Storm and Wastewater

Quality Management for Biosolids Programs

This document is the twelfth in a series of best practices that deal with buried linear infrastructure as well as end of pipe treatment and management issues. For titles of other best practices in this and other series, please refer to <*www.infraguide.ca*>.

National Guide to Sustainable Municipal Infrastructure

NRC · CNRC FCM Federation of Canadian Municipalities Fédération canadienne des municipalités Canada

Quality Management for Biosolids Programs

Version 1.0

Publication Date: October 2005

ISBN 1–897094–95–7

InfraGuide® — Innovations and Best Practices

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Canadian municipalities spend $12 to $15 billion annually on infrastructure but it never seems to be enough. Existing infrastructure is aging while demand grows for more and better roads, and improved water and sewer systems responding both to higher standards of safety, health and environmental protection as well as population growth. The solution is to change the way we plan, design and manage infrastructure. Only by doing so can municipalities meet new demands within a fiscally responsible and environmentally sustainable framework, while preserving our quality of life.

This is what the National Guide to Sustainable Municipal Infrastructure (InfraGuide) seeks to accomplish.

In 2001, the federal government, through its Infrastructure Canada Program (IC) and the National Research Council (NRC), joined forces with the Federation of Canadian Municipalities (FCM) to create the National Guide to Sustainable Municipal Infrastructure (InfraGuide). InfraGuide is both a new, national network of people and a growing collection of published best practice documents for use by decision makers and technical personnel in the public and private sectors. Based on Canadian experience and research, the reports set out the best practices to support sustainable municipal infrastructure decisions and actions in six key areas: decision making and investment planning, potable water, storm and wastewater, municipal roads and sidewalks, environmental protocols, and transit. The best practices are available online and in hard copy.

A Knowledge Network of Excellence

InfraGuide's creation is made possible through $12.5 million from Infrastructure Canada, in-kind contributions from various facets of the industry, technical resources, the collaborative effort of municipal practitioners, researchers and other experts, and a host of volunteers throughout the country. By gathering and synthesizing the best Canadian experience and knowledge, InfraGuide helps municipalities get the maximum return on every dollar they spend on infrastructure—while being mindful of the social and environmental implications of their decisions.

Volunteer technical committees and working groups —with the assistance of consultants and other stakeholders—are responsible for the research and publication of the best practices. This is a system of shared knowledge, shared responsibility and shared benefits. We urge you to become a part of the InfraGuide Network of Excellence. Whether you are a municipal plant operator, a planner or a municipal councillor, your input is critical to the quality of our work.

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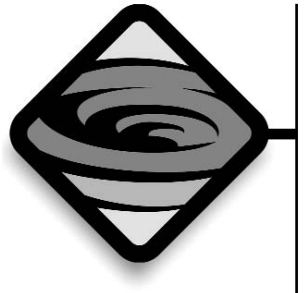


Storm and Wastewater

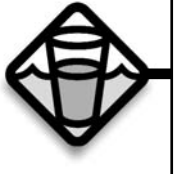
Ageing buried infrastructure, diminishing financial resources, stricter legislation for effluents, increasing public awareness of environmental impacts due to wastewater and contaminated stormwater are challenges that municipalities have to deal with. Events such as water contamination in Walkerton and North Battleford, as well as the recent CEPA classification of ammonia, road salt and chlorinated organics as toxic substances, have raised the bar for municipalities. Storm and wastewater best practices deal with buried linear infrastructure as well as end of pipe treatment and management issues. Examples include ways to control and reduce inflow and infiltration; how to secure relevant and consistent data sets; how to inspect and assess condition and performance of collections systems; treatment plant optimization; and management of biosolids.

Decision Making and Investment Planning

Elected officials and senior municipal administrators need a framework for articulating the value of infrastructure planning and maintenance, while balancing social, environmental and economic factors. Decision making and investment planning best practices transform complex and technical material into non-technical principles and guidelines for decision making, and facilitate the realization of adequate funding over the life cycle of the infrastructure. Examples include protocols for determining costs and benefits associated with desired levels of service; and strategic benchmarks, indicators or reference points for investment policy and planning decisions.

Environmental Protocols

Environmental protocols focus on the interaction of natural systems and their effects on human quality of life in relation to municipal infrastructure delivery. Environmental elements and systems include land (including flora), water, air (including noise and light) and soil. Example practices include how to factor in environmental considerations in establishing the desired level of municipal infrastructure service; and definition of local environmental conditions, challenges and opportunities with respect to municipal infrastructure.



Potable Water

Potable water best practices address various approaches to enhance a municipality's or water utility's ability to manage drinking water delivery in a way that ensures public health and safety at best value and on a sustainable basis. Issues such as water accountability, water use and loss, deterioration and inspection of distribution systems, renewal planning and technologies for rehabilitation of potable water systems and water quality in the distribution systems are examined.

Transit

Urbanization places pressure on an eroding, ageing infrastructure, and raises concerns about declining air and water quality. Transit systems contribute to reducing traffic gridlock and improving road safety. Transit best practices address the need to improve supply, influence demand and make operational improvements with the least environmental impact, while meeting social and business needs.

Municipal Roads and Sidewalks

Sound decision making and preventive maintenance are essential to managing municipal pavement infrastructure cost effectively. Municipal roads and sidewalks best practices address two priorities: front-end planning and decision making to identify and manage pavement infrastructures as a component of the infrastructure system; and a preventive approach to slow the deterioration of existing roadways. Example topics include timely preventative maintenance of municipal roads; construction and rehabilitation of utility boxes; and progressive improvement of asphalt and concrete pavement repair practices.

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The dedication of individuals who volunteered their time and expertise in the interest of the *National Guide to Sustainable Municipal Infrastructure (InfraGuide)* is acknowledged and much appreciated.

This Best Practice was developed by stakeholders from Canadian municipalities and specialists from across Canada based on information from a scan of municipal practices and an extensive literature review. The following members of InfraGuide's Storm and Wastewater Technical Committee provided guidance and direction in the development of this best practice. They were assisted by InfraGuide Directorate staff, by R. V. Anderson Associates Limited and by Adhawk Communications Inc.

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In addition, the Storm and Wastewater Technical Committee would like to express its sincere appreciation to the following individuals and institution for their participation in the working group for this document and for their support.

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The Committee would also like to thank the following individuals for their participation in the review of the best practice:

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Acknowledgements

This and other best practices could not have been developed without the leadership and guidance of the InfraGuide Governing Council, the Relationship Infrastructure Committee and the Municipal Infrastructure Committee, whose members are as follows:

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EXECUTIVE SUMMARY

Public concern about the safety of biosolids management practices is increasing across North America, bringing biosolids management programs under much greater scrutiny. In Canada, several provinces—the primary regulators of Biosolids—have re-examined their legislation and practices.

This best practice can help Canadian municipalities improve biosolids management programs and gain public acceptance. It describes ways to develop, implement and integrate quality management principles into municipal biosolids management programs.

This best practice should be read in conjunction with InfraGuide's best practices on *Biosolids Management Programs*, and *Communication and Public Consultation for Biosolids Management*.

Municipalities that implement a quality management system for their biosolids management program can expect to realize several benefits, including improved product quality, better cost effectiveness, wider public acceptance and increased public confidence.

This best practice outlines a four-stage approach to developing and implementing a quality management program for biosolids:

1. Plan — *STATE clearly what you PLAN to achieve*. Develop a vision for the program that defines the goals and objectives and the roles and responsibilities of the various staff.
2. Do — *DO what you need to do to achieve your plan*. Train of staff and develop standard (and emergency) operating procedures to improve the quality of the product and achieve compliance.
3. Check — *CHECK that you are doing what you said you were going to do*. Monitor activities, processes and the final product, maintain records and report to the various interested parties including management, elected officials, the public and regulatory agencies.
4. Review — *REVIEW to see if what you are doing is achieving your plan*. Review and evaluate results against objectives and implement any corrective actions that are necessary to achieve what was planned.

The approach is not linear; it is a cycle of improvement. After the Review stage, planning begins again as the municipality seeks to improve on what it has built. Two elements are integral to all four stages—communication (internal and external) and documentation of the program.

This best practice makes reference to the National Biosolids Partnership's *Environmental Management System Guidance Manual*, which has been used as a guide. Readers are referred to this manual for more detailed information about specific elements. The document can be found at *<http://www.biosolids.policy.net/>*.

