BENEFITS AND CONCERNS

THIS CHAPTER WILL:

- **describe the benefits and concerns of land application**
- **give a measure of the significance of some of the concerns, and**
- **explain how concerns are addressed.**

There are potential risks with applying biosolids to cropland – but there are real benefits to everyone as well.

Read on to find out more about how benefits outweigh concerns through new technology and improved management practices.

BENEFITS OF LAND-APPLYING SEWAGE BIOSOLIDS

URBAN-RURAL NUTRIENT RECYCLING

Land application is a practical and responsible way to close the loop of urban-rural nutrient recycling, and complete the nutrient cycle. Many stakeholders, including farmers as well as municipalities generating sewage biosolids, are concerned with environmental protection and resource conservation. They consider beneficial re-use preferable to incineration or disposal in a landfill.

Crop nutrients are returned to the land, closing the loop from crops to urban consumption and back to cropland.

COST-EFFECTIVENESS FOR TAXPAYERS

When all factors are taken into consideration, land application is often less expensive than alternative methods of management such as disposal in a landfill.

Land-applied biosolids can give cropland a boost. The added organic matter and nutrients improve soil quality and ultimately crop yields.

IMPROVED SOIL QUALITY AND CROP YIELDS

Sewage biosolids contain essential crop nutrients such as nitrogen and phosphorus as well as organic matter. All of these are needed in an agricultural production system in order to maintain soil quality and maximize crop yields.

The solid component of sewage biosolids is about 50% mineral material, which supplies most of the essential nutrients, and 50% organic matter, which is needed to maintain good soil structure, permeability, moisture-holding capacity, and natural fertility.

The enhanced colour and growth in the same crop due to biosolids application are significant.

REDUCED REQUIREMENT FOR OTHER FERTILIZERS

The amount of nutrients in sewage biosolids, especially nitrogen and phosphorus, allows farmers to reduce the amount of commercial fertilizer that must be obtained from other sources. Sewage biosolids are also a source of sulphur. The resulting nutrient cost-savings can be significant, depending on the type of sewage biosolids used and the crop grown following land application.

Biosolids applications reduce the need for additional fertilizer. This saves time, energy, and money.

ADDED MICRONUTRIENTS

Sewage biosolids also supply essential plant micronutrients. These are needed by crops for healthy growth, but may not otherwise be applied by farmers because crop response to their application is unpredictable. Some key micronutrients in sewage biosolids include manganese, zinc, copper, iron, and molybdenum.

Micronutrient deficiencies often show up during the growing season long after fertilizer materials have been applied. Regular use of biosolids can help to prevent deficiencies.

ADDED ORGANIC MATTER

Maintaining good soil tilth and fertility can be a challenge in Ontario soils as the organic matter lost through normal cropping practices can be greater than that returned to the soil by crop residues.

Adding organic matter from other sources such as sewage biosolids can help to improve seedbed structure – making it easier to till the soil. It will also help to improve the suitability of the soil as a seedbed. Adding organic matter to lighter, coarse-textured sandy soils also improves their moisture-holding capacity and minimizes soil erosion. Adding the organic matter found in sewage biosolids:

- ► increases water infiltration into the soil and soil moisture-holding capacity
- ► reduces soil compaction
- ► increases the soil's ability to retain and provide nutrients
- ► reduces soil acidification
- ► provides an energy source (carbon) for beneficial micro-organisms.

Biosolids applications can have an immediate and cumulative impact on soil organic matter levels – particularly with sandy soils where there are few other sources of organic matter additions.

Regular additions of sewage biosolids and other sources of organic matter will improve a soil's seedbed structure, moisture availability, and resistance to degradation.

To a fine-textured clay soil, adding organic matter found in biosolids will:

- help make the soil more friable and easier to work
- increase the amount of pore space available for root growth and entry of water and air into the soil.

In coarse-textured sandy soils, organic matter residues resulting from the application of biosolids can:

- increase the soil's water-holding capacity
- provide additional sites where nutrients can be held temporarily and exchanged for uptake by crop roots.

