benzo(k)fluoranthene, chrysenes, dibenzo(a,h)anthracene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, methylnaphthalene, naphthalene, phenanthrene, pyrene
Volatile Organic Compounds (VOCs)	Benzene, bromodichloromethane, bromoform, carbon tetrachloride, chlorobenzene, chlorodibromomethane, chloroform, 1,2-dichlorobenzene, 1,4-dichlorobenzene, 1,2-dichloroethane, 1,1-dichloroethene, dichloromethane, ethylbenzene, 1,1,1,2-tetrachloroethane, 1,1,2,2-tetrachloroethane, tetrachloroethene, toluene, trichloroethene, vinyl chloride m/p-xylene, o-xylene
Phenolic compounds	2,3,4,6–tetrachlorophenol, 2,4,6-trichlorophenol, 2,4-dichlorophenol, pentachlorophenol

Step 2-2: Add Substances Associated with Industrial Discharges to the Generic List

Monitoring programs should be reviewed with respect to industrial effluents being discharged to the sewer system. Industrial effluent characterizations may be consulted where available or the CCME data base (2007) can be used to identify substances possibly associated with the industrial processes present. The list of potential substances of concern is augmented based on those substances associated with industrial activity.

3.0 Initial Characterization Program

This section provides guidance on the requirements for the initial characterization program to commence with the environmental risk assessment. Initial characterization is to be tailored according to facility categorization.

3.1 Facility Categorization

Step 3-1: Categorize Facility Size

To differentiate the risk posed by various levels of MWWE discharged to surface waters, facilities are to be categorized into five categories as shown in Table 3-1 (CCME 2007). Categories are based on the flow capacity of the facility, or actual annual average flow, whichever is the highest.

Table 3-1. Municipal Wastewater Facility Size Categories

Size Category	Flow [m^3/day]
Very Small[1]	≤ 500
Small[1]	> 500 – 2,500
Medium	> 2,500 – 17,500
Large	> 17,500 – 50,000
Very Large	> 50,000

Note:
[1] *Very small* and *small* facilities which have industrial input associated with wastewater will be considered in the *medium* size category

3.2 Perform MWWE Characterization

Step 3-2: Select Monitoring Substances

The first step in conducting the environmental risk assessment is the identification of substances of concern in the MWWE. The steps outlined in Section 2.0 – Substances of Potential Concern, must be completed prior to commencing **Step 3-2**.

Furthermore, TRC needs to be monitored in facilities where chlorine or chlorine compounds are used in the treatment process. In the case where an effluent is chlorinated and subsequently dechlorinated, the effluent may be tested for the dechlorination chemical instead of TRC on the basis that the presence of the dechlorination substance is indicative of no residual chlorine.

Step 3-3: Select Toxicity Testing Methods

Toxicity tests should be carried out according to facility size as shown in Table 3-2. For acute toxicity testing, either a single concentration or multiple concentration Rainbow Trout test and *Daphnia magna* test are required. For chronic toxicity testing the Fathead Minnow test and *Ceriodaphnia dubia* test are required.

Table 3-2. Toxicity Testing at Difference Size Facilities

Facility Size	Acute Toxicity Tests	Chronic Toxicity Tests
Very Small[1]	n/a[2]	n/a

Small[1]	- Rainbow Trout - *Daphnia magna*	- Fathead Minnow - *Ceriodaphnia dubia*
Medium	- Rainbow Trout - *Daphnia magna*	- Fathead Minnow - *Ceriodaphnia dubia*
Large	- Rainbow Trout - *Daphnia magna*	- Fathead Minnow - *Ceriodaphnia dubia*
Very Large	- Rainbow Trout - *Daphnia magna*	- Fathead Minnow - *Ceriodaphnia dubia*

Note:
[1] *Very small* and *small* facilities should be considered as *medium* sized in the initial categorization if industrial influent is present
[2] n/a – not applicable

Step 3-4: Determine Sampling Frequency

Continuous Discharge

For the purpose of this sampling guide, quarterly monitoring may be conducted during the specified period as shown in Table 3-3. For continuous discharges, the monitoring frequency will vary according to facility size. Table 3-4 details the monitoring frequency required for different substances according to facility size. Monitoring frequencies are given in daily, weekly, monthly and quarterly increments.

Table 3-3. Quarterly Monitoring

Quarter	Period
1st	October – December
2nd	January – March
3rd	April – June
4th	July – September

Table 3-4. Monitoring Frequencies

Facility Size	TRC[1] (or dechlorination agent)	$CBOD_5$, TSS, Pathogens and Nutrients[2]	Test Series / Substance	Acute Toxicity	Chronic Toxicity
Very Small	Daily	Monthly	n/a	n/a	n/a
Small	Daily	Monthly	n/a	Quarterly	Quarterly
Medium	Daily	Every two weeks	Quarterly	Quarterly	Quarterly
Large	Twice per day	Weekly	Quarterly	Monthly	Monthly
Very Large	Three times per day	Daily (5-7 days/week)	Quarterly	Monthly	Monthly

Note:
[1] If chlorine is used in the facility
[2] Nutrients include ammonia, TKN (ammonia + organic N), nitrate, nitrite and total phosphorus. Temperature and pH must also be measured to determine the level of toxicity of ammonia.

All test series and substances associated with industrial or commercial activities must be completed for each effluent from *medium*, *large* and *very large* facilities over a one year period. *Very small* and *small* facilities which receive industrial input are to be considered *medium* facility category.

Intermittent Discharge

For intermittent discharges in each size classification, two samples are required during each discharge period, with the total number of tests not exceeding the number required for continuous discharges:

- One sample near the start of the discharge period;
- One sample near the end of the discharge period.

Flow Monitoring

On each day of sampling, the average daily flow rate must be recorded along with the samples. Annual average flows may be calculated using the total volume of effluent discharged each day. The average daily flow should be recorded for each facility. Flows may be monitored with a system that takes continuous measurements or by using a method that meets generally accepted engineering principles, such as those in the standards for the measurement of liquid flow in open channels or measurement of fluid flow in closed conduits published by the International Organization for Standardization. Flow monitoring equipment should be accurate to within 15% of the measured flow, and should be calibrated.

Step 3-5: Perform Sample Collection and Analysis

Protocols for sampling, preservation and storage, and sample analysis are described in Section 4.0 – Implementation of the Initial Characterization Program.

Sampling Weather Conditions

Facilities collect wastewater from residential, industrial, commercial and institutional establishments. During wet weather conditions, rain, snow and ice enter the sewer system and also become part of the facility influent. The composition of the runoff that washes into the sewer from roads, high ways, rooftops and other surfaces can contain any substances that the precipitation encountered as it made its way towards the sewer: road salt, oil, gasoline, pesticides, etc. Predominantly, precipitation will contain sulphate, chloride, sodium, calcium and potassium ions. The influent during wet weather, thus, will be of a different quality than that during dry weather.

Sampling Type and Techniques

Because the water detention time for mechanical treatment facilities is usually about 2-4 days, it is recommended that sampling be done at least 2 days after rainfall or a rise in temperature that would cause the melting of ice and snow.

For continuous discharges, the monitoring frequency for each facility size is listed in Table 3-4 in **Step 3-4**. Samples are a 24-hour composite sample, except when grab samples are required. Continuous discharges include regular discharges from batch treatment processes, such as a sequencing batch reactor, that discharge on a frequent and regular basis.

For intermittent discharges in each size classification, two samples should be taken during each discharge period – one sample near the start of the discharge period and one near the end. For facilities with more than one discharge per year, each discharge should be sampled but the number of tests required should not be more than that required for continuous discharges from the same size facility.

Jurisdictions with very large facilities may, instead of collecting one 24-hour composite sample for test series / substance, collect three consecutive 24-hour composite samples of the final effluent. Sampling

three continuous days is expected to better represent variations especially for the compounds in the test series / substances. Final effluent samples should be taken at the outfall of the facility, after chlorination / dechlorination (or after UV disinfection) and prior to discharge to the receiving water bodies.

Automated composite samples can be taken either proportional to the sewage stream flow (in which case there must be flow-sensing devices connected to the sampler) or on an equal volume / equal time basis. Both of these methods require fully automated, programmable sampling devices.

4.0 Implementation of the Initial Characterization Program

The following sections contain information regarding sampling, sample preservation and storage and analytical methods summarized from *Standard Methods for the Examination of Water and Wastewater* (APHA 2005), *Water and Air Monitoring and Reporting - Sampling, Methods and Quality Assurance, Part E Water and Wastewater Sampling* (BC MoE 2003), *Analysis of Industrial/Municipal Wastewater* (MOE 1999), Environment Canada (2000a-d), and Ministère du Développement Durable de l'Environnement et des Parcs du Québec, Centre d'Expertise en Analyse Environnementale du Québec (MDDEP-CEAEQ 2003, 2007).

4.1 Guidelines for Sampling

All samples obtained for analysis must be from a point in the MWWE stream that is representative of the whole stream composition. The sample should closely resemble the population being measured and should be handled in a manner that prevents or minimizes changes from its original form. The volume of sample taken must be sufficient to allow for analysis of all required analytes plus associated quality control samples (e.g., field duplicate, laboratory replicate and spiked sample).

It is recommended that all automated and manual sampling devices and equipment, their containers and all tubing, valves and contact components be dedicated to a particular sampling site in order to minimize the possibility of cross contamination. As an alternate to this dedicated application, it is the user's responsibility to demonstrate that the sampling equipment is clean, free from contamination and suited to the sampling and analysis needs at the next location. Generally, the cleaning and preparation of relocated equipment should include hot water, phosphate free detergent washing, hot and cold water rinsing, distilled water rinsing and, finally, multiple rinses with the actual MWWE being sampled. This is especially important where trace levels of contaminants are being analyzed.

Appendix A lists the sampling requirements for each test group identified in Section 2.

4.1.1 Field Notes/Observations

Detailed field notes should be carried out during sampling activities to include:

- Facility name;
- Date and time;
- Weather;
- Names of all the personnel on the sampling crew;
- Influent, effluent or sludge;
- Preservatives used (for each sample).

All information should be recorded in a logbook and should be initialled by the data recorder and entered into a database as soon as possible upon return from the field.

4.1.2 Sample Types and Techniques

MWWE samples are often obtained by the use of automated equipment capable of either flow or time proportional sub-sampling of a MWWE stream. These **automated sampling devices (autosamplers)** must be mechanically and electrically suited to the environment in which they will operate and, in consideration of safety and accessibility, be physically located to facilitate routine use, maintenance and inspection by field staff.

Grab Samples

A grab sample is meant to represent the MWWE stream at a given point in time as opposed to a composite sample which represents the MWWE stream over a longer time period (i.e., 24 hours). Grab samples should be collected by dipping an appropriate container, bucket, bottle or vial, into the MWWE stream using an appropriate retrieval device, such as a chain or pole.

Grab samples may be taken from a valved slipstream; after purging the sample line, the samples should be collected into appropriate laboratory containers.

Grab sampling may also be conducted using an automated sampler in manual mode when the automatic function fails. Three grab sampling techniques are outlines below:

a) MWWE is collected in a bucket or other container and immediately transferred to the appropriate laboratory container(s), preserved as necessary and capped.
b) The appropriate laboratory sample container is submerged in the MWWE stream on a chain or pole until it is full; it is retrieved, preserved as necessary and capped.
c) MWWE is collected in a bucket as for *grab technique a)* and the appropriate clean (outside as well) laboratory container (e.g., volatiles vial) is held at an angle and submerged into the liquid until it is full and air bubbles have been expelled at which time it is carefully retrieved, preserved as necessary and capped.

4.1.3 Composite Samples

As stated in Section 3.2 composite samples are required for continuous discharges. Composite samples can be collected either by automated or manual methods.

A manual composite sample consists of grab samples typically taken at equally spaced time intervals and combined (composited) once all sub-samples have been collected. Grab samples may also be composited proportional to the stream flow. Flow records must be recorded at the time of sampling and the volume for each sampling event is adjusted proportionally to the flow.

Generally, composite samples are collected by the following techniques:

Flow Proportional

There are two methods to collect flow proportional samples:

a) Automatic equipment collecting samples proportional to the MWWE stream flow at time intervals of at least once per hour over the sampling period (typically 24 hours), under typical flow conditions. For example, if the collection of 1% of the effluent discharge is required, and the total discharge is 100 L/s, 1000 mL should be collected for the sample.
b) A minimum of 8 grab samples taken at equally spaced time intervals over the sampling period (e.g., every 3 hours in a 24 hour period) combined in proportion to the MWWE stream flow.

Equal Time / Equal Volume

There are two methods where equal time / equal volume sampling can be carried out:

a) Automatic equipment collecting samples of equal volume at equally spaced time intervals of 15 minutes or less over the sampling period.
b) A minimum of 8 grab samples taken at equally spaced time intervals over the sampling period (e.g., every 3 hours in a 24 hour period) combined in equal volumes.

The time periods described above may be modified, depending on site-specific situations. Regardless which sampling mode is selected, it should be documented and adhered to, so as to provide consistency in the data produced.

4.1.4 Automated Sampler Considerations

Three important characteristics of autosamplers are discussed in this section.

Materials Composition

All wettable surfaces that contact the MWWE sample must be inert (i.e., must not contaminate, absorb or adsorb chemicals required to be analyzed in the MWWE sample). This requirement can generally be met through consistent use of materials such as Teflon®, glass, stainless steel and, where dictated by sampler design and function (e.g., peristaltic type pumps, pinch valves, volume control tubes), short sections of surgical grade silicone rubber tubing. This type of tubing should be preferentially replaced by Teflon® or other chemically inert materials as far as possible without impairing the performance of the sampling device. Where surgical grade silicone rubber tubing is used the total length should be kept to an absolute minimum and it is generally accepted that this should be less than 2 m. Particular care should be taken to ensure that this tubing and all other wettable parts are cleaned or replaced appropriately.

Temperature Stability

A requirement for autosamplers is that they maintain the sample storage environment at a temperature between the freezing point of the sample and 10°C. This may require cooling and / or heating capabilities depending on location and time of year. The temperature must be monitored daily during sample collection and storage and the readings documented. A min-max thermometer may be used for this purpose. Sampling records must be maintained such that all data including repair, inspection, use, maintenance and temperature records are available for inspection.

Ability to Obtain a Representative Sample

Automated sampling devices can provide either a single large sample composite which can be further subdivided at the end of a predefined sampling period, as suitable, for the analysis to be performed or multiple individual composites each of which can be individually assigned to specific test groups. The latter capability can provide better flexibility and accommodate a wider range of analysis requirements by providing the option of individual container preservation, and multiple composite samples for specialty testing needs.

The choice of autosampler design and capability will be dictated by specific sampling and analysis requirements. It is, however, essential that the autosampler take the sample from a location in a MWWE stream that will provide a representative sample. This requirement will typically be met by sampling at a point of thorough mixing with no excessive turbulence, and at a point away from walls or surfaces of a pipe or channel that may cause insufficient mixing due to currents and eddies. The sampling location must be determined by preliminary testing to evaluate the impact of any site specific turbulence and mixing phenomena.

The sampler must maintain the sample integrity when transferring effluent from the stream to the sample container, in particular by maintaining adequate velocities (1 m/s) in the transport system to exceed the scour and settling velocities of the constituents of interest.

4.1.5 Compositing Techniques

Where a sample is collected in a large container and requires analysis for several groups of compounds, the MWWE must be transferred to appropriate laboratory containers. Teflon® or other suitable tubing and gravity suction is recommended for transfer of the MWWE to the individual laboratory container. A peristaltic pump may be used to transfer the aliquots into the appropriate laboratory containers. The sample may also be poured into the individual laboratory containers. Sample transfer must be accompanied by continuous mixing of the composite sample by using a mechanical stirrer, manual swirling or other appropriate means. Use of magnetic stirring bars should be avoided since they may adsorb suspended solids containing metals, thus affecting the sample integrity.

The laboratory should be consulted prior to sampling to determine minimum sample volumes required for all required analyses. The volume used for analysis must be sufficient to meet all the analytical requirements including laboratory and field QC obligations and also be sufficient for the laboratory to achieve its analytical **Method Detection Limit (MDL).**

4.1.6 On-Line Analyzers

On-line analyzers may also be used to continuously monitor and report the presence and concentration of selected constituents in the MWWE stream. The sampling equipment and instrumentation must however satisfy requirements identified in Section 4.1.3. The procedures must also meet the analytical principles criteria set out in Section 4.4.

4.1.7 Unique Sampling Requirements

Sampling for almost all test groups should be carried out using the *flow proportional techniques* (Section 4.1.3). However, sampling requirements may be altered to suit the nature and sensitivity of certain chemicals to be analyzed:

- ***pH*** - Where the characteristics of the MWWE may lead to changes in pH over the sampling period, an on-line analyzer must be used or grab samples must be collected and analyzed as soon as reasonably possible.
- ***Ammonia*** - Samples containing strong oxidizing agents (e.g., chlorine) should be neutralized as soon as possible after sample collection to prevent oxidation / degradation.
- ***Volatiles*** - Grab samples must be collected for volatile organics analysis and composite samples must be taken by manual sampling techniques. Use of automated samplers in manual mode or pumps for volatiles sampling is not allowed. A volatiles sample should be obtained at a location of quiescence and uniform concentration upstream of turbulence which might strip volatile constituents from the MWWE. To minimize losses of target parameters, the sample should be collected directly into the laboratory container with no headspace and the container sealed, refrigerated and analyzed as soon as possible. Where the water collected is below 4°C, some headspace may be needed to accommodate increasing pressure within the sealed containers.
- ***TRC*** - Must be sampled and analyzed using an on-line analyzer or by collecting a grab sample (see Section 4.1.2) and analyzing it as soon as reasonably possible (within 1 hour).
- ***E. coli*** - *E. coli* samples must be collected by the grab sampling technique as outlined in Section 4.1.2. Where disinfection is accomplished through the use of oxidizing agents (e.g., chlorine or sodium hypochlorite), sodium thiosulphate must be added to *E. coli* samples as soon as possible after sample collection (if the sample container is not pre-charged with sodium thiosulphate).

4.1.8 Changes in Sampling Techniques

Any changes in sampling techniques must be documented and reported.

4.2 Guidelines for Preservation and Storage

Appendix A lists common sampling preservation and storage requirements for each test group and other test groups identified in Section 2. In some jurisdictions or regulatory programs, the measures taken to prevent reduction or loss of target analytes can be somewhat different, but they are generally well documented and satisfy the objective.

4.2.1 Preservation

Some samples require preservation to ensure stability of target compounds during transportation and storage or to eliminate substances which may interfere with the analysis. In some cases preservation of the sample is optional, and if selected, will allow for a longer storage period before analysis must be initiated.

Generally, samples requiring preservation must be preserved immediately upon collection, either at the end of the collection period for samples collected with an automated sampling device or after collection of each grab sample.

Where a composite sample is collected in a large container for analysis for test groups, some of which require preservation, the samples must be preserved immediately following their transfer into laboratory containers.

Where samples are to be preserved to a fixed set-point (pH, colour) care must be taken that the set point has been reached by using detection techniques such as confined range pH paper, pocket / portable pH meters, standard colour comparison charts etc. The use of these techniques and / or devices must not contaminate the sample and should be employed after the sample and preservative have equilibrated.

It is recommended that the volume of preservative not exceed 1% of the total sample volume.

4.2.2 Storage

Storage time is defined as the time interval between sample pick-up (typically at the end of the 24 hour composite sampling period) and the initiation of analysis.

All samples must be stored for as short a time interval as possible and under conditions that will minimize sample degradation. Samples must be maintained at temperatures above the freezing point of the MWWE and under 10°C, with minimal exposure to light.

In the case where analysis is considered to be initiated by the sample extraction step, the extracts should be completely analyzed within 60 days. Samples digested for metals analysis may be maintained in a sealed container and analyzed within 30 days.

4.3 Test Methods for Toxicity Testing

Toxicity tests may be conducted following test methods as referenced in the following documents:

- Biological Test Method: Reference Method for Determining Acute Lethality of Effluents to *Daphnia magna*. Environment Canada, 2000. EPS 1/RM/14 Second Edition.
- Détermination de la toxicité létale CL_{50}48h *Daphnia magna*. Centre d'expertise en analyse environnementale du Québec (CEAEQ, 2000). Ministère de l'Environnement. MA 500 – D.mag. 1.0.
- Biological Test Method: Reference Method for Determining Acute Lethality of Effluents to Rainbow Trout. Environment Canada, 2000. EPS 1/RM/13 Second Edition.

- Détermination de la létalité aiguë chez la truite arc-en-ciel (*Oncorhynchus mykiss*). Environnement Canada, 2000. Méthode d'essai biologique : méthode de référence pour la détermination de la létalité aiguë d'effluents chez la truite arc-en-ciel. Environnement Canada, Conservation et Protection, Ottawa. SPE 1/RM/13 deuxième édition.
- Biological Test Method: Test of Larval Growth and Survival Using Fathead Minnows. Environment Canada, 1992. EPS 1/RM/22.
- Essai de croissance et de survie des larves de tête-de-boule *(Pimephales promelas).* Environnement Canada, 1992. Méthode d'essai biologique : essai de croissance et de survie des larves de tête-de-boule. Environnement Canada, Conservation et Protection, Ottawa. SPE 1/RM/22.
- Biological Test Method: Test of Reproduction and Survival Using the Cladoceran *Ceriodaphnia dubia*. Environment Canada, 1992. EPS 1/RM/21.
- Biological Test Method: Acute Lethality Test Using *Daphnia* spp. Environment Canada, 1996. EPS 1/RM/11 Amended.

Routine monitoring requires the conduct of single concentration tests (i.e., exposures of aquatic organisms to the undiluted effluent). However, toxicity investigations may require the conduct of multi-concentration tests (i.e., exposure of aquatic organisms to the undiluted effluent as well as a series of dilutions of the effluent) in order to estimate an LC_{50} (concentration estimated to cause mortality to 50% of the test organisms).

It is understood that the Rainbow Trout acute lethality test procedure may be modified to include pH stabilizations in order to minimize / eliminate artificial lethality as a result of the aeration process.

4.4 Guidelines for the Analysis of Samples

4.4.1 Principles of Analysis

This section describes and provides guidance on the general principles and procedures to be followed in sample preparation, clean-up and instrumental analysis.

All laboratories conducting analyses are required to be accredited. Key requirements that should be met are:

- Analysis should be carried out by competent laboratory personnel in a properly equipped and maintained laboratory environment.
- Analytical procedures should meet generally accepted principles of good laboratory practice and quality control.
- Analytical techniques should be appropriate for the sample matrix and must lead to adequate separation and accurate identification of the compounds to be analyzed.
- Recovery of target parameters should be optimized.
- Procedures used should meet or exceed the Performance Criteria included in the Method Summary (Appendix B).

4.4.2 Analytical Methodology

Appendix B outlines common analytical principals for each test group. The table in Appendix B provides Methods Summaries and **Method Detection Limits (MDL)** for substances of concern. Alternative equivalent methods may also be used as employed in some jurisdictions.

Any new method should be validated prior to use and all methods should be re-evaluated periodically to ensure their continued validity. Instrumental measurement methods must meet performance criteria as set out in Appendix B. All analytical instruments must also be calibrated.

4.4.3 Analytical Performance Criteria

Laboratory Method Detection Limits

To ensure that all laboratories performing analyses have the capability to perform these analyses at appropriate levels, they are required to determine a **Laboratory Method Detection Limit (LMDL)** for each parameter to be analyzed.

An analytical method should not be used for samples until all LMDLs have been demonstrated to fall at or below the applicable MDL values listed in Appendix B. The LMDLs should be re-determined whenever a significant change is made to a method.

LMDLs should be determined using the routine sample aliquot and dilution factor that will be applied to "real" samples because the size of sample analyzed and associated changes in dilution will affect the LMDL value proportionately. If a dilution factor is applied to the LMDL, a sample where the measurement is near or below this adjusted LMDL should be reanalyzed using a larger aliquot to meet the requirement to measure down to a LMDL which is less than the MDL.

Precision

Precision is the degree of agreement among independent measurements of a quantity under specified conditions. Both within-run (repeatability) and between-run (reproducibility) precision should be established. This can be done by using replicate sample analysis (within-run) and analysis of spiked blank samples or certified reference materials, if available (between-run). Control limits for these should be established and maintained as part of the analytical performance criteria.

Accuracy

Accuracy represents the degree of agreement of individual measurements with an accepted reference value. **Certified Reference Materials (CRM)**, if available, can be used to assess laboratory accuracy. If suitable CRMs are not available, samples spiked with known amount of analytes may be substituted. Results obtained must be compared with the true or designed value. A sample size of 10 or more and performance of the *Student's t-test* are recommended to demonstrate "no bias".

4.5 Quality Management

4.5.1 Quality Assurance

Quality Assurance (QA) encompasses those activities which define the level of quality required, the critical system components which may impact quality, the procedures whereby quality status will be determined, and the nature and timing of any remedial action required. A comprehensive QA program will ensure that the quality of the process and its product is monitored, documented, and controlled on a continuing basis.

4.5.2 Quality Control

Quality Control (QC) encompasses those activities which specifically monitor and control discrete laboratory tasks or systems to produce the information that is required to verify and demonstrate that they meet predefined operating criteria or to substantiate the need for remedial action.

Field QC Samples

Field QC samples include duplicate samples and optional travel blanks that indicate sampling variability and the presence of field contamination: A *duplicate sample* is one of two separate samples collected at the same time and in similar conditions in a manner that minimizes differences. A *travel blank* is a sample of uncontaminated reagent water, free of the analytes of interest which is prepared by the laboratory performing the analysis. It is brought to the sampling site, opened during sampling activities,

preserved as necessary and returned to the lab as necessary. Appendix A contains field QC sampling requirements for different test groups.

Laboratory QC Samples

Laboratory QC samples may include bench quality control, such as method blanks, certified reference materials, spiked samples and replicate samples, and run quality control, such as certified reference materials, calibration, baseline, and sensitivity checks. A *method blank* is an uncontaminated sample of reagent water, free of the target parameters and any substance which may interfere with the analysis. A *replicate sample* is an additional or second aliquot of a randomly selected sample in the analytical run. A *spiked blank* is a method sample blank to which known quantities (i.e., concentrations 2-5 times the individual MDLs) of each target parameter have been added. A *spiked sample* is a randomly selected sample in the analytical run to which known quantities of each target parameter has been added. Appendix B contains laboratory QC sampling requirements for different test groups.

5.0 Environmental Risk Assessment – Single Discharge Approach

5.1 Introduction

Environmental risk assessment is a risk-based decision-making process where MWWE substances are measured and evaluated in order to develop EDOs taking into consideration risk to human and ecosystem health or fishery resources.

An environmental risk assessment can be performed for a single discharge or for multiple discharges based on a watershed approach. This section deals with the single discharge environmental risk assessment approach.

5.2 Determine Environmental Quality Objectives (EQOs)

The single discharge environmental risk assessment begins with the CEQGs, or their provincial equivalent, to first establish the EQOs for the receiving environment. EQOs for water are defined as numerical concentrations or narrative statements to protect the most sensitive designated use at a site (CCME 2007). In some jurisdictions, other EQOs have been developed independently to suit their specific environmental needs. The following steps are defined to set EQOs, which will be used thereafter to set EDOs.

Step 5-1: Define Water Uses

As presented in the list below and in Figure 5-1, define all beneficial uses of water in the particular water body where the MWWE disposal is occurring as EQOs are tied to these uses.

- Water supply - drinking-water supply area (source water);
- Ecosystem health - fisheries, aquatic life or marine life, and wildlife area;
- Agriculture – irrigation;
- Farming – livestock;
- Industrial - process water for industrial activities;
- Recreation - contact recreational activities (swimming, wading);
- Recreation - non-contact recreational activities (fishing, boating).

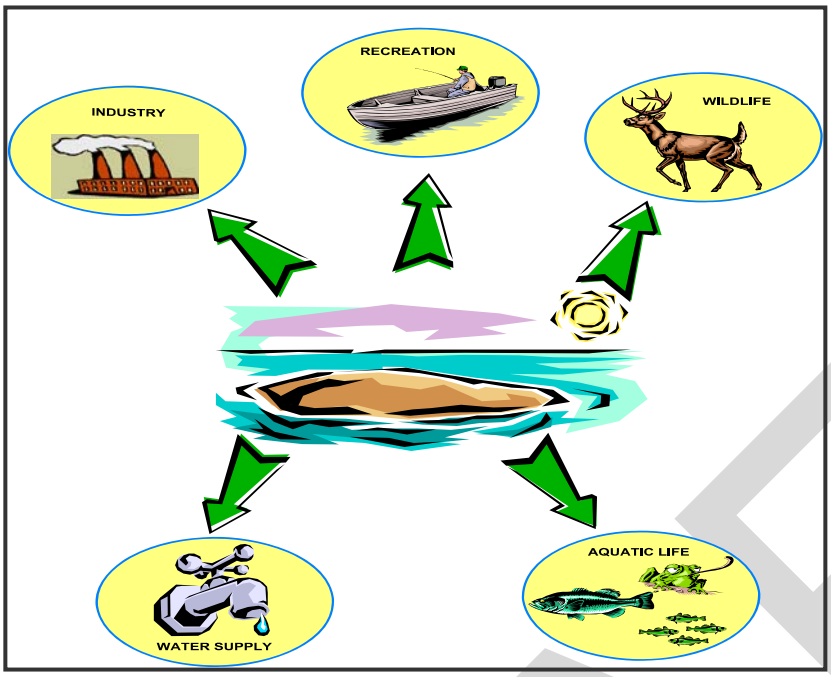

Figure 5-1. Beneficial Uses of Water

Step 5-2: Determine Generic EQOs

EQOs can be determined from one of three approaches:

- Physical / chemical / pathogenic – describing the level of a particular substance of concern (metals, pathogens) that will protect water quality.
- **Whole Effluent Toxicity (WET)** – specifying the proportion of the effluent discharge that may enter the water body without toxicological effect.
- Biological criteria or bio-assessment – describing the level of ecological integrity that must be maintained.

Table 5-1 presents a summary of each of the approaches, capabilities and limitations (CCME 2007).

The three approaches can be used separately or in combination to provide greater assurance in the risk assessment. The most commonly used approach is the physical / chemical / pathogenic approach based on the CEQGs. However, the appropriate provincial guidelines should also be included in determining EQOs. The most stringent guidelines are to be used, which are typically those based on the protection of aquatic life. Results from **Step 5-1** should be used in deciding on the type of guidelines. Finally, establishing the list of EQOs appropriate to a specific MWWE must be according to the substances occurring in the effluent as per the effluent characterization.

The physical / chemical / pathogenic and the WET approaches are described in **Steps 5-4** and **5-5**. As for the biological EQOs approach, the CCME Water Quality Task Group is presently developing bio-criteria that are expected to be a third set of EQOs to be used in a near future.

Table 5-1. Capabilities and Limitations of Water Quality Evaluation Tools

Control Approach	Capabilities	Limitations
Physical / Chemical / Pathogenic	• Human health protection, wildlife protection • Complete toxicology • Straightforward treatability • Fate understood • Less expensive testing if only a few toxicants are present • Prevents or predicts impacts	• Does not consider all toxics present • Bioavailability not measured • Interactions of mixtures unaccounted for • Complete analyses can be expensive • Direct biological impairment not measured
Whole Effluent Toxicity	• Aggregate toxicity • Unknown toxicants addressed • Bioavailability measured • Accurate toxicology • Prevents impacts	• No direct human health or wildlife protection • Incomplete toxicology (few species may be tested) • No direct cause-effect relationship established • No persistency or sediment coverage • Ambient conditions may be different • Incomplete knowledge of causative toxicant
Bio-assessments	• Measures actual receiving water effects • Historical trend analysis • Assesses level of ecological quality above standards • Total effect of all sources, including unknown sources	• Critical flow effects not always assessed • Difficult to interpret impacts • Cause of impact not identified • No differentiation of sources • Impact has already occurred • No direct human health or wildlife protection • Expensive and labour / time intensive

Adapted from US EPA (1991)

Step 5-3: Characterize the Receiving Environment

To characterize the MWWE receiving environment, relevant information to gather includes:

- Upstream water quality to determine background levels
- Critical low-flow and periods in receiving environment
- Effluent flow

Step 5-4: Determine Site-Specific EQOs

Variations in environmental conditions across Canada may be such that site-specific EQOs are needed, instead of generic EQOs. Site-specific EQOs are developed as numerical concentrations or narrative statements recommended to support and maintain the designated water use at a specific site. From the list of generic EQOs obtained at **Step 5-2**, compare that with the list of concentration values for the upstream water quality substances obtained at **Step 5-3**.

According to the background procedure, for any one substance, if the concentration in the upstream location is higher than the generic EQO equivalent, that concentration will apply as a site-specific EQO for the MWWE, and the generic EQO must be set aside. Otherwise, site-specific EQOs are not needed. It is of note that for some substances, the EQO is dependent of the water characteristics (pH, T^o, hardness, etc.).

Step 5-5: Determine Toxicological EQOs

As per **Step 5-2**, toxicological EQOs may be based on acute or chronic toxicity bioassays. These EQOs are determined using the two set of WET tests.

MWWE shall be non-acutely toxic at end-of-pipe (unless it is proven that ammonia is the cause of toxicity, for which there may be an exception when the ammonia EDO is achieved at end-of-pipe or the EQO is achieved at the edge of the mixing zone). MWWE shall also be non-chronically toxic after mixing in an allocated mixing zone.

Acute tests are expressed as the **Lethal Concentration (LC_{50})**, which is the concentration of effluent that is lethal to 50% of exposed organisms. Chronic tests of inhibited growth or reproduction are expressed as **Impairment Concentration, Lowest Observable Effects Concentrations (LOEC), No Observable Effects Concentrations (NOEC)**, or **Effects Concentrations (EC),** dependent upon the jurisdiction.

Toxicological EQOs can be expressed as **Toxic Units (TUs)**, which are defined as the inverse of the sample fraction, and obtained by expressing toxicity as a percentage of sample / effluent divided into 100. Calculate **Acute TU (TU_a)** as 100 / LC_{50} (example: if LC_{50} = 25%, TU_a is 100 / 25 = 4; if LC_{50} = 100%, TU_a is 100 / 100 = 1). Calculate **Chronic TU (TU_c)** as above.

Compare all TU_a and TU_c values separately as they cannot be directly compared by values calculated from the same test endpoints (parameters) and test duration. Samples are considered:

- acutely toxic when TU_a is ≥ 1
- chronically toxic when TU_c is ≥ 1, based on a **No Effect Level (NEL)**

Therefore, toxicological EQOs are always 1 TU_a at end of pipe, or 1 TU_c at the end of the allocated mixing zone. These definitions remain as acute toxicity EDO (acute WET) is < 1 TU_a at end-of-pipe (without dilution), and chronic toxicity EDO is calculated from < 1 TU_c and a dilution factor.

5.3 Determine the Mixing Zone and Assess Dilution

In this section, the mixing zone is defined, the criteria for allocating the mixing zone are presented, and the restrictions on mixing zones and dilution allowed for mixing are specified. The following approach to the mixing zone and the dilution assessment is based on *Technical Supplement 2* (CCME 2007).

Step 5-6: Review the Definition of Mixing Zones

The mixing zone is the portion of the receiving water that dilutes the effluent in the aquatic or marine environment. The water quality beyond the mixing zone boundary should meet the EQOs, as illustrated in Figure 5-2. The mixing zone may be set by regulators. It is of note that the mixing zone will vary from a substance to another. Degradable substances will be allowed to mix in a proportion of the receiving water, whereas toxic, persistent and bioaccumulative substances, such as PCBs, dioxins and furans, will not be allowed a mixing zone (EDOs = EQOs).

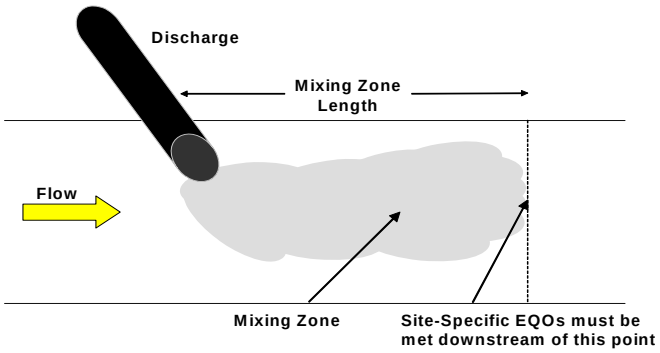

Figure 5-2. Conceptual Diagram of a Mixing Zone

Step 5-7: Evaluate Criteria for Allocating the Mixing Zone

The general criteria recommended for allocating a mixing zone is from CCME (2007) and are listed below.