1. General

1.1 Introduction

This report, developed by the *National Guide to Sustainable Municipal Infrastructure (InfraGuide)*, outlines the best practice for building quality management principles into a municipal biosolids management program. InfraGuide defines a best practice as "state-of-the-art" methodologies and technologies for municipal infrastructure planning, design, construction, management, assessment, maintenance and rehabilitation that consider local economic, environmental and social factors.

This best practice, a subset to another InfraGuide Storm and Wastewater best practice *Biosolids Management Programs* (InfraGuide, 2003), specifically explores the Quality Management for Biosolids Programs.[1]

It is based on review of existing literature as well as a 2003 survey of selected municipalities across Canada. The questionnaire identified current methodologies and technologies used by Canadian municipalities in their biosolids programs.

1.2 Purpose and Scope

By presenting ways to develop, implement, and integrate quality management principles into municipal biosolids programs, this best practice aims to help Canadian municipalities improve their biosolids programs.

The solids stabilization process at municipal wastewater treatment facilities produces Biosolids. As noted in InfraGuide's best practice for *Biosolids Management Programs* (InfraGuide, 2003), several classes of biosolids may be produced—liquid biosolids or cake (Category 2 or 3), pellets or compost (Category 1 or 2), and soil products (Category 1 or 2). See Appendix A for tables listing biosolids categories and quality parameters.

This document considers the stabilization process as the starting point for biosolids programs with two exceptions: source control programs and solids conditioning (thickening prior to stabilization). Source control has a direct effect on the quality of the biosolids. The reader is referred to InfraGuide's Storm and Wastewater best practice: *Wastewater Source Control* (InfraGuide, 2004a).

1.3 How to Use this Document

The practices and methodologies presented in this report give guidance towards the achievement of the best practice. They should not be construed as the definitive best practice.

Section 2 provides an overview of why it is important for municipalities to integrate quality management principles into their biosolids programs, outlining the associated benefits and risks. Biosolids managers can draw on this section to develop an understanding of their program's practices and to evaluate the current state of their quality management.

Section 3 describes the underlying principles of the best practice. Municipal practitioners can refer to this section for an overview of common elements of quality management. This section provides overall guidance on Quality Management System (QMS) methods and concepts that can be applied to biosolids programs to improve biosolids quality, increase management effectiveness, and upgrade overall efficiency.

This document considers the stabilization process as the starting point for biosolids programs with two exceptions: source control programs and solids conditioning (thickening prior to stabilization).

1. In this document, biosolids management programs are simply referred to as biosolids programs to avoid confusion with quality management.

Section 4 describes the application of quality management principles to biosolids programs. Municipal staff can refer to this section for examples of quality management initiatives that can be undertaken for their biosolids programs.

Section 5 outlines methods for evaluating the quality management system. The section also discusses an audit process to evaluate and improve the quality management system.

The appendices and references provide more detailed information. Readers can use them to identify tools for their biosolids programs and to find more detail on what other municipalities are doing.

1.4 Glossary

Beneficial Use — For the purpose of this Guide, taking advantage of the nutrient content and soil conditioning properties of a biosolids product to supply some or all of the fertilizer needs of an agronomic crop or for stabilizing vegetative cover (in land reclamation, silviculture, landfill cover, or similar ventures); or using the biosolids as a fuel source.

Biosolids — A primarily organic product produced by wastewater treatment processes that can be beneficially used. They are the treated solid or semi-solid residues generated during the treatment of domestic sewage in a municipal wastewater treatment facility. (Such facilities may also receive an industrial component). Biosolids must meet regulations of the jurisdiction where they are produced or applied. Requirements may include pollutant concentration, pathogen reduction, and vector attraction reduction criteria.

Composting — The controlled biological oxidation and decomposition of organic matter, including sludge and biosolids at controlled time and temperature conditions specified in the criteria used in that jurisdiction.

Heat Drying — Dewatered cake is dried by direct or indirect contact with a heat source, and the moisture content is reduced to 10 percent or lower. Sludge particles reach temperatures well in excess of 100°C.

Land Application — The placement of biosolids at a predetermined rate and in accordance with relevant site management policies and regulations to support vegetative growth either on the surface or in the subsurface.

Pathogens — Organisms such as bacteria, protozoa, viruses, and parasites causing disease in humans and animals.

Public Consultation — Two-way information exchange between the municipality and the public before decisions are made. It is an open and accountable process whereby individuals and groups can participate in decision-making processes and influence the outcomes.

SOP — Standard Operating Procedure — A step-by-step description of how to carry out an operational or maintenance procedure. The intention of SOPs is that all personnel are required to follow the steps in the SOP in their day-to-day functions.

Stabilization — The use of various processes used to reduce volume, pathogens, vector attraction, and odour potential in order to produce a uniform biosolids product, which meets the requirements for the selected management method.

Stakeholders — Those who have an interest in a particular decision or action, either as individuals or as a group. They include people who can influence a decision, as well as those affected by the decision.

Note: Some definitions have been adapted from the following documents:

1. InfraGuide, 2003. Storm and Wastewater best practice: *Biosolids Management Programs*, Ottawa, Ontario.
2. California Water Environment Association (CWEA), 1998. *Manual of Good Practice — Agricultural Land Application of Biosolids*.
3. United States Environmental Protection Agency, *Use and Disposal of Municipal Wastewater Sludge*, EPA 625/10–84–003.
4. Metcalf & Eddy, 1991. *Wastewater Engineering: Treatment, Disposal, Reuse*, Third Edition.
5. National Biosolids Partnership, *Biosolids EMS Guidance Manual*, March 2001.

2. Rationale

2.1 Background

For the last 30 or more years, common methods of biosolids management have included application of biosolids on agricultural land, use as landfill, and incineration—a method often used in larger urban areas. As governments promoted waste reduction and recycling, application on land and on reclamation sites became more popular. At the same time, regulations and guidelines aimed at protecting human health and the environment were also developed. Land application, in particular, allowed municipalities and farmers to take advantage of the valuable nutrients present in the biosolids.

Recently, however, there has been growing public concern about the safety of biosolids management practices. As a result, several provinces have reviewed their legislation and practices. Some jurisdictions have enacted more stringent requirements to address increasing public concern about safety. Other jurisdictions have encountered little public opposition to date. Information on existing legislation can be found on the Web sites listed in Appendix B. To alleviate public concern, it is important to apply principles of quality management that will continuously improve biosolids management.

2.2 Benefits

By incorporating quality management principles into biosolids programs, municipalities can, over time, achieve regulatory compliance, address public concerns and enhance end-user satisfaction. Municipalities can realize the benefits of a good biosolids program through the implementation of a quality management system (QMS), outlined in InfraGuide's Storm and Wastewater best practice: *Biosolids Management Programs* (InfraGuide, 2003).

Through the process of continuous improvement—an essential element of a QMS—municipalities can show long-term improvements in their biosolids programs, enhancing public trust and acceptance as a result.

Applying quality management principles to a biosolids program can realize significant benefits. In addition to improved public acceptance and trust, other benefits could include:

- improved biosolids quality;
- improved consistency in the biosolids product;
- improved compliance with regulatory requirements;
- more open communications with their biosolids customers and the public;
- well-founded safety record for the program;
- better documentation of the program; and
- the ability to prove due diligence.

2.3 Risks

Applying a QMS will entail additional investment, especially during its development. However, it is expected that the benefits will out-weigh the investment, particularly the benefit of broader public acceptance.

A QMS demands the assignment of sufficient personnel who possess the knowledge to plan, develop and implement the program. Commitment from the organization's management is crucial for the success of the QMS initiative.

The risks of not adopting quality management principles could include:

- deterioration of biosolids product quality;
- erosion of public confidence and increased public concern that may lead to the curtailment of the biosolids program;
- higher number of non-compliance events;
- higher operating costs; and
- the inability to establish due diligence in the event that an incident occurs related to the management of biosolids.

By incorporating quality management principles into biosolids programs, municipalities can, over time, achieve regulatory compliance, address public concerns and enhance end-user satisfaction.

3. Methodology

3.1 General

The development and implementation of a biosolids program should be carried out using quality management system (QMS) principles. All components of a biosolids program should be captured within the QMS[2]. In conjunction with a sound public communication strategy, this should increase the transparency of the biosolids program and raise the level of public confidence and trust.

A comprehensive approach to managing and controlling the process will lead to a biosolids program with a quality product. The ultimate outcomes of a well-planned and implemented QMS will be enhanced product quality and improved public acceptance.