ENVIRONMENTAL CONCERNS AND HOW THEY'RE MANAGED

This section outlines key concerns and what's done to address them. The ✔ indicates actions that "receivers" (farmers) and/or land applicators are advised to take to minimize risk.

Environmental damage can occur when sewage biosolids or other nutrient-rich materials wash off fields and into waterways. Phosphorus and nitrogen can cause algal blooms, oxygen depletion, and fish kills.

IMPROPER OR EXCESSIVE ADDITION OF NUTRIENTS AND RISKS TO WATER QUALITY

Concerns

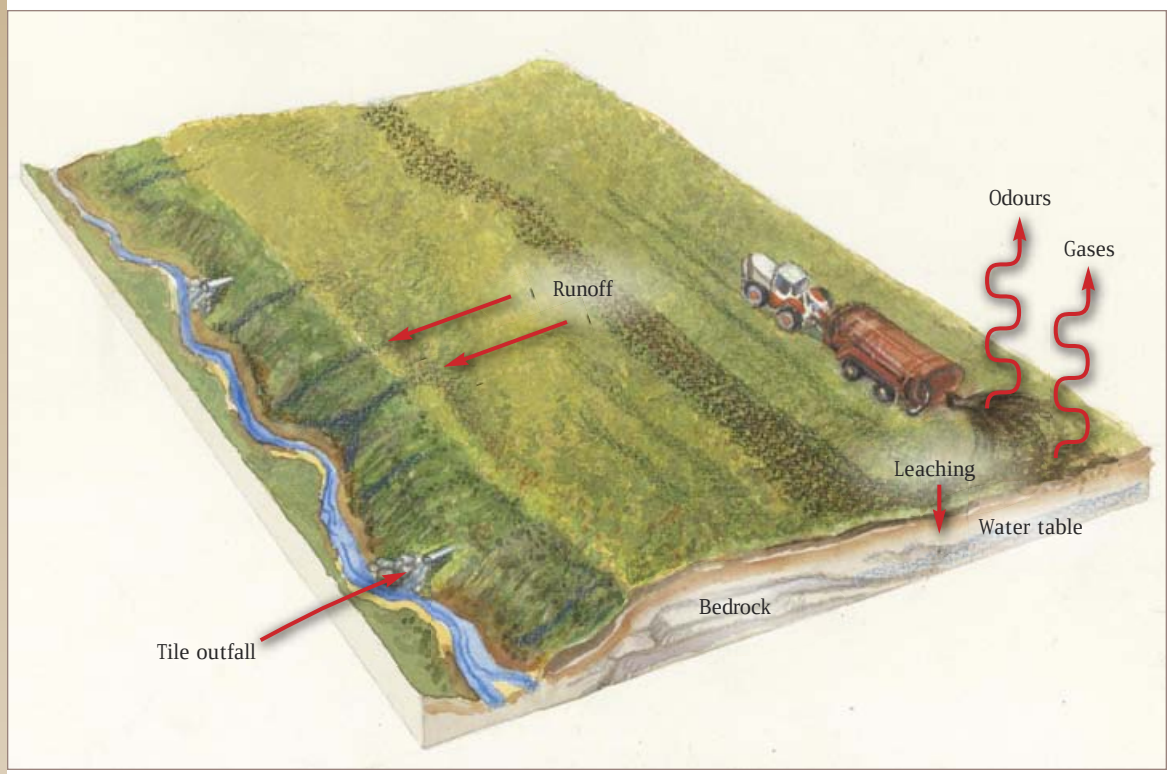
Improper soil fertility practices and excessive application rates can lead to high fertility levels. This is a potential risk with most nutrient sources, such as manure and commercial fertilizers.

Nitrogen and phosphorus in sewage biosolids, as in any fertilizer source, can be harmful and can adversely affect water quality if improperly applied or if applied in excess amounts. Excess nitrogen applied as a plant nutrient may move downward through the soil into groundwater, and phosphorus attached to soil particles may move off-site with eroded soil and then into surface water.