- The dimensions of a mixing zone should be restricted to avoid adverse effects on the designated uses of the receiving water system (i.e., the mixing zone should be as small as possible)
- The mixing zone should not impinge on critical fish or wildlife habitats (e.g., spawning or rearing areas for fish, over-wintering habitats for migratory water fowl)
- Conditions outside the mixing zone should be sufficient to support all of the designated uses of the receiving water system
- Mixing zones must not be established such that drinking water intakes are contained therein
- Wastewaters that are discharged to the receiving water system must not be acutely toxic to aquatic organisms
- Conditions within the mixing zone should not cause acute toxicity to aquatic organisms
- Conditions within a mixing zone should not result in the bioconcentration of substances of concern to levels that are harmful to the health of organisms, aquatic-dependent wildlife, or humans
- A zone of passage for mobile aquatic organisms must be maintained
- Placement of mixing zones must not block migration into tributaries
- Changes to the nutrient status of the water body as a result of an effluent discharge should be avoided; eutrophication or the presence of toxic blooms of algae are unacceptable impacts
- Mixing zones for adjacent wastewater discharges should not overlap
- Mixing zones should not unduly attract aquatic life or wildlife, thereby causing increased exposure to substances of potential concern
- Mixing zones should not be used as an alternative to reasonable and practical pollution prevention, including wastewater treatment (pollution prevention principle)
- Accumulation of toxic substances in sediment to toxic levels should not occur in the mixing zone

- No mixing zones should be allocated for persistent, toxic and bioaccumulative substances
- Adverse effects on the aesthetic qualities of the receiving water system (e.g., odour, colour, scum, oil, floating debris) should be avoided

Step 5-8: Determine Restrictions on Mixing Zones and Dilution Allowed for Mixing

The spatial dimensions allotted to the mixing zone should be restricted in order to protect the water body as a whole. This may be achieved through physical / spatial restrictions or restriction of the flow allotted to the mixing zone. The dimensions serve to delineate where the dilution factor should be estimated and are established with the primary intention of protecting aquatic life.

For each category of aquatic / marine environment described below, default physical limits and dilution factors are to be used where no jurisdictional limits exist. Furthermore, the default values must also be used to define the limits of the mixing zone for ammonia. These are maximum values. Criteria from **Step 5-7** may force a smaller mixing zone.

Streams and rivers – these systems have continuous or intermittent flow, which critical environmental conditions for mixing correspond to periods of lowest flow or no flow. In the latter flow case, a mixing zone is not allocated and the EDOs = EQOs.

- The mixing zone does not exceed 100 m in length
- The dilution factor is based on a mixing zone, which does not exceed 33% of the stream or river flow, at a low flow of 7Q10 (seven-day low flow over 10 years). The percentage of stream flow allocated to the mixing zone is termed the fraction of flow (ff), which is used in the following equation:

  Dilution Factor = Effluent Flow / [*ff x Stream Flow + Effluent Flow*]
  where *ff* ≤ 33%

- The maximum dilution factor allowed for effluent discharges is 1:100

Lakes, reservoirs and enclosed bays - these systems are particularly sensitive to exposure from substances.

- The mixing zone does not exceed 100 m in length in any direction
- The default dilution factor is a maximum of 1:10

Estuarine and marine waters (other than enclosed bays) - these systems are characterized by currents which fluctuate in intensity and direction. A detailed understanding of the mixing zone may be obtained for these systems by modeling and / or tracer studies.

- The mixing zone does not exceed 100 m in length in any direction
- The default dilution factor is a maximum of 1:100

Mixing zones should be thoroughly evaluated to ensure integrity of the water body as a whole is intact. A mixing zone assessment, which predicts the dilution process of the substance through a mixing zone, is recommended for situations in which the effluent does not mix rapidly or completely with the receiving waters (US EPA 1996).

5.4 Determine EDOs Using a Single Discharge Approach

Once the EQOs have been established for the receiving environment, the EDOs for the MWWE discharge can be determined. EDOs are the maximum concentrations or load of substances at the end of pipe that will enable the receiving water to meet the EQOs at the edge of the mixing zone. EDOs provide guidance on the desired characteristics of the effluent discharge, preventing the existence of substances in excess of EQOs beyond the mixing zone. It is of note that while NPSs represent minimum requirements for $CBOD_5$, TSS and TRC, the risk assessment may require EDOs to be more stringent then NPSs. EDOs are developed using EQOs, receiving water conditions and appropriate modelling.

A simple calculation example assumes that an effluent plume discharge reaches 100 m, at a maximum 26% of stream flow. The dilution factor is then calculated at 100 m, as it is the first limit reached. If the dilution factor estimated at 100 m is 1:5, the EDO will be calculated from the EQO with a 1 in 5 dilution factor, since this factor is lower than the 1:100 maximum. Had the dilution factor been, for instance 1:250, the EDO would have been calculated with a 1:100 dilution factor, as this is the maximum allowed.

Water quality models may be used to predict whether the effluent will cause levels to exceed EQOs for the substances of potential concern in the receiving environment. The simplest water quality model uses a basic mass-balance approach to determine the concentration of effluent in the receiving water. The mass-balance equations are developed below and their parameters are illustrated in Figure 5-3. More complicated models incorporating water-fate-and-transport are also recommended. Worst-case scenarios of periods of high effluent discharge and low flow in the receiving water should be modelled.

Mass-Balance Equations

The mass-balance approach assumes a complete mixing of the effluent in the receiving water and allows the resultant substance concentration / load to be calculated such that, after dilution:

The resulting load of a substance at the edge of the mixing zone	**=**	**the load of the substance in the effluent**	**+**	**the background load of the substance in the**

Where:
load = flow x concentration

This basic mass-balance equation is presented as:

$$Q_r C_r = Q_d C_d + Q_s C_s$$

Where:
Q_d = effluent discharge flow (m^3/s)
C_d = substance concentration in discharge (µg/L or TU)
Q_s = background stream flow above point of discharge (m^3/s)
C_s = concentration of substance in stream above point of discharge (µg/L)
Q_r = resultant stream flow after point of discharge, or $Q_d + ff\ Q_s$ (m^3/s)
C_r = resultant concentration after point of discharge (µg/L or TU)

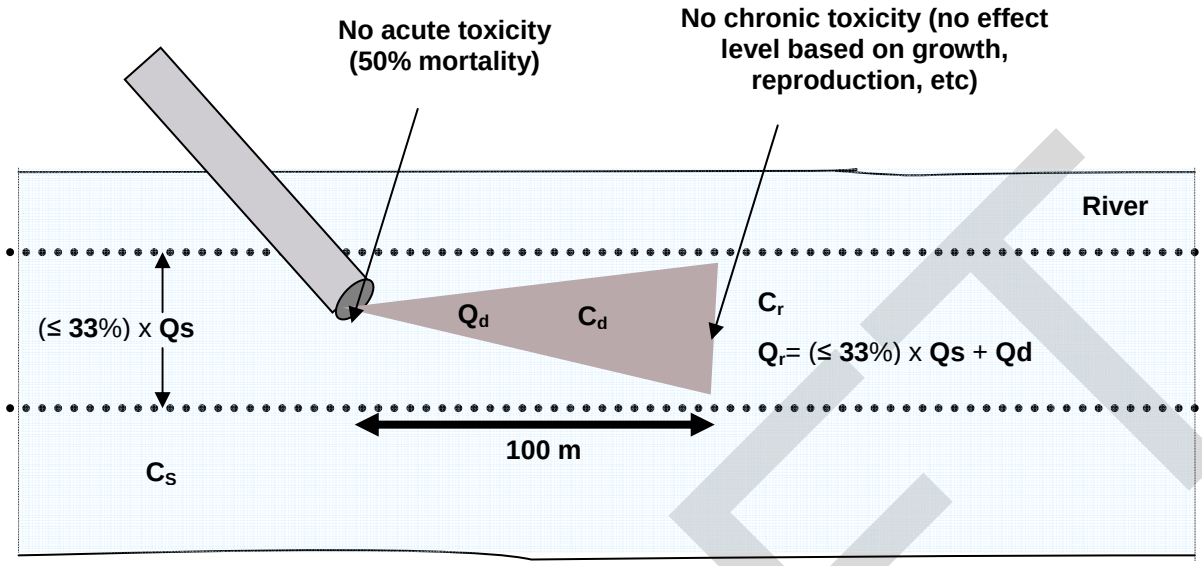

Figure 5-3. The Mass-balance Equation

This equation may be rearranged to calculate the resultant concentration of discharge in the stream after mixing and dilution as:

$$C_r = \frac{C_d Q_d + C_s Q_s}{Q_r}$$

When modified to account for the (*ff*), the equation becomes:

$$C_r = \frac{C_d Q_d + ff\,(Q_s C_s)}{Q_d + ff\,(Q_s)}$$

To determine what is referred to as an assessment of "reasonable potential", the highest value observed throughout the characterization period or a worst-case projection (e.g., high effluent discharge) is used to calculate the resultant in-stream concentration. An EDO should be developed if reasonable potential is demonstrated by a resultant concentration in excess of the EQO. The US EPA (1991) should be referenced for details on the statistical method used to address the uncertainty in effluent data.

EDOs for new discharges are calculated in the same way as for existing discharges (i.e., based on EQOs and available dilution), but with estimated effluent characteristics. Facilities should be designed to achieve EDOs or come as close as possible.

Since end-of-pipe concentrations and whole-effluent toxicity (WET) will vary from day to day for a number of reasons, statistical analyses should be performed to determine which effluent requirements are conservative enough to assure, with a minimum level of confidence, that the EDOs are being achieved. This means that discharge limits should be lower than EDOs and the lesser the sampling frequency, the lower the discharge limits have to be for the same level of confidence that EDOs are being achieved. As an example, the United States Environmental Protection Agency (US EPA 1991) published its *Technical Support Document for Water Quality Based Toxics Control* to aid with establishing statistically-based discharge limits. Some provinces also have guidance documents based on the US EPA method.

As expressed in the basic mass-balance equation above, the background concentration of a substance should be established prior to determining the EDO. The background concentration of a substance is the concentration that naturally occurs upstream from a MWWE point of discharge. The datasets available on the effluent and the receiving water will influence the selection of the water quality model used to derive the EDOs.

- A receiving water with limited data - steady-state models may be used to estimate worst-case steady-state conditions (example: PLUME and CORMIX models);
- A receiving water with large datasets – dynamical models may be used, allowing incorporation of background concentrations of substances over time (example: WASP models).

Finally, both steady-state and dynamic water-transport models may be applied. Where municipal resources are rather limited, simplified modeling approaches such as a basic mass-balance approach and a CORMIX approach are acceptable. To obtain the data, receiving water monitoring may be needed. Stringent monitoring may be necessary in areas where multiple discharge points exist in the watershed. However, Provinces and Territories, and specific studies, may also have monitoring data that may be consulted first.

A more thorough discussion of steady-state and dynamic models, including development of EDO equations for chemical substances and WET using steady-state models, is presented below.

Steady-State Modelling

Steady-state modeling is a simple approach used to ensure the basic protection of water quality. Less data and resource intensive than more sophisticated methods, it assumes complete mixing and constant conditions for effluent input, background levels in receiving water, design stream flow, and environmental conditions (i.e., temperature). The disadvantage of steady-state models is that they can be too conservative when using worst-case scenarios in their calculations. However, in reality, the receiving water and effluent are variable. These scenarios consist of restrictive conditions under which the guidelines should be met, such as high effluent discharge of the substance of concern and projected background concentrations. The use of worst-case conditions at steady state provides a level of protection that should allow attainment of the EQO even when actual substance levels vary.

Development of EDO equations for chemical substances using steady-state models

The premise of the steady-state model is the mass-balance equation. This equation can be rearranged, as shown below, to calculate the EDO (in concentration) that will not exceed the EQO in downstream receiving waters:

$$Q_d C_d + Q_s C_s = Q_r C_r$$

becomes

$$C_d = \frac{Q_r C_r - Q_s C_s}{Q_d}$$

The resulting equation may be further modified to take into consideration only the fraction of the background stream flow that is designated for the mixing zone:

$$C_d = \frac{C_r(Q_d + ff \cdot Q_s) - ff \cdot Q_s C_s}{Q_d}$$

This equation may be used to determine the EDO. The concentration of a chemical in the effluent, C_d, represents the EDO where C_r (the resultant concentration in the stream after mixing of effluent discharge) is given the value of the EQO:

$$EDO(conc) = \frac{EQO \cdot (Q_d + ff \cdot Q_s) - ff \cdot Q_s C_s}{Q_d}$$

and

$$EDO(load) = EDO(concentration) \cdot Q_d$$

This basic steady-state model assumes that dilution is the only mitigating factor. However, steady-state models can be adapted to include processes such as degradation or sorption of the substance (US EPA 1991). The EDO may be expressed as the substance concentrations / loads at the effluent discharge that will result in a concentration / load at the edge of the mixing zone (C_r) that will not exceed the EQO.

Development of EDO equations for WET using steady-state models

The same equations may be used to determine a chronic WET EDO:

$$C_d = \frac{C_r(Q_d + ff \cdot Q_s) - ff \cdot Q_s C_s}{Q_d}$$

To develop an EDO from WET-based EQOs, toxicity units should be used. The EQO and EDO should be expressed as chronic toxic units, because exposure at the edge of the mixing zone is predicted to be chronic. The background toxicity of a receiving water body is assumed to equal 0. The EDO is represented by C_d, where:

$$EDO = \frac{EQO(Q_d + ff \cdot Q_s)}{Q_d}$$

To prevent chronic toxicity at the edge of the mixing zone, the WET-based EQO may be defined as $1TU_c$:

$$EQO \leq 1TU_c$$

This specifies that no chronic effects should result from exposure to the effluent, after dilution, at the edge of the mixing zone. Taking this into account, the equation:

$$EDO(conc) = \frac{EQO \cdot (Q_d + ff \cdot Q_s) - ff \cdot Q_s C_s}{Q_d}$$

may be rewritten as

$$EDO = 1TUc \frac{(Q_d + ff \cdot Q_s)}{Q_d}$$

where the EDO is expressed in TU_cs.

The acute WET EDO is equivalent to the acute WET EQO, as it should be met at the end of pipe directly. Therefore, the acute WET EDO = 1 TU_a.

Dynamic Modelling

Dynamic modeling may be applied where sufficient information exists to account for the variability of environmental substances and stream and effluent flow. These methods calculate a complete probability distribution that an EQO will be exceeded in receiving waters. Dataset requirements are more rigorous than for steady-state modeling, but may be more accurate. An additional advantage of dynamic modeling methods is that they determine the effluent concentration frequency distribution that is required to attain the EQO. The EDO may be easily selected from this output. The dynamic models used by the US EPA include continuous simulation, Monte Carlo simulation, and Log-normal probabilistic dilution (US EPA 1996).

Continuous simulation models use time series input data to predict receiving water quality concentrations in the same chronological order as the input data (US EPA 1996). They provide several advantages over steady-state models. Rather than provide a single, worst-case scenario estimate, continuous simulation models incorporate the variability and interaction of pH, flow, temperature and substance discharge over time. In addition, long simulation times can prevent the initial conditions used in the model from affecting the interpretation of fate and transport processes (US EPA 1991).

Monte Carlo simulations involve the random selection of sets of input data for use in repetitive model runs to predict the probability distribution of receiving water quality concentrations (US EPA 1996). Unlike the continuous simulation model and the lognormal dilution method, the Monte Carlo simulation does not require a time series for model input data or a specific statistical distribution (US EPA 1991).

The lognormal probabilistic dilution model predicts the probability distribution of receiving water concentrations from the lognormal probability distributions of input variables. This method is not dependent on time-series data and is practical, as in-stream water quality data are often log-normally distributed. The US EPA (1991) presents these models in greater detail.

The output of the dynamic modeling method is the predicted substance load / concentration allocated to the point source under certain conditions that will not exceed the EQO after the effects of dilution and mixing.

Appendix C presents a simple case study which demonstrates the steps that may be followed in developing EDOs.

6.0 Environmental Risk Assessment – Watershed Approach

6.1 Introduction

In many cases, an individual MWWE discharge is only one of several sources of pollutant loadings that may influence the quality of receiving streams and lakes. As a result, the single discharge approach to environmental risk assessment and determining EDOs may overlook significant sources of impairment of designated uses or impose EDOs on a discharger that is more stringent than necessary. The watershed approach follows the same basic steps to environmental risk assessment as the single discharger approach, but the geographic scope, water quality objectives, and stakeholder involvement are significantly broader. The watershed approach also encourages innovative and cost-effective strategies to overall reduction of pollutant loadings to the aquatic or marine environment.

Canada's traditional approach to managing MWWE dischargers is based on addressing each facility on an individual basis. This approach is simple and unambiguous, and allows for timely issuance of discharge

permits that are specifically tailored to local environmental conditions, facility characteristics, and regulatory requirements.

In recent years, however, the potential interaction of multiple dischargers on a receiving water system has been recognized. In addition, the significant contribution of non-point sources of pollution loadings has been measured in many aquatic and marine ecosystems around the world. These non-point sources include, but are not limited to, agriculture (both crops and livestock management), urban and suburban runoff, and air deposition. Further, other point-source discharges, such as storm water conveyances and combined sewer overflows, may also contribute significant pollutant loadings in wet weather. As a result, many jurisdictions in numerous countries have begun to apply a watershed approach to environmental risk assessment. Examples of watershed approaches include the following, presented in increasing order of complexity:

- Synchronized permits within a basin for several MWWE;
- Synchronized permits within a basin for one or more MWWE and other point source discharges;
- Developing water-quality based effluent limits using a multiple-discharge modeling analysis;
- Permits and plans that include provisions for reductions in pollutant loadings from non-point sources.

6.2 Benefits of the Watershed Approach

Among the benefits of the watershed approach to environmental risk assessment are the following:

- Holistic approach to environmental management;
- Optimization of pollutant discharge reduction among point sources;
- Increased effectiveness through consideration of non-point sources;
- Overall increased cost-effectiveness of controls and monitoring;
- Increased involvement of all stakeholders, including the public.

6.3 Guiding Principles

There are several principles based on the core environmental values of long-term sustainability and the protection of the natural environment that support the use of a watershed approach. These are:

- The management of a MWWE will be based on the watershed water quality objectives;
- Watershed objectives will be set by the users and managers who regulate the inputs into the water system, as well as the affected public;
- In establishing the individual discharge limits, the inputs of upstream users and the needs of downstream users will be considered;
- The approach will be beneficial to the discussion of source control with industrial users of the municipal treatment facility.

6.4 When to Use a Watershed Approach

The use of a watershed approach to environmental risk assessment may be required by the jurisdiction that issues discharge permits. Even if the approach is not required, however, there are a number of circumstances in which it may be recommended, including:

- When assessing pollutants such as nutrients that are common to many sources (both point and non-point) and impact large geographical areas with non-lethal effects;
- Where MWWE and other point sources are clustered together geographically;

- Where MWWE discharges are impacting downstream uses, including water intakes;
- When non-point sources, such as agriculture, are known to contribute significant loadings of pollutants of concern.

6.5 Determine EDOs Using a Watershed Approach

The following approach is based on US EPA's *Handbook for Developing Watershed Plans to Restore and Protect our Waters* (US EPA 2005). A thorough discussion of all aspects of the recommended approach is beyond the scope of this document. This reference should be consulted for more detail. More information and an on-line version of the document can be found at http://www.epa.gov/owow/watershed/. Other helpful information can be found at the web sites for US EPA's **Total Maximum Daily Load (TMDL)** program (http://www.epa.gov/owow/tmdl/) and NPDES permitting program (http://cfpub.epa.gov/npdes/wqbasedpermitting/wspermitting.cfm).

At the outset, it should be recognized that a watershed plan is highly site-specific, and that the approach used may be modified based on local environmental, regulatory, or other factors. However, each of the following steps should be evaluated as a plan is developed. In addition, note that watershed planning is an iterative and adaptive process. After the initial plan is implemented, the evaluation process may suggest changes to the plan. This process could continue for several cycles. This allows to improve the initial plan, which might need to be modified over time as more complete information becomes available.

Step 6-1: Build Partnerships

Bringing together people, policies, priorities, and resources through a watershed approach blends science and regulatory responsibilities with social and economic considerations. Each potential stakeholder has different concerns, goals, and ideas. In addition, sharing resources allows for a more economical watershed plan development process. The eventual success of the plan depends on involving all relevant stakeholders from the very beginning. Among tasks are the following:

- Identify driving forces:
  - Regulatory issues (e.g., laws, regulations, permit requirements);
  - Government issues (e.g., federal or provincial initiatives);
  - Community-driven issues (e.g., local environmental and human health concerns).
- Identify and engage relevant stakeholders:
  - Identify categories of stakeholders (e.g., MWWE and industrial dischargers, farmers, landowners, local public officials, environmental organizations);
  - Determine roles and responsibilities and identify structure of stakeholder group;
  - Initiate outreach activities and encourage participation and involvement.
- Integrate relevant local, provincial, and federal programs into planning process.

Step 6-2: Define Scope of Watershed Planning Effort

It is very important to define an appropriate scope from the outset of the watershed planning process. The scope must be defined both in terms of geographical extent and the issues to be addressed. Too broad a scope may overtax the available human and financial resources and lead to problems in implementation. On the other hand, too narrow a scope may not allow addressing the goals successfully. All of these factors, in turn, will affect the time scope of the plan. Among the tasks are the following:

- Obtain background information from stakeholders;
- Identify issues of concern and design a conceptual model;

- Define the geographic extent of the watershed:
  - Identify the level of geographical coverage (e.g., small stream drainage area or large river drainage basin);
  - Map geographical extent of selected watershed.
- Develop preliminary goals;
- Select quantitative EQOs (e.g., CEQGs, provincial guidelines, or site-specific values).

Step 6-3: Gather Existing Data and Create Inventory

At this stage, the characterization of the watershed begins. In order to develop the watershed plan in a timely and cost-effective manner, it is important to build on existing data and information. Among the tasks are the following:

- Identify sources of data and information:
  - Investigate local, municipal, provincial and federal sources;
  - Utilize universities and non-governmental organizations.
- Identify types of data and compile available information:
  - Physical and natural features (e.g., hydrology, soils, fish and wildlife, habitat);
  - Land use and human population characteristics (e.g., land use and cover, land management practices, demographics);
  - Waterbody and watershed conditions (e.g., water quality reports);
  - Pollutant sources (e.g., point and non-point sources);
  - Waterbody monitoring data (e.g., chemistry, biology).
- Select tools for data management (e.g., geographical information systems (GIS));
- Create data inventory.

Step 6-4: Identify Data Gaps and Collect Additional Data as Needed

A balance must be struck between the desire to collect as much information as possible and the time and resource constraints of the watershed plan development process. Typically, existing information is inadequate in one or more respects and the collection of some additional data is necessary. Among the tasks are the following:

- Conduct data review:
  - Identify key parameters of concern for your watershed;
  - Identify data gaps (e.g., parameters, location, time);
  - Determine data quality / acceptability.
- Determine whether additional data collection is necessary;
- Design sampling plan for collecting new data:
  - Select monitoring program design (e.g., parameters, location, time, number of samples);
  - Develop data quality objectives and **Quality Assurance Project Plan (QAPP);**
  - Collect new data.

Step 6-5: Analyze Data to Characterize the Watershed and Pollutant Sources

Once sufficient data have been collected and inventoried, they must be analyzed to characterize the watershed. The goal of this step is to identify potential causes and sources of impairment due to the pollutant(s) of concern. Among the tasks are the following:

- Analyze instream and watershed data:
  - Confirm impairment(s) and identify problems (e.g., exceedances of EQOs);
  - Calculate summary statistics (e.g., mean and standard deviation, standard error, median, range);
  - Conduct spatial analysis (e.g., areas of concern, relationship to individual point sources and categories of non-point sources);
  - Conduct temporal analysis (e.g., seasonal variations, relationship to precipitation);
  - Look for other trends or patterns (e.g., flow vs. water quality, relationships between pollutants);
  - Conduct visual assessments and apply local knowledge.
- Evaluate data analysis results to identify causes and sources:
  - Group sources for further assessment (e.g., categories of point sources or non-point sources).

Step 6-6: Estimate Pollutant Loads

At this stage, the pollutant loads source can be estimated. By estimating source loads, one can evaluate the relative magnitude of sources, the location of sources, and the timing of source loading. The loading analysis can help to plan restoration strategies, target load reduction efforts, and project future loads under new conditions. Among the possible approaches are the following:

- Use monitoring data to directly estimate loads;
- Use literature values to estimate loads (e.g., runoff rates from categories of land use);
- Conduct watershed modeling:
  - Select appropriate model(s) for watershed and pollutant(s) of concern;
  - Delineate watershed;
  - Assign land uses;
  - Select parameters;
  - Test model;
  - Estimate existing conditions and baseline scenarios.

Watershed models utilize a set of equations to describe man-made or natural processes in a watershed system. These processes typically include rainfall / runoff, erosion and sediment transport, pollutant loading, stream transport, and management processes. The level of detail in which these processes are addressed depends on the model that is selected.

The key step is the selection of the appropriate watershed model for the task at hand. The model should be relevant to the particular watershed, study objectives, and available data, have established technical credibility, and be relatively easy to learn to use. US EPA (2005) presents a useful inventory of available watershed models that evaluates the models across a set of key characteristics including:

- Model type;
- Level of complexity;
- Time step (i.e., the unit of time in which results are calculated);
- Hydrology;
- Water quality (i.e., the type(s) of pollutant(s) to be modeled;
- Types of management practices.

Among the most commonly used models are:

- AGNPS (Agricultural Non-Point Source);
- STEPL (Spreadsheet Tool for Estimating Pollutant Load);

- GWLF (Generalized Watershed Loading Function);
- HSPF (Hydrologic Simulation Program – Fortran);
- P8-UCM (Urban Catchment Model);
- SWAT (Soil and Water Assessment Tool);
- SWMM (Storm Water Management Model).

US EPA (2005) reviews and compares these models for a variety of capabilities and characteristics to help the user to choose the best model for the particular application.

Step 6-7: Set Objectives and Identify Load Reductions

The preliminary goals from **Step 6-2** can now be refined into more specific management objectives. The load reductions needed to achieve the EQOs can also be identified. Among the tasks are the following:

- Translate watershed goals into management objectives;
- Select specific environmental indicators and numeric targets to evaluate compliance with management objectives (e.g., instream concentration of a particular pollutant);
- Determine load reductions to meet targets using appropriate estimation methods (e.g., mass balance, empirical approaches, water quality modeling);
- Focus load reductions on individual sources or categories of sources.

Step 6-8: Identify Possible Management Strategies

Depending upon the load reductions identified in **Step 6-7**, there may be a number of potential strategies for managing the major sources. These include approaches for both point and non-point sources. Among the tasks are the following:

- Identify existing management efforts in the watershed (e.g., discharge permits for point sources, ordinances for land usage);
- Quantify effectiveness of existing management programs;
- Identify critical areas in watershed where additional management efforts are needed;
- Identify possible management strategies:
  - Point source (e.g., new or more stringent EDOs – identical among multiple dischargers or allocated by treatability, etc.);
  - Non-point source (e.g., structural or non-structural **Best Management Practices (BMPs)**).
- Identify relative pollutant reduction efficiencies;
- Evaluate means of distributing load reductions among sources (e.g., equal reductions, proportional to treatability / reduction efficiencies);
- Rank alternative strategies.

Step 6-9: Evaluate Options and Select Final Management Strategies

The final management strategies will likely be a combination of several different approaches for non-point sources and recommended EDOs for point sources. An important part of the evaluation process is a cost / benefit analysis with the goal of the most cost-effective set of strategies to meet the management objectives. For example, are stringent EDOs more or less cost effective than non-point source controls? Can some point sources economically achieve more stringent EDOs than others? Among the tasks are the following:

- Select approach to quantify effectiveness of management strategies (e.g., literature values, compilations spreadsheets, or water quality models);
- Identify costs and compare benefits of management strategies:
  - Identify cost considerations;
  - Compare costs and effectiveness.
  - Select final management strategies.

Step 6-10: Design Implementation Program and Assemble Watershed Plan

The final management strategies form the heart of the watershed plan. However, the process by which these strategies will be implemented and evaluated must be established. Among the tasks are the following:

- Develop information / education component;
- Establish interim measurable milestones;
- Establish criteria to measure progress towards achieving EQOs;
- Develop monitoring component;
- Estimate financial and technical assistance needed:
  - Estimate costs;
  - Identify funding sources;
  - Identify technical assistance needs;
  - Identify relevant authorities needed for implementation.
- Develop evaluation framework:
  - Inputs (e.g., time, resources, stakeholder participation);
  - Outputs (e.g., implementing strategies, completing information / education efforts);
  - Outcomes (e.g., meeting interim goals, changed behaviours, attaining EQOs).

Step 6-11: Implement Watershed Plan and Measure Progress

The final step is the actual implementation of the watershed plan. The implementation process will have a profound effect on the ultimate effectiveness of the plan in achieving its objectives. An important component of the implementation is the evaluation process. This evaluation feeds the iterative process described previously, in which the watershed plan is refined based on the results of the evaluation. Among the tasks are the following:

- Create organizational structure for implementation;
- Implement activities;
- Prepare work plans with schedules;
- Communicate results;
- Evaluate program:
  - Track progress against work plans;
  - Analyze monitoring data.
- Make adjustments if:
  - Implementation milestones are not met;
  - Load reductions are not achieved.

6.6 Water Quality Trading

Water quality trading is an innovative approach to achieve water quality goals more efficiently. Trading is based on the fact that sources in a watershed can face very different costs to control the same pollutant.

Trading programs allow facilities facing higher pollution control costs to meet their regulatory obligations by purchasing environmentally equivalent (or superior) pollution reductions from another source at lower cost, thus achieving the same water quality improvement at lower overall cost. Such trading programs can be considered as part of **Step 6-9** (Evaluate Options and Select Final Management Strategies).

Water quality trading works bests when:

- There is a "driver" that motivates facilities to seek pollutant reductions (e.g., more stringent EDOs or a requirement for load reductions by a non-point source);
- Sources within the watershed have significantly different costs to control the pollutant of concern;
- The necessary levels of pollutant reduction are not so large that all sources in the watershed must reduce as much as possible to achieve the total reduction needed – in this case there may not be enough surplus reductions to sell or purchase;
- Watershed stakeholders and the regulatory jurisdiction are willing to try an innovative approach and engage in trading design and implementation issues.

Trading is most appropriate for pollutants such as nutrients or suspended solids. Trading can be considered for some toxic pollutants if potential toxicity "hot spots" are not present. Trading is discouraged for bioaccumulative substances.

Trading is sometimes performed on a "pound for pound" basis. In order to address uncertainty in load reduction efficiency, however, trading ratios or offsets are sometimes used (e.g., 4 kg removed is equivalent to 1 kg purchased).

The following is a brief summary of the steps involved in establishing a water quality trading program. More detailed information is available in US EPA's *Water Quality Trading Assessment Handbook* (US EPA 2004) or online at:
http://www.epa.gov/owow/watershed/trading.htm

Step 6-12: Determine Suitability of Pollutant for Trading

The first step in evaluating the potential for trading is to determine the suitability of the pollutant. The key characteristics to be evaluated are:

- **Type/form** - trading can only occur in an "apples for apples" scenario. Different chemical forms of a pollutant should not be considered as equivalent for trading.
- **Impact** - trading must not create locally high loadings or "hot spots".
- **Timing** - production and purchase of load reductions should occur over the same time period. Seasonal variations in loads and removal efficiencies should be considered.
- **Quantity** - the supply of tradable loads must be sufficient to meet the demand.

Step 6-13: Analyze the Financial Attractiveness of Trading

One of the primary incentives for water quality trading is financial. In order to determine whether a trading program is feasible and desirable, an evaluation of the costs of load reductions is necessary. This analysis has already been considered as part of **Step 6-9** above. Costs for incremental load reductions (e.g., dollars/kg removed) can be compared among point and non-point sources. Those sources with low incremental costs may be suitable "sellers", while those with high incremental costs may be interested "buyers".

Step 6-14: Establish the Trading Market Infrastructure

Establishing a trading market has many considerations common to any financial market. Some of the key factors to be considered are:

- Assure compliance with the EQOs and other environmental indicators, as well as other regulatory requirements;
- Define and execute the trading process;
- Define marketable reductions;
- Ensure water quality equivalence of trades and avoid hotspots;
- Establish communication among buyers and sellers;
- Track trades;
- Manage risk among parties to trades;
- Provide information to the public and other stakeholders.

Appendix D presents three examples of variations on watershed management of pollutants:

- US EPA – Total Daily Maximum Load (TMDL);
- Watershed Management for Several Discharges;
- Water Quality Trading.

7.0 Selection of Substances for Compliance Monitoring

Based on the initial characterization results and environmental risk assessment, EDOs are established for certain substances on a site-specific basis. In general, the monitoring requirements are specified as site-specific regulatory instruments (e.g., permits, certificates, licenses, regulations) issued by the jurisdictional regulatory agency. It is expected that the government regulatory agencies will select substances to be monitored to demonstrate compliance with CCME / agency regulatory requirements.

The following steps may be followed by the agencies to develop compliance monitoring strategies:

Step 7-1: Selection of Substances

- TSS, $CBOD_5$ and TRC (when chlorination is used) must be selected for compliance monitoring regardless of initial characterization results.
- From the initial characterization, select other substances that exceed EQOs.
- Select the substances with mean effluent values $\geq$ 80% of established EDOs.
- Select surrogate substance(s) that can be used as an indicator substance. Surrogate substances are those that can be used as substitutes for other substances or groups of substances to improved monitoring cost savings. For example, **Dissolved Organic Carbon (DOC)** can be used as a surrogate substance for organic compounds; benzene is a surrogate for toluene and xylene.

Step 7-2: Selection of Monitoring Frequencies

- Compliance monitoring frequencies for TSS, $CBOD_5$, TRC and toxicity testing are outlined in Tables 7-1 and 7-2;.
- Monitoring frequencies for TSS, $CBOD_5$ shown in Tables 7-1 and 7-2 represent minimum requirements. Jurisdictions may whish to monitor these substances more frequently since they reflect the conditions of well operated facilities.

- If nutrients and pathogens have EDOs, the same monitoring frequencies as for TSS and $CBOD_5$ should apply for nutrients and pathogens. No frequency reduction is allowed for $CBOD_5$, TSS, TRC, nutrients and pathogens since removal of these substances depends on facility operation.
- Jurisdictions will establish monitoring frequencies for other substances of concern or their surrogates as required.
- When results have demonstrated that a substance concentration is consistently < 80% of the EDO value, the monitoring frequency can be reduced when the regulatory instrument is periodically reviewed or the instrument allows. Should the effluent discharge quality subsequently exceed 80% of the EDO, the monitoring frequency must return to the initial, more frequent one.
- Monitoring must also return to the initial frequency if there is a major change in the wastewater system, such as the addition of significant lengths of new sewers, the addition of major new industrial discharges to the sewer system, or alterations or upgrades to the treatment system.

Table 7-1. Minimum Compliance Monitoring Frequencies for NPSs, Continuous Discharge

Facility Size	**TRC[1] (or dechlorination agent)**	**TSS and $CBOD_5$**	**Period for calculation of periodic averages[4]**
Very Small	Daily	Monthly[2]	Quarter
Small	Daily	Monthly[2]	Quarter
Medium	Daily	Every 2 weeks	Quarter
Large	Twice per day	Weekly	Month
Very Large	Three times per day	Daily[3]	Month

1, TRC or the dechlorination chemical that is used. Only required if chlorine is used in the wastewater facility.
2, May be reduced to quarterly for existing lagoons, in which case averaging period would be annual.
3, 5 – 7 days per week.
4, For compliance with the NPSs for $CBOD_5$ and TSS. Period is based on facility size and does not change for facilities that may have a higher monitoring frequency.

Table 7-2. Toxicity Testing

Facility Size	**Acute Toxicity Tests**	**Acute Toxicity Testing Frequency**	**Chronic Toxicity Tests**	**Chronic Toxicity Testing Frequency**
Very Small	n/a	n/a	n/a	n/a
Small	n/a	n/a	n/a	n/a
Medium	-Rainbow trout -*Daphnia magna*	Quarterly	-Fathead minnow -*Ceriodaphnia dubia*	Quarterly
Large	-Rainbow trout -*Daphnia magna*	Quarterly	-Fathead minnow -*Ceriodaphnia dubia*	Quarterly
Very Large	-Rainbow trout -*Daphnia magna*	Monthly	-Fathead minnow -*Ceriodaphnia dubia*	Monthly

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Biological, Toxicological, Microbiological and Chemical Analytical Test Methods for the Examination of Gaseous Effluents, Water, Wastewater and Solid Wastes are available at:
(French) http://www.ceaeq.gouv.qc.ca/analyses/index.htm
(English) http://www.ceaeq.gouv.qc.ca/analyses/index_en.htm
Also pertinent information about Sampling Methods, Sample Preservation, Quality Assurance, Accreditation and Proficiency Testing are available at:
(French) http://www.ceaeq.gouv.qc.ca/index.htm
(English) http://www.ceaeq.gouv.qc.ca/index_en.htm

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Appendix A Sampling, Preservation and Storage

Table A-1. Sampling, Preservation and Storage Requirements for Substances of Potential Concern

Substances	**Sampling**			**Preservation**	**Storage**		**Precautions / Notes**
	Container	***Volume***	***Field QC*** [1]		***Conditions***	***Time***	
Fluoride	PET, Teflon®, polypropylene, polyethylene, polystyrene or glass containers with plastic lids	50 mL	DS, OT	None	n/a	up to 30 days	If sample is expected to have high (>5%) hydrocarbon or organic solvent content, use glass or Teflon® container only with Teflon® lined caps.
Nitrate + Nitrite	PET, Teflon®, polypropylene, polyethylene, polystyrene or glass containers with plastic lids	50 mL	DS, OT	None	n/a	up to 5 days	If sample is expected to have high (>5%) hydrocarbon or organic solvent content, use glass or Teflon® container only with Teflon® lined caps.
Ammonia plus Ammonium, as Nitrogen	PET, Teflon®, polypropylene, polyethylene, polystyrene or glass containers with plastic lids	50 mL min	DS	None	at 5 ± 4°C	up to 7 days	n/a

Substances	Sampling			Preservation	Storage		Precautions / Notes
	Container	***Volume***	***Field QC [1]***		***Conditions***	***Time***	
Metals	PET, Teflon®, polypropylene, polyethylene, polystyrene or glass containers with plastic lids	50 mL	DS	Preserve samples immediately on collection (nitric acid to pH of < 2)	Preserved to pH <2	A holding time of 60 days for samples	If boron analysis is required, glass containers should not be used due to the potential for sample contamination.
Phosphorus	PET, Teflon®, polypropylene, polyethylene, polystyrene or glass containers with plastic lids	20 mL min	DS	None	at 5 ± 4°C	up to 7 days	n/a
Total Suspended Solids	PET, Teflon®, polypropylene, polyethylene, polystyrene or glass containers with plastic lids	5 - 500 mL min	DS	None	at 5 ± 4°C	Up to 14 days	n/a
Carbonaceous Biochemical Oxygen Demand (5-day), $CBOD_5$	PET, Teflon®, polypropylene, polyethylene, polystyrene or glass containers with plastic lids	5 - 500 mL min	n/a	None	at 5 ± 4°C, in the dark	up to 7 days	If natural samples are received frozen, they should not be analyzed due to the detrimental affect of freezing on cellular material which can lead to biased results.