An Environmental Management System (EMS) is one type of QMS. The National Biosolids Partnership (NBP) in the US has developed an EMS and a Code of Practice for all types of biosolids programs. The *Biosolids EMS Guidance Manual* (NBP, 2001a) and the *Biosolids Manual of Good Practice* (NBP, 2001b) can be downloaded from the NBP's Web site[3].

The most important ingredients of a quality management system are:

- considering quality at each stage of the biosolids program—not just at the end;
- committing to a cycle of continuous improvement;
- involving the public in open communication about the program and its performance; and
- developing and using a proper documentation and reporting system.

While there may be several approaches to implementing quality management, the overriding principle of the QMS is continuous improvement brought about by the implementation of a Plan – Do – Check – Review approach, a methodology that is the foundation of all quality management systems.

This approach may be applied to each element of the biosolids program as follows:

- Plan — State clearly what and how you PLAN to achieve.
- Do — DO what you need to do to achieve your plan.
- Check — CHECK that you are doing what you said you were going to do.
- Review — REVIEW to see if what you are doing is achieving your plan.

Figure 3–1 shows the continuous improvement aspect of quality management. A more comprehensive illustration is included in Appendix F.

Figure 3–1: Flow Diagram for Quality Mananagement

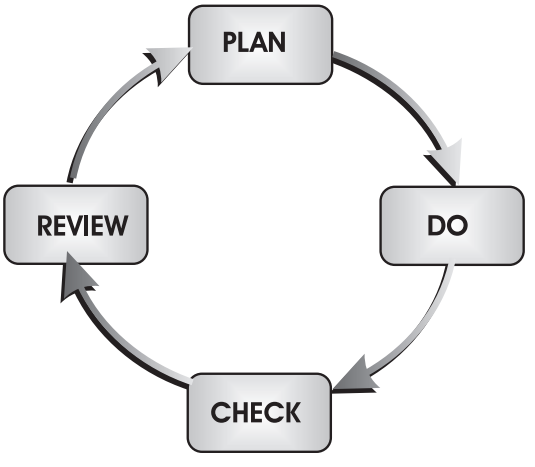


Figure 3–1
Flow Diagram for Quality Mananagement

The ultimate outcomes of a well-planned and implemented QMS will be enhanced product quality and improved public acceptance.

2. See InfraGuide's Storm and Wastewater best practice: *Biosolids Management Programs* (InfraGuide, 2003). See reference sections of documents (NBP, 2001a and b).
3. See reference sections of documents (NBP, 2001a and b).

Figure 3–2
Hierarchy of Planning Activities

3.2 Planning

3.2.1 Setting a Vision

Planning is one of the key components of the quality management process. All planning, should keep in mind the mission and core values of the municipality. It is important, in the initial planning stage, to develop a roadmap that will guide all future planning, decision-making and activities. Figure 3–2 presents the hierarchy of the planning process.

All planning, should keep in mind the mission and core values of the municipality.

Figure 3–2: Hierarchy of Planning Activities

Planning will include the following:

- Development of a Mission Statement for the program. This statement should reflect the core values of the municipality and form the basis for policy decisions. A code of practice is a useful planning document. See Appendix C for examples of core values and a sample code of practice.
- Development of a Vision for the program and Policies arising from the Mission Statement. The Vision should be consistent with the Mission Statement and set out clearly the desired outcomes of the QMS.
- Identification of long-term goals for the program. Long-term goals should be stated clearly, be specific, measurable, achievable, relevant and time-bounded.
- Identification of short-term objectives. The objectives are the interim targets that will lead to the achievement of long-term goal and should also be clearly stated and meet the same criteria as the long-term goals. See Appendix D for examples of goal setting and identification of objectives.

3.2.2 Committing Resources

A key component of the planning process is commitment to the program from all levels of the municipality. Without this commitment, the initiative will ultimately fail even if all the other elements are properly planned and executed. The initiative may fail because of inadequate resources and competing priorities. Staff may lose motivation in the absence of support and feedback from senior management.

Management's Role

The role of management—i.e., anyone in a supervisory role who is not involved in the day-to-day operation of the biosolids program—will include:

- formally adopting the vision and objectives of the program;
- assigning sufficient resources;
- identifying and providing staff training geared to the program objectives;
- assuring that all stakeholders are given sufficient opportunity to participate in the process; and
- being part of the solution and participating in regular review and implementation of corrective measures as appropriate.

Biosolids/QMS Program Staff

Staff involved in the program will have the following roles:

- Implement the policy on a day-to-day basis;
- Participate in training initiatives when necessary;
- Understand and follow standard procedures;
- Look for ways to improve operations;
- Act as a program ambassador, particularly when dealing with the public and other stakeholders;
- Report incidents and participate in evaluation; and
- Take ownership of the program in the day-to-day operational quality of the program.

3.3 Doing

The "doing" or implementation stage of the QMS will involve the following activities:

- Development of standard operating procedures (SOPs);
- Training of staff;
- Development of emergency response procedures; and
- Operating the program in accordance with the SOPs and emergency response procedures.

3.3.1 Standard Operating Procedures

Development of standard operating procedures is essential to improved performance. When all staff use standard procedures, it is easier to troubleshoot failures, to take corrective measures and to introduce preventive actions—all leading to better quality. Standard operating procedures should include safety considerations so that workers will be protected when they properly follow the procedures.

The following are important in the development and use of standard operating procedures:

- Each step in a procedure should be clearly stated and listed in the exact order that it is to be carried out.
- The language used must be simple and concise.
- The procedures should be verified in the field by the staff that will be using them.
- The procedures must be readily accessible either in hard copy or on the network so that staff can easily refer to them.
- There must be proper control of issuing revisions and identifying which version is current (See the section on documentation).

3.3.2 Training

Staff employed must be trained in the standard operating procedures for biosolids as well as the QMS. Training should address:

- knowledge of SOPs and an understanding of the importance of adhering to the standards;
- understanding of the requirements of the QMS and the importance of achieving program goals;
- general operating knowledge of biosolids (source, content and variability), biosolids processes and end-use; and
- appropriate knowledge of regulations.

Training should also be provided to contractors and their staff. Staff training will be more effective if it is developed to meet the needs of individual staff members, taking into account their existing skill levels and the requirements of their job position. Records of training should be maintained for each member of staff.

3.3.3 Emergency Procedures

One of the often-overlooked elements of any program is planning for the unforeseen. Emergency response and contingency planning is necessary to maintain the effectiveness of the program, be consistent with the vision, comply with regulatory requirements and demonstrate due diligence.

There are two elements-first, recognizing the potential for occurrence (the risk) and determining the possible consequences, and second, planning the measures necessary to counteract the event. There should be a documented response procedure for each risk or emergency event that is identified. In some cases, it may be necessary to conduct simulation drills and training exercises to see if the procedure is adequate, e.g., fire in a facility, haulage truck accident.

Emergency response and contingency planning is necessary to maintain the effectiveness of the program, be consistent with the vision, comply with regulatory requirements and demonstrate due diligence.

Emergency response plans should:

- outline the roles of management and staff;
- describe procedures that need to be followed;
- identify when to involve emergency services (fire, police and ambulance);
- note if any regulatory agencies are to be notified; and
- outline the location of, or how to procure, special vehicles or equipment.

3.4 Checking

This step involves "checking" that you are doing what you said you were going to do. Checking will include the following:

- Verifying that SOPs are being followed on an on-going basis;
- Confirming that staff training is being carried out in all areas of the program and at the required frequency;
- Checking that regulatory and license requirements are being met on an on-going basis; and
- Confirming that required reports are being prepared and submitted.

3.4.1 Compliance

Compliance with applicable legislation is a minimum requirement. In some cases, operations may need to go beyond the legal requirements to address public concerns. In others, the municipality may identify a linkage to its corporate vision or simply believe it is appropriate to do so voluntarily. To improve public acceptance of biosolids program, municipalities should strongly consider going beyond minimum legislated requirements.

To improve public acceptance of biosolids program, municipalities should strongly consider going beyond minimum legislated requirements.

A key element of good practice in regard to compliance is a thorough knowledge and understanding of applicable laws and regulation, including certificates of approval, licenses, or permits that govern operations. Resources will be required to obtain (and update) a library of the applicable legislation and guidelines. In addition, investments, both financial and staff (including management) resources will be required, to provide and maintain training of personnel.

Should there be no applicable guideline, then the municipality should consider basing its operations on the regulations from a neighbouring jurisdiction or creating a set of guidelines that could become a voluntary code of practice.