Management Response

- ✔ Test soils. Develop a nutrient management plan. Apply biosolids at rates required by crops, at times when crops can use the nutrients.
- ✔ Comply with regulatory specifications. Keep application operations at safe distances from environmentally sensitive areas.
- ✔ Apply only the amount of nitrogen needed and that can be utilized by the crop(s), so as to prevent excess nitrogen from reaching groundwater.
- ✔ Use conservation practices to prevent the potential contamination of surface water (ponds, streams or lakes) from eroded soil or runoff.

Soil and water conservation practices such as no-till and reduced tillage help keep soils and applied nutrients in place.



For the most part, environmental risk from land application of biosolids is similar to the potential risks from manure application. Risks are highest when poor management practices are employed on sensitive sites. For example, if surface-applied on sloping land adjacent to surface waters, crop nutrients from biosolids application can pose a risk to surface water where no precautions to prevent runoff have been taken. Examples of precautions include injection, crop residue, and buffer strips.

Heavy metals are present in biosolids. Sewer use bylaws and proactive industry initiatives have resulted in lowering concentrations in biosolids.

HEAVY METALS

Concerns

Heavy metals, known as the "regulated metals," occur naturally in the environment. For the most part there are low but measurable concentrations of heavy metals in sewage biosolids. Eleven of these elements have been identified as of concern when sewage biosolids are applied to agricultural land. See page 38 for a complete list.

Heavy metals are found in agricultural soils, occurring naturally as a result of soil deposition and development. Further additions can result from long-term atmospheric deposition and the use of commercial fertilizers.

Some metals have no agricultural value. If they're applied excessively, there's a risk of accumulation in soils and increased uptake by crops. This can have phytotoxic effects that reduce crop yield, impact crop quality, or result in further potential bioaccumulation in the food chain.

Heavy metals are often bound with other elements and not easily converted to a form suitable for uptake by crops. For this reason, crop uptake tends to be very low. The risk of heavy metal uptake increases, however, if the pH of the soil is acidic (pH <6.0).

Management Response

- ✔ Monitor levels of heavy metals: some are micronutrients needed by crops for healthy growth.
- ✔ Abide by current regulations, which require the pH of the soil to be 6.0 or greater if biosolids are to be applied.
- ✔ Abide by regulations that set out maximum heavy metal concentrations allowed in any material applied to agricultural soils, as well as maximum heavy metal additions. The regulations also prohibit biosolids application where these elements exceed a maximum concentration in the receiving soil.

Soils prone to acidity should be limed prior to receiving biosolids.

PATHOGENIC MICRO-ORGANISMS

Concerns

Many micro-organisms live naturally in the environment and are harmless to animals and humans. However, some micro-organisms can cause disease or illness if they come into contact with or are ingested by humans or other animals.

These micro-organisms are often simply referred to as “pathogens.” Pathogens are tiny organisms commonly found in the digestive tract of infected humans and animals, leading to elevated levels in the feces of these individuals. This poses a potential risk of waterborne transmission.

Biosolids originate from a sewage treatment process designed to reduce pathogen levels. While the treatment process greatly reduces the presence of these micro-organisms, it does not eliminate them completely.

WWTP treatment processes are designed to eliminate over 99% of E. coli in sewage biosolids.

Management Response

✔ Deploy best management practices and standard operating procedures at the sewage treatment plant to significantly reduce pathogens

► pathogen reduction is a design standard for the digesters used in the treatment process.

✔ Use in-field management practices such as setback distances, pre-tillage, injection, and timely incorporation into the soil to significantly reduce the potential for micro-organisms to reach surface water or groundwater.

CONSTITUENTS FROM PHARMACEUTICALS AND PERSONAL CARE PRODUCTS

Concerns

Sewage biosolids may contain trace amounts of a wide variety of residues from:

► personal care products such as soaps, shampoos, and detergent
► the use of healthcare products (e.g., pharmaceutical residues from antibiotics, medications, and both natural and manmade hormonal compounds).

