BEST MANAGEMENT PRACTICES FOR PHOSPHORUS

Practical and proven best management practices (BMPs) can reduce phosphorus pollution from agricultural sources. Most BMPs are site-specific, meaning that every BMP will not be suitable for every source and form of phosphorus, nor for every farm operation. This section is designed to help you select what will work for your circumstances.

BMPs are grouped by farm type on pages 18 and 19.

There are some guiding principles that apply to many of the phosphorus management challenges encountered in most agricultural operations. We'll start with these.

For all **on-farm point sources** of phosphorus:

✔ reduce the amount at the source – reduce volumes and concentrations where possible

✔ divert clean water – keep clean water clean with eavestroughs and berms

✔ manage all liquids – make sure that all contaminated liquids are managed

✔ manage concentrated sources differently from dilute sources

For *concentrated* sources of P on the farm:

✔ properly store, contain and use this nutrient-rich material – this applies to manure storages and handling, sewage biosolids, fertilizers, and concentrated nutrient solutions (e.g., greenhouses).

For *dilute* sources of P on the farm:

✔ collect and treat or re-use the material – this applies to manure runoff, livestock yards, runoff, greenhouse and container irrigation waters, and washwaters (including milking centre).

For **on-farm non-point sources**, the goals for field P management are to:

✔ know what you've got – using nutrient management planning, materials testing, P Index

✔ add what you need, when required, where required, and in the most suitable form

✔ keep what you've got – keep phosphorus in the soil and keep your soil on your cropland through soil management, soil erosion control, and the establishment of natural area BMPs.

Keep phosphorus in the soil and keep your soil on your cropland through soil management, soil erosion control, and the establishment of natural area BMPs.

BMP SUMMARY TABLE, BY FARM TYPE

The following table will show you which BMPs will likely best suit your operation. To use the table, look at the column headings for your type of farm operation and note the BMPs appropriate to it. The rest of this chapter contains brief outlines of BMPs, and links to resources for more detailed information.

BMPs	CONFINED LIVESTOCK	GRAZED LIVESTOCK	GRAIN & OILSEED CROPS	ANNUAL HORT. CROPS	MUCK CROPS	PERENNIAL HORT. CROPS[3]	GREENHOUSE & CONTAINER NURSERY	RURAL NON-FARM
POINT SOURCE BMPS								
NUTRIENT [1] STORAGE	✔		✔	✔	✔	✔	✔	✔
VEGETATED FILTER STRIPS	✔			✔	✔		✔	
CONSTRUCTED WETLANDS	✔				✔		✔	
TANK + TREATMENT TRENCH[2]	✔						✔	✔

Footnotes:

1. Nutrient Storage = for manure, fertilizers, solutions, biosolids, compost, nutrient-enriched irrigation water etc.
2. Tank + Treatment Trench = for septage, milking centre washwaters
3. Perennial Horticulture Crops = field nursery, ginseng, orchards, small fruit, etc.

BMPs	CONFINED LIVESTOCK	GRAZED LIVESTOCK	GRAIN & OILSEED CROPS	ANNUAL HORT. CROPS	MUCK CROPS	PERENNIAL HORT. CROPS[3]	GREENHOUSE & CONTAINER NURSERY	RURAL NON-FARM
NON-POINT SOURCE BMPS								
DO A NMP	✔	✔	✔	✔	✔	✔	✔	
SOIL + SOLUTIONS TEST	✔	✔	✔	✔	✔	✔	✔	✔
RIGHT SOURCE	✔	✔	✔	✔	✔	✔	✔	✔
RIGHT RATE	✔	✔	✔	✔	✔	✔	✔	✔
RIGHT TIME	✔	✔	✔	✔	✔	✔	✔	✔
RIGHT PLACE	✔	✔	✔	✔	✔	✔	✔	✔
MONITORING[4]	✔	✔	✔	✔	✔	✔	✔	
SOIL IMPROVEMENT[5]	✔	✔	✔	✔	✔	✔		✔
SOIL DRAINAGE	✔	✔	✔	✔	✔	✔	✔	
CONTROLLED DRAINAGE			✔	✔	✔			
RESIDUE MANAGEMENT[6]	✔		✔	✔				
EROSION CONTROL PRACTICES[7]	✔		✔	✔	✔	✔	✔	
EROSION CONTROL STRUCTURES[8]	✔	✔	✔	✔	✔	✔	✔	✔
RIPARIAN MANAGEMENT[9]	✔	✔	✔	✔	✔	✔	✔	✔