Substances	**Sampling**			**Preservation**	**Storage**		**Precautions / Notes**
	Container	***Volume***	***Field QC*** [1]		***Conditions***	***Time***	
Chemical Oxygen Demand	PET, Teflon®, polypropylene, polyethylene, polystyrene or glass containers with plastic lids	25 mL	DS, OT	H_2SO_4 to pH between 1.5 and 2	Protect from light	up 30 days preserved, 4 days unpreserved	If sample is expected to have high (>5%) hydrocarbon or organic solvent content, use glass or Teflon® container only with Teflon® lined caps.
Polychlorinated Biphenyls (PCBs), Organochlorines (OCs), Chlorobenzenes (Cbs)	Amber bottles, l litre, with Teflon®-lined caps. Prior to sample collection, bottles are washed with detergent, rinsed with dilute acetic acid, rinsed with hot tap water, rinsed with distilled water and baked for 4 hours at 300 ± 5°C. EPA and / on industry standard bottles with proof not contaminated	800 mL	n/a	None	2°-10°C, in the dark	up to 42 days	n/a

Substances	**Sampling**			**Preservation**	**Storage**		**Precautions / Notes**
	Container	***Volume***	***Field QC*** [1]		***Conditions***	***Time***	
Acid / Base and Neutral Compounds (including Polycyclic Aromatic Hydrocarbons)	Amber bottles, I litre, with Teflon®-lined caps	200 mL min	n/a	None	at 4 ± 3°C, in the dark	up to 30 days	Refrigerate at 4 ± 3°C to avoid bacterial degradation, and store in the dark to avoid photo-decomposition, up to 30 days.
Total Cyanide	PET, Teflon®, polypropylene, polyethylene, polystyrene or glass containers with plastic lids	500 mL	DS, OT	NaOH to raise pH to 12	n/a	up to 7 days	If sample is expected to have high (>5%) hydrocarbon or organic solvent content, use glass or Teflon® container only with Teflon® lined caps.

Substances	**Sampling**			**Preservation**	**Storage**		**Precautions / Notes**
	Container	***Volume***	***Field QC*** [1]		***Conditions***	***Time***	
Hydrogen Ion (pH)	PET, Teflon®, polypropylene, polyethylene, polystyrene or glass containers with plastic lids	50 mL	DS	None	at 5 ± 4°C	up to 4 days	Analysis should be initiated as soon as possible (i.e. field measurement). When the characteristics of the wastewater may lead to rapid changes in pH, an on-line analyzer should be used. If sample is expected to have high (>5%) hydrocarbon or organic solvent content, use glass or Teflon® container only and Teflon® lined caps.
Volatile Organic Compounds (VOCs) – 1,4 (Dichlorobenzene)	Clear on amber glass with airtight septa-type cap	Min 2, 40 mL vials	n/a	No preservatives added. Use sodium thiosulphate ($Na_2S_2O_3$) if residual Chlorine is present	<10°C	<14 days	Samples should be analyzed as soon as possible after collection

Substances	**Sampling**			**Preservation**	**Storage**		**Precautions / Notes**
	Container	***Volume***	***Field QC*** [1]		***Conditions***	***Time***	
Total Kjeldahl Nitrogen (TKN) - Organic Nitrogen + Total Ammonia Nitrogen	PET, Teflon®, polypropylene, polyethylene, polystyrene or glass containers with plastic lids	100 mL min	DS, OT	None	at 5 ± 4°C	up to 7 days	Samples may be preserved with sulphuric acid (H_2SO_4) to pH <2; preserved samples may be stored up to 14 days. Samples containing strong oxidizing agents (e.g., chlorine) should be neutralized as soon as possible after sample collection to prevent oxidation / degradation.

Substances	**Sampling**			**Preservation**	**Storage**		**Precautions / Notes**
	Container	***Volume***	***Field QC*** [1]		***Conditions***	***Time***	
Mercury	Glass container with plastic lids. Contact with metal foil is not recommended	25 mL	DS	Samples should be preserved in the field using 0.5 - 1.0 mL of concentrated nitric acid and 5 - 10 drops of 5% Potassium Dichromate Saturated Solution, sufficient for the sample to turn a bright yellow colour.	Room temperature	< 14 days	Storage of samples for more than 14 days can result in loss of mercury; therefore, analysis should be carried out as soon as possible.
Phenolic Compounds	Glass or Teflon® containers with phenolic-free caps	250 mL	DS, OT	H_2SO_4 to pH between 1.5 to 2	n/a	up to 30 days	
Total Residual Chlorine (TRC)	Amber glass containers with ground-glass stoppers	1,000 mL	DS, OT	None; protect from light	n/a	< 1 hour	On-line analyzer is the preferred method of monitoring. If a Grab sample is taken, analysis must take place within I hour

Substances	**Sampling**			**Preservation**	**Storage**		**Precautions / Notes**
	Container	***Volume***	***Field QC*** [1]		***Conditions***	***Time***	
Arsenic	PET, Teflon®, polypropylene, polyethylene, polystyrene or glass containers with plastic lids	50 mL	DS	Preserve samples immediately on collection (nitric acid to pH of < 2)	n/a	30 days for preserved sanples	If sample is expected to have high (>5%) hydrocarbons or organic solvent content, use glass or Teflon®-lined caps
Chromium (Hexavalent)	Glass or Teflon® container with plastic lids. Contact with metal foil is not recommended	200 mL	DS	None	n/a	5 days	Unless specifically requested, analyze for Hexavalent Chromium only if total Chromium is> I mg/L.

Substances	**Sampling**			**Preservation**	**Storage**		**Precautions / Notes**
	Container	***Volume***	***Field QC*** [1]		***Conditions***	***Time***	
Escherichia coli (E.	Sterile plastic or glass containers with plastic lids	200 – 250 mL (leave headspace to allow shaking of sample)	DS	30 mg Sodium thiosulphate ($Na_2S_2O_3$) inhibits chlorine; this optional if there is no chlorination of the wastewater	at 5 ± 3°C	48 hours	Transport chilled, not frozen. Do not touch the inside of the sample container or lid (aseptic technique). Sodium thiosulphate must be added as soon as possible after sample collection when chlorine or sodium hypochlorite has been used as a disinfectant. It is strongly recommended that suitable containers be used which are pre-charged with the preservative.

Note:
[*] *Field QC Legend* - DS: Duplicate Samples, OT: Optional Travel Blanks

Appendix B Analytical Requirements

Table B-1. Analytical Laboratory Guidelines for Substances of Potential Concern

Substance	**Method Principle***	**Performance**
		MDL (mg/L)
Fluoride	Preparation of measurement system as appropriate. Colourimetry, ion selective electrode or ion chromatography.	0.1
Nitrate + Nitrite	Preparation for measurement system as appropriate. Colourimetry, Ion chromatography or Ion Selective Electrode.	0.25 as Nitrogen
Ammonia plus Ammonium, as Nitrogen	The procedure is based on the formation of indophenol blue product in buffered alkaline media; ammonia is converted to indophenol blue using sodium nitroprusside as catalyst. The absorbance of the solution is measured at between 630 and 660 nm and a 1.5 cm flow cell at least or equivalent SCFA system. The concentration is determined by comparison to known standards. Samples can be analyzed directly or distilled prior to analysis, to remove interferences.	0.25 as N

Substance	Method Principle*	Performance
		MDL (mg/L)
Metals	An aliquot of the digested sample (concentrated Nitric/Hydrochloric Acids) is aspirated into the argon plasma discharge of an Inductively Coupled Plasma -Atomic Emission Spectrometer (ICP-AES) or mass spectrometer (ICP-MS). The plasma serves as an atomization device as well as a source of excitation energy. The atoms emit their characteristic radiation and the energy of this radiation indicates the amount of analyte present. A computer-controlled spectrometer is used to analyze the plasma discharge and the concentrations are printed directly.	See Table C-2
Total Phosphorus	For the determination of total phosphorus, samples are digested in sulphuric acid-mercuric oxide-potassium sulphate media using 3 block digesters maintained at 180°C, 210°C and 360°C or by using only one block of digestion but which is programmable at various temperatures. The orthophosphate content in the digestate is determined by the formation of a reduced phospho-antimonylmolybdate complex using ascorbic acid as the reducing agent. The absorbance of the solution is measured at 660 or 880 nm and a 1.5 cm flow cell at least or equivalent SCFA system. The concentration of phosphorus is determined by comparison with a set of known standards. Acidity levels are controlled throughout analysis.	0.1 as P
Total Suspended Solids	A well mixed aliquot of sample is filtered through a 1.5 to 2.0 pm glass fibre filter. The material is dried at 103 ± 2°C. The Suspended Solids is calculated after weighing the dried material. Samples are analyzed directly, after mixing. An analytical balance capable of reading to 0.0000Ig or better is required.	2.5

Substance	Method Principle*	Performance
		MDL (mg/L)
Carbonaceous Biochemical Oxygen Demand (5-day), $CBOD_5$	$CBOD_5$ is a measure of the biochemical degradation of organic material (carbonaceous demand) over a specified time period. The dissolved oxygen depletion is determined during a 5-day incubation period at a specified temperature (20°C), after a nitrification inhibitor has been added. Modifications are introduced, if necessary, to ensure a suitable level of bacterial activity. The $CBOD_5$ is determined by analyzing a sample or dilution thereof with Dilution Water. The dilution should be such that about 50% of the dissolved oxygen is depleted after 5 days incubation. The dissolved oxygen is determined as soon as possible after preparation and again after the incubation period. The $CBOD_5$ is expressed as the amount of dissolved oxygen in mg utilized by I litre of sample during a 5-day incubation period at 20°C An appropriate amount of inhibitor such as 2-chloro-6-(trichloro methyl) pyridine (TCMP) at 10 mg per litre sample is added to each sample.	2
Chemical Oxygen Demand	Preparation of measurement system as appropriate, followed by reflux. Instrumental measurement: Colourimetric measurement of trivalent chromium or back titration. High chloride content in samples may cause severe problems in the analysis of COD.	10
Polychlorinated Biphenyls (PCBs), Organochlorines (OCs), Chlorobenzenes (Cbs)	An 800 mL volume of sample is extracted with 5 mL Hexane, concentrated, reconstituted in Toluene, and analyzed by Gas Chromatography / Mass Spectrometry (GC/MS).	See Table C-3

Substance	Method Principle*	Performance
		MDL (mg/L)
Acid / Base and Neutral Compounds (including Polycyclic Aromatic Hydrocarbons)	Samples are processed using an in-situ acetylation followed by liquid / liquid extraction with dichloromethane. The extracts are then dried using sodium sulphate and concentrated prior to instrumental analysis. The analysis is performed using a Gas Chromatograph-Mass Spectrometer (GC-MS) operated in the Selected Ion Monitoring (SIM) mode.	See Table C-4
Total Cyanide	Acid distillation / ultraviolet digestion. Instrumental measurement: Colourimetry.	0.005 as HCN
Hydrogen Ion (pH)	pH, a measurement of the hydrogen ion activity, is defined as the negative logarithm of the hydrogen ion activity, and is expressed in logarithmic units. Hence, it is important to realize that a pH change of one unit constitutes a tenfold change in hydrogen ion concentration. pH is determined using a calibrated potentiometric system consisting of a pH meter and a combination glass electrode with a reference cell. The electromotive force produced in the glass electrode system varies linearly with pH. Analysis requires immersion of the combination electrode in the sample, and recording the reading of the pH meter	n/a

Substance	**Method Principle***	**Performance**
		MDL (mg/L)
Volatile Organic Compounds (VOCs) – 1,4 (Dichlorobenzene)	Water, leachates and effluent samples are first screened for VOC5 (aliphatic / anomatic hydrocarbons and / or organohalldes) by headspace gas chromatography equipped with a flame ionization detector and an electron capture detector (HS/GC/FID/ECD). Headspace analysis involves the sampling of an aliquot of the gaseous phase (headspace) above the aqueous phase of a sample, after it has been heated in a sealed glass vial. The compounds are identified by their retention times and quantification by measurement of peak areas relative to an external calibration standard. Quantification is based on the equilibration of compounds between vapour and liquid phases as governed by Henry's Law. Initial screening will provide information on presence / absence and initial quantification. Samples are then routed, with any necessary dilutions, to a Purge and Trap Gas Chromatograph with a Mass Spectrometer (PT/GC/MS). Purge and trap analysis involves the sparging of an aliquot of water with an inert gas, helium, and then trapping the compounds on a combination trap. The trap is later heated (desorbed), passing the compounds into the gas chromatograph. The PT/GC/MS uses a multi point external standard, with an internal standard (fluorobenzene) correction for quantification. The technique uses a defined fragment ion for quantification and either one or two other ions in conjunction with retention time, for confirmation of chemical identification. Two surrpogate standards (d8-toluene, bromofluorobenzene) are also used to monitor method performance.	0.5

Substance	Method Principle*	Performance
		MDL (mg/L)
Total Kjeldahl Nitrogen (TKN) - Organic Nitrogen + Total Ammonia Nitrogen	For the determination of TKN, samples are analyzed via a semi-automated procedure that includes batch digestion, automated neutralization, and automated colourimetry. Aliquots of samples are digested, in block digesters, with Kjeldahl's reagent to convert the tn-negative nitrogen content of organic compounds to ammonium ions (highly acidic media). After restoring the volume integrity, the sample is presented to an AutoAnalyzer system where it is neutralized in two stages, and then analyzed for ammonia species using phenate-hypochlorite colou rimetiy. The absorbance of the blue dye is measured at between 630 and 660 nm. The TKN concentration is determined by comparison with a known set of standards.	0.25 as N
Mercury	Mercury in the sample is oxidized to its divalent ion form by an acid digestion procedure (Concentrated Nitric / Sulphuric Acid / Persulphate / Dichromate mixture is added and samples are heated at 87°C for two hours or at room temperature overnight). The sample is then reduced by a stannous chloride solution to its elemental form. An air stream carries the mercury vapour into a flow through absorption cell positioned between a light source, set at 253.7 nm wavelength and a detector. The amount of absorption is proportional to the concentration of mercury in the sample.	0.1
Phenolic Compounds	Preparation for measurement system as appropriate, followed by distillation of acidified sample. Colourimetry of buffered sample.	0.002 as Phenol
Total Residual Chlorine (TRC)	Amperometry or Potentiometry. Note: As chlorine evaporates easily and quickly. It is preferable to minimize transport. Ideally, this analysis is done, in the minutes which follow, directly on the place of sampling.	0.01 as Cl

Substance	Method Principle*	Performance
		MDL (mg/L)
Arsenic	The determination of arsenic (As), selenium (Se) and antimony (Sb) entails digestion of samples in oxidizing acid mixtures, hydride generation, and atomization for measurement by Flameless Atomic Absorption Spectrophotometry (FAAS). An acidic analyte solution is mixed with an alkaline solution of sodium borohydride. The sodium borohydride is immediately decomposed and hydrogen evolved simultaneously. The generated volatile hydrides (arsine, hydrogen selenide, and stibine) are transported by the hydrogen and an argon carrier gas through a gas-liquid separator containing sulphuric acid. The hydride gas and entrained air are stripped from the solution, ending in an electrically heated quartz cuvette where the analyte is atomized for AAS measurement. Arsenic (As), selenium (Se) and antimony (Sb) can also be analysed by Inductively Coupled Plasma Mass Spectrometry (ICP-MS) after digestion like other metals.	0.005
Chromium (Hexavalent)	I ,5-diphenylcarbohydrazide reacts with chromium VI to give a reddish-purple colour, the absorption of which is measured spectrophotometrically at a wavelength of 540 nm.	0.01
Escherichia coli (E. coli)	A suitable volume of sample is passed through a gridded, membrane filter. The filter is transferred to the surface of an agar plate and incubated at the required temperature and time specific to the medium and target colonies. Enumerate the target colonies after the required incubation time. Use of additional light and magnification may assist in the enumeration process. Levels of *E. coli* are reported as colony forming units (CFU) per 100 mL, using the following formula: Count/I 00 mL = 100 x the number of colonies per filter divided by the millilitres of sample filtered.	1 (CFU/100mL)

Substance	**Method Principle***	**Performance**
		MDL (mg/L)
Dibenzo-p-dioxins / dibenzofurans	All samples are fortified prior to sample extraction, digestion or elution with known amounts of [$^{13}C_{12}$-] isotopically labeled PCDD5/PCDF5 and / or DLPCBs. The samples are filtered using a C_{18} Solid hase adsorption disk. Particulate bound PCDDs/PCDFs and DLPCBs are trapped on top of the disk while dissolved PCDDs/PCDFs and DLPCBs are adsorbed to the disk. Toluene / Ethanol is used to extract the PCDDs/PCDFs and DLPCBs from the disk and particulate matter. The extracts are cleaned using a 2-stage chromatographic clean-up procedure in order to remove potential chemical interferences. Sample extracts are cleaned using a 2-stage (silica / alumina) when PCDDs/PCDFs only are requested on no interferences such as polychioninated diphenyl ethers (PCDPEs) are expected in the sample. If PCDDs/PCDFs and DLPCBs are requested on if a sample is highly contaminated with bulk interferences, a carbon cleanup procedure must be incorporated (3-stage). The samples are analyzed by gas chromatography with mass spectrometric detection. PCDDs/PCDFs and DLPCB5 are quantified against the labeled standards added initially (isotope dilution technique). Fortify each sample with solution of $^{'3}C_{12}$-isotopically labeled PCDD and PCDF congenens and a solution of $^{13}C_{12}$-isotopically labeled DLPCB congeners.	See Table C-5

Note:

* Laboratory QC methods usually include method blanks, spikes, replicates and referenced in house control / CRM (Section 4.4)

Table B-2. MDL for Metals

Contaminant	**MDL (mg/L)**
Cadmium	0.002
Chromium	0.01
Cobalt	0.01
Copper	0.01
Lead	0.02
Molybdenum	0.01
Nickel	0.02
Zinc	0.01
Vanadium	0.02
Beryllium	0.01
Thallium	0.03
Silver	0.01
Aluminum	0.03
Strontium	0.02
Lithium	0.05
Boron	0.05

Table B-3. MDL for PCBs, OCs and Cbs

Contaminant	**MDL (µg/L)**
Hexachlorobenzene	0.01
Aldnin/Dieldrin	0.01/0.02
Hexachlorocyclohexane, y	0.01
Chlordane (total)	0.02
DDT(total)	0.05
Mirex	0.05
Octachlorostynene	0.01
Toxaphene	5.0
PCB (total)	0.05
Endnin	0.05
Heptachlor **+** Heptachlor Epoxide	0.01/0.02
Hexachlorobutadiene	0.01
1,2,3,4-Tetrachlorobenzene	0.01
I,2,4,5-Tetrachlonobenzene	0.01

Table B-4. MDL for Acid/Base and Neutral Compounds (including PAHs)

Contaminant	**MDL (µg/L)**
Anthracene	0.6
Pentachlorophenol	1
Benz(a)anthracene	0.5
Benzo(b)fluoranthene	0.7
Phenanthrene	0.4
Benzo(g,h,i)perylene	0.7
Perylene	1
Benzo(a)pyrene	0.6
Chrysene	0.3
Pyrene	0.4
Benzo(k)fluoranthene	0.7
Dibenzo(a,h)anthracene	1.3
Indeno(1,2,3-c,d)pyrene	1.3
Fluoranthene	0.4

Appendix C Case Study: Single Discharge

The following simple case study demonstrates the steps that may be followed in developing EDOs.

C-1 Aquatic-Life Use Designation

Assume that a MWWE discharges into a water body with an aquatic-life use designation in which there are no protected spawning or nursery grounds for fish and no species at risk. The water body is not a source of drinking water nor does it have recreational uses. Monitoring information identifies copper as a substance of concern in the MWWE discharge.

C-2 Development of a Physical/Chemical/Pathogenic Effluent Discharge Objective

A chemical/physical/pathogenic EQO is determined using a generic guideline for copper: a CEQG for the Protection of Aquatic Life, which is 2-4 µg/L for copper, depending on water hardness. Since the water hardness of the receiving body is 120-180 mg/L ($CaCO_3$), the CEQG for copper is 3 µg/L; therefore, the site's EQO, for the purpose of protecting aquatic life from chronic exposure to copper, is 3 µg/L.

Implementation of the EQO

The EQO is applied at the edge of the mixing zone. To protect aquatic life, copper levels at the edge of the zone should not exceed 3 µg/L.

Development of the EDO

The EDO is then developed to estimate the level of copper that may be present in the effluent at the point of discharge, so that it will not exceed the EQO of 3 µg/L at the edge of the mixing zone. An appropriate model must be selected to determine the EDO based on the level of sophistication required, the characteristics of the stream and effluent flows and the background concentration and dilution capacity. For the purposes of this example, a basic steady-state model, considering dilution as the only mitigating factor, will be used. This model consists of the modified mass-balance equation previously presented:

$$EDO = \frac{EQO \cdot (Q_d + ff \cdot Q_s) - ff \cdot Q_s C_s}{Q_d}$$

Assume that the background concentration of copper in the stream is 0.70 µg/L, the design flow of the stream is 5.5 m^3/s, and that mixing occurs with 33 % of the receiving stream before the 100 m mixing zone limit is reached. For a discharge flow of 0.04 m^3/s, and using 33 % of the design flow of the stream, the effluent does not exceed the maximum 1:100 dilution factor. Therefore, the effluent concentration of copper at the point of discharge that will ensure that receiving waters meet the EQO of 3.0 µg/L at the edge of the mixing zone will be:

$$EDO = \frac{3.0 \cdot (0.04 + 0.33 \cdot 5.5) - 0.33 \cdot 5.5 \cdot 0.70}{0.04}$$

EDO (conc) = 107.3 µg/L

EDO (load) = (107.3 µg/L) (10^{-9} kg/µg) (0.04 m^3/s) ($10^3 L/m^3$) (86400 s/d)
= 0.37 kg/d

Therefore, the EDO for copper for this MWWE discharge is 107 µg/L in concentration, and 0.37 kg/d in load.

C-3 Development of an Effluent Discharge Objective Based on Whole Effluent Toxicity Testing

Although the substances of concern were identified for the effluent, the additive toxicological properties of the effluent should also be determined. This involves WET testing.

Assume that acute and chronic tests are conducted. The effluent passes the 96-hr LC50 rainbow trout test, with less than 50 per cent mortality observed after exposure to the whole effluent. The effluent therefore meets the objective of no acute toxicity at the end of the pipe (assuming that the rainbow trout test is the only one required). A value of 75 per cent effluent is reported for a 14-day growth, no observable effects concentration, with fathead minnow.

Implementation of the EQO

The chronic WET-based EQO at the edge of the mixing zone should not exceed 1.0 TU_c.

Developing the EDO from a WET-test derived EQO

To develop an EDO from a chronic WET EQO, the simple steady-state model is again selected. Stream flow and discharge flow remain the same. The background level of effluent is given a value of 0. The EQO is defined as 1 TU_c. The EDO is calculated as:

$$\mathrm{EDO} = 1\mathrm{TUc}\frac{(Q_d + \mathrm{ff}\cdot Q_s)}{Q_d}$$

$$\mathrm{EDO} = 1\mathrm{TUc}\frac{(0.04 + 0.33\cdot 5.5)}{0.04}$$

$$\mathrm{EDO} = 46\ TU_c$$

Toxic units

To determine whether the chronic toxicity surpasses the EDO, the no-effect or low effect concentration (depending on jurisdiction) is determined through WET tests with the most sensitive species. The no-effect concentration is converted to TUs:

$$\mathrm{TUc} = \frac{100}{75}$$

$$\text{Effluent } \mathrm{TUc} = 1.3$$

The EDO for the MWWE discharge is 46 TU_cs. The chronic testing in this example does not surpass the EDO and will, therefore, meet the EQO:

46 TU_c > 1.3 TU_c

Since the effluent passes the acute toxicity test and meets the chronic test objective, the MWWE discharge meets both objectives for toxicity at the end of the pipe and the EQO at the edge of the mixing zone.

Appendix D Case Study: Watershed Approach

A watershed approach allows greater flexibility in meeting water quality objectives as it includes several factors so that the costly upgrading of a plant would be only one of several options to improve water quality. Three variations on watershed management of pollutants will be examined:

1. United States Environmental Protection Agency (US EPA) – Total Daily Maximum Load (TMDL);
2. Watershed Management for Several Plants; and
3. Water Quality Trading.

D-1 US EPA – Total Maximum Daily Load

The United States has actively participated in watershed-based management over the last 20 years, making substantial reductions in pollutant discharges into the nation's air, lakes, rivers, wetlands, estuaries, coastal waters and ground water. These successes have been achieved primarily by controlling point sources of pollution.

The United States total maximum daily load approach to setting effluent objectives accounts for all loadings into a water body as a result of declaring a water body as impaired under section 303(d) of the *Clean Water Act*. The maximum amount of a substance a body of water can accommodate without becoming impaired is called the total maximum daily load (TMDL). The objective of a TMDL approach is to allocate allowable loads among all of the substance sources throughout a watershed so that appropriate control measures can be implemented and water quality standards achieved. All organizations within a watershed can trade pollution credits to either offset a greater than allocated pollution discharge or to gain reward from an especially clean operation.

An example of a U.S. initiative that is supporting watershed management is the alteration of requirements to the National Pollutant Discharge Elimination System (NPDES) permit program. The NPDES permit program allows States that are reorienting programs on a watershed basis to have short-term backlogs on NPDES permit reviews without penalty. This flexibility gives States time to synchronize the re-issuance of major and minor permits within a watershed. By managing NPDES permits on a watershed basis, all discharge permits can be coordinated and the most efficient and equitable allocation of pollution control responsibility can be made

Truckee River

The Truckee River flowing from Lake Tahoe, California, into Nevada's Northern Basin, has seen heavy growths of aquatic weeds and benthic algae caused by high nutrient loads and low flows in recent years. Plant respiration and decaying biomass have decreased dissolved oxygen (DO) levels in the river. In response to these problems, the Nevada Division of Environmental Protection (NDEP) developed the *Truckee River Strategy*, a plan to coordinate the activities of the agencies involved in restoring the quality of the Truckee River and Pyramid Lake. The strategy includes timetables for numerous non-point source control projects, such as storm water permitting, wetlands treatment systems, pasture improvements, riparian restoration and landowner education. Also, as part of the strategy, NDEP used DSSAM III, a water quality model, to develop nitrogen, phosphorus, and total dissolved solids TMDLs for the Truckee at Lockwood, Nevada. The TMDLs for total nitrogen, total phosphorus and total dissolved solids were approved in March 1994 by the US EPA. These include load allocations for non-point and background sources and one waste load allocation for the major point source discharger in the basin, the Truckee Meadows Wastewater Reclamation Facility. The Truckee River TMDLs provide quantitative goals for the improvement of water quality in the basin.

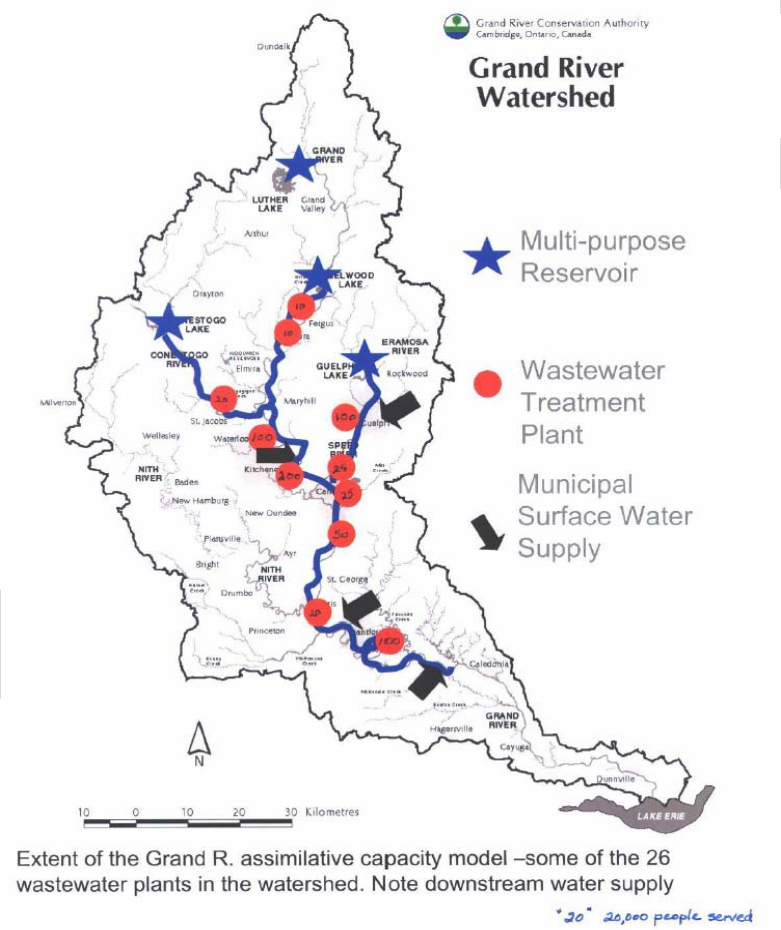
D-2 Watershed Management of Several Dischargers

In this case, several wastewater facilities in a watershed collaborate in setting effluent limits for one substance (phosphorus) to ensure watershed objectives are met.

Grand River Conservation Authority

The Grand River Conservation Authority has established a Water Management Committee to address concerns in the watershed. This strategy involved collaboration of water management agencies and 6 municipalities that are situated along the Grand River. Due to the dissolved oxygen (DO) sensitivities to temperature in the river, phosphorus management was identified as a priority. The original basin study of the Grand River set an objective of maintaining the DO at not less than 5 mg/L for 55% of the time.

The Grand River Conservation Authority, as a coordinating body, undertakes monitoring and modeling of DO, nitrogen and phosphorus. Reports of monthly loadings are made regularly to the Water Management Committee who decides on the effluent limits to ensure protection of downstream users. From the map in Figure E-1, the number of water intakes and wastewater treatment plants serving various populations can be seen. The Regional Municipality of Waterloo, which is responsible for 9 plants within the watershed, plans to develop a wastewater master plan which will direct growth to the wastewater treatment plants with the most cost efficient operations and least environmental impact.



Extent of the Grand R. assimilative capacity model –some of the 26 wastewater plants in the watershed. Note downstream water supply

"30" 20,000 people served

Figure D-1. Grand River Watershed

D-3 Water Quality Trading

Trading pollutant loads between point sources or mixing point and non-point sources has been recognized by the US EPA since January 2003, when they issued a *Water Quality Trading Policy*. The policy recognizes the costs and benefits of the program which encourages states and tribes to "develop and implement water quality trading programs for nutrients, sediments and other pollutant where opportunities exists to achieve water quality improvements at reduced costs."

Trading works best when the following conditions apply:

- A driver which motivates wastewater facilities to seek pollutant reductions;
- Sources have significantly different costs associated with pollutant reductions;
- Necessary levels of substance reduction not so large that all sources must be reduced;
- Jurisdictions are willing to be innovative.

Water quality trading allows dischargers to take advantage of treatment efficiencies and various economies of scale leading to a more cost-effective achievement of water quality goals. In the U.S., estimated cost savings for the regulated community ranges from hundreds of millions to billions of dollars.

Lake Simcoe

The local municipality of Lake Simcoe recently had to address demands to increase their urban area to accommodate a growing population. It was calculated that the proposed new development would contribute an additional phosphorus (P) load of 20 kg/year. As their local wastewater facility was already operating at maximum efficiency and their Certificate of Approval required them to maintain existing phosphorus loadings entering the watercourse, management action was required. After undertaking an engineering cost-benefit study to evaluate the costs of upgrading the plant, it was determined that the cost would be $500,000 or $25,000/kg P/year.

The municipality decided to approach the Lake Simcoe Region Conservation Authority to assess if a phosphorus trade was feasible. The following steps were followed:

1. Determine if there are sufficient opportunities for urban storm water retrofit trades within the sub-watershed to ensure that the water quality of the local watercourse is not further degraded.
2. If the capacity exists, the trading option is evaluated using a trading ratio of 8:1, based on a unit cost phosphorus reduction of $2,500/kg for storm water retrofits, i.e. for every kg of P allowed to be discharged by the plant, 8 kg must be reduced from urban runoff through storm water control best management practices. The total cost to the municipality for the trade is:

   8 (trading ratio) X 20 (kg P to trade) X $2,500 (cost/kg P)
   = $400,000

   Savings: about $100,000 and reduction of an additional 140 kg of phosphorus per year from entering the local watercourse and Lake Simcoe.

South Nation

The village of Winchester in North Dundas Township was under a development freeze pending an increase in water supply and expansion of their wastewater facilities. The village consulted with the Ontario Ministry of the Environment (MOE) and realized that policy requirements did not allow any new phosphorus discharges into the South Nation River. The village council passed a resolution to conduct a Phosphorus Management and Water Quality Environmental Assessment in December 2002. This would include:

1. Assess the current situation and future conditions;
2. Determine options for treatment;

3. Conduct public consultation;
4. Recommend preferred options environmentally, economically and socially.

Based on the environmental study report, the proposed resolution included an expansion of the wastewater facility and a reduction of phosphorus (P) from non-point sources. The cost to reduce phosphorus would be $300/kg P removed and would be administered through the existing Clean Water Program. The cost was calculated based on program experience and dependent on the amount of phosphorus to be removed as approved by MOE. The new phosphorus loading was projected to be 160 kg from the treatment plant with an offset ratio of 4:1. The calculation for removal was:

160 kg P (discharge) X 4 (offset ratio)
= 640 kg P

640 kg of phosphorus was to be removed from non-point source projects.

The cost was calculated as follows:

640 kg P (offset target) X $300/kg P (Clean Water Program Delivery Costs)
= $192,000

This project was supported by the province and funded over 5 years. Annual reports are submitted to the MOE as part of the certificate of approval reporting requirements until total monies are spent and the offset load is accounted for.

Lake Dillon, Colorado

Studies determined in the early 1980s that excessive phosphorus discharge was accelerating algae growth, causing low dissolved oxygen levels in Dillon Reservoir, 70 miles west of Denver, Colorado. Data collection and modeling results indicated that about half of the anthropogenic phosphorus loads entering the reservoir were contributed by point sources, mainly from four wastewater facilities, and half from non-point sources, primarily individual septic systems and urban runoff. The State of Colorado estimated that the health of Lake Dillon would require a reduction in the amount of phosphorus coming from the four major wastewater facilities. Rather than having to upgrade their own facilities, the plants were offered the option of implementing controls for existing urban non-point sources. Cost studies showed that wastewater facilities could achieve the same overall reductions in phosphorus for half the cost if they concentrated on non-point sources rather than solely on their own emissions.

The EPA approved a trade ratio of 2:1 so that there would be enough phosphorus reduction in the basin to allow for growth of the wastewater facilities and new non-point-sources on the basis of estimated population growth. The Frisco Sanitation District wastewater facility decided to address non-point source storm water runoff of phosphorus into the lake. The district built storm water control structures to guide the surface runoff back underground. Approximately 50-70 percent of the phosphorus was removed as the water filtered through the pipes. The number of credits gained from this project was set equal to the amount of phosphorus removed, determined by monitoring the flow and concentration of incoming and outgoing water – an example of a direct measurement of non-point source effluent discharge. The District was offered phosphorus credits for its non-point source reduction by the Colorado Water Control Commission. The District needed only a few phosphorus credits allocated to it annually and donated its surplus credits to offset increased phosphorus discharge associated with the construction of a new town golf course. Here, trading allowed further development while still improving lake water quality. The example of Dillon Reservoir demonstrated that the direct measurement of non-point source load is not impossible and, in addition, that trading does not necessarily need a tangible cash transaction for cost savings to occur.

New Hamburg

The wastewater facility located in New Hamburg had to address environmental concerns associated with phosphorus effluent discharges, as their plant had recently reached their maximum allowable limit. The cost to increase treatment at the plant would have been approximately $1000/kg P reduced. The municipality decided to take an alternate approach and target non-point sources through a water quality program which developed a program of incentives for local landowners to control the phosphorus discharging into the surface waters. The cost of this program was $85/kg P reduced, representing significant savings compared to traditional treatment upgrades.