3.4.2 Reporting

Generally, two types of reports are required. First, mandatory reports are required by a regulatory agency. In Ontario, for example, owners of wastewater treatment plants are required to submit annual reports that describe their operation and performance. Second, reports are required by the QMS, such as internal reports for senior management to assess program performance and efficiency, or reports to the public to demonstrate accountability.

Both reports should be prepared according to templates adopted by the QMS, following its standards for content and presentation. Templates should be developed that address all essential reporting requirements, both mandatory and voluntary requirements.

In addition to reporting the operation and performance, the QMS reports should also include incidents that affect the program during the period.

Reporting requirements under the QMS should be viewed as one of the most important elements.

3.5 Reviewing

As indicated in Figure 3–1, quality management requires repeated reviews as part of the on-going cycle. The "review" stage compares goals and objectives (legal or voluntary) with performance results that are obtained through the "checking" phase. If the results indicate that the objectives are being met, the only required follow-up is to record and report on the findings. This stage also includes a determination

of whether new goals and objectives are necessary to deal with changing regulatory requirements, emerging issues or new public concerns.

If, however, the results of the monitoring indicate that objectives are not being met, then the program would be in a state of non-conformance. Non-conformance is defined as a deviation from the agreed-upon objectives of the QMS. Non-conformances can relate to legal or voluntary objectives. Non-conformances could also arise as a result of an emergency, or complaints from the public, or affected stakeholders.

Once a non-conformance has been discovered, the primary effort is to determine its root cause, take corrective actions and put preventive measures in place. The QMS team should consider the following questions:

- *Has the non-conformance been verified? Is the non-conformance also a non-compliance?*
- *Who needs to be informed?*
- *Why did this happen? What is the primary (root) cause? What can be done to correct this?*
- *Is there any way that we could have discovered the non-conformance earlier?*
- *How can we prevent this from happening again?*
- *How can we be better prepared the next time?*

The QMS team must take a structured approach to determining the root cause of a non-conformance. It is occasionally difficult to pinpoint an exact cause in a biological process. But applying measures that are not directed to the real cause could produce other problems.

Corrective action is a systematic process that addresses non-conformance problems. It also includes any steps necessary to mitigate or eliminate environmental or social impacts.

Preventive action aims to prevent problems before they occur, or before they become more severe. In all cases of non-conformance, preventive action measures should automatically be developed and put in place. Preventive action could also focus on identifying potential problems that could eventually lead to non-conformances.

One frequent omission in corrective/preventive action programs is the failure to adequately address the recurrence of identified problems. In most cases the process ends once the problem is "fixed", with little attention given to prevention. The analysis of every non-conformance should include the identification of measures to prevent a recurrence.

3.6 Communications

Greater public acceptance is one of the major goals of a biosolids QMS, and an effective communication strategy will be the cornerstone for achieving this goal. In addition to an internal communication program, a proactive external communication must be implemented to reach out to interested parties (stakeholders), including local regulators, farmers and the general public.

In addition to an internal communication program, a proactive external communication must be implemented to reach out to interested parties (stakeholders), including local regulators, farmers and the general public.

An effective communication strategy is open, educational, responsive and candid and delivered in a way to achieve the goals and objectives set out at the start of the QMS. The communications program should be designed to promote awareness, knowledge, and understanding of the biosolids program and its activities.

The importance of the communications program is often overlooked. A breakdown in the communications program could lead to failure of the QMS. More information about building an effective communications program may be found in the Storm and Wastewater best practice: *Communication and Public Consultation for Biosolids Management* (InfraGuide, 2004b).

3.7 Documentation

Documentation for the QMS, like communication, is an activity that touches all four stages of the system. It is necessary for:

- compliance with legislative requirements;
- providing information to elected officials and the public;
- providing feedback to management and employees on the effects of the QMS; and
- demonstrating due diligence.

It is important that a document management system be developed for all electronic and hardcopy data. This will make it easier to retrieve these files at a later date.[4]

4 The reader is referred to InfraGuide's Multi-Discipline best practice: *Best Practices for Utility-Based Data* (InfraGuide, 2002).

4. Applications and Limitations

4.1 General

This section examines how the quality management principles described in Section 3 can be applied to a biosolids program. The discussion is not exhaustive; rather it provides an overview. More comprehensive information may be found in the references.

This section takes the principles presented in Figure 3–1: Flow Diagram for Quality Management and applies them to a biosolids program element. Biosolids land application is used as the example. The importance of communication and documentation is also discussed.

The reader should keep in mind that any QMS must be specific to the municipality and the size of the biosolids program to which it is applied.

4.2 Limitations

In developing a QMS for biosolids programs, it is important to recognize the key stages that affect the quality of the program and end product. The quality of any biosolids product depends on a sequence of stages listed in Table 4–1.

The general sequence of stages and points of control presented in Figure 4–1 are applicable to a range of biosolids programs. Each stage has a number of points of control—locations or processes—to which systematic quality management procedures should be applied according to the four-step process outlined in Section 3.

The production and operation sequence will vary for each biosolids program. It is important to document the sequence so that attention can be focused on each stage and the municipality can then identify the key points of control at which QMS principles need to be applied.

Table 4–1
Program Stages and Points of Control

The production and operation sequence will vary for each biosolids program. It is important to document the sequence so that attention can be focused on each stage and the municipality can then identify the key points of control at which QMS principles need to be applied.

Table 4–1: Program Stages and Points of Control

Stages of a Biosolids Program				
COLLECTION	LIQUID TREATMENT	SOLIDS TREATMENT	STORAGE AND TRANSPORT	END USE
Points of Control				
■ Industrial dischargers ■ Commercial dischargers ■ Sewer use by-law ■ Residential ■ Combined sewer overflows	■ Headworks ■ Preliminary treatment ■ Primary treatment ■ Secondary treatment ■ Tertiary treatment	■ Aerobic digestion ■ Anaerobic digestion ■ Chemical stabilization ■ Composting air & thermal drying ■ Solids storage ■ Solids thickening	■ Biosolids storage ■ Truck loading ■ Transportation equipment, routes and procedures	■ Storage & staging ■ Land application sites and procedures ■ Incineration ■ Land-fill disposal applications ■ Sale of biosolids for beneficial use

When the policies, procedures, monitoring protocols, and record-keeping guidelines for each control point in the production and operation sequence are correctly applied, the chance of the end product being out of conformance is remote.

4.3 Different Types of Biosolids

The implementation of a QMS for a biosolids program will depend on the size of municipality, the nature of its program, the end product and its uses, and available resources.

A survey of municipalities in 2003 found a range of biosolids products produced in Canada. They are identified in the following table, alongside their potential end-use and categorization, according to criteria described in the *Biosolids Management Programs* (InfraGuide, 2003). For more information about the categories see Appendix A.

As shown in Tables 4–1 and 4–2, biosolids programs differ in processes, products and end-uses. The implementation of a QMS is best illustrated by example. The following pages describe the implementation of a biosolids QMS in relation to a biosolids program that applies Category 3 biosolids to agricultural land as a model, since approximately 47% of Canadian municipalities surveyed in 2003 reported land application as their primary end-use of biosolids. However, it is recognized that other options are included in local government programs.

4.4 Planning

The planning process sets the direction of the quality management system by defining a vision and policies that will govern the QMS. For example, the vision for a QMS may read as follows:

Table 4–2: Different Types of Biosolids

Category	Examples of products	Possible Uses
1	Near pathogen-free compost, pellets, and soil amendment and other stabilized products that meet more stringent metal requirements. (This would be consistent with the EPA's definition of Exceptional Quality or British Columbia's Class A compost standard.)	Unrestricted use including: sale to the public as bagged product; use in nurseries, sod farms, recreational parks, urban green areas, golf courses, land reclamation, silviculture, sale as fertilizer for wide range of crops.
2	Near pathogen-free compost, pellets, and soil amendment, dewatered and liquid biosolids meeting relaxed metal standards. (This would meet with the EPA's definition of Class A)	Semi-restricted use including: blended with other material for use as a bagged fertilizer, nurseries, golf courses, sod farms, land reclamation, agriculture, fuel source (pellets).
3	Reduced pathogen compost, dewatered or liquid biosolids, air dried biosolids meeting relaxed metal requirements (This would meet the EPA definition of Class B)	Restricted use including: application on agricultural land (for certain crops), land fill cover and co-disposal, land reclamation, silviculture.