Footnotes continued:

3. Perennial Horticulture Crops = field nursery, ginseng, orchards, small fruit, etc.
4. Monitoring = there is a monitoring component to most environmental management systems
5. Soil Improvement = cover crops, add organic matter, crop rotation
6. Residue Management = no-till, mulch tillage
7. Erosion Control Practices = field buffers, strip cropping
8. Erosion Control Structures = grassed waterways, WASCoBs, diversion terraces, grade control structures, etc.
9. Riparian Management = buffer strips, livestock exclusion, streambank protection

BMPs FOR ON-FARM POINT SOURCES OF PHOSPHORUS

On-farm control of phosphorus at the source is possible by implementing BMPs from the following categories:

✔ nutrient storage – to contain liquid and solid nutrients

✔ vegetated filter strips – to treat agricultural washwaters

✔ constructed wetlands – to treat washwaters and crop inputs

✔ tank and treatment trench – for onsite treatment of domestic septage and milking centre wastewater

✔ phosphorus reduction at the source – through livestock feeding practices.

NUTRIENT STORAGE

Nutrient storages are constructed facilities designed to contain liquid and solid forms of nutrients used in agricultural operations. Phosphorus loss is reduced by complete containment of the concentrated form of nutrients until the material is applied or transferred to another location.

Nutrient storages are used for:

- liquid and solid manure – including yard runoff, milking centre and other washwaters
- sewage biosolids
- greenhouse and container-nursery nutrient solutions
- on-farm fertilizer storage.

These pictures will give you some general ideas about storage issues and management. There is much more detailed information in companion BMP books.

Manure runoff can contain phosphorus, ammonium, organic matter and pathogens.

✔ Keep clean water clean: divert clean water from system.

✔ Collect and store manure runoff in liquid manure storage systems, or treat in vegetated filter strip systems.

The solid fraction (portion) of liquid manure contains phosphorus.

✔ Design and size liquid manure storages to contain all manure solids and contaminant liquids from livestock operations.

Greenhouse or container-nursery operations may be able to collect and store irrigation and nutrient solutions, which can subsequently be "fertigated" on existing crops or adjacent alternative crops (e.g., orchards, lawns).

✔ Ensure holding ponds are properly designed.

Organic phosphorus compounds are found in the solid fraction of sewage biosolids.

✔ Make sure temporary storage – such as this liquid sewage biosolid bladder – is properly designed and managed to reduce the potential risk of runoff of liquid and dewatered biosolids before they are used for application.

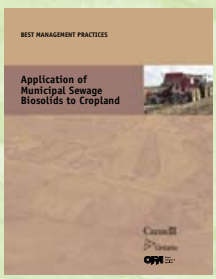
Chemical fertilizers, which can come in granular, liquid solution or gaseous forms, contain concentrated forms of phosphorus and other crop nutrients. There is a risk of phosphorus contamination of surface water if fertilizers are stored too close to watercourses and lakes.

✔ Prevent runoff from spills or leaks with proper containment and curbed, impervious floors.

VEGETATED FILTER STRIPS

Vegetated filter strips (VFS) are used for treatment of agricultural wastewaters. They are designed to remove contaminants such as phosphorus from wastewater as it is spread out over a wide area on a gentle downslope.

VFS can be used to treat greenhouse and container-nursery nutrient solutions, fruit and vegetable washwaters, and livestock yard runoff.



BMPi

See these BMP books for more info.