PART B - CONTRACTING PROVISIONS

1.0 Introduction

The following Contracting Provisions were prepared for CCME by SENES Consultants Limited. These provisions have not been developed to meet the needs of any particular municipality or community. Municipalities and communities should obtain proper legal advice before using any of the following provisions, for their own purposes.

The **Canadian Council of Ministers of the Environment (CCME)** has developed a strategy to improve the management of **Municipal Wastewater Effluent (MWWE)** in Canada. A key element of the strategy is the establishment of **Effluent Discharge Objectives (EDOs)** through an environmental risk assessment.

This document is intended to assist Canadian municipalities, particularly *very small* and *small* municipalities, with the contracting process in obtaining professional services for the environmental risk assessment for **Municipal Wastewater Facilities (facilities)**. It contains general provisions that should be considered by owners of wastewater facilities and their lawyers when requesting, evaluating and contracting professional services for the completion of environmental risk assessments.

This document is not legal advice and is not intended as such. Owners of facilities should obtain proper legal advice before using any provisions herein for their own purposes.

2.0 Terms of Reference

2.1 Title

Development of Environmental Risk Assessment for Municipal Wastewater Facilities.

2.2 Background

As part of CCME's Canada-wide strategy for the management of MWWE, a risk management framework is proposed where **National Performance Standards (NPSs)** are considered as set limits for substances commonly found in MWWE.

CCME has established NPS requirements for **Total Suspended Solids (TSS)** at 25 mg/L, **Carbonaceous Biochemical Oxygen Demand ($CBOD_5$)** at 25 mg/L and **Total Residual Chlorine (TRC)** at 0.02 mg/L. In addition, CCME has identified the need for wastewater facilities to conduct site-specific environmental risk assessments and manage those risks appropriately. A standard method has been developed for the completion of site-specific environmental risk assessments which take into account both the effluent and receiving surface waters (or environment). This environmental risk assessment aims to determine site-specific **Environmental Quality Objectives (EQOs)** for receiving waters and establish site-specific EDOs to ensure that the environment is protected. Wastewater treatment facilities should be designed to achieve EDOs at the point of discharge, or as come as close as possible.

CCME has categorized municipal wastewater facilities into 5 categories: *very small, small, medium, large* and *very large* based on flows (Table 2-1). *Very small* and *small* facilities with industrial input are considered *medium* facilities and must assume medium facility requirements, as described in the supporting documentation. They can return to their *small* or *very small* status if it can be proven that the process water being discharged into the sewer system is not causing EDO exceedances.

For s*mall* and v*ery small* wastewater facilities that have no industrial input, complete characterization of the effluent is not deemed necessary. Industrial input is defined as non-domestic process water from industry categories specified below that together exceeds 5% of total dry weather flow:

- resource exploration and development (e.g. mining, forestry, oil and gas);
- manufacturing/ fabrication;
- processing (including food);
- marine or air transport (including container cleaning);
- landfill leachate; and,
- hospitals and laboratories (but not nursing stations).

In these cases, EDOs are only established for nutrients and pathogens (in addition to NPS substances, when necessary).

Table 2-1. Municipal Wastewater Facility Size Categories

Size Category	Flow [m^3/day]
Very Small[1]	≤ 500
Small[1]	> 500 – 2,500
Medium	> 2,500 – 17,500
Large	> 17,500 – 50,000
Very Large	> 50,000

Note:
[1] *Very small* and *small* facilities which have industrial input associated with wastewater will be considered in the *medium* size category

2.3 Purpose and Objective

The main objectives of the project are:

- Complete environmental risk assessment to set EDOs that will not result in impairment to the receiving waters and / or environment.

2.4 Supporting Documentation

Documentation that should be reviewed prior to commencing the environmental risk assessment includes:

- Canadian Council for Ministers of the Environment (CCME). 2007. *Technical Supplement 2 - Canada-wide Strategy for the Management of Municipal Wastewater Effluent, Environmental Risk Management: Framework and Guidance*.

A recommended supporting reference for MWWE characterization is:

- American Public Health Association (APHA), American Water Works Association (AWWA) and Water Environment Federation. 2005. *Standard Methods for the Examination of Water and Wastewater*.

2.5 Tasks

The project will be undertaken by a suitably qualified and experienced consultant. Table 2-2 provides the tasks required to perform an environmental risk assessment. All tasks conducted for an environmental risk assessment should follow the general guidelines of *Technical Supplement 3* and *Technical Supplement 2 – Environmental Risk Management: Framework and Guidance* (CCME 2007). The table also references the relevant sections in the Standard Methodology document (Part A). Procedural changes must be documented.

Table 2-2. Environmental Risk Assessment Task Matrix

Step #	Task	Reference[1]	Environmental Risk Assessment Activity
1	Identify any industrial input to MWWE and select list of substances to be sampled, as well as, the need for toxicity testing. Note that small and very small facilities without industrial input are required to only monitor TRC (if chlorination is used), $CBOD_5$, TSS, pathogens and nutrients, and not the complete series of tests as required by larger facilities.	Section 2 and Section 3	*List of Substances of Potential Concern*
2	Carry out sampling of identified substances in the effluent following recommended sampling, preservation and storage protocol, at the recommended frequency for one year.	Section 4, Appendix A	*Initial Characterization*
3	Complete sampling analysis, testing and reporting of all identified substances at an accredited laboratory, following recommended protocols.	Section 4, Appendix B	
4	Select *Single Discharge* or *Watershed* approach, as applicable to the effluent discharge to receiving waters, and determine load allocation/mixing zone assessment modelling techniques.	n/a	*Establish EQOs, EDOs*
5	Determine site-specific EQOs (e.g., from Canadian Environmental Quality Guidelines, CEQG, or provincial equivalent)	Section 5 *or* Section 6	
6	Calculate EDOs for substances of potential concern at discharge location of effluent into receiving waters using *Single Discharge* or *Watershed* approach.	Section 5 *or* Section 6	
7	Design compliance monitoring program for all substances with mean effluent values over 80% of the EDO.	Section 7	*Risk Management Recommendations*
8	Provide recommendations for risk management for substances exceeding EDOs (substances of concern) and cost estimates for any continued monitoring	See the Strategy document (CCME 2007)	

Note: [1] See relevant sections in *Standard Methodology - Environmental Risk Assessment for the Management of Municipal Wastewater Effluents* (SENES 2007).

2.6 Deliverables

Contractors should be expected to provide draft and final reports at a schedule determined by the contracting owner of the wastewater facility. Contracting owners may request the submission of a report containing at least the following sections:

- ***List of Substances of Potential Concern***
- ***Initial Characterization Program***
  - Report on results of initial characterization, providing statistical and graphical analysis of monitored substances;
- ***Determination of EQOs and EDOs*** *(based either on a Single Discharge or Watershed Approach)*
  - Describe the environmental risk assessment methodology that was followed to set EQOs and EDOs;
  - Provide relevant water quality / mixing zone assessment modelling description, computer outputs and results; and
  - Provide list of all monitored substances, determined EQOs, EDOs and substances of concern.
- ***Risk Management Recommendations***
  - Provide detailed compliance monitoring program for substances of concern; and,
  - Provide cost estimates for compliance monitoring.

2.7 Scheduling

Contracting owners should determine the timeframe that is suitable for the completion of the project, taking into account the size of the facility. As a guideline, the contracting municipality may expect at least one year for the completion of the initial characterization. Following the initial characterization, a further two months may be expected for a complete draft report for the environmental risk assessment to be prepared.

2.8 Budget

Contracting owners should estimate the range of cost for the completion of the project. Considerations for total costs should include:

- *Sampling and Analysis* – This component will constitute a major portion of the cost. Travel time for sample collection for the entire monitoring period must also be considered.
- *Modelling Techniques (single discharge or watershed approach)* – This component may also significantly contribute to the total cost, dependent upon modelling complexities.

3.0 Proposal Evaluation Criteria

Contracting owners may evaluate proposals from potential bidders based on the general criteria set out in this section.

3.1 General Criteria

Proposals from bidders should satisfy the following criteria on which they will be assessed:

- ***Technical***
  - The bidder's proposal must demonstrate a clear understanding of the scope of work;

- The bidder must provide a detailed description of its proposed methodology in relation to the Standard Methods document set out by CCME and the specific wastewater facility;
- The bidder must detail the technical methods it intends to use in regards to equipment, modelling software and other tools required to complete the environmental risk assessment;
- The bidder must describe anticipated problems and proposed solutions; and,
- The bidder should note possible changes to the protocol in the Standard Methods document.

- ***Management, Team Organization and Experience***
  - The bidder must clearly define the *Project Team* and its organizational structure, including the *Project Manager* and *Key Personnel*. Resumes, relevant expertise and experience paragraphs should be provided;
  - The bidder must include at least one *Key Personnel* with an area of specialty in environmental risk assessment;
  - The bidder must include examples of past projects in the areas of wastewater and risk assessment in which the Project Team members participated;
  - The bidder must identify all sub-contractors and their roles. Where applicable, qualifications of accredited laboratories or individuals carrying out sampling, testing and analysis should be provided;
  - The bidder must provide a preliminary work schedule detailing tasks for completion; and,
  - The bidder must detail specific quality management measures to be implemented.

- ***Financial***
  - The bidder must demonstrate an understanding of the cost factors and provide a full detailed breakdown including costs and fees showing the allocation of the proposed budget.

3.2 Enforcement of Mandatory Requirements

Contracting owners may choose to enforce relevant mandatory requirements which bidders must demonstrate in order to be considered for assessment.

Mandatory requirements are generally evaluated on a simple pass/fail basis. Failure by bidders to meet any of the mandatory requirements will render the bidder's proposal non-responsive. Table 3-1 provides an example of a possible *Mandatory Requirements Checklist* related to the environmental risk assessment, which bidders must include with their proposals. Bidders must clearly identify relevant sections or pages within the proposal that address the mandatory requirements as set out in the table.

3.3 Point-Rating System

The contracting municipality or community may evaluate a bidder's proposal based on a weighted scoring system as shown in Table 3-2. This table separates the rating criteria into the 3 categories (Technical; Management, Team Organization and Experience; and Financial). Each criterion will be given a rated score out of a maximum 10 points, following a general semi-quantitative guideline as below:

0-2 Unacceptable
3-4 Weak
5-6 Fair
7-8 Good
9-10 Excellent

Each criterion is also provided with a weight factor to be multiplied with the rated score to give a weighted score. The *sum* of all weighted scores will provide the *final rating* of the bidder's proposal out of a maximum of 100 points. As can be seen in Table 3-2, the final rating of a proposal can be broken down to 40% Technical, 40% Management, Team Organization and Experience, and 20% Financial. Bidders may then be ranked according to their respective final ratings.

Table 3-1. Example of a Mandatory Requirements Checklist

#	**Criteria**	**Bidder Response**		
		YES	*NO*	*Proposal Reference*
1	The *Project Team* must include at least one qualified engineer, biologist *or* chemist.			
2	The *Project Manager* must demonstrate experience in managing at least two projects in the areas of water and wastewater.			
3	The *Project Manager* must demonstrate knowledge and expertise in wastewater collection and treatment processes.			
4	At least one member of the *Key Personnel* in the *Project Team* must demonstrate experience in relevant projects in conducting environmental risk assessments.			
5	The *Project Team* must demonstrate past experience in wastewater related projects.			
6	The *Project Team* must clearly demonstrate capabilities in the modelling and analysis of mixing zones in receiving waters (i.e., specify software to be used or other analytical methods).			

Table 3-2. Evaluation Criteria: Point-Rating system

Criteria	*Maximum Score*	*Weight*
Technical		
Proposal demonstrates understanding of scope of work	10	2
Proposal demonstrates understanding of methodology to be applied with regard to municipality and standard methods to be applied (including knowledge of alternate/changes in standard methods).	10	1.5
Proposal describes expertise with relevant modelling tools and mixing zone analysis methods.	10	0.5
Management, Team Organization and Experience		
Project Manager demonstrates managerial experience in managing relevant projects.	10	1
Project Manager demonstrates technical expertise and similar projects in wastewater related projects.	10	0.5
Key Personnel demonstrate expertise and experience in environmental risk assessment.	10	1
Qualifications and experience of the overall *Project Team* is diverse and ample to satisfy all project needs.	10	0.5
Proposal describes a reasonable and attainable work schedule for the completion of the project.	10	0.5
Proposal demonstrates specific quality management measures to be applied during the project.	10	0.5
Financial		
Proposal demonstrates understanding of cost factors through a detailed breakdown of expected costs and fees.	10	0.5
Proposal cost does not exceed upset limit and will result in best value to the municipality or community.	10	1.5

4.0 Contract Clauses

Since all owners of wastewater facilities are different and will have their own unique requirements when obtaining professional services, this section provides a general list of contract clauses that may be considered by the owners and their lawyers when preparing a **Request for Proposal (RFP)** or contract.

- Proposal Deadline and Submission Requirements;
- Awarding of Contract;
- No Payment for Pre-Contract Costs;
- Workplace Safety and Insurance Board;
- Insurance;
- Licensing;
- Safety Regulations and Labour Codes;

- Conflicts of Interest / Influence;
- Indemnity.

Contracting owners should add additional contract clauses as applicable.

CCME

Canadian Council of Ministers of the Environment | Le Conseil canadien des ministres de l'environnement

Technical Supplement 4

Canada-wide Strategy for the Management of Municipal Wastewater Effluent

Model Sewer Use Bylaw

October 2006

Table of Contents

Introduction

This Model Sewer Use By-law has not been developed to meet the needs of any particular municipality or community. Municipalities and communities should obtain proper legal advice before using this model by-law, or any provision thereof, for their own purposes.

Acknowledgements

This Model Sewer Use Bylaw was prepared for CCME by Marbek Resource Consultants Ltd. In developing this Model Sewer Use Bylaws, several bylaws and model bylaws were used as a basis for text development: the Model Sewer Use Bylaws of Nova Scotia and Ontario, and the sewer use bylaws of several municipalities. In addition, several municipalities contributed information regarding waste prohibitions, restrictions and limits. The Steering Committee for the project also provided numerous reference documents and input for the document development.

Objectives of the Model Sewer Use Bylaw

This Model Bylaw is developed to suit a wide scope of objectives for sewer use bylaws, including:

- Municipal staff and infrastructure protection
- Enable optimum wastewater system efficiency and use
- Prevent stormwater and 'clear' water from entering the system
- Protect wastewater sludge quality
- Public and property protection
- Protection of the environment.

Model Sewer Use Bylaw Audience

The Model Sewer Use Bylaw is written for use by communities of all sizes. For this reason, it is presented in two modules:

- Module 1 outlines a basic bylaw for communities that are primarily residential. It is anticipated that primarily residential communities have some commercial activities, such as restaurants and auto repair garages and have local services, in particular, dental services. Module 1 addresses sanitary, combined and storm sewer use. Schedules A and B outline prohibited and restricted wastes for sanitary and combined sewers. (A Supplementary List of Substances provides a list of substances from which municipalities may select additional substances to add to either Schedule A or B, as appropriate for the mix of community sewer dischargers and the municipality's bylaw objectives.)

- Module 2 outlines bylaw options for industrial sewer use controls, including pollution prevention planning, codes of practice and associated programs, such as compliance agreements. Schedules C, D and E outline additional management measures (including codes of practice and pollution prevention plans) for industrial sectors and provides a template for pollution prevention subject pollutants. Communities with both residential and industrial sewer connections can combine Modules 1 and 2 for a comprehensive bylaw to address all sewer dischargers.

Other supplementary information is provided, including:

- Sample forms for permits (Appendix A)

This Model Bylaw applies to all discharges to the sanitary, storm, and combined sewers, including, but not limited to:

(1) Domestic wastewater
(2) Industrial/commercial/institutional wastewater
(3) Hauled waste and wastewater, including septage
(4) Over strength matter, storm water, clear-water waste, sub-surface water.

Waste disposal site leachate is not specifically addressed in the bylaw. Practice varies across Canada with respect to acceptance of leachate by wastewater facilities. Unless specific wastewater and wastewater sludge treatment capability is in place to address leachate contaminants, it is recommended that municipalities add leachate to the schedule of prohibited wastes (i.e. Schedule A).

Use of the Model Sewer Use Bylaw

To use this Model Sewer Use Bylaw, municipalities should:

- Identify their objectives in creating a sewer use bylaw
- Identify the nature of their community influent to sewers (i.e. is it primarily residential or is it a mix of residential, industrial, commercial and institutional?)
- Review the Modules to identify applicable clauses
- Review the list of prohibited and restricted wastes to identify which ones, if any, should not be included in the sewer use bylaw. Note that, as a default, the CCME recommends including the full list of wastes identified in the Schedules to the Model Bylaw unless specific rationale can be identified for exclusion.
- Consider additional substances, from the Supplemental List of Substances, not identified in Schedules A or B that may be of particular concern in the community and add these to the Schedules, as appropriate. Information on potential industrial sources of these substances is provided to assist municipalities in identifying particular substances of potential concern based on the industrial client base of the municipality. [*Note that a searchable database is under development by the CCME to provide industrial sector- substance information in a more accessible format.*]

In preparing a Sewer Use Bylaw, municipalities should consult with regulatory agencies to ensure that the standards set through the bylaw will enable the resulting wastewater treatment plant effluent to be in compliance with regulatory requirements.

Overview of the Parts of the Model Sewer Use Bylaw

The Model Sewer Use Bylaw consists of 2 Modules as follows:

Module 1

Introduction to Bylaw

This part provides introductory text for use by the municipality in identifying the objectives of the sewer use bylaw.

Part 1 - Definitions

This part defines the terms used in the by-law such as “industrial”, “sanitary sewer”, “sewage”, “storm water” and “storm sewer”.

Part 2 - Sanitary and Combined Sewer Requirements
Conditions and restrictions for the discharge of sewage to sanitary and combined sewer systems are listed, with schedules

Part 3 - Storm Water Requirements
Municipalities are responsible for stormwater entering municipal sewers that is discharged to natural watercourses. Conditions are listed for the discharge of storm water which will assist a municipality in meeting receiving water quality objectives.

Part 4 - Prohibition of Dilution
Discharge of additional water is prohibited to achieve the conditions and restrictions of Part 2.

Part 5 – Sampling and Analytical Requirements
A municipality requires information to assess potential impacts of the various sources which discharge to the sewer system. A suggested format for the gathering of information is appended to the by-law.

Part 6 - Discharger Self-Monitoring and Sampling
Self-monitoring by the discharger may be required where a municipality requires additional information on the nature of sewage from a specific site.

Part 7 – Additional Connection Requirements
Requirements for food-related grease, vehicle service oil and grease, sediment interceptors and dental amalgam separators.

Part 8 - Spills
Information to be reported to the municipality and actions to be completed by the persons responsible for the spill to the sanitary, combined or storm sewer are listed. Note: Requirements for a reporting a spill event to appropriate provincial or territorial ministry still apply.

Part 9 - Authority of Designated Sewer Officer to Investigate
Identifies the authority of a Designated Sewer Officer to investigate inspect, observe, sample and measure the flow in any private drainage system, wastewater disposal system, or storm water management facility.
Part 10 - Offences
Fines are provided for as applicable under the delegated authority of municipalities or communities.

Part 11 – Access to Information
Information submitted to the municipality is subject to public access unless such information is confidential or proprietary or otherwise, it may be exempt from disclosure upon demonstration of the nature of the information

Module 2
Part 1 – Additional Definitions
This part defines the terms used in the second module such as “codes of practice” and “pollution prevention plans”.

Part 7 – Additional Connection Requirements
Optional requirement for prohibition of garbage grinders.

Part 12 - Maintenance Access Points

Location, accessibility, construction and maintenance requirements are listed for maintenance access points which are used for monitoring and sampling.

Part 13 - Extra Strength Surcharge Agreement (ESSA)

A municipality may require a discharger to enter into an ESSA where:

- a site is discharging a contaminant treatable by the receiving sewage treatment plant
- the concentration of the discharge exceeds the limit in the local sewer use by-law
- and the sewage treatment plant has sufficient capacity to treat the additional waste loadings.

All conditions are defined by the municipality. The CCME recommends recovery of the cost for the treatment of the additional loadings.

Part 14 - Compliance Programs

A municipality may require a discharger to enter into a compliance agreement where:

- the discharger is out of compliance with the by-law
- no immediate negative impact is expected
- and the discharger is willing to work towards compliance in a reasonable period of time.

All conditions are defined by the municipality.

Part 15 Codes of Practice

Municipalities may identify suitable codes of practice to be undertaken by specified industrial or commercial sectors to improve wastewater discharge characteristics or to reduce volumes of wastewater discharged.

Part 16 Pollution Prevention Plans

Municipalities may identify specific pollutants of concern and the industrial or commercial sectors associated with the release of the substances of concern. Theses sectors can be required to develop pollution prevention plans to reduce or eliminate the discharge of the pollutants.

Module One (For Primarily Residential Communities)

Introduction

[***Note to bylaw author f9or this clause***: Each municipality should adjust the introduction as appropriate for its infrastructure and objectives for source control.]

This Bylaw outlines controls for the discharge of pollutants to the sewer system. The objectives of the bylaw are to:

- Protect the sewer collection system from corrosion, other damage and obstruction
- Protect the wastewater treatment process from upset
- Protect the public, municipal workers and property from hazardous conditions (such as explosions)
- Assist optimum wastewater system efficiency by preventing uncontaminated water from entering the system
- Protect wastewater sludge quality
- Protect the environment from contaminants that are not removed by the public system.

1. Definitions[1]

As used in this bylaw, the following terms shall have the meanings indicated:

ACCREDITED LABORATORY — Any laboratory accredited by an authorized accreditation body in accordance with a standard based on "*ISO/IEC/EN 17025: General Requirements for Competence of Calibration and Testing Laboratories*" established by the International Organization for Standardization, as amended. The Canadian Association for Environmental Analytical Laboratories (CAEAL) is such an authorized accreditation body in Canada.

BIOCHEMICAL OXYGEN DEMAND (BOD) — The five-day BOD which is the determination of the molecular oxygen utilized during a five-day incubation period for the biochemical degradation of organic material (carbonaceous demand), and the oxygen used to oxidize inorganic material such as sulphides and ferrous iron, and the amount of oxygen used to oxidize reduced forms of nitrogen (nitrogenous demand).

BIOMEDICAL WASTE — Biomedical waste as defined in the [federal, provincial or territorial Statute or Regulation as appropriate for the municipality], as amended from time to time.

BLOWDOWN WATER — Recirculating water that is discharged from a cooling or heating water system for the purpose of controlling the level of water in the system or for the purpose of discharging from the system materials contained in the system, the further build-up of which would or might impair the operation of the system.

COMBINED SEWER — A sewer intended to function simultaneously as a storm sewer and a sanitary sewer.

COMBUSTIBLE LIQUID — A liquid that has a flash point not less than 37.8 degrees Celsius and not greater than 93.3 degrees Celsius.

[1] Based on Toronto Sewer Use Bylaw. Some modifications completed on definitions that were specific to Ontario. Definition for 'Wastewater' taken from Edmonton Sewer Use Bylaw.

COMPOSITE SAMPLE — A volume of wastewater, storm water, uncontaminated water or effluent made up of three or more grab samples that have been combined automatically or manually and taken at intervals during the sampling periods.

CONNECTION or DRAIN — That part or those parts of any pipe or system of pipes leading directly to a wastewater works.

COOLING WATER — Water that is used in a process for the purpose of removing heat and that has not, by design, come into contact with any raw material, intermediate product, waste product or finished product, but does not include blowdown water.

DENTAL AMALGAM — A dental filling material consisting of an amalgam of mercury, silver and other materials such as copper, tin or zinc.

DENTAL AMALGAM SEPARATOR — Any technology, or combination of technologies, designed to separate dental amalgam particles from dental operation wastewater.

DESIGNATED SEWER OFFICER - The person appointed by the Municipality, and his or her successors or his or her duly authorized representative.

DOUBLE MUNICIPAL SEWER CONNECTION — A municipal sewer connection providing service to two or more premises.

FUELS — Alcohol, gasoline, naphtha, diesel fuel, fuel oil or any other ignitable substance intended for use as a fuel.

GRAB SAMPLE — A volume of wastewater, storm water, uncontaminated water or effluent of at least 100 milliliters which is collected over a period not exceeding 15 minutes.

GROUND WATER — Water beneath the earth's surface accumulating as a result of seepage.

HAULED WASTEWATER — Waste removed from a wastewater system, including a cesspool, a septic tank system, a privy vault or privy pit, a chemical toilet, a portable toilet or a wastewater holding tank.

HAULED WASTE — Any industrial waste which is transported to and deposited into any location in the wastewater works, excluding hauled wastewater.

HAZARDOUS SUBSTANCES —

A. Any substance or mixture of substances, other than a pesticide, that exhibits characteristics of flammability, corrosivity, reactivity or toxicity; and

B. Any substance that is designated as a hazardous substance within the meaning of [federal, provincial or territorial Statute or Regulation as appropriate for the municipality], as amended from time to time.

IGNITABLE WASTE — A substance that:

A. Is a liquid, other than an aqueous solution containing less than 24 percent alcohol by volume and has a flash point less than 93 degrees Celsius, as determined by the Tag Closed Cup Tester (ASTM D-56-97a), the Setaflash Closed Cup Tester (ASTM D-3828-97 or ASTM D-3278-96e1),

the Pensky-Martens Closed Cup Tester (ASTM D-93-97), or as determined by an equivalent test method;
B. Is a solid and is capable, under standard temperature and pressure, of causing fire through friction, absorption of moisture or spontaneous chemical changes and, when ignited, burns so vigorously and persistently that it creates a danger;
C. Is an ignitable compressed gas as defined in the regulations under the [federal, provincial or territorial Statute or Regulation as appropriate for the municipality], as amended; or
D. Is an oxidizing substance as defined in the regulations under the [federal, provincial or territorial Statute or Regulation as appropriate for the municipality], as amended.

INDUSTRIAL — Of or pertaining to manufacturing, commerce, trade, business or institutions as distinguished from domestic or residential.

INDUSTRY — Any owner or operator of industrial or commercial premises from which there is a discharge of any matter directly or indirectly into a sanitary sewer, combined sewer or storm sewer of the Municipality.

INSPECTOR — A person authorized by the Municipality to carry out observations and inspections and take samples as prescribed by this by-law.

INSTITUTION – A facility, usually owned by a government, operated for public purposes, such as schools, universities, medical facilities (hospitals, nursing stations, nursing homes), museums, prisons, government offices, military bases. Some of these facilities produce non-residential discharges to sewers from, for example, laboratories, chemical use, industrial processes.

MAINTENANCE ACCESS POINT — An access point, such as a chamber, in a private sewer connection to allow for observation, sampling and flow measurement of the wastewater, uncontaminated water or storm water therein.

MATTER — Includes any solid, liquid or gas.

MUNICIPALITY – means the Municipality of "_____".

MUNICIPAL SEWER CONNECTION — That part of any drain leading from the private sewer connection and connected to the municipal sewer and located within the limits of the public road allowance, or other public lands or public land interests held for sewerage purposes.

NON-CONTACT COOLING WATER — Water which is used to reduce temperature for the purpose of cooling and which does not come into direct contact with any raw material, intermediate product other than heat, or finished product.

PATHOLOGICAL WASTE — Pathological waste within the meaning of [federal, provincial or territorial Statute or Regulation as appropriate for the municipality].

PCBs — Any monochlorinated or polychlorinated biphenyl or any mixture of them or mixture that contains one or more of them.

PERSON — An individual, association, partnership, corporation, municipality or an agent or employee of such a person.

PESTICIDE — A pesticide regulated under [federal, provincial or territorial Statute or Regulation as appropriate for the municipality].

POLLUTION PREVENTION — The use of processes, practices, materials, products or energy that avoid or minimize the creation of pollutants and wastes, at the source.

PRIVATE SEWER CONNECTION — That part of any drain or system of drains, including drains or subsurface drainage pipe for surface or subsurface drainage of the land in or adjacent to a building, lying within the limits of the private lands and leading to a municipal sewer connection.

PROHIBITED WASTE – means prohibited waste as defined in Schedule "A" to this bylaw

REACTIVE WASTE — A substance that:

A. Is normally unstable and readily undergoes violent changes without detonating;
B. Reacts violently with water;
C. Forms potentially explosive mixtures with water;
D. When mixed with water, generates toxic gases, vapours or fumes in a quantity sufficient to present danger to human health or the environment;
E. Is a cyanide or sulphide bearing waste which, when exposed to pH conditions between 2 and 12.5, can generate toxic gases, vapours or fumes in a quantity sufficient to present danger to human health or the environment;
F. Is capable of detonation or explosive reaction if it is subjected to a strong initiating source or if heated under confinement;
G. Is readily capable of detonation or explosive decomposition or reaction at standard temperature and pressure; or
H. Is an explosive (Class 1) as defined in the regulations under the [federal, provincial or territorial Statute or Regulation as appropriate for the municipality], as amended.

RESTRICTED WASTE – means restricted waste as defined in Schedule "B" to this bylaw

SANITARY SEWER — A sewer for the collection and transmission of domestic or industrial wastewater or any combination thereof.

WASTEWATER SLUDGE — Organic solid material recovered from the wastewater treatment process.

WASTEWATER WORKS — Any works for the collection, transmission, treatment and disposal of wastewater, storm water or uncontaminated water, including a combined sewer, sanitary sewer or storm sewer, or any part of such works, but does not include plumbing or other works to which the applicable Building Code applies.

SEWER — A pipe, conduit, drain, open channel or ditch for the collection and transmission of wastewater, storm water or uncontaminated water, or any combination thereof.

SPILL — A direct or indirect discharge into the wastewater works, storm sewer or the natural environment which is abnormal in quantity or quality in light of all the circumstances of the discharge.

STANDARD METHODS — A procedure or method set out in *Standard Methods for the Examination of Water and Wastewater* published jointly by the American Public Health Association, American Water Works Association and the Water Environment Federation, latest edition.

STORM SEWER — A sewer for the collection and transmission of uncontaminated water, storm water, drainage from land or from a watercourse or any combination thereof.

STORM WATER — Water from rainfall, other natural precipitation, drainage or from the melting of snow or ice.

SUBSURFACE DRAINAGE PIPE — A pipe that is installed underground to intercept and convey subsurface water, and includes foundation drain pipes.

TOTAL PAHs — The total of all of the following polycyclic aromatic hydrocarbons:[2] anthracene, benzo(a)pyrene, benzo(a)anthracene, benzo(e)pyrene, benzo(b)fluoranthene, benzo(j)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, chrysene, dibenzo(a,h)anthracene, dibenzo(a,i)pyrene, dibenzo(a,j)acridine, 7Hdibenzo(c,g)carbazole, dinitropyrene, fluoranthene, indeno(1,2,3-c,d)pyrene, perylene, phenanthrene, and pyrene.

TOXIC SUBSTANCE – any substance defined as toxic under the *Canadian Environmental Protection Act* 1999, as amended from time to time and within the meaning of [provincial or territorial Statute or Regulation as appropriate for the municipality], as amended from time to time.

UNCONTAMINATED WATER — Water with a level of quality which is typical of potable water normally supplied by the Municipality or whose quality meets or exceeds the values in Schedule C - Limits for Storm Sewer Discharge of this bylaw.

WASTE DISPOSAL SITE LEACHATE — The liquid containing dissolved or suspended contaminants which emanates from waste (solid waste or garbage) and is produced by water percolating through waste or by liquid in waste.

WASTE RADIOACTIVE PRESCRIBED SUBSTANCES — Uranium, thorium, plutonium, neptunium, deuterium, their respective derivatives and compounds and such other substances as the Atomic Energy Control Board may by regulation designate as being capable of releasing atomic energy or as being requisite for the production, use or application of atomic energy.

WASTEWATER - means the composite of water and water-carried wastes from residential, commercial, industrial or institutional premises or any other source;
WASTEWATER TREATMENT FACILITY - means any structure or thing used for the physical, chemical, biological or radiological treatment of wastewater, and includes sludge treatment, wastewater sludge storage and disposal facilities;
WATERCOURSE — An open channel, ditch or depression, either natural or artificial, in which flow of water occurs either continuously or intermittently.

2. Sanitary and Combined Sewer Requirements

(1) No person shall release, or permit the release of, any matter into the sanitary sewer system except[3]:

[2] Taken from Toronto Sewer Bylaw. PAHs listed under Canada Ontario Agreement Tier I and II Substances Lists.

[3] Taken from Whitehorse Sewer Use Bylaw.

(a) Domestic wastewater that complies with the requirements of this bylaw;
(b) Industrial/commercial/institutional wastewater that complies with the requirements of this bylaw;
(c) Hauled wastewater, including septage, that complies with the requirements of this bylaw;
(d) Over strength matter, storm water, clear-water waste, sub-surface water or other matter where a Permit to Discharge has been issued by the Designated Sewer Officer.

(2) No person shall release, or permit the release of, any prohibited substance listed in Schedule 'A' of this bylaw.

(3) No person shall release, or permit the release of, any restricted substance which does not meet the concentrations listed in Schedule 'B' of this bylaw.

(4) All industrial/commercial/institutional wastewater dischargers shall complete and submit **Form 1 "Abbreviated Discharger Information Report"** (Appendix A) to the Municipality.

(5) If required by the Municipality, the industrial/commercial/institutional wastewater discharger shall complete and submit **Form 2 "Complete Discharger Information Report"** (Appendix A) to the Municipality.

(6) Industrial dischargers shall not discharge to the sanitary sewer system, until the discharger has obtained **Form 3 "Waste Discharger Permit"** (Appendix A).

3. Storm Sewer Requirements

(1) No person shall discharge or deposit or cause or permit the discharge or deposit of matter of any type into a storm sewer, watercourse, municipal or private sewer connection to any storm sewer which may or could:

A. Interfere with proper operation of a storm sewer.
B. Obstruct or restrict a storm sewer or the flow therein.
C. Damage a storm sewer.
D. Result in any hazard or other adverse impact to any person, animal, property or vegetation.
E. Contravene or result in the contravention of approved discharge quality or quantity with respect to the storm sewer, its discharge, or both the sewer and its discharge.
F. Have one or more of the following characteristics:
    (1) Visible film, sheen or discolouration.
    (2) Two or more separate layers.
    (3) A pH less than 6.0 or greater than 9.5.
    (4) A temperature greater than 40 degrees Celsius.
G. Contain one or more of the following:
    (1) Hazardous substances.
    (2) Blowdown water.
    (3) Combustible liquids.
    (4) Floating debris.
    (5) Fuel.
    (6) Hauled wastewater.
    (7) Hauled waste.
    (8) Ignitable waste.

(9) Pathological waste.
(10) PCBs
(11) Pesticides.
(12) Reactive waste.
(13) Toxic substances
(14) Wastewater.
(15) Waste radioactive prescribed substances.
(16) A substance from raw materials, intermediate or final product, used or produced in, through or from an industrial process.
(17) A substance used in the operation or maintenance of an industrial site.

H. Contain E. coli colonies in excess of 200 per 100 mL.

(2) Property owners must ensure that appropriate and necessary practices are undertaken to prevent prohibited discharges described in 3(1) and to prevent discharge of suspended solids (total) in excess of 15 milligrams per liter (15 mg/L) as a result of activities on their property, including:

A. Construction activities that may result in erosion or sediment runoff from the property
B. Outside storage activities that may result in mobilization of stored materials as a result of rain or runoff from the property, including sand and granular material storage.

4. Prohibition of Dilution

(1) No person shall discharge directly or indirectly, or permit the discharge or deposit of wastewater into a sanitary sewer, combined sewer, storm sewer, where water has been added to the discharge for the purposes of dilution to achieve compliance with Schedule "A" or Schedule "B" of this bylaw.

5. Sampling and Analytical Requirements[4]

(1) Where sampling is required for the purposes of determining the concentration of constituents in the storm water, uncontaminated water or wastewater, the sample shall be collected according to the terms and conditions outlined in the "**Waste Discharger Permit**" (contained in Appendix A, Form 3) and may:

a) be collected manually or by using an automatic sampling device; and
b) contain additives for its preservation.

6. Discharger Self-Monitoring and Sampling[5]

(1) The discharger shall complete any monitoring or sampling of any discharge to a wastewater works, as required by the Municipality, and provide the results to the Municipality in the form specified by the Municipality (i.e. hard copy or protected software file).

(2) The obligations set out in or arising out of 6(1) shall be completed at the expense of the discharger.

(3) All tests, measurements, analyses and examinations of wastewater, its characteristics or contents shall be carried out in accordance with "Standard Methods." Additional testing or re-testing of

[4] This section taken from Edmonton Sewer Bylaw 9675.

[5] This section taken from proposed 1998 Ontario Model Sewer Use Bylaw.

wastewater, made necessary by noncompliance with this bylaw, or at the request of the Municipality, shall be carried out at the cost of the discharger.[6]

7. Additional Connection Requirements

7.1 Food-Related Grease Interceptors

(1) Every owner or operator of a restaurant or other industrial, commercial or institutional premises where food is cooked, processed or prepared, which premises is connected directly or indirectly to a sewer, shall take all necessary measures to ensure that oil and grease are prevented from entering the storm or sanitary sewer.

(2) The owner or operator of a premises as set out in this Subsection shall install, operate, and properly maintain an oil and grease interceptor in any piping system at its premises that connects directly or indirectly to a sewer. The oil and grease interceptors shall be installed in compliance with the most current requirements of the applicable Building Code. The installation of the oil and grease interceptor shall meet the requirements of the Canadian Standards Association national standard CAN/CSA B-481.* [*NB: *This standard is anticipated to have completed the final stage of implementation by the end of 2006; CWWA Communique No. 08/06, Feb 27, 2006*.]