To ensure the quality of our biosolids management program in a manner that is transparent to the public by:

- committing to the QMS, with unity of purpose and sufficient resources;
- becoming a model biosolids program through the adoption of best practices;
- providing a high quality product with a guarantee of minimum nutrient content;
- providing high quality service to end users such as farmers;
- involving affected stakeholders and the public in planning, monitoring and review; and
- having a "good neighbour policy in all aspects of the biosolids program".

Once the vision has been identified, the planning process can begin setting long-term goals and short-term objectives, using the vision to help in prioritizing efforts of the QMS Team.

One of the early steps a municipality should undertake is a land bank analysis to determine the quantity of land available, the locations and the requirements for interim storage if necessary, and preferred transportation routes.

The overall plan should also identify whether additional staff will be required to implement the QMS. This is extremely important, as the failure to commit sufficient resources to the QMS will result in failure of the quality management effort.

4.5 The "Do" Stage—Implementation

Once the planning of the QMS is completed, the various activities begin, resources are recruited or assigned, training commenced, and procedures are documented.

4.5.1 Procedures, Practices, and Standardization

The quality management system will incorporate a set of standard procedures and practices that the biosolids program manager, and staff involved in the program, will develop and use to improve the effectiveness of operations, the quality of the product, achieve regulatory compliance and address issues of concern that may be expressed or perceived by any stakeholder.

At a minimum, standard operating procedures should exist or be created for the following:

- operation of the sewer-use by-law program;
- operations of wastewater treatment processes and solids handling processes;
- maintenance of all major equipment;
- sampling and testing for any of the parameters, which are to be monitored for the program, including process performance, mandatory and quality parameters;
- logging and responding to public complaints;
- procurement of contracted services; and
- reporting to the public, elected officials and regulator agencies.

There should be a formal means of revising procedures and documenting these changes.

For a land application program, the following procedures and practices should be carefully reviewed and documented:

- Operating standards for digestion processes (such as target process parameters and digester feeding protocol);
- Operating standards for dewatering process (including target polymer dosing, dewatering equipment set points, etc.);
- Maintenance procedures for all equipment;
- Operating procedures for truck-loading facility, transportation system and application equipment;
- Procedures for procurement of contracted services (including selection process, request for qualification documents, request for proposal documents, standard conditions, agreement, etc.);
- Sampling and analysis procedures for process parameters, (e.g., volatile acids, alkalinity, volatile solids destruction, gas production, and for product quality parameters such as pathogen content,

One of the early steps a municipality should undertake is a land bank analysis to determine the quantity of land available, the locations and the requirements for interim storage if necessary, and preferred transportation routes.

metals, priority organics). The frequency of the sampling for each parameter should be clearly defined and analysis procedures should, whenever possible, follow Standard Methods for examination of Water and Wastewater (APHA, AWWA, WEF, 1995); and

- For land application the following procedures should be included:
  - Written consent from the farmer;
  - Procedures for obtaining certificates of approval, where required;
  - Procedures for the recruitment of landowners;
  - Land application procedures including provision for observing good farm etiquette;
  - Notification of neighbours (format, advance notice required);
  - Complaints procedures;
  - Documentation procedures (land parcels and application rates, dates, weather, intended crop, soils description and conditions); and
  - Procedures for monitoring of soil.

If land application is contracted out, ensure that the contractor's procedures are satisfactory and that sufficient in-house resources exist to undertake appropriate oversight responsibilities.

As part of emergency response planning, municipalities should perform a risk analysis of the facilities and operations, to identify potential problem scenarios, severity of consequences and possible mitigation measures.

4.5.2 Training

Training of staff is imperative if the QMS is to realize its objectives and goals. For a Class B land application, program training should include:

- Digestion and dewatering;
- Knowledge of the sewer-use program and how it affects biosolids quality;
- Theoretical and practical knowledge of all standard operating procedures;
- Working knowledge of all applicable legislation and policies especially those for land application; and
- Understanding of all contracted services, agreements, conditions of contract, specifications, and the monitoring procedures.

4.5.3 Emergency Response Procedures

For a biosolids program with land application of digested, dewatered biosolids, the following are some of the areas where emergency planning may be required:

- failure of wastewater treatment processes or equipment;
- failure of biosolids storage or truck-loading facilities;
- inadequate biosolids quality (moisture, pathogen content, levels of other contaminants, etc.);
- restrictions at application sites;
- severe weather (including wet weather events, saturated soils, and hot and humid days) that limits transportation or application;
- power failure;
- accidents involving haulage trucks, or application equipment; and
- impacts of unauthorized access.

As part of emergency response planning, municipalities should perform a risk analysis of the facilities and operations, to identify potential problem scenarios, severity of consequences and possible mitigation measures.

All emergency response procedures should be documented, and the municipality should provide employee training (including general emergency skills such as CPR). There should be a process for reviewing and updating procedures on an annual basis. Finally, procedures should include a requirement to record and report on what actually happens during an emergency event.

4.6 Checking

Quality cannot be improved unless performance is monitored on a continual basis to detect performance trends. Measurement is a key component of the quality management process. During this stage, the principal activities revolve around monitoring and recording.

4.6.1 Compliance

The framework of laws, regulations and guidelines at the municipal, provincial or federal level is an important consideration in developing and implementing a biosolids program. The biosolids manager and staff must have a thorough working knowledge of the legislation and guidelines.

While they vary from one location to another, they generally include:

- environmental assessment as part of the planning process;
- biosolids quality criteria, emission criteria and monitoring and reporting requirements;
- design, construction and operation of biosolids processing and end use/disposal facilities;
- storage requirements;
- transportation requirements;
- land application rates, nutrient management and site management procedures;
- staff training; and
- requirements for documentation, and contingency planning.

The following is a summary of activities that should be undertaken as part of quality management for regulatory compliance:

- Identify the laws and regulations applicable to the biosolids program and obtain copies of them.
- Designate a person to be familiar with the laws and regulations and to understand their requirements on an on-going basis.
- At a minimum, monitor all parameters for which there is a compliance limit.
- Report in accordance with regulatory requirements.
- Review legislation with all management staff on a quarterly basis as a minimum. Compliance status and status of on-going programs to achieve or maintain compliance, should also be reviewed quarterly.

4.6.2 Monitoring of Program and Product Quality

In this "checking" stage, a municipality should try to verify that what it set out to do as part of the QMS is actually being done. In a program that applies Category 3 biosolids to agricultural land, the following will need to be verified:

- *Are the liquid (digestion) and solids processes (thickening or dewatering) being operated according to the SOPs?* A list of parameters for various process areas is included in Appendix E.
- *Is the equipment being operated and maintained according to the SOPs?*
- *Is the contractor following the procedures laid out for application on land?* Municipal staff should undertake regular and random checks at application sites. Staff should check that the contractor:
  - adheres to the SOPs adopted by the QMS;
  - takes responsibility for ensuring that all activities comply with regulatory requirements;
  - meets the performance requirements defined by the QMS;
  - carries out self-monitoring activities;
  - reports regularly on all operations to the owner;
  - provides a health and safety manual and an emergency preparedness plan consistent with that of the owner; and
  - reports immediately any departures from the norm and any emergency situations that arise.
- *Has the public communication plan been followed in terms of notifying neighbours and responding to complaints?*

Quality cannot be improved unless performance is monitored on a continual basis to detect performance trends.

Being open and transparent by sharing information regarding the performance of the program, whether good or bad, will greatly enhance public trust and confidence.

- *Are the truck-loading, storage and haulage operations being correctly performed? Are trucks in an acceptable state of cleanliness?*
- *Are reporting formats and procedures being followed?*
- *Is there a certificate of approval, if required, for each land parcel that is part of the program?*
- *Is the contractor adhering to the setback requirements for wells, watercourses and residences?*
- *Is a nutrient management plan been developed for each lot?*
- *Have any soil tests been done? Have the results been reported? Are there any issues of concern?*
- *Are proper records being kept of where, when, and how much biosolids are applied? Are these in compliance?*
- *Has the farmer whose land is receiving the biosolids been informed of the nature of biosolids, concerns and nutrient potential? Has the farmer given his consent and is there a contractual arrangement in place? Is the farmer satisfied?*
- *Are temporary storage facilities being properly operated?*
- *Are the trucks that are used properly maintained? Are maintenance records being provided? Are the trucks reasonably clean? Have there been any complaints or negative incidences?*
- *If the contractor is required to have a public communication plan in place, is this being done and is it being done properly?*

Monitoring results should be retained and published for review by interested parties. Being open and transparent by sharing information regarding the performance of the program, whether good or bad, will greatly enhance public trust and confidence.