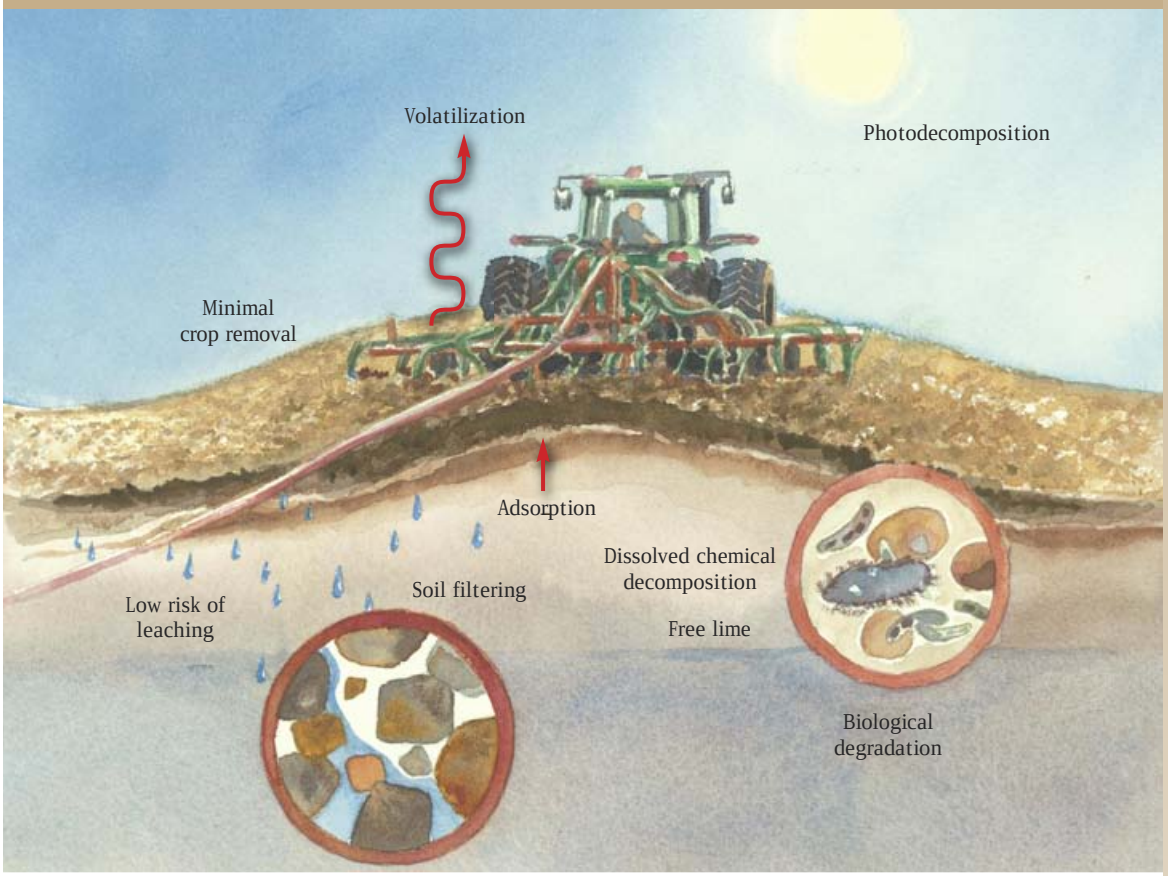
As they enter the environment, some of these residues are of concern because they are known or suspected to affect normal reproductive functions in animals such as fish.

Studies have shown consistently that many do not persist in the soil for extended periods. Also, uptake of these residues by plants is unlikely because plant roots do not absorb most pharmaceuticals and personal care products. Therefore, these residues pose a minimal risk to crop growth and human health.

Management Response

A significant amount of research is underway to examine the impacts of treatment processes on these residues and their fate and persistence after sewage biosolids are applied to agricultural land. The concentrations of these various residues and compounds in sewage biosolids are commonly only just above detection levels (i.e., parts per billion, or parts per trillion).