(3) All interceptors shall be maintained according to the manufacturer's recommendations.[7] The testing, maintenance and performance of the interceptor shall meet the requirements of CAN/CSA B-481.* [NB: *See note for 7.1(2) above.*]

(4) A maintenance schedule and record of maintenance shall be submitted to the Designated Sewer Officer annually for each interceptor installed.[8]

(5) The owner or operator of the restaurant or other industrial, commercial or institutional premises where food is cooked, processed or prepared, shall, for five years, keep the document of proof for interceptor clean-out and oil and grease disposal.

7.2 Vehicle Service Oil and Grease Interceptors

(1) Every owner or operator of a motor vehicle service station, repair shop or garage or of an industrial, commercial or institutional premises or any other establishment where motor vehicles are repaired, lubricated or maintained and where the sanitary discharge is directly or indirectly connected to a sewer shall install an oil and grease interceptor designed to prevent motor oil and lubricating grease from passing into the drainage piping which is connected directly or indirectly to a sewer.

(2) The owner or operator of a premises as set out in Subsection 7.2(1) shall install, operate, and properly maintain an oil and grease interceptor in any piping system at its premises that connects directly or indirectly to a sewer. The oil and grease interceptors shall be installed in compliance with the most current requirements of the applicable Building Code and

(3) All oil and grease interceptors and separators shall be maintained *in good working order and* according to the manufacturer's recommendations and shall be tested regularly to ensure performance is maintained to the manufacturer's specifications for performance.

[6] Text based on Kelowna Sewer Bylaw.

[7] Taken from Fredericton Sewer Bylaw

[8] Taken from Fredericton Sewer Bylaw.

(4) A maintenance schedule and record of maintenance shall be submitted to the Designated Sewer Officer annually for each oil and grease interceptor installed.

(5) The owner or operator of a premises as set out in Subsection 7.2(1), shall, for five years, keep the document of proof for interceptor clean-out and oil and grease disposal.

7.3 Sediment Interceptors

(1) Every owner or operator of a premises from which sediment may directly or indirectly enter a sewer, including but not limited to premises using a ramp drain or area drain and car and vehicle wash establishments, shall take all necessary measures to ensure that such sediment is prevented from entering the drain or sewer.

(2) Catch basins installed on private property for the purposes of collecting storm water and carrying it into the storm sewers shall be equipped with Goss Traps (i.e. inverted elbow pipes) or an equivalent and the installation of these catch basins on private property shall comply with the Municipality's Standard Construction Specifications and Drawings, as they may be amended from time to time.

(3) All sediment interceptors shall be maintained in good working order and according to manufacturer's recommendations and shall be tested regularly to ensure performance is maintained to the manufacturer's specifications for performance.

(4) A maintenance schedule and record of maintenance shall be submitted to the Designated Sewer Officer annually for each sediment interceptor installed.

7.4 Dental Waste Amalgam Separator

(1) Every owner or operator of a premises from which dental amalgam may be discharged, which waste may directly or indirectly enter a sewer, shall install, operate and properly maintain dental amalgam separator(s) with at least 95% efficiency in amalgam weight and certified *ISO 11143 – "Dental Equipment: Amalgam Separators"*[9], in any piping system at its premises that connects directly or indirectly to a sewer by no later than [date to be specified by municipality], except where the sole dental-related practice at the premises consists of one or more of the following specialties or type of practice:

(a) Orthodontics and dentofacial orthopaedics;
(b) Oral and maxillofacial surgery;
(c) Oral medicine and pathology;
(d) Periodontics; or
(e) A dental practice consisting solely of visits by a mobile dental practitioner who prevents any dental amalgam from being released directly or indirectly to the wastewater works.

(2) Notwithstanding Subsection 7.4(1), any person operating a business from which dental waste amalgam is or will be discharged directly or indirectly to a sewer, at premises which are constructed or substantially renovated on or after the date that Section 7.4 comes into force, shall install, operate and properly maintain dental waste amalgam separator(s) in any piping system which is connected directly or indirectly to a sewer.

(3) Notwithstanding compliance with Subsection 7.4 (1) and 7.4 (2), all persons operating or carrying on the business of a dental practice shall comply with Schedule "A" and Schedule "B" of this bylaw.

[9] Reference taken from Montreal Sewer Bylaw.

(4) All dental waste amalgam separators shall be maintained in good working order and according to the manufacturer's recommendations.

(5) A maintenance schedule and record of maintenance shall be submitted to the Designated Sewer Officer annually for each dental amalgam separator installed.

(6) The operator of a dental clinic shall, for five years, keep the documents covering amalgam shipment provided for under the bylaw respecting transportation of hazardous material *[insert applicable bylaw for municipality]*.

8. Spills

(1) In the event of a spill to a wastewater works, the person responsible or the person having the charge, management and control of the spill shall immediately notify the Municipality and provide any information with regard to the spill that is requested.

(2) The person shall provide a detailed report on the spill to the Municipality, within five days after the spill, containing the following information to the best of his or her knowledge:

(1) Location where spill occurred;
(2) Name and telephone number of the person who reported the spill and the location and time where they can be contacted;
(3) Date and time of spill;
(4) Material spilled;
(5) Characteristics of material spilled;
(6) Volume of material spilled;
(7) Duration of spill event;
(8) Work completed and any work still in progress in the mitigation of the spill; and
(9) Preventive actions being taken to ensure a similar spill does not occur again.

(3) The person responsible for the spill and the person having the charge, management and control of the spill shall do everything reasonably possible to contain the spill, protect the health and safety of citizens, minimize damage to property, protect the environment, clean up the spill and contaminated residue and restore the affected area to its condition prior to the spill.

(4) The person responsible for the spill and the person having the charge, management and control of the spill shall also notify other government agencies, including federal and provincial [*or territorial*] as required and appropriate for the material and circumstances of the spill.

9. Authority of Designated Sewer Officer to Investigate[10]

[***Note to bylaw author for this clause***: Each municipality must confirm the authority of its inspectors to enter buildings. Although municipal inspectors generally have rights to enter onto property, they may need permission to enter buildings. This permission is particularly relevant for Section 9(viii) following.]

(1) The Designated Sewer Officer has the authority to carry out any investigation reasonably required to ensure compliance with this bylaw, including but not limited to
   i) inspecting, observing, sampling and measuring the flow in any private
      (1) drainage system,
      (2) wastewater disposal system,
      (3) storm water management facility, and
      (4) flow monitoring point;
   ii) determine water consumption by reading water meters;
   iii) test flow measuring devices;
   iv) take samples of wastewater, storm water, clear-water waste and subsurface water being released from a premises or flowing within a private drainage system;
   v) perform on-site testing of the wastewater, storm water, clear-water waste and subsurface water within or being released from private drainage systems, pretreatment facilities and storm water management facilities;
   vi) collect and analyze samples of hauled wastewater coming to a discharge location;
   vii) make inspections of the types and quantities of chemicals being handled or used on a premises in relation to possible release to a drainage system or watercourse;
   viii) investigate the premises where a release of prohibited or restricted wastes or of water containing prohibited or restricted wastes has been made or is suspected of having been made, and to sample any or all matter that in his opinion could have been part of the release.

(2) No person shall hinder or prevent the Designated Sewer Officer from carrying out any of his powers or duties.

10. Offences

[***Note to bylaw author for this clause***: Each municipality must check the applicable statutes that govern the limit on the fines they can pursue for contraventions of the bylaw.]

(1) Every person other than a corporation who contravenes any provision of this bylaw is guilty of an offence and on conviction is liable, for every day or part thereof upon which such offence occurs or continues, to a fine of not more than $10,000 for a first offence and $25,000 for a second offence.

(2) Every corporation that contravenes any provision of this bylaw any provision of this bylaw is guilty of an offence and on conviction is liable, for every day or part thereof upon which such offence occurs or continues, to a fine of not more than $50,000 for a first offence and not more than $100,000 for a second offence.

[10] This section taken from Edmonton Sewer Bylaw.

11. Access to Information

(1) All information submitted to and collected by the Municipality that is contained in plan summaries, reports, surveys, monitoring and inspection and sampling activities will, except as otherwise provided in this section, be available for disclosure to the public in accordance with the [*applicable Freedom of Information legislation that governs the Province or Territory*].

(2) In the event that any person in submitting information to the Municipality or to the Municipality in any form, as required under this article, where such information is confidential or proprietary or otherwise, may be exempt from disclosure under the [*applicable Freedom of Information legislation that governs the Province or Territory*], the person submitting the information shall so identify that information upon its submission to the Municipality or the Municipality and where such information is confidential or proprietary or otherwise, may be exempt from disclosure.

Schedule "A" Prohibited Wastes

A. No person shall discharge directly or indirectly or deposit or cause or permit the discharge or deposit of wastewater into a sanitary sewer, combined sewer, municipal or private sewer connection to any sanitary sewer or combined sewer in circumstances where:

(1) To do so may cause or result in:

(a) A health or safety hazard to a person authorized by the Municipality to inspect, operate, maintain, repair or otherwise work on a wastewater works;

(b) An offence under the [*applicable federal, provincial, territorial environment protection or water resources act]*, as amended from time to time, or any regulation made thereunder from time to time;

(c) Wastewater sludge from the wastewater treatment facility works to which either wastewater discharges, directly or indirectly, to fail to meet the objectives and criteria as listed in the [*applicable federal, provincial, territorial environment protection or water resources act or policy]*, as amended from time to time;

(d) Interference with the operation or maintenance of a wastewater works, or which may impair or interfere with any wastewater treatment process;

(e) A hazard to any person, animal, property or vegetation;

(f) An offensive odour to emanate from wastewater works, and without limiting the generality of the foregoing, wastewater containing hydrogen sulphide, carbon disulphide, other reduced sulphur compounds, amines or ammonia in such quantity as may cause an offensive odour;

(g) Damage to wastewater works;

(h) An obstruction or restriction to the flow in wastewater works.

(2) The wastewater has one or more of the following characteristics:

(a) A pH less than 6.0 or greater than 11.5;

(b) Two or more separate liquid layers; or

(c) A temperature greater than 60 degrees Celsius.

(3) The wastewater contains:

(a) Hazardous substances;

(b) Combustible liquid;

(c) Biomedical waste, including any of the following categories:[11] human anatomical waste, animal waste, untreated microbiological waste, waste sharps and untreated human blood and body fluids known to contain viruses and agents listed in "Risk Group4" as defined in "Laboratory Biosafety Guidelines" published by Health Canada, dated 1996, as amended.

(d) Dyes or colouring materials which may or could pass through a wastewater works and discolour the wastewater works effluent;

(e) Fuel;

(f) Hauled wastewater, except where:

[1] The carrier of the hauled wastewater operating as a waste management system has certificate of approval or provisional certificate of approval issued under the [*applicable federal, provincial, territorial environment protection act]* or is exempt from the requirement to have a certificate or provisional certificate of approval;

[2] A copy of the most recent certificate of approval or provisional certificate and any amendment is provided to the Municipality; and

[3] The carrier meets all conditions for discharge that are or may be set from time to time with respect to the haulage of wastewater by the Municipality.

(g) Hauled waste, except where:

[1] The carrier of the hauled waste operating as a waste management system has a certificate of approval or provisional certificate of approval issued under the [*applicable federal, provincial, territorial environment protection act]*or is exempt from the requirement to have a certificate or provisional certificate of approval;

[2] A copy of the most recent certificate or provisional certificate and any amendment of approval is provided to the Municipality;

[3] Hauled waste meets the conditions set out in [*applicable federal, provincial, territorial environment protection regulation*], as amended from time to time; and

[4] The carrier meets all conditions for discharge that are or may be set from time to time with respect to the haulage of waste by the Municipality.

(h) Ignitable waste.

(i) Pathological waste.

(j) PCBs.

(k) Pesticides.

[11] Category inclusions taken from Capital Regional District (Victoria) Bylaw.

(l) Reactive waste.

(m) Toxic substances.

(n) Waste radioactive prescribed substances.

(o) Solid or viscous substances in quantities or of such size to be capable of causing obstruction to the flow in a sewer, including but not limited to ashes, bones, cinders, sand, mud, soil, straw, shaving, metal, glass, rags, feathers, tar, plastics, wood, unground garbage, animal parts or tissues, and paunch manure.

(4) The wastewater contains a concentration, expressed in milligrams per litre, in excess of any one or more of the limits in Schedule "B" of this Bylaw, unless:

(a) The discharge is in accordance with a valid discharge agreement or compliance program.

B. The discharge of non-contact cooling water or uncontaminated water to a sanitary sewer or combined sewer from any residential properties is prohibited. The discharge of non-contact cooling water or uncontaminated water to a sanitary or combined sewer from industrial, commercial or institutional properties is permissible where:

(1) In the case of a proposed building, no storm sewer exists adjacent to the building; or
(2) In the case of an existing building, no storm connection exists to the building.

C. Discharge of water originating from a source other than the Municipal water supply.

[***Note to bylaw author for this clause***: Where the municipality does not own or operate a Municipal water supply system, clause C does not apply and can be removed.]

(1) The discharge of water originating from a source other than the Municipality water supply, including storm water or groundwater, directly or indirectly to a sanitary sewer or combined sewer is prohibited, unless:

(a) The discharge is in accordance with a sanitary discharge agreement; and

(b) The discharge does not exceed the limits set out under Schedule "B", with respect to biochemical oxygen demand, total phosphorus or total suspended solids; or

(c) In the event the discharge does exceed the limits set out under Schedule "B", with respect to any of biochemical oxygen demand, total phosphorus or total suspended solids, the discharge is in accordance with an industrial waste surcharge agreement.

Schedule "B" Restricted Waste – Sanitary and Combined Sewers Discharge

[***Notes to Bylaw Author for Schedule B Substances and Limits***:
Substances identified in Schedule B have the potential to (1) harm sewer workers, (2) to inhibit biological/ activated sludge process, or (3) are known to accumulate in wastewater sludge.

Concentration limits are preliminary recommendations based on a methodology focusing on effluent quality and best available treatment technologies. Review of the limits is recommended to suit municipal wastewater sludge quality requirements and pollution prevention goals.

Additional substances may be appropriate to add to Schedule A or Schedule B, depending on community dischargers and municipal bylaw objectives. See the Supplemental List of Substances (following Schedule B). Appendix B provides information, by substance, on sectors discharging Schedule B substances and Supplemental List substances.]

A - CONVENTIONAL CONTAMINANTS and PHYSICAL PARAMETERS

Substance	**Total Concentration Limit– Preliminary Recommendation [mg/L, except as noted]**
Biochemical Oxygen Demand	300
Oil and grease - animal and vegetable	85
Oil and grease - mineral and synthetic	15
Suspended Solids, Total	300
pH	6.0 - 11.5 (unitless)
Temperature	60 Degrees Celsius

B - ORGANIC CONTAMINANTS

Substance	**Total Concentration Limit– Preliminary Recommendation [mg/L, except as noted]**
Benzene	0.01
Benzidine and benzidine dihydrochloride	Insufficient data to establish limit
Chloroform	0.04
Dichlorobenzene (1,2-)	0.088
Dichlorobenzene (1,4)	0.09
Ethylbenzene	0.057
Hexachlorobenzene	0.055
Methylene chloride (dichloromethane)	0.0981
PCBs (chlorobiphenyls)	0.004
Phenols, Total (or Phenolic	1

compounds)	
Tetrachloroethane (1,1,2,2 -)	0.04
Tetrachloroethylene	0.05
Toluene	0.08
Trichloroethylene	0.054
Xylenes, total	0.32

C - INORGANIC CONTAMINANTS

Substance	**Total Concentration Limit– Preliminary Recommendation [mg/L, except as noted]**
Ammonia	24
Arsenic, total	0.1
Cadmium, total	0.2
Chloride	1500
Chromium, total	0.37
Cobalt, total	5
Copper, total	1
Cyanide, total	1.0
Lead, total	0.1
Mercury	0.1
Molybdenum, total	5
Nickel, total	0.55
Nitrogen, Total Kjeldahl	70
Phosphorus, total	12
Selenium, total	0.82
Silver, total	0.29
Sulphates (as SO_4)	1500
Sulphide (as H_2S)	0.3
Zinc, total	0.03

Supplemental List of Substances

[***Note to Bylaw Author***: substances identified in this supplemental list may be appropriate for addition to Schedule A or Schedule B. Information is provided in Appendix B, by substance, on the industrial sectors potentially discharging all contaminants in Schedule B and this Supplemental List of Substances. With this information and information on your community profile, refer to the following list to supplement and tailor the Schedules of the model bylaw for your community, as appropriate.]

SUPPLEMENTAL LIST OF SUBSTANCES [for tailored additions to Schedules A or B; Refer to Appendix B for additional information on sources of these substances.]

Substance Group 1: Substances of National and International Concern	**Substance Identifier**		
	CEPA Schedule 1	**Tier I or Tier II Canada Ontario Agreement (COA) (2002)**	**Level I or Level II Canada-US Binational Toxics Strategy (1997)**
Acetaldehyde	CEPA-Sch.1		
Acrolein	CEPA-Sch.1		
Acrylonitrile	CEPA-Sch.1		
Aldrin/dieldrin		Tier I COA	Level I Binational Toxic
Alkyl-lead		Tier I COA	Level I Binational Toxic
Benzo(a)pyrene		Tier I COA	Level I Binational Toxic
Bis(2-ethylhexyl)phthalate	CEPA-Sch.1		
Bis(chloromethyl) ether	CEPA-Sch.1		
Bromochlorodifluoromethane	CEPA-Sch.1		
Bromochloromethane	CEPA-Sch.1		
Bromotrifluoromethane	CEPA-Sch.1		
Butadiene (1,3-)	CEPA-Sch.1		
Butoxyethanol (2-) (ethylene glycol monobutyl ether)	CEPA-Sch.1		
Carbon tetrachloride (tetrachloromethane)	CEPA-Sch.1		
Chlordane		Tier I COA	Level I Binational Toxic
Chloromethyl methyl ether	CEPA-Sch.1		
Chromium (hexavalent)	CEPA-Sch.1		
DDT	CEPA-Sch.1	Tier I COA	Level I Binational Toxic
Dibenzofuran	CEPA-Sch.1		
Dibenzo-para-dioxin	CEPA-Sch.1		
Dibromotetrafluoroethane	CEPA-Sch.1		
Dichlorobenzidine (3,3' -) (3,3-dichlorobenzene)	CEPA-Sch.1	Tier II COA	Level II Binational Toxics
Dichloroethane (1,2-)	CEPA-Sch.1		

Fluoride	CEPA-Sch.1		
Formaldehyde	CEPA-Sch.1		
Hexachlorobutadiene (hexachloro-1-3-butadiene)	CEPA-Sch.1		Level II Binational Toxic
Methoxyethanol (2-)	CEPA-Sch.1		
Methyl bromide	CEPA-Sch.1		
Mirex	CEPA-Sch.1	Tier I COA	Level I Binational Toxic
N-nitrosodimethylamine	CEPA-Sch.1		
Nonylphenol	CEPA-Sch.1		
Nonylphenol ethoxylate	CEPA-Sch.1		
Octachlorostyrene		Tier I COA	Level I Binational Toxic
PAHs	CEPA-Sch.1	Tier II COA	Level II Binational Toxic
PCDD (Dioxins)	CEPA-Sch.1	Tier I COA	Level I Binational Toxic
PCDF (Furans)	CEPA-Sch.1	Tier I COA	Level I Binational Toxic
Pentachlorobenzene	CEPA-Sch.1		Level II Binational Toxic
Polybrominated biphenyls	CEPA-Sch.1		
Polychlorinated terphenyls	CEPA-Sch.1		
Tetrachlorobenzene (1,2,3,4- and 1,2,4,5-)	CEPA-Sch.1		Level II Binational Toxic
Toxaphene		Tier I COA	Level I Binational Toxic
Tributyltetradecylphosphonium chloride	CEPA-Sch.1		
Trichloroethane (1,1,1-) (methyl chloroform)	CEPA-Sch.1		
Vinyl chloride (chloroethylene)	CEPA-Sch.1		
Substance Group 2: Other Substances of Potential Concern for Discharges to Community Wastewater Systems	**Substance Identifier**		
	CEPA Schedule 1 (N/A for Group 2)	**Tier I or Tier II Canada Ontario Agreement (COA) (2002)**	**Level I or Level II Canada-US Binational Toxics Strategy (1997)**
2,4-D			
Aluminum			
Anthracene		Tier II COA	Level II Binational Toxic
Benzo(a)anthracene		Tier II COA	Level II Binational Toxic
Boron			
Chemical Oxygen Demand			
Chlorinated paraffins			

Chlorophenol (Phenols, chlorinated)			
Chromium (trivalent)			
Dichloroethylene (Cis-1,2-)			
Dichlorophenol (2,4-)			
Dichloropropylene (Trans-1,3-)			
Di-n-butyl phthalate			
Dinitropyrene		Tier II COA	Level II Binational Toxic
Endosulfan			
Endrin			Level II Binational Toxic
Fluoranthene			
Fluorene			
Heptachlor (+heptachlor epoxide)			Level II Binational Toxic
Iron			
Lindane (Hexachlorocyclohexane)		Tier II COA	Level II Binational Toxic
MCPA			
Methylenebis (4,4-) (2-chloraniline)		Tier II COA	Level II Binational Toxic
Nitrate			
Pentachlorophenol		Tier II COA	Level II Binational Toxic
Phenanthrene		Tier II COA	Level II Binational Toxic
Phenolics (4AAP - specific compound)			
Pyrene			
Quinoline			
Thallium			
Tin			
Titanium (total)			
Tributyl tin		Tier II COA	Level II Binational Toxics
Trichlorophenoxyacetic acid (2,4,5-)			
Xylene (o-)			

Module Two (Clauses for Sector-Specific Wastes)

Guidance for Module Two

This module outlines additional clauses for municipalities with industrial sector discharges or other discharges of potential concern (such as ground food wastes from residential or industrial/ commercial/ institutional sectors). The module includes clauses for additional definitions, potential requirements for garbage grinders, requirements for maintenance access points, extra strength agreements and compliance programs. In addition, two key features of Module Two are:

- Codes of Practice; and
- Pollution Prevention Plans.

Municipalities may choose to use both or either one of these options in developing their sewer use bylaws. The use and mix of these instruments will depend on the municipality's sewer use objectives, substances of concern in the community wastewater stream, the industrial/ commercial sector profile in the community, capacity of the industrial/ commercial sector to meet requirements and municipal resources for communication of the requirements.

Codes of Practice outline requirements for a commercial or industrial sector to undertake as a requirement for discharge to the sewer. These Codes of Practice can be thought of as best management practices with respect to sewer discharges. Once implemented, Codes of Practice will reduce pollutant loads to sewers, such as food waste (and therefore BOD) from the Food Industry for example. Codes of Practice are also educational tools for the specific sector addressed. Codes of Practice are prescriptive in terms of equipment, practices and other measures required.

Pollution Prevention Plans originate from the need to reduce specific substances of concern, such as toxic, bioaccumulative or carcinogenic substances. Industrial and commercial sectors within the community that may potentially release these substances of concern are identified and required to develop plans to reduce or eliminate releases of the substances. The identified sectors choose the methods most suitable to them to meet the pollution prevention planning requirements outlined in this Model Bylaw. Therefore pollution prevention plans allow more flexibility, unlike Codes of Practice which are prescriptive. However, pollution prevention plans require a higher degree of sophistication within the industrial / commercial sectors in order to respond with appropriate plans and may require more effort on the part of the municipality to review and approve. Pollution prevention plans can be expected to be more effective in addressing specific pollutants than Codes of Practice.

1. Additional Definitions

BEST MANAGEMENT PRACTICES (BMP) — An integrated plan to control and reduce the release of restricted and prohibited waste into the wastewater works to a practicable extent, through methods including physical controls, pre-treatment processes, operational procedures and staff training.

CODE OF PRACTICE - means a set of practices applicable to specific industrial, commercial or institutional sector operations; a code of practice identifies mandatory procedures, equipment, training or other provisions required as a condition of wastewater discharge into the sewer system by the specified sector discharger.

DESIGNATED SECTOR OPERATIONS – means industrial, commercial or institutional sectors required to adopt Codes of Practice.

POLLUTION PREVENTION PLAN or PLAN — A detailed plan that identifies operations or activities of an owner or operator of commercial, institutional or industrial premises identifying specific pollution prevention methods to be implemented within a specific time frame.

POLLUTION PREVENTION PLAN SUMMARY or PLAN SUMMARY — A summary of the pollution prevention plan and a brief summary of an owner's or operator's progress towards its pollution prevention goals.

7. Additional Connection Requirements [Optional Addition]

7.5 Garbage Grinders

(1) No person shall install or operate within the Municipality any garbage grinding devices for domestic purposes, the effluent from which will discharge directly or indirectly into a sanitary combined or storm sewer.

(2) In the case of industrial, commercial or institutional properties where garbage grinding devices are installed in accordance with the Building Code, the effluent from such garbage grinding devices must comply with Schedule 'A' and Schedule 'B'.

8. Spills

(5). Industries at whose premises a spill has occurred which are required to have a Pollution Prevention Plan as a requirement of this bylaw shall prepare an updated plan and plan summary incorporating the information set out in this Section and shall submit the plan summary so updated to the Municipality within 30 days of the spill.

12. Maintenance Access Points

(1) The owner or operator of commercial, institutional or industrial premises or multi-storey residential buildings with one or more connections to a wastewater works shall install and maintain in good repair in each connection a suitable maintenance access point to allow observation, sampling and flow measurement of the wastewater, uncontaminated water or storm water therein, provided that, where installation of a maintenance access point is not possible, an alternative device or facility may be substituted with the prior written
approval of the Designated Sewer Officer.

(2) The maintenance access point or alternative device shall be located on the property of the owner or operator of the premises, as close to the property line as possible, unless the Designated Sewer Officer has given prior written approval for a different location.

(3) Each maintenance access point, device or facility installed shall be designed and constructed in accordance with good engineering practice and the requirements of the Municipality, and shall be constructed and maintained by the owner or operator of the premises at his or her expense.

(4) The owner or operator of an industrial, commercial or institutional premises or a multi-storey residential building shall at all times ensure that every maintenance access point, alternative device or facility installed as required by this bylaw is accessible to the Designated Sewer Officer for the purposes of observing, sampling and flow measurement of the wastewater, uncontaminated water or storm water therein.

(5) The provisions of this Section do not apply to those who own or operate dental offices. Dental offices shall provide a sampling port consisting of a valve, tap, or similar device consistent with technical guidelines that the Municipality may establish from time to time.

13. Extra Strength Surcharge Agreements

(1) The discharge or deposit of wastewater by a person that would otherwise be prohibited by this bylaw may be permitted to an extent fixed by:

(a) An **industrial waste surcharge agreement**, including conditions for payment of additional costs of operation, repair and maintenance of the wastewater works, and on other terms and conditions as may be deemed appropriate by the Municipality; and/or

(b) A **sanitary discharge agreement**, including conditions for payment for water pollution control treatment purposes that otherwise would have been obtained from a surcharge on the water had it been supplied by the Municipality and on other terms and conditions as may be deemed appropriate by the Municipality; and

(c) The industrial waste surcharge rate and the sanitary discharge rate will be reviewed and adjusted accordingly from time to time as determined by the Municipality.

(2) An industrial waste surcharge agreement may only be entered into with respect to the discharge of the following treatable parameters in wastewater: biochemical oxygen demand, total phosphorus, total suspended solids and total Kjehldahl nitrogen.

(3) A sanitary discharge agreement may be entered with respect to the discharge of wastewater, which contains water that has originated from a source other than the Municipal water supply system.

(4) Industrial waste surcharge agreements and sanitary surcharge agreements shall be generally in the form designated by the Municipality from time to time. The Designated Sewer Officer shall be authorized to execute industrial waste surcharge agreements and sanitary discharge agreements on behalf of the Municipality in the form designated by the Municipality.

(5) The agreements contemplated in this Section may be terminated by the Municipality by written notice at any time where there is an emergency situation of immediate threat or danger to any person, property, plant or animal life, water or wastewater works.

14. Compliance Programs

(1) An Industry may submit to the Municipality a proposed compliance program setting out activities to be undertaken by the Industry that would result in the prevention or reduction and control of the discharge or deposit of matter from the Industry's premises into municipal or private sewer connections to any sanitary sewer or combined sewer.

(2) An Industry may submit to the Designated Sewer Officer a proposed compliance program setting out activities to be undertaken by the Industry that would result in the prevention or reduction and control of the discharge or deposit of uncontaminated water, ground water or storm water from the Industry's premises to eliminate the discharge of matter into municipal or private sewer connections to any storm sewer.

(3) Upon receipt of an application pursuant to Subsection 14 (1) or (2) above, the Municipality may issue an approval for a compliance program for an Industry to discharge an effluent that does not comply with Schedule "A" and "B" of this bylaw, such approval to be in accordance with [*insert Municipality Name, Municipal Code*] guidelines therefore adopted by the Municipality from time to time. The Industry shall be entitled to make non-complying discharges in the amount and only to the extent set out in the Municipality's approval during the planning, design and construction or installation of facilities or works needed to implement the approved compliance program.

(4) Every proposed compliance program shall be for a specified length of time during which treatment facilities are to be installed and shall be specific as to the remedial actions to be implemented by the Industry, the dates of commencement and completion of the activity and the materials or other characteristics of the matter to which it relates. The final activity completion date shall not be later than the final compliance date in the compliance program.

(5) The Industry to which a compliance program has been issued shall submit a compliance program progress report to the Municipality within 14 days after the scheduled completion date of each activity listed in the compliance program.

(6) The Municipality may terminate any proposed compliance program by written notice at any time to the Industry in the event that the Industry fails or neglects to carry out or diligently pursue the activities required of it under its approved compliance program.

(7) The Municipality is authorized to execute agreements with industries with respect to approved compliance programs, which agreements may, in accordance with guidelines adopted by the Municipality from time to time, include a provision for a reduction in the payment otherwise required from the Industry to the Municipality pursuant to an industrial waste surcharge agreement. The reduction in payment to the Municipality may be in such an amount and for such duration as the agreement may specify.

(8) The Municipality may terminate any approved compliance program agreement entered into pursuant to Section 14 by written notice at any time to the Industry in the event that the Industry fails or neglects to carry out or diligently pursue the activities required of it under its approved compliance program, and in the event of any such termination, the Industry shall pay to the Municipality the full difference in amount between what it was required to pay to the Municipality pursuant to the industrial waste surcharge agreement, and the amount actually paid to the Municipality as a result of having entered into an agreement with respect to the approved compliance program.

15. Codes of Practice[12]

(1) Application:
(a) A code of practice applies to the Designated Sector Operations, as outlined in Schedule "C" of this bylaw
(b) A code of practice does not apply to a discharging operation that is subject to a waste discharge permit or authorization, unless otherwise specified in the waste discharge permit or authorization.
(c) A code of practice does not apply to the discharge of domestic waste.

(2) Nothing in a code of practice relieves a person discharging waste from complying with this bylaw, a waste discharge permit or any other applicable enactment.

[12] Adapted from the Capital Regional District (Victoria) bylaw

(3) The Designated Sewer Officer may require a discharging operation to obtain a waste discharge permit if considered necessary by the Designated Sewer Officer because of circumstances not covered by a code of practice.

(4) As a condition of discharge of waste into a sewer connected to a sewage facility, an operator of a discharging operation must submit to the manager a completed code of practice registration form attached as Schedule "C" to this bylaw:

(a) Within 90 days of the date of adoption of the applicable code of practice in the case of a discharging operation in existence on the adoption date; or

(b) In all other cases, within 30 days of the discharging operation commencing the discharge of waste into a sewer connected to a sewage facility.

(5) An operator must report any change in the ownership, name, location, contact person, telephone number, or fax number of a discharging operation registered under a code of practice to the Designated Sewer Officer within 30 days of the change by submitting a completed code of practice registration form referred to in Section 15.4 showing the changes.

(6) An operator must report any change in the discharging operation registered under a code of practice resulting in the operation no longer meeting the definition applicable to that type of discharging operation within 30 days of the change by submitting a completed code of practice registration form referred to in Section 15.4 describing the changes.

(7) If a code of practice establishes a requirement in relation to a specific discharging operation which differs from a provision in this bylaw, the requirement in the code of practice prevails.

16. Pollution Prevention Planning

(1). Every subject sector Industry identified in Schedule “D” of this bylaw and every Industry which discharges any amount of a subject pollutant identified in Schedule “E” of this bylaw shall prepare a Pollution Prevention Plan and submit to the Municipality a Plan Summary with respect to the premises from which the discharge occurs, unless such Industry continually meets the requirements of Schedule “A” and Schedule “B”. [*Dates for the submissions to be identified by the Municipality*.]

(2). Plan Summaries submitted to the Municipality shall be approved by the Municipality unless the Municipality determines that the pollution prevention plan summary or combined pollution prevention plan and pollution prevention plan summary does not comply with the requirements of this article.

(3). The Pollution Prevention Plan shall be in the form designated by the Municipality for that purpose from time to time.

(4) In addition to any other matter or requirement designated by the Municipality, and notwithstanding Subsection 16(3), each Pollution Prevention Plan shall include the following:

(a) A description of the processes at the premises which use or produce subject pollutants.

(b) A description of those processes at the premises which are to be the subject of pollution prevention planning.

(c) A list of the subject pollutants present at the premises at any stage of the operations of the premises.

(d) A description setting out the types, quantities and concentrations of all subject pollutants discharged, directly or indirectly, to a sewer.

(e) A description of current waste reduction, recycling, waste treatment and pollution prevention activities with respect to sewer discharges at the premises.

(f) A description of pollution prevention options for subject pollutants and sewer discharge and an evaluation of those options.

(g) A list of possible targets and timeframes [*as specified by the municipality*] to reduce or eliminate the discharge of subject pollutants to the City's sewers.

(h) A declaration from an authorized person that the content of the plan is, to the best of that person's knowledge, true, accurate and complete.

(5) In the event that the activity or business of an Industry which discharges any amount of a subject pollutant listed in Schedule "E" is not listed in Schedule "D" of this bylaw, then that Industry shall prepare a Pollution Prevention Plan and submit a Pollution Prevention Plan Summary by no later than [*date specified by municipality*].

(6) Any subject sector Industry and any Industry discharging any amount of a subject pollutant which commences business operations after [*date specified by municipality*], shall have one year from the date of the commencement of its business operations to prepare a Pollution Prevention Plan and prepare and submit a Pollution Prevention Plan Summary or combined Pollution Prevention Plan and Pollution Prevention Plan Summary to the Municipality.

(7) In the event that an Industry submitting a Pollution Prevention Plan is not sent written notice from the Municipality that its Pollution Prevention Plan is not approved by the Municipality within 90 days of the Industry delivering the Pollution Prevention Plan Summary or combined Pollution Prevention Plan and Pollution Prevention Plan Summary to the Municipality, the Pollution Prevention Plan shall be deemed to have been approved by the Municipality.

(8) Where an Industry receives notice from the Municipality that its Pollution Prevention Plan has not been approved, the Industry shall have 90 days to amend and resubmit its Pollution Prevention Plan Summary or combined Pollution Prevention Plan and Pollution Prevention Plan Summary to the Municipality for approval in accordance with this article.

(9) In the event that a Pollution Prevention Plan resubmitted to the Municipality in accordance with Subsection 16 (8) of this section continues to fail to comply with the requirements of this bylaw, the Municipality shall so notify the Industry, and the Industry shall be in contravention of Subsection 16 (1) of this article and shall continue to be in contravention of this article until such time as the Municipality approves of an amended Pollution Prevention Plan resubmitted by the Industry, in accordance with this article.

(10) Every subject sector Industry and every Industry discharging a subject pollutant shall submit a revised Pollution Prevention Plan Summary for the approval of the Municipality at least once every two years from the date which the original plan was required to be submitted. Such revised and updated Pollution Prevention Plan Summary or combined Pollution Prevention Plan and Pollution Prevention Plan Summary shall, in addition to the requirements otherwise set out in this article, detail and evaluate the progress of the Industry to accomplish the objectives set out in its Pollution Prevention Plan and the Industry's ability to accomplish those pollution prevention objectives.

(11) Every subject sector Industry and every Industry discharging a subject pollutant shall prepare a revised and updated Pollution Prevention Plan no less frequently than once every *[number of years to be*

specified by the Municipality] years from the date which the original plan was required to be prepared, and shall prepare and submit for the Municipality's approval a Pollution Prevention Plan Summary with respect thereto no later than the date by which any revised and updated Pollution Prevention Plan must be prepared.

(12) Where a subject sector Industry makes changes to the process(es), product(s) or facility configuration that will result in changes to the Pollution Prevention Plan, a revised or updated Pollution Prevention Plan must be prepared and a Pollution Prevention Plan Summary shall be prepared and submitted for the Municipality's approval within 2 calendar months of the change(s).

(13) The Municipality may designate any class of business or activity not included in Schedule "D" of this bylaw, as a subject sector Industry and may designate a date with respect to which any such subject sector shall be required to submit to the Municipality a Pollution Prevention Plan and a Pollution Prevention Plan Summary or combined Pollution Prevention Plan and Pollution Prevention Plan Summary.

(14) The Municipality may designate any matter as a subject pollutant and may designate a date with respect to which any Industry discharging such subject pollutant shall be required to submit to the Municipality a Pollution Prevention Plan and a Pollution Prevention Plan Summary or combined Pollution Prevention Plan and Pollution Prevention Plan Summary.