Municipalities should recognize that the public would react favourably to a commitment to any planned corrective measures. In the event of a non-conformance or unforeseen event, it is essential that any news release or report to the public emphasizes the corrective and preventive measures that are planned.

4.6.3 Reporting

Program performance reports are needed to summarize the performance of the biosolids program. These reports should contain at a minimum:

- summaries of the monitoring and test results that demonstrate the performance of the biosolids program relevant to mandatory standards and to the goals and objectives determined in the planning process;
- summary reports of operational monitoring that is not legislated such as process testing for wastewater treatment or solids handling, perhaps on a monthly and annual basis;
- any incidents of non-compliance, either in regard to mandatory standards or to voluntary standards, together with corrective actions taken, and details of any changes made to standard operating procedures;
- monitoring of performance by any contracted parties, with reports prepared by contractors appended;
- details of any emergency events or unforeseen circumstances arising during the reporting period together with the action taken and the need for any follow-up; and
- review of resource assignments, and the adequacy of the resources together with the need for additional resources or additional training as necessary, with sufficient justification.

For a land application reporting should include product quality (pathogens, metals, organics); quantities produced; where the biosolids were applied; application rates; any adverse conditions encountered (e.g., wet conditions preventing application) and the actions taken; non-conformances, action taken and action planned.

4.7 Review

4.7.1 Areas for Review

In the "review" stage municipal staff will try to determine whether the actions taken are achieving the goals set out at the start of the QMS. In the land application example, the following should be reviewed:

- *Has the number of non-conformances declined?*
- *Have staff members associated with the program (managers, truck operators, field staff) benefited from the training, and are they aware of the QMS goals and vision?*
- *Are all reports being submitted on time and to the standard required?*
- *Is the information that is being made public easy to access for members of the public? Is the public satisfied?*
- *Is the number of farmers involved in the program increasing?*
- *Has the number of public complaints increased or decreased? Have people who have complained been satisfied with the response?*
- *Is the public reasonably well represented at public meetings?*

4.7.2 Corrective and Preventive Action

Corrective action is taken to address non-conformance problems after they have occurred and could include steps to mitigate environmental impacts.

Preventive action is taken to prevent potential problems before they occur, or before they become more severe. Whenever there is a non-conformance, corrective action should be taken immediately and, after a review of the causes, preventive action measures should be developed and put in place. In both cases, the following points should be addressed:

- Determine which staff members will need to be involved in the development and implementation of the corrective and preventive measures.
- Determine what changes are required to any SOPs. Implement these changes following the protocols in place for revising procedures.
- Determine if additional or different monitoring measures could predict the non-conformance.
- Determine who is to be informed about the non-conformance and who needs to know about the corrective and preventive measures that are planned?
- Document the corrective and preventive measures.

4.8 Communication

Communication is an element that will affect every step in the QMS process. There are two forms of communication—external, with the public, stakeholders, elected officials and regulatory agencies; and internal with program managers and staff.

Generally, external communication will include:

- public education for all stakeholders;
- means for stakeholders to initiate communication, voice concerns and seek further information;
- a summary of all monitoring and test results carried out as part of the QMS;
- information about policy commitments, values and goals for the program; and
- information about economic, environmental and public health issues related to the biosolids program.

Several tools can be used for external communications including fact sheets, newsletters and websites. For more information about public awareness programs, readers are referred to the best practice: *Communication and Public Consultation for Biosolids Programs* (InfraGuide, 2004b).

Staff need access to the same information as the public, in particular any reports that relate to the program's performance. In addition, they need a clear understanding of the following:

- their role and responsibilities and how they fit into the overall biosolids program;
- knowledge and understanding of the procedures, checkpoints, monitoring and reporting requirements for the work areas they are responsible for;

Several tools can be used for external communications including fact sheets, newsletters and websites.

Table 4–3
Principal Categories of Documents

- appreciation for the roles and responsibilities of other departments and their staff; and
- up-to-date information regarding the status of goals and objectives, monitoring results, as well as preventive and corrective actions.

4.9 Documentation

The following is an outline of the process that may be used for preparing various documents:

- Review existing documentation to determine if there is a standard format and whether it is acceptable.
- Determine whether the contents of the documents (for example, operating procedures) are adequate to meet the requirements of the QMS and are easily understood by staff.
- Develop standard templates and content guides for procedures, records and reports.
- Create a procedure for making revisions to procedural documents and a method for tracking revisions. All document versions should be clearly identified.

Table 4–3 summarizes the four principal categories of documents that will be part of the QMS.

Table 4–3: Principal Categories of Documents

Planning	Process/ Procedures	Records	Reports
■ Mission ■ Vision ■ Policy ■ Code of Practice	■ Standard operating procedures related to plant and biosolids ■ QMS procedures ■ Contract procurement and agreements ■ Sampling and testing protocols for all processes ■ Complaints procedures	■ Laboratory results ■ Other monitoring results ■ Inspections ■ Corrective actions ■ Preventive measures ■ Notes of meetings ■ Public communiqués ■ Training ■ Complaints log	■ Periodic performance reports ■ Mandatory reports ■ Reports prepared by contractors ■ Management reviews ■ Third party reports ■ Emergency events

5. Evaluation

Evaluation is built into the QMS through the "check" and "review" stages of the process. The primary goal of the evaluation process is to determine whether the program is meeting the goals and objectives set out in the planning stage. Completion of the evaluation process should lead back to planning for the quality management cycle to begin again. In this way, continuous improvement, the basic principle of quality management, is maintained.

Periodically, an audit of the QMS should be undertaken either through an internal audit or by turning to external auditors. In most cases, an internal audit is sufficient.

An internal audit approach is a formal self-assessment of the effectiveness of the biosolids program. Knowledgeable people who are familiar with the audit process, as well as the legal obligations and operating processes of the biosolids program should do the audit.

The audit protocol should define the frequency of the audit and its scope—i.e., is the audit to cover the whole program or only certain elements? The audit process should culminate in a report to management, which is reviewed, then shared with staff and the public.

Management reviews can vary from a single element review to a complete program review. It is recommended that a complete program review be undertaken at least once a year.

Once a municipality has its QMS program operational, it may consider evaluating its program against ISO standards and eventually becoming ISO registered.

Completion of the evaluation process should lead back to planning for the quality management cycle to begin again. In this way, continuous improvement, the basic principle of quality management, is maintained.

Appendix A: Tables of Biosolids Quality Categories and Quality Parameters for Various Canadian Jurisdictions

Table A–1: Categories of Biosolids Products

Parameter	Category 1	Category 2	Category 3
Terminology			
US EPA Alberta British Columbia Ontario Quebec	Exceptional Quality EQ) (No Classification) Class A Compost (No Classification)* C1, P1 or CAN/BNQ 0413-400	Class A Class A Class A (No Classification)* C2, P1	Class B Class B Class B (No Classification)* C2, P2 or P3
PATHOGEN REDUCTION REQUIREMENTS (Note: EPA uses *Fecal Coliform* or *Salmonella* but Quebec's C1 requires both *FC* and *Salmonella* standards be met. Ontario uses *E-Coli* and *Colony Forming Units* instead of fecal coliforms and MPN)	Less than 1000 MPN fecal coliforms per gram of total solids, dry weight OR Density of *Salmonella* less than 3 MPN per 4 grams of total solids, dry weight	Less than 1000 MPN fecal coliforms per gram of total solids, dry weight OR Density of *Salmonella* less than 3 MPN per 4 grams of total solids, dry weight	Less than 2 Million MPN fecal coliforms per gram of total solids, dry weight
In additional to meeting the pathogen reduction requirements above, the biosolids must be treated by one of the following processes below.			
ACCEPTABLE PROCESSES (For details see US EPA Part 503)			
	■ Composting ■ In vessel ■ Windrow ■ Heat drying ■ Heat treatment ■ Liquid biosolids ■ Thermophilic Aerobic Digestion ■ Pasteurization ■ Heat and High pH ■ Other processes that meet specific time-temperature relationships	■ Composting ■ In vessel ■ Windrow ■ Heat drying ■ Heat treatment ■ Thermophilic Aerobic Digestion ■ Pasteurization ■ Heat and High pH ■ Other processes that meet specific time-temperature relationships	■ Aerobic digestion ■ Anaerobic digestion ■ Composting ■ Lime stabilization ■ Air drying

* Ontario regulates through a nutrient management approach (Nutrient Management Act, 2002), which requires that all biosolids meet $2x10^6$ *colony forming units (CFU).*

Note: This table, adapted from InfraGuide's Storm and Wastewater Best Practice: *Biosolids Management Programs*, describes three categories of biosolids with descriptions of terminologies in use in some Canadian provinces and in the USA (US EPA 503 Regulation).