DECOMPOSITION OF RESIDUES BY SOIL MICROBES



Soil microbes rapidly decompose residues from the low concentrations of soaps and personal care products found in treated sewage biosolids. Soils filter chemicals out of the soil solution where they are adsorbed by soil minerals and organic matter particles. On these sites, chemicals are subjected to microbial decomposition and further chemical transformations.

Here's an example to help you understand the concentration of the various constituents in sewage biosolids and related terminology:

- **1 part per million (ppm) is equivalent to 1 second in ~ 11.6 days (0.03 years)**
- **1 part per billion (ppb) is equivalent to 1 second in 30 years**
- **1 part per trillion (ppt) is equivalent to 1 second in 30,000 years.**

OTHER ORGANIC COMPOUND RESIDUES

Concerns

Organic compounds include dioxins and furans, polychlorinated biphenyls, polyaromatic hydrocarbons, and various phenolic compounds. These compounds pose or are suspected of posing a cancer risk if ingested by humans in large enough amounts.

Organic compound residues have been found in sewage biosolids at extremely low or trace concentrations, i.e., a few parts per billion or parts per trillion. At these very low concentrations, the potential for crop uptake or bioaccumulation is minimal.

Management Response

Research indicates that many of these compounds will:

- volatilize
- be consumed by soil microbes, or
- degrade quickly within the treatment plant and in the soil after land application.

Other research shows crop uptake is minimal, because the compounds are too complex for uptake by root tissues.

Many of these compounds bind tightly to soil particles, thereby reducing the risk of off-site movement, and facilitating degradation.

Although complex organic chemicals such as dioxins and furans are a significant concern, research has consistently shown that the trace concentrations found in treated biosolids are subject to volatilization and biological degradation after land application. Moreover, plant tissue analyses indicate that crop uptake of these chemicals is minimal.

RESPONDING TO LOCAL CONCERNS

Land application of biosolids is not without controversy, as noted earlier. Most of the concerns are expressed locally. Typically, they involve one or more of the following:

- odours from biosolids
- attraction of vectors (e.g., insects, birds)
- threats to well water quality and food safety
- road traffic
- risk of damage to local public roads by the trucks used to transport biosolids.

Responding to local concerns can be the responsibility of any of the key players in a land application program for biosolids. This includes municipal staff, consultants, haulers, receivers (farmers), and provincial government staff.

The best approach to addressing concerns is proactive, not reactive. Proactive means advance work: careful site selection, proper approvals process, and prior communication with neighbours. Adapting operations to reduce nuisance impacts wherever possible can go a long way too. There is no single approach to addressing concerns. Approaches will vary, depending on stakeholder knowledge and specific concerns.

Being well-informed about the regulations in place to protect the environment can also be part of an effective response.

Careful planning, good communication, listening, and respect are key ingredients in responding effectively to local concerns.

Biosolids can have their own distinctive odour, depending on the type of treatment used. Some biosolids may have only a slightly musty, ammonia odour. Much of the odour is caused by compounds containing sulphur and ammonia, both of which are plant nutrients.

Rural residents' concerns often involve nuisances such as truck traffic and dust generated during application operations.

NUISANCES AND ODOURS

Biosolids odour does vary with treatment process and application method. Treatment can reduce odours but does not eliminate them completely. Odour control and proper application greatly reduce the presence of nuisances such as flies, birds, and rodents, which can be carriers of harmful micro-organisms.

Good site management procedures include injection of sewage biosolids into the soil, or incorporation soon after application. Increasing the setback distance to a nearby residence or residential area is also effective in minimizing potential impacts on neighbours.

Current injection technologies reduce odours dramatically.

Everyone in the biosolids industry relies on one another and the processes in place for safe and effective biosolids application. Generators who choose to have their materials land-applied must provide assurance to land applicators (and ultimately farmers) that the materials meet specifications for quality and safety. Permits and approvals are in place to ensure suitable quality, site selection and management practices – all within the overarching mandate of environmental protection. Land applicators know it's in their best interest to comply with all the regulatory requirements and use BMPs whenever possible. Farmers use their NASM plans and nutrient management BMPs to ensure their operations are receiving the appropriate nutrients for their land, when and where they need them.