(15) A copy of the Pollution Prevention Plan and Pollution Prevention Plan Summary or combined Pollution Prevention Plan and Pollution Prevention Plan Summary shall be kept at all times at the premises in respect to which it was prepared and shall be available for inspection by the Municipality at any time.

(16) Implementation of the Pollution Prevention Plan shall be initiated within [*one year, or timeframe as identified by the municipality*] of Plan Summary approval by the Municipality.

Schedule "C" Code of Practice Registration Form for Designated Sector Operations

[Designated Sewer Officer title and address]

The following is an application to register a discharging operation under a CODE OF PRACTICE as outlined in [Municipality] Sewer Use Bylaw No. [number] **or** to change or cancel an existing registration. This application is to be filed with the Designated Sewer Officer, at the above address, per the requirements of the sewer use bylaw. To apply for a change of information or cancellation of an existing registration, an application is to be filed with the sewage control manager within 30 days of the date on which the applied changes will take affect at the operation.

1. Operation Name (name of company, partnership, individual or institution):
Hereby apply to: (Check one of the following)

. **Register as a discharging operation under one or more of the following Codes of Practice:**

Check applicable code(s) below	**Service or Industrial Category for Designated Sector Operations** [***Note to Bylaw Author***: Designated Sector Operations list should be reviewed and tailored for your community; some sectors following may be candidates for pollution prevention plan requirements where specific pollutants are of concern.][13]	**Applicable Code of Practice**
	Food Services Operations	[Identify Schedule or Source of Code of Practice]
	Dry Cleaning Operations	
	Photographic Imaging Operations	
	Dental Operations	
	Automotive Repair Operations	
	Vehicle Wash Operations	
	Carpet Cleaning Operations	
	Fermentation Operations	
	Printing Operations	
	Recreation Facility Operations	
	Laboratory Operations	
	Etc, as determined by the municipality	

Or

. **Change an existing registration under a code of practice**

Reason for change:
Or

. **Cancel an existing registration under a code of practice**

Reason for cancellation:
Operation Located at:
Postal Code:

[13] This list of sectors is from the Capital Regional District, BC sewer use bylaw.

Telephone:
Fax:
Company Name (if different from above):
Mailing Address (if different from above):
Postal Code: Telephone: Fax:

Contact Information

Owner

Name:
Telephone:
Fax:

Facility Manager

Name:
Telephone:
Fax:

2. Code of Practice Information (Please check the appropriate box for each question)

Is this operation **connected to a municipal sanitary sewer system**? ☐ Yes ☐ No ☐ Don't know

Is waste from this operation discharged to the **treatment works** specified in the applicable code of practice? ☐ Yes ☐ No ☐ Don't know

Does this operation use **off-site waste management** to comply with the requirements of the applicable code of practice? ☐ Yes, all wastes ☐ Yes, some wastes ☐ No ☐ Don't know

3. Declaration

I hereby acknowledge that the information on this form is correct to the best of my knowledge.

Signature:
Name (please print):
Title:
Date:

Schedule "D" Subject Sectors for Pollution Prevention Plans

North American Industry Classification System (NAICS) Code	**Industrial Category** [***Note to Bylaw Author:*** The industrial categories identified for pollution prevention plans should be reviewed and tailored for your community for those sectors with specific pollutants requiring reduction; specific sub-sectors by NAICS Code should be identified for clarity.]	**Due Date for P2 Plan** (as determined by the municipality)
[*Insert NAICS Code by Sub-sector, as appropriate for the municipal industrial customer base*]	**Metal finishing/metal plating industries**	
	Chemical manufacturing industries	
	Other manufacturing industries, as appropriate for the community	
	ICI sectors discharging Schedule "E" pollutants	

Schedule "E" Subject Pollutants for Subject Sectors Requiring Pollution Prevention Plans

[***Note to Bylaw Author***: Identify substances requiring specific reductions through pollution prevention plans by industrial sectors noted in Schedule "D". Substances in this Schedule may be drawn from Schedules A or B or from the Supplemental list of Substances found in this Model. Additional substances of particular concern for the community may also be added as appropriate.]

Substance
Arsenic
Cadmium
Cobalt
Chromium
Copper
Mercury
Molybdenum
Nickel
Lead
Selenium
Zinc
Additional substances, as determined by the municipality for its customer base and pollution prevention goals

Appendix A Discharge Application Forms & Discharge Permit Forms

Form #1
The Municipality of _____ Sewer Use Program

This completion of this form is required by all dischargers to sewage works under Bylaw #_____ addressing sewer use in the Municipality of _____ .

**If you have any questions on the form, please call 123-456-789

The completed form is to be forwarded to :
Attention : Designated Sewer Officer, the Municipality of _____
P.O. Box 9000, Modelville, Ontario M0D EL0

Please print clearly while completing the form.

The "Short Version of the Discharger Information Report"	
1	**Name of Company**
2	**Address of Company** Phone: Fax:
3.	**Owner of property** (if different from Company listed above) Phone: Fax:
4	**Brief Description of Product or Service**
5	**Brief Description of the Process(es) used in the Manufacturing of Servicing**

The "Short Version of the Discharger Information Report"	
6	**'Are there' or 'Will there be' any of the following wastewater discharges from the description as provided in #5?** Process wastewater Yes / No Cooling water Yes / No Other sources of wastewater (other than sanitary) Yes / No (if yes, brief description)
7	**Does the site have any existing connections to the following sewers?** sanitary Yes / No combined Yes / No storm Yes / No
8	Location of Process units? Inside / Outside / Outside but covered Storage of raw materials? Inside / Outside / Outside but covered Storage of intermediate products? Inside / Outside / Outside but covered Storage of final products? Inside / Outside / Outside but covered
9	**Does the site have any of the following programs in place to address discharges to the sewer system?** Pollution Prevention Yes / No Best Management Plan Yes / No Environmental Management System Yes / No Other program / practices Yes / No

Date form completed :
Name and Title of Company Representative:

Signature of Authorized Company Representative

Note: Completion of the "Complete Discharger Information Report" may be required based on this report and/or subsequent verification of the site by the Municipality.

For Municipality use only - date completed form received :

Form #2
The Municipality of _____ Sewer Use Program

This completion of this form by dischargers to the sewage works is required under certain circumstances by By-law #_____ addressing sewer use in the Municipality of _____ .

**If you have any questions on the form, please call 123-456-789

The completed form is to be forwarded to :
Attention : Designated Sewer Officer, the Municipality of _____
P.O. Box 9000, Modelville, Ontario M0D EL0

Please note the following:
Print clearly while completing the form.
Additional information and attachments - are required .
Indicate what material has been attached to ensure that the municipality is aware of all the information provided.
.

The "Complete Discharger Information Report"	
1	**Name of Company**
2	**Address of Company** Phone: Fax:
3.	**Owner of property** (if different from Company listed above) Phone: Fax:
4	**General Site Operation Information** Number of Employees involved in plant: office: other: Total: Number of Shifts per day: Number of operating days per week:

The "Complete Discharger Information Report"	
5	**Description of Product(s) or Service** Include Standard Industrial Code (SIC) - state if SIC is Canadian or American
6	**Description of the Process(es) used in the Manufacturing or Servicing** Include characteristics such as Batch (how many per time period), Continuous, or Both (explanation to be provided), Seasonal Production Cycles, Specific Clean-up Periods and Clean-up Activities
7	**Average Daily Water Use and Sources** Municipal Supply Yes / No _____m3/day Estimated or Measured Surface Water** Yes / No _____m3/day Estimated or Measured Groundwater* Yes / No _____m3/day Estimated or Measured Other sources** Yes / No _____m3/day Estimated or Measured If flow rate varies significantly provide peak flow rates per day and month and explanation. * Provide copy of the Permit to Take Water (as required by the OWRA) according to By-law Requirements ** If 'Yes' - provide explanation as an attachment.
8	**Discharge Points from Site** List all discharge points and average daily flow in cubic metres per day of sanitary, noncontact cooling water, process wastewater, contact cooling water and other discharge water to the sanitary sewer, combined sewer, storm sewer, groundwater, surface water, evaporation losses (if applicable), and percent of water in final product (if significant and applicable to the site).

The "Complete Discharger Information Report"	
	i.e. process wastewater from manufacturing line to sanitary sewer at an average daily flow of 200 m3/day (measured)
9	**Known Characteristics of Discharges** Provide existing data on quality of the discharges listed above in # (complete Parameter Information Form for each discharge point as provided with this form)
10	**Physical Layout** • Provide sketch of property (to scale or approximate) showing buildings, pretreatment works, • property boundaries, effluent lines, and connections to sanitary, combined and storm sewers. • Please identify sewers as listed on the Parameter Information Form as completed above. • Layout may be attached as separate document - leave note to indicate submission with this form. • A flow diagram of the site flows/processes is also required.
11	**Regulation 347 Information** Provide any Generator Registration Numbers that the site under the requirements of Ontario Regulation 347 under the EPA.
12	**Extra Strength Surcharge Agreements (ESSA)** Does the site have an existing ESSA with the Municipality? Yes / No Did the site previously have an ESSA with the Municipality? Yes / No If Yes to either question - Attach a copy of each agreement to this form

The "Complete Discharger Information Report"	
13	**Pretreatment of Discharges Prior to Discharge** Does the site have any pretreatment systems for process effluents prior to discharge to the sewer system? Yes / No If Yes- provide a description of the pretreatment devices, contaminants removed, operational procedures for the device and description of process utilized in the device.
14	**Does the site have any of the following programs addressing discharges to the sewer system in place?** Pollution Prevention Yes / No Best Management Plan Yes / No Environmental Management System Yes / No Other program / practices Yes / No If yes - attach copy of each to the form and explanation for implementation.

Date form completed :

Name and Title of Company Representative:

Signature of Authorized Company Representative

The information submitted in this form may subject to verification by the municipality:

For Municipality use only date completed form received :
date information verified/approved:

Form # 3
Municipality of _____ Industrial Waste Discharge Permit[14]

Under the provisions of the Municipality of _____ Sewer Use Bylaw No. _____, _____ hereinafter referred to as the Permittee, is authorized to discharge Non-Domestic Waste to the Sanitary or Storm Sewer located at _____

This Waste Discharge Permit, hereinafter refererred to as the "Permit", has been issued under the terms and conditions, including definitions, prescribed in the Municipality of _____ Sewer Use Bylaw No. _____ hereinafter referred to as the "Bylaw".

This Permit sets out the standard conditions, engineering units, and the requirements for emergency procedures.

A. STANDARD CONDITIONS

1. Except as otherwise provided in this Permit, all terms and conditions stipulated in the Bylaw shall apply to this Permit.

2. The terms and conditions of this Permit may be amended, by the Municipality pursuant to the Bylaw.

3. Definitions contained within Bylaw No. _____ apply to this Permit.

B. MAINTENANCE AND OPERATION OF WORKS AND PROCEDURES

Wastewater control works and procedures associated with maintaining the discharge criteria and/or the monitoring requirements specified in the Permit shall be employed at all times during the discharge of industrial/commercial wastes to sewer. All such works and procedures shall be inspected regularly and maintained in good working condition.

C. EMERGENCY PROCEDURES

In the event of an emergency or condition which prevents the continuing operation of any wastewater works or procedures designated by this Permit or results, or may result in a violation of any discharge criteria specified in this Permit, the Permittee shall notify the Municipality at [phone number] (24 hours) at the first available opportunity, and shall undertake appropriate remedial action as soon as possible.

D. BY-PASSES
The discharge of wastes which by-pass any wastewater works or are not in accordance with procedures designated by the Permit is prohibited, unless prior approval of the Municipality is obtained and confirmed in writing.

E. DISCHARGE MONITORING

1. Discharge measurement, sampling, analysis and reporting shall be undertaken by the Permittee when required by the Designated Sewer Officer. The Designated Sewer Officer may also undertake audit sampling, at the Designated Sewer Officer's discretion.

[14] Based on Kelowna Sewer Bylaw Waste Discharge Permit, with modifications.

F. pH MONITORING

Enforcement of pH levels, as listed in this Permit, shall be based on grab samples. The Permittee should be aware that pH levels measured in a Composite Sample [if required] will provide an average pH of the waste stream and will not indicate the total range of pH in the effluent. The Permittee is encouraged to do periodic grab sample pH analyses to ensure permit compliance.

G. DISCHARGE SAMPLING AND ANALYSES

The Permittee shall carry out the following sampling and analysis program, to commence on _____.

1. Continuous Discharges

(a) Effective _____, the Permittee shall measure or estimate, using an approved flow monitoring device or method, the daily discharge during each month of operation. The following information shall be recorded:

Total flow for the month (m3)
Number of operating days during the month
Average daily flow for the month (m3/day)
Maximum daily flow for the month (m3/day)

2. Continuous and Batch Discharges

(a) Composite Samples – A 24 hour [if facility operates 24 hours per day] or 8 hour [if facility operates 8 hours per day] composite sample shall be taken by the discharger using sampling equipment installed in the maintenance access point, or other sample point approved by the Designated Sewer Officer at the following frequency: _____. The Discharge flow for the periods that the Composite Sample [if required] are collected shall be recorded.
[optional requirement if the Industry has a composite sampler available to be installed in the maintenance access point – otherwise, municipality will need to use composite sampling equipment to conduct this, if required]

(b) One grab sample shall be collected from the maintenance access point, or other sample point approved by the Designated Sewer Officer during normal facility operating hours, and at the time of day approved by the Designated Sewer Officer, at the following frequency: _____. The sample date and time shall be recorded.
This GRAB SAMPLE shall be analyzed for the following parameters:

[insert parameters]

3. Sample Analysis

All sampling, measurements, tests and analyses of waste discharges shall be carried out in accordance with the latest edition of "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, or an alternate method approved by the Designated Sewer Officer. Samples shall be submitted for analysis to a laboratory accredited by the Canadian Association for Environmental Analytical Laboratories[15], at the expense of the discharger, unless other arrangements

[15] Refer to CAEAL website at for accredited laboratories: http://www.caeal.ca

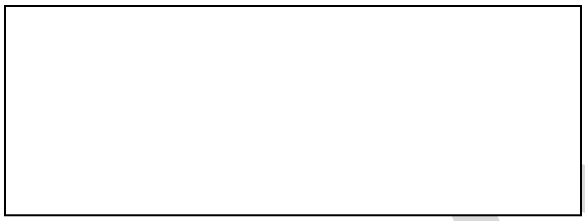
have been approved by the Designated Sewer Officer. The owner shall supply hard copies of the results of the analysis to the Designated Sewer Officer in a format acceptable to the inspector within the time specified by the inspector.

H. LOCATION OF APPROVED SAMPLE POINTS

The approved sample points are as follows, and as shown on the attached schematic of approved sample points and treatment processes. Sample point _____ is considered to be the point of discharge to sewer.

SAMPLE POINT NO. DESCRIPTION
Sample Point 1 _____
Sample Point 2 _____

PHOTOGRAPH OF APPROVED SAMPLING POINT SUPPLIED BY PERMITTEE



I. AUTHORIZED DISCHARGE CHARACTERISTICS

1. AUTHORIZED RATE OF DISCHARGE
The Permittee shall not exceed the following:

[insert flow rates]

2. AUTHORIZED DISCHARGE CRITERIA

This Permit sets out requirements for the quantity and quality of the discharge of Non-Domestic Waste from a _____. Where a compliance program has been specified, existing works or procedures must be maintained in good operating condition and operated in a manner to minimize the discharge of contaminants during the interim period until the net works have been installed.

a) The Permittee shall not discharge prohibited waste, as defined in Schedule "A" of the Bylaw.

b) The Permittee shall not discharge restricted waste, as defined in Schedule "B" of the Bylaw with the following exceptions:

[insert Parameter Authorized Range orMaximum Concentration]

Compliance with the above-noted exceptions is to be achieved by: _____

c) The Permittee shall not discharge storm water or cooling water into the sewer system.

J. AUTHORIZED WORKS AND PROCEDURES

This Permit sets out the waste sources, works and procedures for the authorized discharges to sewers. The Designated Sewer Officer may require that further works be installed if the existing works, in his opinion, do not provide an acceptable level of treatment. New works or alterations to existing works must be approved, in principle, by the Designated Sewer Officer.

New waste sources must be authorized, in writing, by the Designated Sewer Officer.

The authorized waste sources, works and procedures to treat and/or control the waste discharge are:

SOURCE COMPLETION DATE WORKS & PROCEDURES
1. _____ _____ _____
2. _____ _____ _____

K. REPORTING REQUIREMENTS FOR WASTE DISCHARGE PERMIT

The Permittee is required to submit the following reports to the Designated Sewer Officer:

a) The Permittee shall submit the results of effluent sampling (as required by the Designated Sewer Officer) to the Designated Sewer Officer at the following frequency *[insert frequency]*.

b) By not later than _____, the Permittee shall submit a written report outlining the specifications of the flow monitoring device or method used to determine the discharge flow rate.

c) Additional reporting shall be undertaken by the Permittee when required by the Designated Sewer Officer. *[i.e. insert reporting requirements for compliance programs, status on pollution prevention activities, etc.]*

Appendix B Sources of Contaminants in Municipal Wastewater[16]

Sources of Contaminants in Municipal Wastewater[17]

Substance Name	Industrial Source	Secondary Source
2,4-D	325320 - Pesticide and Other Agricultural Chemical Mfg	diffusive, non-point source (parks, lawns)
Acetaldehyde	325199 - Acetaldehyde mfg; 311999 - nutritional yeast mfg	
Acrolein	325199 - acrolein mfg	
Acrylonitrile	325190- Chemical mfg (other)	
Aldrin	Banned in Canada since end of 1995; diffusive, non-point	
Alkyl lead	325190- Chemical mfg (other)	
Aluminum	333317- Aluminum rolling, drawing, extruding and alloying; 415110 - automobile and light duty truck wholesalers/distributors; automotive parts and accessories stores; automotive repair (general); 811199- automotive repair & maintenance (all other); 44111 - car dealers (new); 56174 - carpet & upholstery cleaning services; 325 - chemical mfg; 325189 - chemical mfg (all other basic inorganic); 325190 - chemical mfg (other basic organic); 331221 - cold-rolled steel shape mfg; 33422 - die-casting foundries (non-ferrous); 611 - educational services; 332113 - forging; 331529 - foundries (non-ferrous except die-casting); 482113 - freight rail transportation (Mainline); 4832112 - freight rail transportation (short-haul); 44719 - gasoline stations (other); 441711 - gasoline stations with convenience stores; 622111 - hospitals general (except pediatrics); 721111 - Hotels (except casino hotels) and motels; 33111 - iron and steel mills and ferro-alloy mfg; 541380 - Laboratories (testing); 812330 - linen & uniform supply; 488320 - marine cargo handling; 562920 - material recovery facilities; 331410 - metal smelting and refining (non-ferrous except aluminum); 33242 - metal tank (heavy gauge mfg; 332321metal window and door mfg; 332810 - metals-coating and allied activities; 33633 - motor vehicle chassis components (except spring) mfg; 336320 - motor vehicle electronic equipment mfg; 336310 - motor vehicle gasoline mfg; 336390 - motor vehicle parts mfg - other; 415290 - motor vehicle parts wholesaler/distributors (others-new); 51111 - newspaper publishers; 332329 - ornamental metal products mfrs (others); 322121 - paper (excepts newsprint) mills; 812930 - parking lots & garages; 482114 - passenger rail transportation; 32411 - petroleum refineries; 81292 - photo finishing services; 32311 - printing; 562910 - remediation services; 322291 - sanitary paper product mfg; 334410 - semiconductor mfg; 337215 - shelving, showcase, partition and locker mfg; 321112 - shingle and shake mills; 221330 - steam & air (conditioning and supply); 331222 - steel wire drawing; 31331 - textile & fabric finishing; 485110 - urban transit systems; 562990 -waste management services (all other); 562210 - waste treatment & disposal; 332619 - wire product mfg (all other)	domestic wastewater (personal care products)

[16] Note that the CCME is undertaking the development of a searchable database by substance or by industrial sector, to assist municipalities in identifying substances and sectors of interest in the development of sewer use bylaws.

[17] Hydromantis Inc., Minnow Environmental Inc., University of Waterloo (Dept. of Civil Engineering). (September 2005, Revised November 26, 2005). Review of the State of Knowledge of Municipal Effluent Science and Research. Final Report – Tasks 2 and 3: Review of Existing and Emerging Technologies, Review of Wastewater Treatment Best Management Practices.

Substance Name	Industrial Source	Secondary Source
Ammonia	32552 - adhesive mfg; 324122 - asphalt shingle & coating material mfg; 415110 - automobile and light duty truck wholesalers/distributors; automotive parts and accessories stores; 811111 - automotive repair (general); 811199- automotive repair & maintenance (all other); 31212 - breweries; 56174 - carpet & upholstery cleaning services; 325313 - chemical fertilizer (except potash) mfg; 325189 - chemical mfg (all other basic inorganic); 325190 - chemical mfg (other basic organic); 325999 - chemical product mfg (all other misc.); 31132 - chocolate & confectionery mfg; 33410 - computer and peripheral mfg; 621210 - dental offices; 331523 - die-casting foundries (non-ferrous); 81232 - dry cleaning and laundry services (except coin-operated); 611 - educational services; 325920 - explosives mfg; 722 - Food services and drinking places; 331529 - foundries (non-ferrous except die-casting); 311420 - Fruit & Vegetable Canning, pickling and drying; 44719 - gasoline stations (other); 441711 - gasoline stations with convenience stores; 622111 - hospitals general (except pediatrics); 721111 - Hotels (except casino hotels) and motels; 331511 - iron foundries; 541380 - Laboratories (testing); 31611 - Leather & hide tanning & finishing; 562920 - material recovery facilities; 332999 - metal product mfg (all other misc.); 327990 - mineral product mfg (all other non-metallic); 812930 - parking lots & garages; 325320 - pesticide & other agricultural chemical mfg; 32511 - petrochemical mfg; 324190 - petroleum & coal products mfg (Other); 32411 - petroleum refineries; 325410 - pharmaceutical and medicine mfg; 81292 - photo finishing services; 562910 - remediation services; 325210 - resin & synthetic rubber mfg; 311940 - seasoning & dressing mfg; 334410 - semiconductor mfg; 325610 - soap & cleaning compounds mfg; 221330 - steam & air (conditioning and supply); 331514 - steel foundries; 562990 -waste management services (all other); 562210 - waste treatment & disposal; 221310 - water supply & irrigation systems	
Anthracene	Source of dyestuffs (manufacture of alizarin dyes), chemical intermediate for dyes, raw material for anthraquinone; also in production of synthetic fibers, plastics and monocrystals, as a component of smoke screens, as scintillation counter crystals; in semiconductor research	
Arsenic	415110 - automobile and light duty truck wholesalers/distributors; automotive parts and accessories stores; 811111 - automotive repair (general); 811199- automotive repair & maintenance (all other); 56174 - carpet & upholstery cleaning services; 325189 - chemical mfg (all other basic inorganic); 325190 - chemical mfg (other basic organic); 212233 - copper-zing ore mining; 81232 - dry cleaning and laundry services (except coin-operated); 611 - educational services; 482113 - freight rail transportation - mainline); 482112 - freight rail transportation (short haul); 44719 - gasoline stations (other); 441711 - gasoline stations with convenience stores; 212220 - gold & silver ore mining; 721111 - Hotels (except casino hotels) and motels; 21221 - iron ore mining; 541380 - Laboratories (testing); 812310 - laundries (coin-operated) and dry cleaners; 562920 - material recovery facilities; 621510 - medical & diagnostic laboratories; 212299 - metal ore mining (all other); 331410 - metal smelting & refining (non-ferrous except aluminum); 332810 - metals coating & allied products; 212232 - nickel-copper ore mining; 322121 - paper (except newsprint) mills; 482114 - passenger rail transportation; 325320 - pesticide & other agricultural chemical mfg; 32411 - petroleum refineries; 325410 - pharmaceutical and medicine mfg; 562910 - remediation services; 322291 - sanitary paper product mfg; 334410 - semiconductor mfg; 321112 - shingle & shake mills; 221330 -	

Substance Name	Industrial Source	Secondary Source
	steam & air (conditioning and supply); 485110 - urban transit systems; 562990 - waste management services (all other); 562210 - waste treatment & disposal; 321114 - wood preservation	
Benzene	811199- automotive repair & maintenance (all other); 44111 - car dealers (new); 325190 - chemical mfg (other basic organic); 482113 - freight rail transportation - mainline); 482112 - freight rail transportation (short haul); 44719 - gasoline stations (other); 441711 - gasoline stations with convenience stores; 331511 - iron foundries; 541380 - Laboratories (testing); 812330 - linen & uniform supply; 482114 - passenger rail transportation; 32511 - petrochemical mfg; 32411 - petroleum refineries; 562910 - remediation services; 331514 - steel foundries; 485110 - urban transit systems; 562990 - waste management services (all other)	
Benzidine dihydrochloride	intermediate in production of dyes and pigments	
Benzo(a)anthracene	811199- automotive repair & maintenance (all other); 482113 - freight rail transportation (mainline); 482112 - freight rail transportation (short haul); 44719 - gasoline stations (other); 441711 - gasoline stations with convenience stores; 482114 - passenger rail transportation; 32411 - petroleum refineries; 485110 - urban transit systems; 321114 - wood preservation	diffusive, non-point (auto tire particles, road oils, atmos. deposition)
Benzo(a)pyrene	331511 - Iron foundries; 331514 - steel foundries	diffusive, non-point (auto tire particles, road oils, atmos. Deposition
Biochemical Oxygen Demand	327910 abrasive product mfg; 32552 adhesive mfg; 488119 airport operations (other); 311611 - animal (except poultry) slaughtering; 311119 - animal food mfg (other); 324122 - asphalt shingle and coating material mfg; 415110 - automobile and light duty truck wholesalers/distributors; 811121 - Automotive body, paint and interior repair & maintenance; 811111 - automotive repair (general); 811199- automotive repair & maintenance (all other); 311814 - bakeries (commercial) fresh & frozen mfg; 31123 - breakfast cereal mfg; 31212 - breweries; 44111 - car dealers (new); 56174 - carpet & upholstery cleaning services; 325 - chemical mfg; 325190 - chemical mfg (other basic organic); 325999 - chemical product mfg (all other misc.); 31132 - chocolate & confectionery mfg; 31192 - coffee and tea mfg; 323113 - commercial screen printing; 31134 - confectionery mfg (non-chocolate); 311821 - cookie & cracker mfg; 325991 - custom compounding of purchased resins; 315210 - cut & sew clothing contracting; 332210 - cutlery & hand tool mfg; 331523 - die-casting foundries (non-ferrous); 312140 - distilleries; 81232 - dry cleaning & laundry services (except coin-operated); 611 - educational services; 325920 - explosives mfg; 311211 - flour milling; 311822 - flour mixes& dough mfg from purchased flour; 311990 - food mfg (all other); 311111 - food mfg (dog & cat food); 722 - food services & drinking places; 413110 - food wholesaler-distributors (general-line); 413190 - food wholesaler-distributors (specialty-line); 331529 - foundries (non-ferrous except die-casting); 482113 - freight rail transportation (Mainline); 482112 - freight rail transportation (short-haul); 311420 - Fruit & Vegetable Canning, pickling & drying; 812210 - funeral homes; 44719 - gasoline stations (other); 441711 - gasoline stations with convenience stores; 622111 - hospitals general (except pediatrics); 721111 - Hotels (except casino hotels) and motels; 541380 - Laboratories (testing); 812310 - laundries (coin-operated) & drycleaning; 31611 - leather & hide tanning & finishing; 812330 - linen & uniform supply; 562920 - material recovery facilities; 621510 - medical & diagnostic laboratories; 332999 - metal	

Substance Name	Industrial Source	Secondary Source
	product mfg (all other misc.); 311511 - milk mfg (fluid); 327990 - mineral product mfg (all other non-metallic); 51111 - newspaper publishers; 311224 - oilseed processing; 322121 - paper (excepts newsprint) mills; 482114 - passenger rail transportation; 325320 - pesticide & other agricultural chemical mfg; 324190 - petroleum & coal products mfg; 32411 - petroleum refineries; 325410 - pharmaceutical & medicine mfg; 81292 - photo finishing services; 311615 - poultry processing; 32311 - printing; 323119 - printing (other); 413160 - red meat & meat product wholesaler-distributors; 562910 - remediation services; 311614 - rendering & meat processing from carcasses; 325210 - resin & synthetic rubber mfg; 311811 - retail bakeries; 322291 - sanitary paper product mfg; 311710 - seafood product preparation & packaging; 311940 - seasoning & dressing mfg; 311919 - snack food mfg (other); 325640 - soap & cleaning compound mfg; 312110 - soft drink & ice mfg; ; 221330 - steam & air (conditioning and supply); 311310 - sugar mfg; 31193 - syrup & other flavouring concentrates mfg; 31331 - textile & fabric finishing; 312210 - tobacco stemming & redrying; 31183 - tortilla mfg; 485110 - urban transit systems; 321217 - waferboard mills; 562990 -waste management services (all other); 562210 - waste treatment & disposal; 31213 - wineries; 321114 - wood preservation - milk mfg (fluid); 327990 - mineral product mfg (all other non-metallic); 51111 - newspaper publishers; 311224 - oilseed processing; 322121 - paper (excepts newsprint) mills; 482114 - passenger rail transportation; 325320 - pesticide & other agricultural chemical mfg; 324190 - petroleum & coal products mfg; 32411 - petroleum refineries; 325410 - pharmaceutical & medicine mfg; 81292 - photo finishing services; 311615 - poultry processing; 32311 - printing; 323119 - printing (other); 413160 - red meat & meat product wholesaler-distributors; 562910 - remediation services; 311614 - rendering & meat processing from carcasses; 325210 - resin & synthetic rubber mfg; 311811 - retail bakeries; 322291 - sanitary paper product mfg; 311710 - seafood product preparation & packaging; 311940 - seasoning & dressing mfg; 311919 - snack food mfg (other); 325640 - soap & cleaning compound mfg; 312110 - soft drink & ice mfg; ; 221330 - steam & air (conditioning and supply); 311310 - sugar mfg; 31193 - syrup & other flavouring concentrates mfg; 31331 - textile & fabric finishing; 312210 - tobacco stemming & redrying; 31183 - tortilla mfg; 485110 - urban transit systems; 321217 - waferboard mills; 562990 -waste management services (all other); 562210 - waste treatment & disposal; 31213 - wineries; 321114 - wood preservation	
Bis(2-ethylhexyl)phthalate	326220 - rubber &plastic hosing & belting mfg	
Bis(chloromethy l)ether	used as intermediates in organic synthesis and in the production of anion exchange resins, membranes and other aromatic products.	
Boron	331317 - aluminum rolling, drawing, extruding & alloying; 311611 - animal (except poultry) slaughtering; 311119 - animal food mfg (other); 811111 - automotive repair (general); 811199- automotive repair & maintenance (all other); 311814 - bakeries (commercial) fresh & frozen mfg; 31123 - breakfast cereal mfg; 44111 - car dealers (new); 56174 - carpet & upholstery cleaning services; 325189 - chemical mfg (all other basic inorganic); 325190 - chemical mfg (other basic organic); 325999 - chemical product mfg (all other misc.); 31192 - coffee and tea mfg; 31134 - confectionery mfg (non-chocolate); 311821 - cookie & cracker mfg; 311515 - dairy products(dry & condensed mfg); 611 - educational services; 311211 - flour milling; 311822 - flour mixes& dough mfg from purchased flour; 311990 - food mfg (all other); 311111 - food mfg (dog &	

Substance Name	Industrial Source	Secondary Source
	cat food); 332113 - forging; 331529 - foundries (non-ferrous except die-casting); 482113 - freight rail transportation (Mainline); 482112 - freight rail transportation (short-haul); 44719 - gasoline stations (other); 441711 - gasoline stations with convenience stores; 622111 - hospitals general (except pediatrics); 721111 - hotels (except casino hotels) and motels; 31152 - ice cream & frozen dessert mfg; 541380 - Laboratories (testing); 812310 - laundries (coin-operated) & drycleaning; 812330 - linen & uniform supply; 562920 - material recovery facilities; 332810 - metals coating & allied activities); 311511 - milk mfg (fluid); 51111 - newspaper publishers; 311224 - oilseed processing; 322121 - paper (excepts newsprint) mills; 812930 - parking lots & garages; 482114 - passenger rail transportation; 32411 - petroleum refineries; 81292 - photo finishing services; 311615 - poultry processing; 32311 - printing; 562910 - remediation services; 311614 - rendering & meat processing from carcasses; 311811 - retail bakeries; 322291 - sanitary paper product mfg; 311710 - seafood product preparation & packaging; 311940 - seasoning & dressing mfg; 321112 - shingle & shake mfg; 311919 - snack food mfg (other); 221330 - steam & air (conditioning and supply); 311310 - sugar mfg; 31193 - syrup & other flavouring concentrates mfg; 31331 - textile & fabric finishing; 485110 - urban transit systems; 562990 -waste management services (all other); 562210 - waste treatment & disposal; 321114 - wood preservation	
Bromochlorodifluoromethane	No information in Hydromantis (2005) Report.	
Bromochloromethane	As chemical Intermediate; as fire extinguishing agent.	
Bromotrifluoromethane	No information in Hydromantis (2005) Report.	
Butadiene (1,3-)	32510 - resin & synthetic rubber mfg	
Butoxyethanol (2-) (ethylene glycol monobutyl ether)	No information in Hydromantis (2005) Report.	
Cadmium	488119 - airport operations (other); 441310 - automotive parts and accessories stores; 811199- automotive repair & maintenance (all other); 44111 - car dealers (new); 56174 - carpet & upholstery cleaning services; 325189 - chemical mfg (all other basic inorganic); 33422 - communications broadcasting equipment mfg; 332314 - concrete reinforcing bar mfg; 81232 - dry cleaning and laundry services (except coin-operated); 611 - educational services; 332113 - forging; 482113 - freight rail transportation - mainline); 482112 - freight rail transportation (short haul); 44719 - gasoline stations (other); 44711 - gasoline stations with convenience stores; 622111 - hospitals general (except pediatric); 721111 - Hotels (except casino hotels) and motels; 812310 - laundries (coin-operated) and dry cleaners; 335120 - lighting fixture mfg; 812330 - linen & uniform supply; 339990 - manufacturing (all other); 488320 - marine cargo handling; 562920 - material recovery facilities; 339110 - medical equipment & supplies mfg; 332439 - metal container mfg (other); 331490 - metal processing & alloying (except Fe, Cu and Al); 332999 - metal product mfg (all other misc.); 331410 - metal smelting & refining (non-ferrous except aluminum); 33242 - metal tank (heavy gauge) mfg; 332910 - metal valve mfg; 332810 - metals coating & allied products; 33633 - motor vehicle chassis components (except spring) mfg; 336320 - motor vehicle electronic equipment mfg; 336310 - motor vehicle gasoline mfg; 336390 - motor vehicle parts mfg (other); 415290 - motor vehicle parts wholesaler-distributors (other new); 322121 - paper (except newsprint) mills; 482114 - passenger rail transportation; 32411 - petroleum refineries; 562910 - remediation services; 322291 - sanitary	

Substance Name	Industrial Source	Secondary Source
	paper product mfg; 334410 - semiconductor mfg; 321112 - shingle & shake mills; 332611 - spring (heavy gauge) mfg; 332118 stamping; 221330 - steam & air (conditioning and supply); 331222 - steel wire drawing; 485110 - urban transit systems; 562990 - waste management services (all other); 562210 - waste treatment & disposal; 332619 - wire product mfg (all other); 321114 - wood preservation	
Chemical Oxygen Demand	No information in Hydromantis (2005) Report.	
Chlordane	diffusive, non-point; Banned in Canada since end of 1995;	
Chloride	325181 - Alkali & chlorine mfg; 325189 - chemical mfg (all other basic inorganic); 33111 - iron & steel mills & ferro-alloy mfg; 31611 - leather & hide tanning & finishing; 313 textile mills	diffusive, non-point, from winter road-salting
Chlorinated paraffins	No information in Hydromantis (2005) Report.	
Chloroform	325189 - chemical mfg (all other basic inorganic); 325190 - chemical mfg (other basic organic); hospitals general (except pediatric); 541380 laboratories (testing)	
Chloromethyl methyl ether	used in the synthesis of chloromethylated compounds and as an alkylating agent and solvent used in the manufacture of water repellents, ion-exchange resins, and industrial polymers	
Chlorophenol	322191 - sanitary paper product mfg; 321114 - wood preservation	
Chromium (hexavalent and trivalent)	336410 - Aerospace product & parts mfg; 488119 - airport operations (other); 415110 - automobile & light duty truck wholesaler-distributors; 441310 - automotive parts and accessories stores; 811111 - automotive repair (general); 811199- automotive repair & maintenance (all other); 44111 - car dealers (new); 56174 - carpet & upholstery cleaning services; 325189 - chemical mfg (all other basic inorganic); 325190 - chemical mfg (other basic organic); 331221 - cold-rolled steel shape mfg; 33422 - communications broadcasting equipment mfg; 332314 - concrete reinforcing bar mfg; 6212101 - dental offices; 81232 - dry cleaning and laundry services (except coin-operated); 611 - educational services; 332113 - forging; 331529 - foundries (non-ferrous except die-casting); 482113 - freight rail transportation - mainline); 482112 - freight rail transportation (short haul); 44719 - gasoline stations (other); 44711 - gasoline stations with convenience stores; 33251 - hardware mfg; 622111 - hospitals general (except pediatric); 721111 - Hotels (except casino hotels) and motels; 33111 - iron & steel mills and ferro-alloy mfg; 331511 - iron foundries; 541380 - laboratories (testing); 812310 - laundries (coin-operated) and dry cleaners; 31611 - leather &hide tanning & finishing; 335120 - lighting fixture mfg; 812330 - linen & uniform supply; 339990 - Manufacturing (all other); 488320 - marine cargo handling; 562920 - material recovery facilities; 621510 - medical & diagnostic laboratories; 339110 - medical equipment & supplies mfg; 332439 - metal container mfg (other); 331490 - metal processing & alloying (except Fe, Cu and Al); 332999 - metal product mfg (all other misc.); 331410 - metal smelting & refining (non-ferrous except aluminum); 33242 - metal tank (heavy gauge) mfg; 332910 - metal valve mfg; 332321 - metal window & door mfg; 332810 - metals coating & allied products; 33633 - motor vehicle chassis components (except spring) mfg; 336320 - motor vehicle electronic equipment mfg; 336310 - motor vehicle gasoline mfg; 336390 - motor vehicle parts mfg (other); 415290 - motor vehicle parts wholesaler-distributors (other new); 332329 - ornamental metal products mfg (other): 322121 - paper (except newsprint) mills; 482114 - passenger rail transportation; 32411 - petroleum refineries; 81292 - photo finishing services; 562910 - remediation services; 322291 - sanitary paper product	