6. The Fertilizers Act includes a Cobalt limit of 150 ppm in addition to the parameters listed above.

Table A–2
Pollutant Limits for Categories and Various Jurisdictional Product Types

Table A–2: Pollutant Limits for Categories and Various Jurisdictional Product Types

Example of Pollutant Limits (mg per kg dry weight total solids)						
Metal	Category 1[2]			Category 2[2]	Category 3[2]	
	BC[3] Class A Compost	US EPA[4] Exceptional Quality	Canadian Federal Fertilizer Act[5]	US EPA[4] Class A	BC[3] Class B Biosolids	US EPA[4] Class B
Arsenic	13	41	75	75	75	75
Cadmium	3	39	20	85	20	85
Chromium	100	1,200	-	3,000	1,060	3,000
Copper	400	1,500	-	4,300	2,200	4,300
Lead	150	300	500	840	500	840
Mercury	2	17	5	57	15	57
Molybdenum	5	(under review)	20	75	(under review)	75
Nickel	62	420	180	420	180	420
Selenium	2	36	14	100	14	100
Zinc	500	2,800	1,850	7,500	1,850	7,500

Notes

1. This table is adapted from InfraGuide's *Biosolids Management Programs* Best Practice, 2004, Ottawa, Ontario.
2. Category 1 and 2 are both "near pathogen-free" but Category 1 has significantly less metals and therefore has unrestricted use. Category 2 differs from Category 3 primarily because of pathogen limits. The BC Class B compost has significantly less metals but the pathogens are 2000 times higher. Refer to Table A–1.
3. British Columbia.
4. United States Environment Protection Agency, EPA 503 Regulation
5. Canada's Fertilizers Act (1985), administered by the Canadian Food Inspection Agency, controls and regulates all agricultural fertilizers, specialty fertilizers, fertilizer/pesticide mixes and supplements that are manufactured, sold or imported. The primary purpose of this Act is to ensure that products are free of substances that are harmful to crops, animals, humans and the environment. It also ensures that they contain the necessary plant nutrients, are effective, and are labelled to avoid fraud.

Appendix B: List of Web Sites for Provincial Regulations and Guidelines

British Columbia

Waste Management Act and Health Act: Organic Matter Recycling Regulation
<http://www.qp.gov.bc.ca/statreg/reg/W/WasteMgmt/18_2002.htm>

Waste Management Act: Municipal Sewage Regulation
<http://www.qp.gov.bc.ca/statreg/reg/W/WasteMgmt/129_99.htm>

Alberta

Environmental Protection and Enhancement Act
<http://www.qp.gov.ab.ca/document_print.cfm>

Saskatchewan

Guidelines
<http://www.se.gov.sk.ca/environment/protection/water/epb%20296%20-%20land%20application%20of%20municipal%20sewage%20sludge.pdf>

Environment Management and Protection Act
<http://www.qp.gov.sk.ca/index.cfm?fuseaction=publications.details&p=489>

Manitoba

The Environment Act
<http://web2.gov.mb.ca/laws/statutes/ccsm/e125e.php>

The Environment Act: Water and Wastewater Facilities Operator Regulation
<http://web2.gov.mb.ca/laws/regs/pdf/e125-077.03.pdf>

Ontario

Environmental Protection Act O. Reg. 363/98: Fees – Certificates of Approval
<http://www.e-laws.gov.on.ca:81/ISYSquery/IRL474A.tmp/106/doc>

Food Safety and Quality Act, 2001
<http://www.e-laws.gov.on.ca:81/ISYSquery/IRL5EE2.tmp/2/doc>

Nutrient Management Act, 2002: O. Reg. 267/03 General
<http://www.e-laws.gov.on.ca:81/ISYSquery/IRL5EE2.tmp/3/doc>

Nutrient Management Act, 2002
<http://www.e-laws.gov.on.ca:81/ISYSquery/IRL5EE2.tmp/4/doc>

Quebec

Quebec Residual Materials Management Policy 1998–2008
<http://www.menv.gouv.qc.ca/matieres/mat_res-en/fertilisantes/index.htm>

Environment Quality Act
<http://publicationsduquebec.gouv.qc.ca/dynamicSearch/telecharge.php?type=2&file=/Q_2/Q2_A.HTM>

Environment Quality Act: Waste water disposal systems for isolated dwellings, Regulation respecting, R.Q. Q-2, r.8
<http://www.canlii.org/qc/laws/regu/q-2r.8/20040901/whole.html>

Nova Scotia

Guidelines for Land Application and storage of biosolids in Nova Scotia <http://www.gov.ns.ca/enla/ecs/Biosolids_Guidelines_May1304.pdf>

Environment Act (Amended) Prohibiting the use of certain biosolids on Agricultural lands <http://www.gov.ns.ca/legi/legc/bills/59th_1st/1st_read/b120.htm>

New Brunswick

Guidelines for Issuing Certificates of Approval for the Utilization of Wastes as Soil Additives Clean Environment Act <http://www.gnb.ca/acts/acts/c-06.htm>

Newfoundland and Labrador

Environmental Protection Act (nothing specifically references biosolids but there is a section on waste management that deals with sludge, etc.) <http://www.gov.nf.ca/hoa/statutes/e14-2.htm#13_>

Prince Edward Island

Environmental Protection Act — Water Resource Management Regulations <http://www.gov.pe.ca/law/regulations/bydept.php3>

Technical Paper <http://www.gov.pe.ca/photos/original/fae_ww_qualcomp.pdf>

Appendix C: Core Values and Code of Practice

C.1 Example of Core Values

- We consider the protection of the environment and public health to be of utmost importance.
- We will strive to attain public acceptance of our programs.
- We will comply with all regulatory requirements.
- We will provide the highest level of service while still being fiscally responsible.
- We will take all necessary measures to ensure safety of staff.

C.2 Sample Code of Practice

The following Code of Practice, reproduced from the National Biosolids Partnership EMS, is a broad framework of goals and commitments to guide the production, management, transportation, storage, and end-use of biosolids.

Compliance: To commit to compliance with all applicable federal, state, and local requirements regarding production at the wastewater treatment facility, and management, transportation, storage, and use or disposal of biosolids away from the facility.

Product: To provide biosolids that meet the applicable standards for their intended use or disposal.

Environmental management system: To develop an environmental management system for biosolids that includes a method of independent third-party verification to ensure effective ongoing biosolids operations.

Quality monitoring: To enhance the monitoring of biosolids production and management practices.

Quality practices: To require good housekeeping practices for biosolids production, processing, transport, and storage, and during final use or disposal operations.

Contingency and emergency response plans: To develop response plans for unanticipated events such as inclement weather, spills, and equipment malfunctions.

Sustainable management practices and operations: To enhance the environment by committing to sustainable, environmentally acceptable biosolids management practices and operations through an environmental management system.

Preventive maintenance: To prepare and implement a plan for preventive maintenance for equipment used to manage biosolids and wastewater solids.

Continual improvement: To seek continual improvement in all aspects of biosolids management.

Communications: To provide methods of effective communication with gatekeepers, stakeholders, and interested citizens regarding the key elements of each environmental management system, including information relative to system performance.

Appendix D: Example of Goal Setting and Objectives

In a municipality with the core values presented in Appendix A–1, and a vision statement that reads: "To become a model biosolids program," the long-term goals and short-term objectives, with suggested timeframes, could be as follows:

Table D–1
Long-term goals and short-term objectives

Table D–1: Long-term goals and short-term objectives

Long-Term Goals	Short-Term Objectives
Have a successful public communications program implemented within 12 months. (Assume Council approval is given and implementation start is January of a given year)	■ Appoint a lead communications person by mid-February. ■ Identify and contact stakeholder groups by mid-March. ■ Create an advisory committee, with a clear mandate. Hold first meeting before mid-April. ■ Create fact sheets. First fact sheet issued May 1. ■ Council briefings quarterly. First briefing before issue of fact sheet—end of April. ■ Hold a Public Open House and/or a Plant Tour in September.
Document the existing biosolids management program by December	■ Analyze and confirm size of program—sewage flows, biosolids production quantities—February. ■ Outline the stages of the biosolids program—by March. ■ Describe compliance requirements and outline history of monitoring—February. ■ Review existing procedures and determine if modifications are necessary. Develop new procedures by September. ■ Review capacity of biosolids processing units and end-use options—end of March. ■ Prepare report and present to Council then to advisory committee by June.
Implement a Quality Management System within two years	■ Develop an outline of the QMS and prepare a Briefing Document for Council. Obtain commitment from Council to proceed with QMS planning by March. ■ Conduct planning workshops and develop a vision in April. ■ Meet with stakeholders to discuss the vision, goals and objectives—mid-May. ■ Complete the plan and provide an update to Council. Obtain Council commitment by end of July. ■ Begin implementing QMS Plan—September.
Complete a 20-year master plan for biosolids within 2 years	■ Carry out an analysis of wastewater flow projections and anticipated biosolids production—July. ■ Obtain approval from Council to hire Technical Advisors to conduct the master plan. Complete hiring process by September. ■ Launch the planning exercise with provision to consult with the Stakeholder Advisory Committee—October. ■ Interim Report by June of the following year. To be reviewed by Council, stakeholders and obtain input from the QMS initiative. ■ Complete master plan and obtain Council endorsement—December of following year.

Appendix E: Possible Monitoring Activities for Various Biosolids Program Elements

The following table provides a summary of the key parameters that should be monitored and recorded regularly within a quality management system for a biosolids program. Many of these monitoring results should be reported to the management of the biosolids management program, as well as to the public, as part of the municipality's communications strategy. In addition, regulated parameters are reported to relevant authorities as required.

Biosolids Program Elements	Processes/Products	Key Parameters to be Considered for Monitoring
Source Control	1. Industrial dischargers 2. Commercial dischargers 3. Residential dischargers 4. Storm water—combined sewer systems	■ Flow ■ Time and duration of discharges ■ Temperature ■ Biochemical Oxygen Demand (BOD) ■ Chemical Oxygen Demand (COD) ■ Total Suspended Solids (TSS) ■ Fats, Oils and Greases (FOG) ■ Total Kjeldahl Nitrogen (TKN) ■ Total Phosphorus ■ Phenols ■ Mercury ■ Heavy Metals ■ Petroleum Hydrocarbons ■ Pesticides
Solids Generation	1. Preliminary treatment 2. Primary treatment 3. Secondary treatment 4. Advanced/tertiary treatment	■ Weight, volume ■ Moisture content ■ Odours ■ Volatile fraction
Stabilization	Anaerobic digestion	■ Volumetric loading ■ Total solids loading ■ Volatile solids loading ■ Detention time ■ Digester temperature ■ pH, nutrients ■ Volatile acids/alkalinity ■ Volatile solids destruction ■ Methane gas production

(Continued)

E. Possible Monitoring Activities for Various Biosolids Program Elements

Biosolids Program Elements	Processes/Products	Key Parameters to be Considered for Monitoring
	Aerobic digestion	■ Digester temperature ■ Detention time ■ Aeration requirements (oxygen transfer and mixing) ■ Specific oxygen uptake rate ■ Feed characteristics
	Chemical stabilization	■ Specific dose ■ Mixing capacity ■ Contact time ■ pH, temperature
	Composting	■ Feed mix % solids ■ Carbon to nitrogen ratio ■ Aeration requirements ■ Oxygen concentration in compost ■ Moisture content ■ Temperature
	Air drying	■ Feed solids concentration ■ Turning schedules
	Thermal drying	■ Temperature ■ Feed solids concentration ■ Feed rate ■ Particle size ■ Final moisture content ■ Odours
Conditioning	1. Thickening 2. Dewatering	■ Type of solids ■ Feed solids concentration ■ Conditioning agent feed rates and concentrations ■ Odours
Final Biosolids Product	1. Biosolids Cake 2. Pellets 3. Compost	■ Pathogens ■ Metals ■ Priority organics ■ Nitrogen-Phosphorus-Potassium content ■ Iron content ■ Moisture

(Continued)

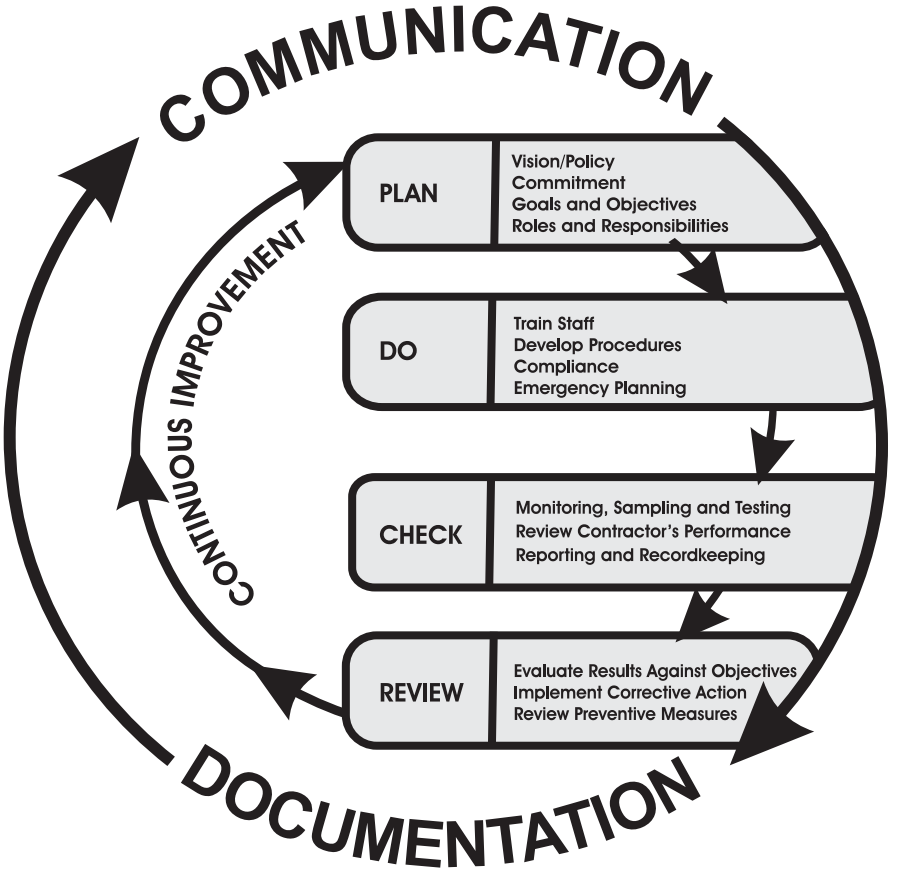
E. Possible Monitoring Activities for Various Biosolids Program Elements

Biosolids Program Elements	Processes/Products	Key Parameters to be Considered for Monitoring
Storage	1. Liquid storage 2. Cake storage 3. Pellet storage 4. Compost storage	■ Material volumes, weights ■ Solids concentration ■ Material characteristics, stability ■ Climatic conditions ■ Odours
Transportation	1. Liquid transportation 2. Cake transportation 3. Pellet transportation 4. Compost transportation	■ Material volumes, weights ■ Solids concentration ■ Waybills, manifests ■ Odours ■ Leaks and spills ■ Travel distances ■ Fuel usage ■ Fleet age and maintenance records
Beneficial Use	1. Land Application 2. Silviculture 3. Mine rehabilitation 4. Land reclamation 5. Use as a fuel for heat recovery/ cogeneration	■ Material characteristics—physical, biological, chemical ■ Soil nutrient characteristics-Land area ■ Intended use of land ■ Climatic conditions ■ Surface and groundwater characteristics ■ Biosolids application rate ■ Odours
Odour Control	1. Wastewater treatment facility 2. Biosolids stabilization facility 3. Biosolids transportation 4. Biosolids storage facility 5. Beneficial use site	■ Physical, chemical, biological characteristics of solids/biosolids ■ Climatic conditions ■ Odour control equipment operating parameters—pH, ORP, flow, free chlorine residual, maintenance schedules ■ Enclosures—doors closed, trucks covered/sealed ■ Biosolids incorporation times ■ Air sampling and odour panel testing

Appendix F: Circle of Quality Management

Figure F–1
Circle of Quality Management

Figure F–1: Circle of Quality Management



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