Substance Name	Industrial Source	Secondary Source
	mfg; 337215 - shelving, showcase, partition & locker mfg; 321112 - shingle & shake mills; 332611 - spring (heavy gauge) mfg; 332118 stamping; 221330 - steam & air (conditioning and supply); 331514 - steel foundries; 331222 - steel wire drawing; 332720 - turned product & screw, nut & bolt mfg; 485110 - urban transit systems; 562990 - waste management services (all other); 562210 - waste treatment & disposal; 332619 - wire product mfg (all other); 321114 - wood preservation metal products mfg (other): 322121 - paper (except newsprint) mills; 482114 - passenger rail transportation; 32411 - petroleum refineries; 81292 - photo finishing services; 562910 - remediation services; 322291 - sanitary paper product mfg; 337215 - shelving, showcase, partition & locker mfg; 321112 - shingle & shake mills; 332611 - spring (heavy gauge) mfg; 332118 stamping; 221330 - steam & air (conditioning and supply); 331514 - steel foundries; 331222 - steel wire drawing; 332720 - turned product & screw, nut & bolt mfg; 485110 - urban transit systems; 562990 - waste management services (all other); 562210 - waste treatment & disposal; 332619 - wire product mfg (all other); 321114 - wood preservation	
Chromium (hexavalent)		
Chromium (trivalent)		
Cobalt	811199- automotive repair & maintenance (all other); 325190 - chemical mfg (other basic organic); 33422 - communications broadcasting equipment mfg; 482113 - freight rail transportation - mainline); 482112 - freight rail transportation (short haul); 44719 - gasoline stations (other); 44711 - gasoline stations with convenience stores; 812330 - linen & uniform supply; 331410 - metal smelting & refining (non-ferrous except aluminum); 332810 - metals coating & allied activities; 336320 - motor vehicle electronic equipment mfg; 322121 - paper (except newsprint) mills; 482114 - passenger rail transportation; 32411 - petroleum refineries; 562910 - remediation services; 334410 - semiconductor mfg; 321112 - shingle & shake mills; 221330 - steam & air (conditioning and supply); 485110 - urban transit systems; 562990 - waste management services (all other); 562210 - waste treatment & disposal; 321114 - wood preservation	
Copper	488119 - airport operations (other); 336110 - automobile & light duty motor vehicle mfg; 415110 - automobile & light duty truck wholesaler-distributors; 811119 - automotive maintenance & mechanical & electrical (other); 441310 - automotive parts and accessories stores; 811111 - automotive repair (general); 811199- automotive repair & maintenance (all other); 44111 - car dealers (new); 56174 - carpet & upholstery cleaning services; 325 - chemical mfg; 325189 - chemical mfg (all other basic inorganic); 325190 - chemical mfg (other basic organic); 33422 - communications broadcasting equipment mfg; 334110 - computer & peripheral equipment mfg; 332314 - concrete reinforcing bar mfg; 331420 - copper rolling drawing, extruding and alloying; 212233 - copper-zinc ore mining; 6212101 - dental offices; 331523 - die-casting foundries (non-ferrous); 81232 - dry cleaning and laundry services (except coin-operated); 611 - educational services; 332113 - forging; 331529 - foundries (non-ferrous except die-casting); 482113 - freight rail transportation - mainline); 482112 - freight rail transportation (short haul); 44719 - gasoline stations (other); 44711 - gasoline stations with convenience stores; 212220 - gold & silver ore mining; 33251 - hardware mfg; 622111 - hospitals general (except pediatric); 721111 - Hotels (except casino hotels) and motels; 33111 - iron & steel mills and ferro-alloy mfg; 21221 - iron ore mining; 541380 - laboratories (testing);	domestic wastewater from copper plumbing

Substance Name	Industrial Source	Secondary Source
	812310 - laundries (coin-operated) and dry cleaners; 335120 - lighting fixture mfg; 812330 - linen & uniform supply; 339990 - Manufacturing (all other); 488320 - marine cargo handling; 562920 - material recovery facilities; 621510 - medical & diagnostic laboratories; 339110 - medical equipment & supplies mfg; 332439 - metal container mfg (other); 332999 - metal product mfg (all other misc.); 332999 - metal product mfg (all other misc.); 331410 - metal smelting & refining (non-ferrous except aluminum); 33242 - metal tank (heavy gauge) mfg; 332910 - metal valve mfg; 332810 - metals coating & allied products; 33633 - motor vehicle chassis components (except spring) mfg; 336320 - motor vehicle electronic equipment mfg; 336310 - motor vehicle gasoline mfg; 336390 - motor vehicle parts mfg (other); 415290 - motor vehicle parts wholesaler-distributors (other new); 51111 - newspaper publishers; 212232 - nickel-copper ore mfg; 322121 - paper (except newsprint) mills; 812930 - parking lots and garages; 482114 - passenger rail transportation; 32411 - petroleum refineries; 81292 - photo finishing services; 32311 - printing; 562910 - remediation services; 322291 - sanitary paper product mfg; 334410 - semiconductor mfg; 337215 - shelving, showcase, partition & locker mfg; 321112 - shingle & shake mills; 332611 - spring (heavy gauge) mfg; 332118 stamping; 221330 - steam & air (conditioning and supply); 331222 - steel wire drawing; 31331 - textile and fabric finishing; 332720 - turned product & screw, nut & bolt mfg; 485110 - urban transit systems; 562990 - waste management services (all other); 562210 - waste treatment & disposal; 332619 - wire product mfg (all other); 321114 - wood preservation gasoline stations (other); 44711 - gasoline stations with convenience stores; 212220 - gold & silver ore mining; 33251 - hardware mfg; 622111 - hospitals general (except pediatric); 721111 - Hotels (except casino hotels) and motels; 33111 - iron & steel mills and ferro-alloy mfg; 21221 - iron ore mining; 541380 - laboratories (testing); 812310 - laundries (coin-operated) and dry cleaners; 335120 - lighting fixture mfg; 812330 - linen & uniform supply; 339990 - Manufacturing (all other); 488320 - marine cargo handling; 562920 - material recovery facilities; 621510 - medical & diagnostic laboratories; 339110 - medical equipment & supplies mfg; 332439 - metal container mfg (other); 332999 - metal product mfg (all other misc.); 332999 - metal product mfg (all other misc.); 331410 - metal smelting & refining (non-ferrous except aluminum); 33242 - metal tank (heavy gauge) mfg; 332910 - metal valve mfg; 332810 - metals coating & allied products; 33633 - motor vehicle chassis components (except spring) mfg; 336320 - motor vehicle electronic equipment mfg; 336310 - motor vehicle gasoline mfg; 336390 - motor vehicle parts mfg (other); 415290 - motor vehicle parts wholesaler-distributors (other new); 51111 - newspaper publishers; 212232 - nickel-copper ore mfg; 322121 - paper (except newsprint) mills; 812930 - parking lots and garages; 482114 - passenger rail transportation; 32411 - petroleum refineries; 81292 - photo finishing services; 32311 - printing; 562910 - remediation services; 322291 - sanitary paper product mfg; 334410 - semiconductor mfg; 337215 - shelving, showcase, partition & locker mfg; 321112 - shingle & shake mills; 332611 - spring (heavy gauge) mfg; 332118 stamping; 221330 - steam & air (conditioning and supply); 331222 - steel wire drawing; 31331 - textile and fabric finishing; 332720 - turned product & screw, nut & bolt mfg; 485110 - urban transit systems; 562990 - waste management services (all other); 562210 - waste treatment & disposal; 332619 - wire product mfg (all other); 321114 - wood preservation parts mfg (other); 415290 - motor vehicle parts	

Substance Name	Industrial Source	Secondary Source
	wholesaler-distributors (other new); 51111 - newspaper publishers; 212232 - nickel-copper ore mfg; 322121 - paper (except newsprint) mills; 812930 - parking lots and garages; 482114 - passenger rail transportation; 32411 - petroleum refineries; 81292 - photo finishing services; 32311 - printing; 562910 - remediation services; 322291 - sanitary paper product mfg; 334410 - semiconductor mfg; 337215 - shelving, showcase, partition & locker mfg; 321112 - shingle & shake mills; 332611 - spring (heavy gauge) mfg; 332118 stamping; 221330 - steam & air (conditioning and supply); 331222 - steel wire drawing; 31331 - textile and fabric finishing; 332720 - turned product & screw, nut & bolt mfg; 485110 - urban transit systems; 562990 - waste management services (all other); 562210 - waste treatment & disposal; 332619 - wire product mfg (all other); 321114 - wood preservation	
Cyanide	415110 - automobile & light duty truck wholesaler-distributors; 811111 - automotive repair (general); 811199- automotive repair & maintenance (all other); 311814 - bakeries (commercial) fresh and frozen mfg; 56174 - carpet & upholstery cleaning services; 325189 - chemical mfg (all other basic inorganic); 325190 - chemical mfg (other basic organic); 212233 - copper-zinc ore mining; 331523 - die-casting foundries (nonn-ferrous); 81232 - dry cleaning and laundry services (except coin-operated); 611 - educational services; 311822 - flour mixes and dough mfg from purchased flour;331990 - food mfg (all other); 331529 - foundries (non-ferrous except die-casting); 44719 - gasoline stations (other); 44711 - gasoline stations with convenience stores; 212220 - gold & silver ore mining; 33251 - hardware mfg; 622111 - hospitals general (except pediatric); 721111 - Hotels (except casino hotels) and motels; 331511 - iron foundries; 21221 - iron ore mining; 541380 - laboratories (testing); 812310 - laundries (coin-operated) and dry cleaners; 562920 - material recovery facilities; 621510 - medical & diagnostic laboratories; 332439 - metal ore mining (other); 331490 - metal processing & alloying (except Fe, Cu & Al); 332999 - metal product mfg (all other misc.); 331410 - metal smelting & refining (non-ferrous except aluminum); 332810 - metals coating & allied products; 51111 - newspaper publishers; 212232 - nickel-copper ore mfg; 812930 - parking lots and garages; 32411 - petroleum refineries; 81292 - photo finishing services; 32311 - printing; 562910 - remediation services; 337215 - shelving, showcase, partition & locker mfg; 221330 - steam & air (conditioning and supply); 331514 - steel foundries; 31331 - textile and fabric finishing; 31183 - tortilla mfg; 332720 - turned product & screw, nut & bolt mfg; 562990 - waste management services (all other); 562210 - waste treatment & disposal	
DDT	diffusive, non-point; DDT use banned in Canada in 1969	
Dibenzofuran	321114 - wood preservation	diffusive, non-point (auto tire particles, road oils, atmos. deposition)
Dibenzo-p-dioxin	321114 - wood preservation	diffusive, non-point (auto tire particles, road oils, atmos. deposition)
Dibromotetrafluoroethane	No information in Hydromantis (2005) Report.	
Dichlorobenzene (1,2-)	323119 - printing (other)	
Dichlorobenzene (1,4-)	323119 - printing (other)	
Dichlorobenzidene (3,3'-)	3,3'-Dichlorobenzidene is used as an intermediate in the manufacture of	

Substance Name	Industrial Source	Secondary Source
	pigments or as a curing agent in polyurethane elastomers. In the United States, there are strict regulations requiring its use in closed systems (HSDB, 1991). The primary stationary sources that have reported emissions of 3,3'-dichlorobenzidene in California are commercial printing and publishing industries	
Dichloroethane (1,2-)	used in the production of vinyl chloride which is used to make a variety of plastic and vinyl products including polyvinyl chloride (PVC) pipes, furniture and automobile upholstery, wall coverings, housewares, and automobile parts. It is also used to as a solvent and is added to leaded gasoline to remove lead.	
Dichloroethene (1,2-)	Both the cis and trans forms - usually as a mixture - are used as a solvent for waxes, resins, and acetylcellulose; in the extraction of rubber; as a refrigerant; in the manufacture of pharmaceuticals and artificial pearls and in the extraction of oils and fats from fish and meat; as a chemical intermediate for making chlorinated compounds	
Dichloromethane	Paint stripping in aircraft, consumer and commercial applications; flexible polyurethane foam blowing; pharmaceutical and chemical intermediates; adhesives; cleaning applications; and testing laboratories	
Dichlorophenol (2,4-)	In synthesis of pesticide for helminthes and mites. As Intermediate for herbicides such as 2,4-dichlorophenoxyacetate, bifenox and dichlorprop herbicides,;further chlorinated to pentachlorophenol, a wood preservative; may be released to the environment in effluents from its manufacture and use as a chemical intermediate and from chlorination processes involving water treatment and wood pulp bleaching	
Dichloropropene (1,2-) (cis and trans)	use not identified	
Dieldrin	diffusive, non-point; Banned in Canada since end of 1995	
Di-n-butyl phthalate	325 - chemical mfg; 4145 - pharmaceuticals, toiletries & related wholesalers	
Dinitropyrene	diffusive, non-point; NitroPAHs originate primarily as direct or indirect products of incomplete combustion, e.g., diesel exhaust	
Endosulfan	32532 - Pesticide mfg, 311420 - Fruit & Vegetable Canning	
Endrin	diffusive, non-point Banned in Canada since 1994	
Ethylbenzene	811119 - automotive maintenance mechanical & electrical (other); 325190 - chemical mfg (other basic organic); 81232 - dry cleaning & laundry Services (except coin-operated); 622111 - hospitals general (except pediatric); 541380 - Laboratories (testing); 812330 - linen & uniform supply; 562920 - material recovery facilities; 32411 - petroleum refineries; 562910 - remediation services; 221330 - steam & air (conditioning & supply); 562990 - waste management services (all other); 562210 - waste treatment & disposal	
Fluoranthene	811199- automotive repair & maintenance (all other); 482113 - freight rail transportation (mainline); 482112 - freight rail transportation (short haul); 44719 - gasoline stations (other); 441711 - gasoline stations with convenience stores; 482114 - passenger rail transportation; 32411 - petroleum refineries; 485110 - urban transit systems; 321114 - wood preservation	diffusive, non-point (auto tire particles, road oils, atmos.deposition)
Fluorene	811199- automotive repair & maintenance (all other); 482113 - freight rail transportation (mainline); 482112 - freight rail transportation (short haul); 44719 - gasoline stations (other); 441711 - gasoline stations with convenience stores; 482114 - passenger rail transportation; 32411 - petroleum refineries; 485110 - urban transit systems; 321114 - wood preservation	diffusive, non-point (auto tire particles, road oils, atmos.deposition)

Substance Name	Industrial Source	Secondary Source
Fluoride	325189 - chemical mfg (other basic inorganic); 325190 - chemical mfg (other basic organic); 334110 - computer & peripheral equipment mfg	
Formaldehyde	327910 - abrasive product mfg; 32552 - adhesive mfg; 324122 - asphalt shingle & coating material mfg; 325190 - chemical mfg (other basic organic); 325999 - chemical product mfg (all other misc.); 334110 - computer & peripheral equipment mfg; 325920 - explosives mfg; 332999 - metal product mfg(all other misc.);327990 - mineral product mfg (all other non-metallic); 325320 - pesticide & other agricultural chemical mfg; 324190 - petroleum & coal products mfg; 322291 - sanitary paper product mfg; 325610 - soap & cleaning compound mfg	
Heptachlor + Heptachlor epoxide	diffusive, non-point; Banned in Canada since 1990	
Hexachloro-1,3-butadiene	325189 - chemical mfg (all other basic inorganic)	
Hexachlorobenzene	325189 - chemical mfg (all other basic inorganic); 325190 - chemical mfg (all other basic organic); 325320 - Pesticide and Other Agricultural Chemical Mfg, 311420 - Fruit & Vegetable Canning, diffusive, non-point; Banned as pesticide since 1981; used to treat seeds, also kills fungi that affect food crops	
Iron	488119 - airport operations (other); 331317 - aluminum rolling, drawing, extruding & alloying; 415110 - automobile & light duty truck wholesaler-distributors; 441310 - automotive parts and accessories stores; 811111 - automotive repair (general); 811199- automotive repair & maintenance (all other); 44111 - car dealers (new); 56174 - carpet & upholstery cleaning services; 331221 - cold-rolled steel shape mfg; 33422 - communications broadcasting equipment mfg; 332314 - concrete reinforcing bar mfg; 81232 - dry cleaning and laundry services (except coin-operated); 611 - educational services; 332113 - forging; 331529 - foundries (non-ferrous except die-casting); 482113 - freight rail transportation - mainline); 482112 - freight rail transportation (short haul); 44719 - gasoline stations (other); 44711 - gasoline stations with convenience stores; 33251 - hardware mfg; 622111 - hospitals general (except pediatric); 721111 - Hotels (except casino hotels) and motels; 33111 - iron & steel mills and ferro-alloy mfg; 541380 - laboratories (testing); 812310 - laundries (coin-operated) and dry cleaners; 335120 - lighting fixture mfg; 812330 - linen & uniform supply; 339990 - Manufacturing (all other); 488320 - marine cargo handling; 562920 - material recovery facilities; 621510 - medical & diagnostic laboratories; 339110 - medical equipment & supplies mfg; 332439 - metal container mfg (other); 332999 - metal product mfg (all other misc.); 331410 - metal smelting & refining (non-ferrous except aluminum); 33242 - metal tank (heavy gauge) mfg; 332910 - metal valve mfg; 332321 - metal window & door mfg; 332810 - metals coating & allied products; 33633 - motor vehicle chassis components (except spring) mfg; 336320 - motor vehicle electronic equipment mfg; 336310 - motor vehicle gasoline mfg; 336390 - motor vehicle parts mfg (other); 415290 - motor vehicle parts wholesaler-distributors (other new); 51111 - newspaper publishers; 332329 - ornamental metal products mfg (other); 322121 - paper (except newsprint) mills; 812930 - parking lots and garages; 482114 - passenger rail transportation; 32411 - petroleum refineries; 32311 - printing; 562910 - remediation services; 322291 - sanitary paper product mfg; 334410 - semiconductor mfg; 337215 - shelving, showcase, partition & locker mfg; 321112 - shingle & shake mills; 332611 - spring (heavy gauge) mfg; 332118 stamping; 221330 - steam & air (conditioning and supply); 331222 - steel wire drawing; 31331 - textile and fabric finishing; 332720 -	

Substance Name	Industrial Source	Secondary Source
	turned product & screw, nut & bolt mfg; 485110 - urban transit systems; 562990 - waste management services (all other); 562210 - waste treatment & disposal; 332619 - wire product mfg (all other); 321114 - wood preservation	
Lead	488119 - airport operations (other); 336110 - automobile & light-duty motor vehicle mfg; 415110 - automobile & light duty truck wholesaler-distributors; 811119 - automotive maintenance mechanical & electrical (other); 441310 - automotive parts and accessories stores; 811111 - automotive repair (general); 811199- automotive repair & maintenance (all other); 44111 - car dealers (new); 56174 - carpet & upholstery cleaning services; 325189 - chemical mfg (all other basic inorganic); 325190 - chemical mfg (all other basic organic); 33422 - communications broadcasting equipment mfg; 334110 - computer & peripheral equipment mfg; 332314 - concrete reinforcing bar mfg; 212233 - copper-zinc ore mining; 621210 - dental offices; 81232 - dry cleaning and laundry services (except coin-operated); 332113 - forging; 482113 - freight rail transportation - mainline); 482112 - freight rail transportation (short haul); 44719 - gasoline stations (other); 44711 - gasoline stations with convenience stores; 212220 - gold & silver ore mining; 622111 - hospitals general (except pediatric); 721111 - Hotels (except casino hotels) and motels; 33111 - iron & steel mills and ferro-alloy mfg; 331511 - iron foundries; 21221 - iron ore mining; 541380 - laboratories (testing); 812310 - laundries (coin-operated) and dry cleaners; 335120 - lighting fixture mfg; 812330 - linen & uniform supply; 339990 - Manufacturing (all other); 488320 - marine cargo handling; 562920 - material recovery facilities; 621510 - medical & diagnostic laboratories; 339110 - medical equipment & supplies mfg; 332439 - metal container mfg (other); 212299 - metal ore mining (all other); 331490 - metal processing & alloying (except Fe, Cu, and Al); 332999 - metal product mfg (all other misc.); 331410 - metal smelting & refining (non-ferrous except aluminum); 33242 - metal tank (heavy gauge) mfg; 332910 - metal valve mfg; 332321 - metal window & door mfg; 332810 - metals coating & allied products; 33633 - motor vehicle chassis components (except spring) mfg; 336320 - motor vehicle electronic equipment mfg; 336310 - motor vehicle gasoline mfg; 336390 - motor vehicle parts mfg (other); 415290 - motor vehicle parts wholesaler-distributors (other new); 2122232 - nickel-copper ore mining; 332329 - ornamental metal products mfg (other); 322121 - paper (except newsprint) mills; 812930 - parking lots and garages; 482114 - passenger rail transportation; 32411 - petroleum refineries; 32311 - printing; 562910 - remediation services; 322291 - sanitary paper product mfg; 334410 - semiconductor mfg; 337215 - shelving, showcase, partition & locker mfg; 321112 - shingle & shake mills; 332611 - spring (heavy gauge) mfg; 332118 stamping; 221330 - steam & air (conditioning and supply); 331514 - steel foundries; 331222 - steel wire drawing; 85110 - urban transit systems; 562990 - waste management services (all other); 562210 - waste treatment & disposal; 332619 - wire product mfg (all other); 321114 - wood preservation parts wholesaler-distributors (other new); 2122232 - nickel-copper ore mining; 332329 - ornamental metal products mfg (other); 322121 - paper (except newsprint) mills; 812930 - parking lots and garages; 482114 - passenger rail transportation; 32411 - petroleum refineries; 32311 - printing; 562910 - remediation services; 322291 - sanitary paper product mfg; 334410 - semiconductor mfg; 337215 - shelving, showcase, partition & locker mfg; 321112 - shingle & shake mills; 332611 - spring (heavy gauge) mfg; 332118 stamping;	

Substance Name	Industrial Source	Secondary Source
	221330 - steam & air (conditioning and supply); 331514 - steel foundries; 331222 - steel wire drawing; 85110 - urban transit systems; 562990 - waste management services (all other); 562210 - waste treatment & disposal; 332619 - wire product mfg (all other); 321114 - wood preservation	
Lindane	325320 - Pesticide and Other Agricultural Chemical Mfg,	diffusive, non-point
MCPA	325320 - Pesticide and Other Agricultural Chemical Mfg, herbicide;	diffusive, non-point; herbicide used for controlling grasses & broadleaf weeds, mainly in cornfields
Mercury	415110 - automobile & light duty truck wholesaler-distributors; 56174 - carpet & upholstery cleaning services; 325189 - chemical mfg (all other basic inorganic); 325190 - chemical mfg (all other basic organic); 621210 - dental offices; 81232 - dry cleaning and laundry services (except coin-operated); 611 - educational services; 722 - food services & drinking places; 622111 - hospitals general (except pediatric); 721111 - Hotels (except casino hotels) and motels; 541380 - laboratories (testing); 812310 - laundries (coin-operated) and dry cleaners; 562920 - material recovery facilities; 621510 - medical & diagnostic laboratories; 562910 - remediation services; 221330 - steam & air (conditioning and supply); 562990 - waste management services (all other); 562210 - waste treatment & disposal	
Methoxyethanol (2-)	No information in Hydromantis (2005) Report.	
Methyl bromide	325190 - chemical mfg (other basic organic)	
Methylenebis(2-chloroaniline) (4,4'-)	industrial	
Mirex	Banned in Canada; diffusive, non-point	
Molybdenum	811119 - automotive maintenance mechanical & electrical (other); 325 - chemical mfg; ; 325189 - chemical mfg (all other basic inorganic); 325190 - chemical mfg (all other basic organic); 33422 - communications broadcasting equipment mfg; 482113 - freight rail transportation - mainline); 482112 - freight rail transportation (short haul); 44719 - gasoline stations (other); 44711 - gasoline stations with convenience stores; 33111 - iron & steel mills and ferro-alloy mfg; 812330 - linen & uniform supply; 562920 - material recovery facilities; 332810 - metals coating & allied products; 322121 - paper (except newsprint) mills; 482114 - passenger rail transportation; 32411 - petroleum refineries; 562910 - remediation services; 322291 - sanitary paper product mfg; 321112 - shingle & shake mills; 221330 - steam & air (conditioning and supply); 485110 - urban transit systems; 562990 - waste management services (all other); 562210 - waste treatment & disposal; 321114 - wood preservation	
Monochloroethene (vinyl chloride)	325190 - chemical mfg (other basic organic); 32511 - petrochemical mfg	
Nickel	488119 - airport operations (other); 415110 - automobile & light duty truck wholesaler-distributors; 441310 - automobile parts & accessories stores; 811119 - automotive maintenance & mechanical & electrical (other); 811111 - automotive repair (general); 811199 - automotive repair & maintenance (all other); 44111 - car dealers (new); 56174 - carpet & upholstery cleaning services; 325189 - chemical mfg (all other basic inorganic); 325190 - chemical mfg (other basic organic); 325999 - chemical product mfg (all other misc.); 331221 - cold-rolled steel shape	

Substance Name	Industrial Source	Secondary Source
	mfg; 33422 - communications broadcasting equipment mfg; 332314 - concrete reinforcing bar mfg; 212233 - copper-zinc ore mining; 6212101 - dental offices; 81232 - dry cleaning and laundry services (except coin-operated); 332113 - forging; 44719 - gasoline stations (other); 44711 - gasoline stations with convenience stores; 212220 - gold & silver ore mining; 33251 - hardware mfg; 622111 - hospitals general (except pediatric); 721111 - Hotels (except casino hotels) and motels; 33111 - iron & steel mills and ferro-alloy mfg; 331511 - iron foundries; 21221 - iron ore mining; 541380 - laboratories (testing); 812310 - laundries (coin-operated) and dry cleaners; 335120 - lighting fixture mfg; 812330 - linen & uniform supply; 339990 - manufacturing (all other); 488320 - marine cargo handling; 339110 - medical equipment & supplies mfg; 332439 - metal container mfg (other); 212299 - metal ore mining (all other); 331490 - metal processing & alloying (except, Fe, Cu & Al); 332999 - metal product mfg (all other misc.); 331410 - metal smelting & refining (non-ferrous except aluminum); 33242 - metal tank (heavy gauge) mfg; 332910 - metal valve mfg; 332321 - metal windows & doors mfg; 332810 - metals coating & allied products; 333634 - motor vehicle brake system mfg; 33633 - motor vehicle chassis components (except spring) mfg; 336320 - motor vehicle electronic equipment mfg; 336310 - motor vehicle gasoline mfg; 336390 - motor vehicle parts mfg (other); 415290 - motor vehicle parts wholesaler-distributors (other new); 212232 - nickel-copper ore mfg; 332329 - ornamental metal products mfg (other); 322121 - paper (except newsprint) mills; 812930 - parking lots and garages; 32411 - petroleum refineries; 81292 - photo finishing services; 323119 - printing (other); 322291 - sanitary paper product mfg; 334410 - semiconductor mfg; 337215 - shelving, showcase, partition & locker mfg; 321112 - shingle & shake mills; 332611 - spring (heavy gauge) mfg; 332118 stamping; 331514 - steel foundries; 331222 - steel wire drawing; 332720 - turned product & screw, nut & bolt mfg; 485110 - urban transit systems; 332619 - wire product mfg (all other); 321114 - wood preservation iron ore mining; 541380 - laboratories (testing); 812310 - laundries (coin-operated) and dry cleaners; 335120 - lighting fixture mfg; 812330 - linen & uniform supply; 339990 - manufacturing (all other); 488320 - marine cargo handling; 339110 - medical equipment & supplies mfg; 332439 - metal container mfg (other); 212299 - metal ore mining (all other); 331490 - metal processing & alloying (except, Fe, Cu & Al); 332999 - metal product mfg (all other misc.); 331410 - metal smelting & refining (non-ferrous except aluminum); 33242 - metal tank (heavy gauge) mfg; 332910 - metal valve mfg; 332321 - metal windows & doors mfg; 332810 - metals coating & allied products; 333634 - motor vehicle brake system mfg; 33633 - motor vehicle chassis components (except spring) mfg; 336320 - motor vehicle electronic equipment mfg; 336310 - motor vehicle gasoline mfg; 336390 - motor vehicle parts mfg (other); 415290 - motor vehicle parts wholesaler-distributors (other new); 212232 - nickel-copper ore mfg; 332329 - ornamental metal products mfg (other); 322121 - paper (except newsprint) mills; 812930 - parking lots and garages; 32411 - petroleum refineries; 81292 - photo finishing services; 323119 - printing (other); 322291 - sanitary paper product mfg; 334410 - semiconductor mfg; 337215 - shelving, showcase, partition & locker mfg; 321112 - shingle & shake mills; 332611 - spring (heavy gauge) mfg; 332118 stamping; 331514 - steel foundries; 331222 - steel wire drawing; 332720 - turned product & screw, nut & bolt mfg; 485110 - urban transit systems; 332619 - wire product mfg (all other); 321114 - wood preservation	

Substance Name	Industrial Source	Secondary Source
Nitrate	336110 - automobile & light-duty motor vehicle mfg; 325189 - chemical mfg (all other basic inorganic); 325190 - chemical mfg (other basic organic); 325999 - chemical product mfg (all other misc.); 334110 - computer & peripheral equipment mfg; 311515 - dairy products (dry & condensed) mfg; 339990 - manufacturing (all other); 311511 - milk mfg (fluid); domestic	domestic source from nitrification of ammonia during wastewater treatment
Nitrogen, total Kjeldahl	No information in Hydromantis (2005) Report.	
N-Nitrosodimethylamine	formed as an unintentional by-product in industries such as tanneries, pesticide manufacturing plants, rubber and tire manufacturing plants, alkylamine manufacture/use industries, fish processing industries, foundries, and dye manufacturing plants	
Nonylphenol	used eg in detergents, resins, plastics, stabilisers in the polymer industry, phenolic oximes, and paints.	
Nonylphenol ethoxylate	31611 - leather & hide tanning & finishing; 32411 - petroleum refineries; 31331 - textile & fabric finishing	
Octachlorostyrene	325189 - chemical mfg (all other basic inorganic); 325190 - chemical mfg (other basic organic)	
Oil and grease	32552 - adhesives mfg; 488119 - airport operations (other); 333317-aluminum rolling, drawing, extruding and alloying; 311611 - animal (except poultry) slaughtering; 311119 - animal food mfg (other); 324122 - asphalt shingle & coating material mfg; 415110 - automobile and light duty truck wholesalers/distributors; 811121 - automotive body, paint & interior repair & maintenance; 441310 - automotive parts and accessories stores; 811111 - automotive repair (general); 811199 - automotive repair & maintenance (all other); 311814 - bakeries (commercial) fresh & frozen mfg; 31123 - breakfast cereal mfg; 231220 - building construction (non-residential); 44111 - car dealers (new); 56174 - carpet & upholstery cleaning services; 325 chemical mfg; 325189 - chemical mfg (all other basic inorganic); 325190 - chemical mfg (other basic organic); 325999 - chemical product mfg (all other misc.); 31192 - coffee and tea mfg; 331221 - cold-rolled steel shape mfg; 332314 - concrete reinforcing bar mfg; 31134 - confectionery mfg (non-chocolate); 311821 - cookie and cracker mfg; 331420 - copper rolling, drawing, extruding and alloying; 311515 - dairy products (dry & condensed) mfg; 331523 - die-casting foundries (non-ferrous); 81232 - dry cleaning and laundry services (except coin-operated); 611 - educational services; 231390 - engineering construction (other); 325920 - explosives mfg; 311211 - flour milling; 311822 - flour mixes & dough mfg from purchased flour; 311990 - food mfg (all other); 311111 - food mfg (dog & cat food); 722 - food services & drinking places; 413110 - food wholesaler-distributors (general-line); 413190 - food wholesaler-distributors (specialty-line); 332113 - forging; 331529 - foundries (non-ferrous except die-casting); 482113 - freight rail transportation (mainline); 4832112 - freight rail transportation (short-haul); 311420 - Fruit & Vegetable Canning, pickling & drying; 44719 - gasoline stations (other); 441711 - gasoline stations with convenience stores; 33251 - hardware mfg; 622111 - hospitals general (except pediatrics); 721111 - hotels (except casino hotels) andmotels; 31152 - ice cream & frozen dessert mfg; 33111 - iron and steel mills and ferro-alloy mfg; 541380 - laboratories (testing); 812310 - laundries (coin-operated) & dry cleaners; 335120 - lighting fixture mfg; 812330 - linen & uniform supply; 339990 - manufacturing (all other misc.); 562920 - material recovery facilities; 625510 - medical & diagnostic laboratories; 339110 - medical equipment & supplies mfg; 332439 - metal container mfg;	

Substance Name	Industrial Source	Secondary Source
	332999 - metal products mfg (all other misc.); 331410 - metal smelting and refining (non-ferrous except aluminum); 33242 - metal tank (heavy gauge) mfg; 332910 - metal valve mfg; 332321 - metal window and door mfg; 332810 - metals-coating and allied activities; 311511 - milk mfg (fluid; 327990 - mineral product mfg (all other non-metallic); 33633 - motor vehicle chassis components (except spring) mfg; 336320 - motor vehicle electronic equipment mfg; 336310 - motor vehicle gasoline mfg; 336390 - motor vehicle parts mfg - other; 415290 - motor vehicle parts wholesaler/distributors (others-new); 311224 - oilseed processing; 332329 - ornamental metal products mfrs (others); 812930 - parking lots & garages; 482114 - passenger rail transportation; 325320 - pesticide & other agricultural chemical mfg; 32511 - petrochemical mfg; 324190 - petroleum & coal products mfg (other); 32411 - petroleum refineries; 81292 - photo finishing services; 311615 - poultry processing; 413160 - red meat & meat product wholesaler-distributors; 562910 - remediation services; 311614 - rendering & meat processing from carcasses; 325210 - resin & synthetic rubber mfg; 311811 - retail bakeries; 311710 - seafood product preparation & packaging; 311940 - seasoning & dressing mfg; 337215 - shelving, showcase, partition and locker mfg; 311919 - snack food mfg (other); 325610 - soap & cleaning compound mfg; 312110 - soft drink & ice mfg; 332611 - spring (heavy gauge) mfg; 221330 - steam & air (conditioning and supply); 331222 - steel wire drawing; 31193 - syrup & other flavouring concentrates mfg; 31183 - tortilla mfg; 485110 - urban transit systems; 562990 -waste management services (all other); 562210 - waste treatment & disposal; 332619 - wire product mfg (all other); 321114 - wood preservation	
PCBs	diffuse, non-point[i] ;manufacture, import and most non-electrical uses of PCBs has been banned in North America since 1977	
PCDD	Dioxins are byproducts of a wide variety of industrialized activities, such as chlorine bleaching in kraft pulp and paper mills and incineration of municipal and industrial wastes; diffusive, non-point	
PCDF	Furans are byproducts of a wide variety of industrialized activities, such as chlorine bleaching in kraft pulp and paper mills and incineration of municipal and industrial wastes.	
Pentachlorobenzene	325189 - chemical mfg (all other basic inorganic); 33111 - iron & steel mills & ferro-alloy mfg	
Pentachlorophenol	PCP is used as a fungicide, insecticide, mollusicide, algicide, disinfectant, and as an anti-fouling paint ingredient. However, it is primarily used as an industrial and commercial wood preservative for such things as fence posts, utility poles, boats, furniture and log homes.	
pH	325181 - alkali & chlorine mfg; 311611 - animal (except poultry) slaughtering; 311119 - animal food mfg (other); 811121 - automotive body, paint & interior repair & maintenance; 331814 - bakeries (commercial) fresh & frozen mfg; 31123 - breakfast cereal mfg; 31212 - breweries; 327310 - cement mfg; 325 chemical mfg; 31192 - coffee and tea mfg; 31132 - chocolate & confectionery mfg; 334110 - computer & peripheral equipment mfg; 31134 - confectionery mfg (non-chocolate); 311821 - cookie and cracker mfg; 332210 - cutlery & hand tool mfg; 311515 - dairy products (dry & condensed) mfg; 221112 - electricity - fossil-fuel power generation; 311211 - flour milling; 311822 - flour mixes & dough mfg from purchased flour; 311990 - food mfg (all other); 311111 - food mfg (dog & cat food); 31152 - ice cream & frozen dessert mfg; 541380 - Laboratories (testing); 331490 - metal processing & alloying	

Substance Name	Industrial Source	Secondary Source
	(except, Fe, Cu and Al); 311224 - oilseed processing; 325410 - pharmaceutical & medicine mfg; 311615 - poultry processing; 323119 - printing (other); 311614 - rendering & meat processing from carcasses; 311811 - retail bakeries; 311710 - seafood product preparation & packaging; 311940 - seasoning & dressing mfg; 311919 - snack food mfg (other); 311310 - sugar mfg; 31193 - syrup & other flavouring concentrates mfg; 31183 - tortilla mfg	
Phenanthrene	325190 - chemical mfg (other basic organic)	
Phenols, Total	32552 - adhesives mfg; 488119 - airport operations (other); 324122 - asphalt shingle & coating material mfg; 415110 - automobile and light duty truck wholesalers/distributors; 811111 - automotive repair (general); 811199 - automotive repair & maintenance (all other); 56174 - carpet & upholstery cleaning services; 325189 - chemical mfg (all other basic inorganic); 325190 - chemical mfg (other basic organic); 325999 - chemical product mfg (all other misc.); 331523 - die-casting foundries (non-ferrous); 81232 - dry cleaning and laundry services (except coin-operated); 611 - educational services; 325920 - explosives mfg; 722 - food services & drinking places; 331529 - foundries (non-ferrous except die-casting); 482113 - freight rail transportation (mainline); 4832112 - freight rail transportation (short-haul); 44719 - gasoline stations (other); 44711 - gasoline stations with convenience stores; 622111 - hospitals general (except pediatrics); 721111 - hotels (except casino hotels) and motels; 331511 - iron foundries; 541380 - laboratories (testing); 812310 - laundries (coin-operated) & dry cleaners; 562920 - material recovery facilities; 812930 - parking lots & garages; 482114 - passenger rail transportation; 32511 - petrochemical mfg; 324190 - petroleum & coal products mfg (other); 32411 - petroleum refineries; 562910 - remediation services; 325210 - resin & synthetic rubber mfg; 322291 - sanitary paper product mfg; 311940 - seasoning & dressing mfg; 325610 - soap & cleaning compound mfg; 221330 - steam & air (conditioning and supply); 331514 - steel foundries; 321217 - waferboard mills; 562990 -waste management services (all other); 562210 - waste treatment & disposal; 321114 - wood preservation services; 311614 - rendering & meat processing from carcasses; 311811 - retail bakeries; 311710 - seafood product preparation & packaging; 311940 - seasoning & dressing mfg; 311919 - snack food mfg (other); 325610 - soap & cleaning compound mfg; 31193 - syrup & other flavouring concentrates mfg; 31331 - textile and fabric finishing; 31183 - tortilla mfg	
Phosphorus (total)	32552 - adhesives mfg; 311119 - animal food mfg (other); 324122 - asphalt shingle & coating material mfg; 415110 - automobile and light duty truck wholesalers/distributors; 811111 - automotive repair (general); 811199 - automotive repair & maintenance (all other); 311814 - bakeries (commercial) fresh & frozen mfg; 31123 - breakfast cereal mfg; 56174 - carpet & upholstery cleaning services; 325 chemical mfg; 325189 - chemical mfg (all other basic inorganic); 325190 - chemical mfg (other basic organic); 325999 - chemical product mfg (all other misc.); 325999 - chocolate & confectionery mfg; 31192 - coffee and tea mfg; 31134 - confectionery mfg (non-chocolate); 311821 - cookie and cracker mfg; 311515 - dairy products (dry & condensed) mfg; 331523 - die-casting foundries (non-ferrous); 81232 - dry cleaning and laundry services (except coin-operated); 611 - educational services; 325920 - explosives mfg; 311211 - flour milling; 311822 - flour mixes & dough mfg from purchased flour; 311990 - food mfg (all other); 311111 - food mfg (dog & cat food); 331529 - foundries (non-ferrous except die-casting); 482113 -	

Substance Name	Industrial Source	Secondary Source
	freight rail transportation (mainline); 482112 - freight rail transportation (short-haul); 44719 - gasoline stations (other); 441711 - gasoline stations with convenience stores; 622111- hospitals general (except pediatrics); 721111 - hotels (except casino hotels) and motels; 31152 - ice cream & frozen dessert mfg; 541380 - laboratories (testing); 812310 - laundries (coin-operated) & dry cleaners; 31611 - leather & hide tanning & finishing; 625510 - medical & diagnostic laboratories; 331490 - metal products & alloying (except, Fe, Cu & Al); 332999 - metal products mfg (all other misc.); 331410 - metal smelting and refining (non-ferrous except aluminum); 311511 - milk mfg (fluid; 327990 - mineral product mfg (all other non-metallic); 51111 - newspaper publishers; 311224 - oilseed processing; 812930 - parking lots & garages; 482114 - passenger rail transportation; 325320 - pesticide & other agricultural chemical mfg; 32511 - petrochemical mfg; 324190 - petroleum & coal products mfg (other); 812922 - photo finishing services; 311615 - poultry processing; 32311 - printing; 562910 - remediation	
Polybrominated biphenyls	mainly used as flame retardants in moulded thermoplastics, mostly in small appliances and automotive applications. Earlier applications in synthetic fibres have been discontinued	diffusive, non-point
Polychlorinated terphenyls	Main uses were as dielectrics in transformers and large capacitors (considered to be closed systems); in heat transfer and hydraulic systems (nominally closed systems); in the formulation of lubricating and cutting oils; as plasticizers in paints, carbonless copying paper, adhesives, sealants, and plastics.	diffusive, non-point
Polycyclic hydrocarbons	811199- automotive repair & maintenance (all other); 482113 - freight rail transportation (mainline); 482112 - freight rail transportation (short haul); 44719 - gasoline stations (other); 441711 - gasoline stations with convenience stores; 482114 - passenger rail transportation; 32411 - petroleum refineries; 485110 - urban transit systems; 321114 - wood preservation	diffusive, non-point (auto tire particles, road oils, atmos. deposition)
Pyrene	811199- automotive repair & maintenance (all other); 482113 - freight rail transportation (mainline); 482112 - freight rail transportation (short haul); 44719 - gasoline stations (other); 441711 - gasoline stations with convenience stores; 482114 - passenger rail transportation; 32411 - petroleum refineries; 485110 - urban transit systems; 321114 - wood preservation	diffusive, non-point (auto tire particles, road oils, atmos.deposition)
Quinoline	used mainly as an intermediate in the manufacture of other products, but has also used as a catalyst, a corrosion inhibitor, in metallurgical processes, in the manufacture of dyes, as a preservative for anatomical specimens, in polymers and agricultural chemicals, and as a solvent for resins and terpenes. It is also used as an antimalarial medicine.	
Selenium	325189 - chemical mfg (all other); 326210 - tire mfg	
Silver	333317- Aluminum rolling, drawing, extruding and alloying; 811199- automotive repair & maintenance (all other); 56174 - carpet & upholstery cleaning services; 621210 - dental offices; 33422 - die-casting foundries (non-ferrous); 611 - educational services; 332113 - forging; 331529 - foundries (non-ferrous except die-casting); 482113 - freight rail transportation (Mainline); 4832112 - freight rail transportation (short-haul); 44719 - gasoline stations (other); 44711 - gasoline stations with convenience stores; 622111 - hospitals general (except pediatrics); 721111 - hotels (except casino hotels) and motels; 812330 - linen & uniform supply; 562920 - material recovery facilities; 332810 - metals-coating and allied activities; 322121 - paper (excepts newsprint) mills; 482114 -	

Substance Name	Industrial Source	Secondary Source
	passenger rail transportation; 32411 - petroleum refineries; 81292 - photo finishing services; 562910 - remediation services; 322291 - sanitary paper product mfg; 221330 - steam & air (conditioning and supply); 485110 - urban transit systems; 541940 - veterinary services; 562990 -waste management services (all other); 562210 - waste treatment & disposal; 321114 - wood preservation	
Sulphate	32552 - adhesives mfg; 324122 - asphalt shingle & coating material mfg; 325 chemical mfg; 325189 - chemical mfg (all other basic inorganic); 325190 - chemical mfg (other basic organic); 325999 - chemical product mfg (all other misc.); 33422 - communications broadcasting equipment mfg; 325920 - explosives mfg; 33111 - iron and steel mills and ferro-alloy mfg; 488320 - marine cargo handling; 332999 - metal products mfg (all other misc.); 331410 - metal smelting and refining (non-ferrous except aluminum); 332321 - metal window and door mfg; 332810 - metals-coating and allied activities; 327990 - mineral product mfg (all other non-metallic); 336320 - motor vehicle electronic equipment mfg; 332329 - ornamental metal products mfrs (others); 325320 - pesticide & other agricultural chemical mfg; 324190 - petroleum & coal products mfg (other); 32411 - petroleum refineries; 322291 - sanitary paper product mfg; 311940 - seasoning & dressing mfg; 334410 - semiconductor mfg; 337215 - shelving, showcase, partition and locker mfg; 321112 - shingle & shake mills; 325610 - soap & cleaning compound mfg; 312110 - soft drink & ice mfg; 331222 - steel wire drawing; 31193 - syrup & other flavouring concentrates mfg; 312210 - tobacco stemming & redrying; 332619 - wire product mfg (all other); 321114 - wood preservation	
Sulphide (as H_2S)	311611 - animal (except poultry) slaughtering; 311119 - animal food mfg (other); 311814 - bakeries (commercial) fresh & frozen mfg; 31123 - breakfast cereal mfg; 325189 - chemical mfg (all other basic inorganic); 3325190 - chemical mfg (other basic organic); 31192 - coffee & tea mfg; 31134 - confectionery mfg (non-chocolate); 311821 - cookie & cracker mfg; 311515 - dairy products (dry & condensed) mfg; 331523 - die-casting foundries (non-ferrous); 81232 - dry cleaning & laundry services (except coin-operated); 311211 - flour milling; 311822 - flour mixes& dough mfg from purchased flour; 311990 - food mfg (all other); 311111 - food mfg (dog & cat food); 331529 - foundries (non-ferrous except die-casting); 482113 - freight rail transportation (mainline); 482112 - freight rail transportation (short-haul); 33251 - hardware mfg; 31152 - ice cream & frozen dessert mfg; 812330 - linen & uniform supply; 488320 - marine cargo handling; 562920 - material recovery facilities; 332810 - metals coating & allied activities; 311511 - milk mfg (fluid); 311224 - oilseed processing; 482114 - passenger rail transportation; 32511 - petrochemical mfg; 32411 - petroleum refineries; 311615 - poultry processing; 562910 - remediation services; 311614 - rendering & meat processing from carcasses; 311811 - retail bakeries; 311710 - seafood product preparation & packaging; 311940 - seasoning & dressing mfg; 311919 - snack food mfg (other); 221330 - steam & air (conditioning and supply); 311310 - sugar mfg; 31193 - syrup & other flavouring concentrates mfg; 31183 - tortilla mfg; 562990 -waste management services (all other); 562210 - waste treatment & disposal	
Temperature	3313131 - aluminum primary production; 31212 - breweries; 331420 - copper rolling, drawing, extruding and alloying; 221112 - electricity fossil-fuel power generation; 33111 - iron & steel mills & ferro-alloy mfg; 331511 - iron foundries; 331440 - metal smelting & refining (non-ferrous; except Al); 311511 - milk mfg (fluid); 211113 - oil & gas - conventional	

Substance Name	Industrial Source	Secondary Source
	extraction; 311224 - oilseed processing; 32511 - petrochemical mfg; 331514 - steel foundries; 311310 - sugar mfg; 313 - textile mills	
Tetrachlorobenzene (1,2,3,4-)	325189 - chemical mfg (all other basic inorganic); 33111 - iron & steel mills & ferro-alloy mfg; 32411 - petroleum refineries	
Tetrachlorobenzene (1,2,4,5-)	325189 - chemical mfg (all other basic inorganic); 33111 - iron & steel mills & ferro-alloy mfg; 32411 - petroleum refineries	
Tetrachloroethane (1,1,2,2-)	no longer produced in Canada; may be a by-product of other chemical production such as vinyl chloride monomer dichloroethane. May enter in leachate from waste disposal sites treated by municipal treatment facilities, and from atmospheric transport	diffusive, non-point
Tetrachloroethylene	325190 - chemical mfg (other basic inorganic); 812310 - laundries (coin-operated) & dry cleaners; 812330 - linen 7 uniform supply; 323119 - printing (other)	
Tetrachloromethane (carbon tetrachloride)	325189 - chemical mfg (all other basic inorganic (325190 - chemical mfg (other basic organic)	
Thallium	now mainly used in the electrical and electronic industries and in the production of special glasses. Another important field of application is the use of radioisotopes in medicine. released into the environment, mainly from mineral smelters, coal-burning power plants, brickworks and cement plants	
Tin	325 - chemical mfg	
Titanium (total)	No information in Hydromantis (2005) Report.	
Toluene	811199- automotive repair & maintenance (all other); 325189 - chemical mfg (all other basic inorganic); 81232 - dry cleaning & laundry services (except coin-operated); 622111 - hospital general (except pediatric); 541380 - laboratories (testing); 812330 - linen & uniform supply; 562920 - material recovery facilities; 32411 - petroleum refineries; 562910 - remediation services; 221330 - steam & air (conditioning & supply); 562990 - waste management services (all other)	
Toxaphene	diffusive, non-point; Toxaphene was banned in Canada in 1985	
Tributyltetradecylphosphonium chloride	used as a corrosion inhibitor in industrial cooling systems; as a pesticide and as a phase transfer catalyst	
Tributyltin	used as molluscicides,as antifoulants on boats, ships, quays, buoys, crab pots, fish nets, and cages, as wood preservatives, as slimicides on masonry, as disinfectants, and as biocides for cooling systems, power station cooling towers, pulp and paper mills, breweries, leather processing, and textile mills	
Trichloroethane (1,1,1-)	mainly used in metal degreasing and as a solvent in many industrial and consumer products, including adhesives, spot removers, and aerosol cans. It is also a chemical intermediate	
Trichloroethylene	325190 - chemical mfg (other basic organic)	
Trichlorophenoxyacetic acid (2,4,5-)	2,4,5-T is no longer on the market, diffusive, non-point	
Xylene	811119 - automotive maintenance mechanical & electrical (other); 541380 - laboratories (testing); 812330 - linen & uniform supply; 562920 - material recovery facilities; 32411 - petroleum refineries; 323119 - printing (other); 562910 - remediation services; 221330 - steam & air (conditioning & supply); 562990 - waste management services (all other); 562210 - waste treatment & disposal	
Zinc	488119 - airport operations (other); 331317 - aluminum rolling, drawing, extruding & alloying; 336110 - automobile and light-duty motor vehicle mfg; 415110 - automobile & light duty truck wholesaler-distributors; 811119 - automotive maintenance mechanical & electrical (other); 441310	

Substance Name	Industrial Source	Secondary Source
	- automotive parts and accessories stores; 811111 - automotive repair (general); 811199- automotive repair & maintenance (all other); 44111 - car dealers (new); 56174 - carpet & upholstery cleaning services; 325 - chemical mfg; 325189 - chemical mfg (all other basic inorganic); 325190 - chemical mfg (other basic organic); 325999 - chemical product mfg (all other misc.); 33422 - communications broadcasting equipment mfg; 332314 - concrete reinforcing bar mfg; 331420 - copper rolling, drawing, extruding and alloying; 212233 - copper-zinc ore mining; 621210 - dental offices; 331523 - die-casting foundries (non-ferrous); 81232 - dry cleaning and laundry services (except coin-operated); 611 - educational services; 332113 - forging; 331529 - foundries (non-ferrous except die-casting); 482113 - freight rail transportation - mainline); 482112 - freight rail transportation (short haul); 44719 - gasoline stations (other); 44711 - gasoline stations with convenience stores; 212220 - gold & silver ore mining; 33251 - hardware mfg; 622111 - hospitals general (except pediatric); 721111 - hotels (except casino hotels) and motels; 33111 - iron & steel mills and ferro-alloy mfg; 331511 - iron foundries; 21221 - iron ore mining; 541380 - laboratories (testing); 812310 - laundries (coin-operated) and dry cleaners; 335120 - lighting fixture mfg; 812330 - linen & uniform supply; 339990 - manufacturing (all other); 488320 - marine cargo handling; 562920 - material recovery facilities; 621510 - medical & diagnostic laboratories; 339110 - medical equipment & supplies mfg; 332439 - metal container mfg (other); 212299 - metal ore mining (all other); 331490 - metal processing & alloying (except Fe, Cu and Al); 331410 - metal smelting & refining (non-ferrous except aluminum); 33242 - metal tank (heavy gauge) mfg; 332910 - metal valve mfg; 332321 - metal window & door mfg; 332810 - metals coating & allied products; 33633 - motor vehicle chassis components (except spring) mfg; 336320 - motor vehicle electronic equipment mfg; 336310 - motor vehicle gasoline mfg; 33637 - motor vehicle metal stamping; 336390 - motor vehicle parts mfg (other); 415290 - motor vehicle parts wholesaler-distributors (other new); 212232 - nickel-copper ore mining; 332329 - ornamental metal products mfg (other); 322121 - paper (except newsprint) mills; 812930 - parking lots and garages; 482114 - passenger rail transportation; 32511 - petrochemical mfg; 32411 - petroleum refineries; 81292 - photo finishing services; 562910 - remediation services; 326220 - rubber & plastic hose & belting mfg; 326290 - rubber product mfg (other); 322291 - sanitary paper product mfg; 334410 - semiconductor mfg; 337215 - shelving, showcase, partition & locker mfg; 321112 - shingle & shake mills; 332611 - spring (heavy gauge) mfg; 332118 stamping; 221330 - steam & air (conditioning and supply); 331514 - steel foundries; 331222 - steel wire drawing; 326210 - tire mfg; 332720 - turned product & screw, nut & bolt mfg; 485110 - urban transit systems; 562990 - waste management services (all other); 562210 - waste treatment & disposal; 332619 - wire product mfg (all other); 321114 - wood preservation 332810 - metals coating & allied products; 33633 - motor vehicle chassis components (except spring) mfg; 336320 - motor vehicle electronic equipment mfg; 336310 - motor vehicle gasoline mfg; 33637 - motor vehicle metal stamping; 336390 - motor vehicle parts mfg (other); 415290 - motor vehicle parts wholesaler-distributors (other new); 212232 - nickel-copper ore mining; 332329 - ornamental metal products mfg (other); 322121 - paper (except newsprint) mills; 812930 - parking lots and garages; 482114 - passenger rail transportation; 32511 - petrochemical mfg; 32411 - petroleum refineries; 81292 - photo finishing services; 562910 - remediation services; 326220 -	

Substance Name	Industrial Source	Secondary Source
	rubber & plastic hose & belting mfg; 326290 - rubber product mfg (other); 322291 - sanitary paper product mfg; 334410 - semiconductor mfg; 337215 - shelving, showcase, partition & locker mfg; 321112 - shingle & shake mills; 332611 - spring (heavy gauge) mfg; 332118 stamping; 221330 - steam & air (conditioning and supply); 331514 - steel foundries; 331222 - steel wire drawing; 326210 - tire mfg; 332720 - turned product & screw, nut & bolt mfg; 485110 - urban transit systems; 562990 - waste management services (all other); 562210 - waste treatment & disposal; 332619 - wire product mfg (all other); 321114 - wood preservation steel wire drawing; 326210 - tire mfg; 332720 - turned product & screw, nut & bolt mfg; 485110 - urban transit systems; 562990 - waste management services (all other); 562210 - waste treatment & disposal; 332619 - wire product mfg (all other); 321114 - wood preservation	

CCME

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Technical Supplement 5

Canada-wide Strategy for the Management of Municipal Wastewater Effluent

Glossary

September 2007

A

Acutely Lethal *(létal aigu)*
At 100 percent concentration of effluent, more than 50 percent of the test species subjected to it over the test period are killed when tested in accordance with the acute lethality test set out in the appropriate method. For rainbow trout this is Reference Method EPS 1/RM/13.

Ammonia *(Ammoniac)*
Total ammonia expressed as nitrogen. Total ammonia means the sum of the unionized ammonia (NH_3) and ionized ammonia (NH_4^+) species which exist in equilibrium in water. Analytical methods measure and typically report on ammonia nitrogen as opposed to total ammonia.

Arctic
The term *arctic* is still under discussion by the Development Committee. Considerations to date in defining arctic include number of growing degree days, mean annual near surface ground temperature, temperature and number of ice-free days.

C

Canadian Environmental Quality Guidelines *(Recommandations canadiennes pour la qualité de l'environnement)*
Nationally endorsed, science-based goals for the quality of atmospheric, aquatic, and terrestrial ecosystems. Environmental quality guidelines are defined as numerical concentrations or narrative statements that are recommended as levels that should result in negligible risk to biota, their functions, or any interactions that are integral to sustaining the health of ecosystems and the designated resource uses they support. Developed by CCME.

Carbonaceous Biochemical Oxygen Demand ($CBOD_5$, 5-day) *(Demande biochimique en oxygène des matières carbonées [DBO_5C, 5 jours])*
A measure of the quantity of oxygen used in the biochemical oxidation of organic matter in 5 days, at a specific temperature, and under specified conditions. The method of analysis is defined by Method 5210 in Standard Methods.

Chronic Toxicity *(Toxicité chronique)*
The ability of a substance or mixture of substances to cause harmful effects over an extended period, usually upon repeated or continuous exposure sometimes lasting for the entire life of the exposed organism. Chronic toxicity results in reduced reproductive capacity or reduced growth of young, in fish or invertebrate populations.

Combined Sewer *(Égout unitaire)*
A sewer intended to receive both sanitary waste and storm water.

Combined Sewer Overflow (CSO) *(Débordement d'égout unitaire [DEU])*
A discharge from a combined sewer system when the hydraulic capacity of the system has been surpassed due to rainfall and/or snow melt events.

Combined Sewer System *(Réseau d'égout unitaire)*
Sewage collection system which conveys sanitary sewage (domestic, commercial and industrial wastewaters) and storm water runoff through a single-pipe system to a sewage treatment works. Combined sewer systems which have been partially separated and which roof leaders and/or foundation drains contribute stormwater inflow to the sewer system conveying sanitary flows are still defined as combined sewer systems.

Community *(Collectivité)*
For the purposes of the strategy, same as municipality but may include recognized assemblages of dwellings and other facilities.

Continuous Discharge *(Rejets continus)*
Continuous discharges include regular discharges from batch treatment processes, such as a sequencing batch reactor, that discharge on a frequent and regular basis.

Conventional Parameters *(Paramètres conventionnels)*
Parameters common to all municipal wastewater effluent discharges. Conventional parameters include Carbonaceous Biochemical Oxygen Demand ($CBOD_5$), Total Suspended Solids (TSS), Total Residual Chlorine (TRC) when chlorine disinfection is used, Ammonia (NH_4).

D

Designated Area *(Zone désignée)*
Includes fish spawning sites, beaches, drinking water intakes, and other sensitive areas as identified by the regulator.

Disinfection *(Désinfection)*
Disinfection of MWWE is typically accomplished by using appropriate dosages of chlorine, hypochlorite or ultraviolet (UV) radiation. Disinfection systems are designed to achieve low levels of indicator microorganisms such as *E. coli* in the range of 100 counts per 100 mL.

Domestic Wastewater *(Eaux usées domestiques)*
Wastewater derived principally from dwellings, business buildings, institutions, and the like. It may or may not contain groundwater, surface water, or storm water.

E

Effluent Discharge Objective (EDO) *(Objectif environnemental de rejet [OER])*
Concentration, load or toxicity units that should be met at the municipal wastewater effluent discharge to adequately protect all water uses in the receiving environment. Effluent discharge objectives are obtained through an environmental risk assessment methodology using the principles of assimilative capacity and mixing zone, in conjunction with environmental quality objectives. (see Technical Supplement 3)

Environmental Quality Objective (EQO) *(Objectif de qualité de l'environnement [OQE])*
Concentration of a substance considered safe for aquatic life and for the human uses that exist or should exist outside of a determined mixing zone. The *Canadian Environmental Quality Guidelines* (CEQG) are generic EQOs often used in Canada. The numerical concentrations or narrative statements that establish the conditions necessary to support and protect the most sensitive designated use of water at a specified site (CCME, 1987)

End-of-Pipe *(émissaire)*
A point between the end of the treatment process and the receiving environment.

Environmental Risk Assessment (ERA) *(Évaluation des risques environnementaux [ERE])*
A procedure that will enable the establishment of effluent discharge objectives for substances of concern. This process will take into account the characteristics of the site-specific receiving environment. The environmental risk assessment includes a one-year period where a facility will characterize its effluent

(initial characterization). A description of the process for both initial characterization and the environmental risk assessment is found in Technical Supplements 2 and 3.

Environmental Risk Management Model (ERMM) [or framework] *(Modèle ou cadre de gestion des risques environnementaux [MGRE])*
A comprehensive framework to guide the decision-making process for the management of municipal wastewater effluents within Canada. It includes National Performance Standards and an environmental risk-based approach that enables the establishment of effluent discharge objectives, while taking into account the characteristics and uses of the site-specific receiving environment.

Existing Facility *(Ouvrage existant)*
Existing collection system, on or before the signing of the Strategy, with a discharge to surface water (with or without treatment).

Expansion/Expanding *(Expansion)*
An increase in the hydraulic capacity of the system.

F

Facility Size

Very Small Facility
Facility discharge is less than 500 m^3 per day on an annual average, based on facility design capacity. Where the actual discharge meets or exceeds design capacity, the actual flow will be used. Under this category, only residential input is considered. Very small facilities receiving industrial input must meet the requirements of Medium sized facilities.

Small Facility
Facility discharge is greater than 500 m^3 per day (m^3/day) but less than 2,500 m^3/day on an annual average, based on facility design capacity. Where the actual discharge meets or exceeds design capacity, the actual flow will be used. Under this category, only residential input is considered. Small facilities receiving industrial input must meet the requirements of a Medium sized facility.

Medium Facility
Facility discharge is greater than 2,500 m^3/day and less than 17,500 m^3/day on an annual average, based on facility design capacity. Where the actual discharge meets or exceeds design capacity, the actual flow will be used. All discharge types are considered. Small and Very Small facilities with industrial input are considered to be Medium facilities.

Large Facility
Facility discharge is greater than 17,500 m^3/day and less than 50,000 m^3/day on an annual average, based on facility design capacity. Where the actual discharge meets or exceeds design capacity, the actual flow will be used. All discharge types are considered.

Very Large Facility
Facility discharge is greater than 50,000 m^3/day on an annual average, based on facility design capacity. Where the actual discharge meets or exceeds design capacity, the actual flow will be used. All discharge types are considered.

Financing
The use of financial instruments (e.g., loans, bonds, etc.) as a means to obtain immediate funding for a project. Financing is a subset of funding.

Funding
The act of providing the resources (funds) for a project. Used to refer to the range of mechanisms that are used to pay for wastewater infrastructure investments.

Fresh Water *(Eau douce)*
Water that generally contains less than 1,000 milligrams per litre of dissolved solids.

I

Industrial Input *(Apport industriel)*
Non-domestic process water from industry categories specified below that together exceeds 5% of total dry weather flow:

- resource exploration or development (e.g. mining, forestry, oil and gas);
- manufacturing/ fabrication;
- processing (including food);
- marine or air transport (including container cleaning);
- landfill leachate; and,
- hospitals and laboratories (but not nursing stations).

Infiltration *(Infiltration)*
The water entering a sewer system, including sewer service connections, from the ground, through such means as, but not limited to, defective pipes, pipe joints, connections, or manhole walls.

Inflow *(Eaux de captage ou captage)*
The water discharged into a sewer system, including service connections, from such sources as, but not limited to, roof leaders, cellar, yard, and area drains, foundation drains, cooling-water discharges, drains from springs and swampy areas, manhole covers, cross connections from storm sewers and combined sewers, catch basins, storm waters, surface runoff, street wash waters, or drainage. Inflow does not include, and is distinguished from, infiltration.

J

Jurisdiction *(Gouvernement)*
All provincial, territorial and the federal governments in Canada, as well as the territorial water boards as regulators of the wastewater sector.

L

Lagoon (*étang*)
Wastewater treatment system that consists of one or more designated and engineered surface impoundments, including enhancement of natural features, where biological and physical treatment of wastewater occurs, but does not include mechanical aeration to keep all the solids in suspension.

M

mg/L *(mg/l)*
Milligrams per litre

Mixing Zone *(Zone de mélange)*
Also called the initial dilution zone. The area contiguous with a point source (effluent discharge site) or a delimited non-point source where the discharge mixes with ambient water and where concentrations of some substances may not comply with water quality guidelines or objectives. For the purpose of the

Strategy, "mixing zone" means the "allocated mixing zone" at the edge of which environmental quality objectives should be met.

Municipal/Municipality *(Municipalité/municipal(e)s)*
As identified in a jurisdictions local government or municipal legislation. For the purposes of the Strategy, the term municipality encompasses municipalities, communities (including First Nations and Métis communities) and federal entities.

Municipal Wastewater Effluent (MWWE) *(Effluents d'eaux usées municipales [EEUM])*
Wastewater discharged to surface water from a collection or treatment system by an owner. Wastewater is a mixture of liquid wastes comprised primarily of domestic or sanitary sewage that may also include wastewater from industrial, commercial and institutional sources. It comprises end-of-pipe discharges and overflows, including combined sewer overflows and sanitary sewer overflows, but does not include separate storm water discharges. Septic tank discharges to infiltration systems are not included.

N

National Performance Standard *(Norme de performance nationale)*
The minimum performance measure to which all MWWE wastewater treatment facilities are measured for common parameters associated with MWWE.

Nutrient *(Élément nutritif)*
Any substance that is assimilated by organisms and promotes growth; generally applied to nitrogen and phosphorus in wastewater, but also to other essential and trace elements.

Nutrient Removal *(Élimination des éléments nutritifs)*
Treatment steps used to remove nitrogen and phosphorous from MWWE. Common types of nutrient removal treatment methods include nitrification (conversion of ammonia to nitrates), denitrification (conversion of nitrates to nitrogen gas) biological excess phosphorous removal and chemical phosphorous removal. Nutrient removal processes are commonly incorporated into either secondary or tertiary treatment for enhanced removal of nitrogen, phosphorous or both to protect sensitive receiving environments. Typical systems with nutrient removal can achieve MWWE concentration levels of total phosphorous down to 0.1 mg/L, total ammonia-nitrogen down to 5 mg/L in winter and less than 1 mg/L in summer.

O

Operator *(Exploitant)*
The person or company that operates the wastewater facility. May be the same as the owner.

Outfall *(Exutoire)*
The location at which and the equipment through which effluent is discharged to the environment.

Owner *(Propriétaire)*
A municipality, a community including aboriginal community, or a federal or other government entity, that owns a wastewater facility. It also includes owners of wastewater facilities situated on federal or aboriginal land.

Overflow (*Débordement*)
A discharge to the environment from a collection system or treatment works at a location other than the final effluent outfall of a sewage treatment works.

P

pH *(pH)*
The logarithm to the base 10 of the reciprocal of the concentration of hydrogen ions in moles per litre of solution.

Phosphorus *(Phosphore)*
An essential chemical element and nutrient for all life forms. Occurs in orthophosphate, pyrophosphate, tripolyphosphate, and organic phosphate forms. Each of these forms and their sum (total phosphorus) is expressed as milligrams per litre (mg/L) elemental phosphorus.

Pollution Prevention Plan *(Plan de prévention de la pollution***)**
A plan that outlines methods to eliminate or prevent the introduction of contaminants into the sewer system. This may include laws limiting the amount of specified contaminants in a discharge, a system of effluent charges, an education program to inform dischargers of the effects of their discharges and plans to limit them.

Preliminary Treatment *(Traitement préliminaire)*
Preliminary treatment involves screening, shredding or grinding for the purpose of removing coarse solids such as sticks, rags and other debris from the incoming wastewater. The purpose of preliminary treatment is to protect downstream treatment components such as pumps and reduce maintenance or operational problems. Preliminary treatment is a common first step to all WWTP

Primary Treatment *(Traitement primaire)*
Primary treatment follows preliminary treatment and involves the use of primary devices that allow flows to be reduced and for solids to settle due to gravity. Commonly, sedimentation tanks that detain flows for 2 to 6 hours to allow settleable solids to settle and be drawn off for separate solids treatment. Typical BOD_5 and TSS removal rates in primary treatment are 30% and 60%, respectively. On stand alone primary treatment, primary effluents can be treated with chemical disinfection prior to release. Primary treatment can also be enhanced using chemicals in which inorganic or organic flocculants are introduced into the wastewater to help improve the effluent quality over primary treatment alone.

R

Receiving Environment *(Milieu récepteur)*
The water body into which effluent is discharged.

Remote *(Éloignée)*
A community with a declining population, that may not be economically sustainable, and/or is isolated.

Residential Input *(Apport résidentiel)*
See domestic wastewater.

S

Sanitary Sewer *(Égout domestique)*
A sewer that carries liquid and water-carried wastes from residences, commercial buildings, industrial plants, and institutions, together with quantities of ground, storm, and surface waters that are not admitted intentionally.

Sanitary Sewer System *(Réseau d'égout domestique)*
A separate sewer system conveying sanitary sewage (domestic, commercial, institutional and industrial wastewaters), including those systems receiving a portion of stormwater flows both directly and indirectly from various sources including basement/footing drains and/or roof leader connections if there is an adjoining, separate storm sewer system.

Sanitary Sewer Overflow (SSO) *(Débordement d'égout domestique [DES])*
A discharge of untreated or raw wastewater to the environment that occurs on an infrequent basis.

Secondary Treatment *(Traitement secondaire)*
Secondary treatment follows primary treatment and is specifically designed for the removal of biodegradable organic matter (in solution or suspension) and the removal of suspended solids. Secondary treatment can include nutrient removal. Typical MWWE quality achieved is a $CBOD_5$ and TSS of 15 mg/L. Compliance standards are commonly set at 25 mg/l to allow for operational variations. The physical, chemical and biological processes in the process design may also fortuitously (not by design) remove other trace contaminants at unpredictable levels. The activated sludge treatment process is the most widely used form of secondary treatment in Canada and the world due to its versatility and relatively low cost.

Sewer *(Égout)*
A pipe or conduit that carries wastewater and/or drainage water.

Sewer System *(Réseau d'égout)*
Collectively, all of the property involved in the operation of a sewer utility. It includes land, wastewater lines and appurtenances, pumping stations, treatment works, and general property. Occasionally referred to as a sewerage system.

Source Control *(Réduction à la source)*
Similar to pollution prevention, it outlines methods to eliminate or prevent the introduction of contaminants into the sewer system. This may include laws limiting the amount of specified contaminants in a discharge, a system of effluent charges, an education program to inform dischargers of the effects of their discharges and plans to limit them. Includes use and generation of harmful substances.

Storm Water *(Eaux pluviales)*
The excess water running off from the surface of a drainage area during and immediately after a period of rain. It is that portion of the rainfall and resulting surface flow that is in excess of that which can be absorbed through the infiltration capacity of the surface of the basin.

Substance *(Substance)*
Chemical substance or any other parameter associated with wastewater, including $CBOD_5$, TSS, temperature, pH, pathogens, etc.

Substances of Concern *(Substances préoccupantes)*
Those substances for which effluent discharge objectives are necessary, based on the results of initial characterization.

Substance of Potential Concern *(Substances potentiellement préoccupantes)*
Those substances that have been identified for initial characterization for a particular facility. They include the list of priority substances, plus any other substances associated with local industry.

Surface Water *(Eau de surface)*
A lake, pond, marsh, creek, spring, stream, river, estuary or marine body of water, or other surface watercourse.

T

Tertiary Treatment *(Traitement tertiaire)*
The additional treatment needed to remove suspended, colloidal, and dissolved constituents remaining after conventional secondary treatment. In Canada this term can refer to physical processes that further remove suspended solids, such as sand filtration. Tertiary treatment may include biological processes for removal of nutrients (see below). Typical tertiary effluent $CBOD_5$ and TSS values are 5 and 5 mg/L. The movement of trace contaminants and metals from the liquid to the slides streams is generally enhanced due the additional physical-chemical or extended processes which are involved.

Total Residual Chlorine (TRC) *(Chlore résiduel total)*
The concentration of free chlorine and combined chlorine (including inorganic chloramines), expressed as Cl.

Total Suspended Solids *(Matières en suspension)*
The quantity of material removed from wastewater in a laboratory test, as prescribed by Method 209C in Standard Methods and referred to as nonfilterable residue.

U

Upgrade *(Amélioration ou modernisation)*
Further development of existing infrastructure which results in expanded throughput capacity. Does not include the addition of disinfection.

W

Wastewater *(Eaux usées)*
A mixture of liquid wastes primarily composed of domestic sewage that can also include other liquid wastes from industrial, commercial and institutional sources.

Wastewater Facility *(Ouvrage d'assainissement)*
Any works for the collection or treatment and release of wastewater or any part of such works. Includes engineered wetlands and those with natural elements considered as design components.

Wastewater Lagoon
See lagoon.