Manure Management

Application of Municipal Sewage Biosolids

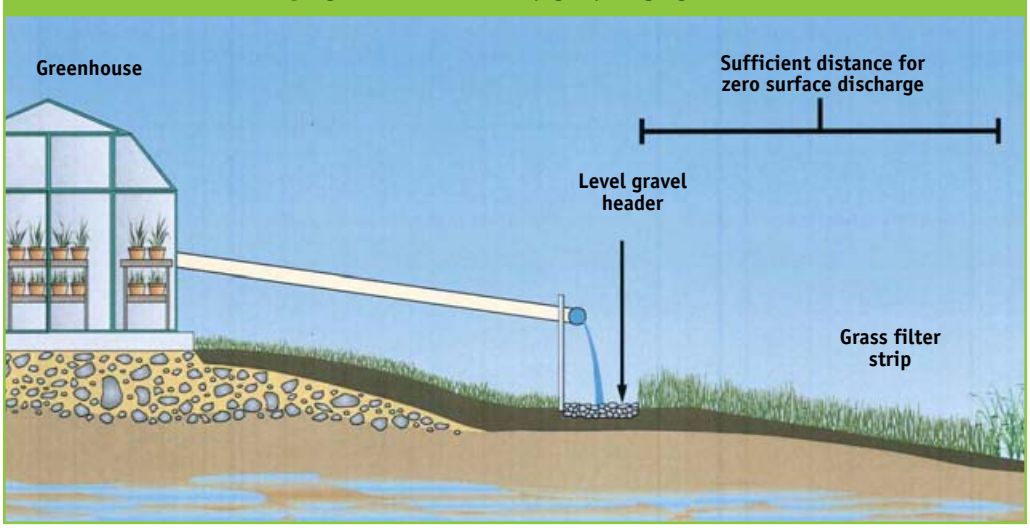
These need a Ministry of the Environment Certificate of Approval.

For design factsheets and manuals, please check the OMAFRA website or contact an OMAFRA resource centre.

www.omafra.gov.on.ca/english/engineer/facts/vfss_manual/vfsmantc.htm

Yard runoff containing both inorganic and organic sources of phosphorus, other nutrients, and enteric bacteria can be a problem for dairy, beef, sheep, horse and goat operations. VFS can be designed to manage and treat yard runoff flows and nutrients.

VEGETATED FILTER STRIP SYSTEM



A VFS system has the following components:

- collection and temporary storage in holding/storage tanks – in this case, in the greenhouse building
- screens for removal of solids in runoff in holding/storage tanks
- a distribution system, either gravity-fed or pump-fed, designed to provide uniform flow across the width of the infiltration area – see pipe and gravel header area
- an infiltration bed of sufficient size and design to allow for uniform and complete infiltration of applied wastewater, i.e., zero discharge under worst-case scenario – see grass filter strip.

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See this BMP book for more info.

Manure Management

CONSTRUCTED WETLANDS

Constructed wetlands are low-cost alternatives to many of the conventional treatment systems for the removal of nutrients, pesticides, and pathogens. Nutrients passing through a constructed wetland are removed by:

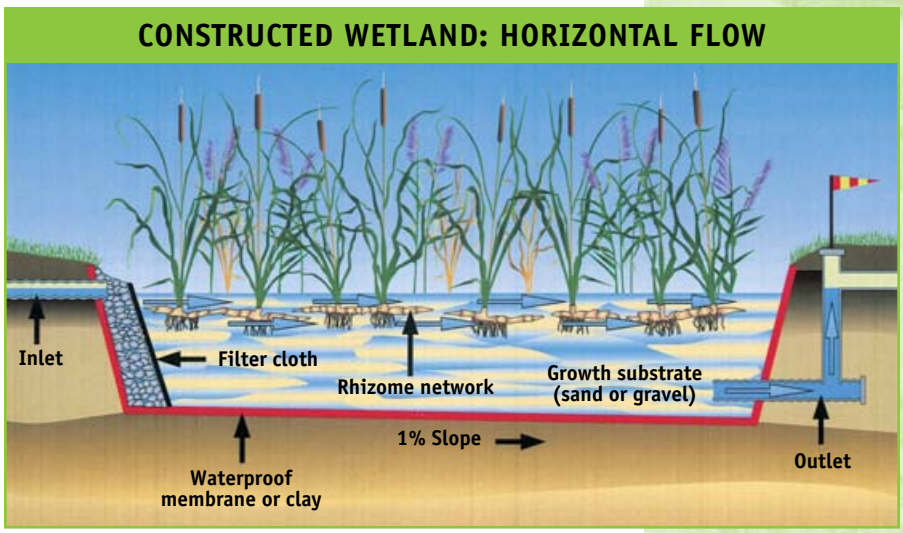
- filtering through the media
- binding to the media
- uptake by plants
- uptake or conversion by attached micro-organisms on plant roots and on media itself.

Constructed wetlands have been used to treat:

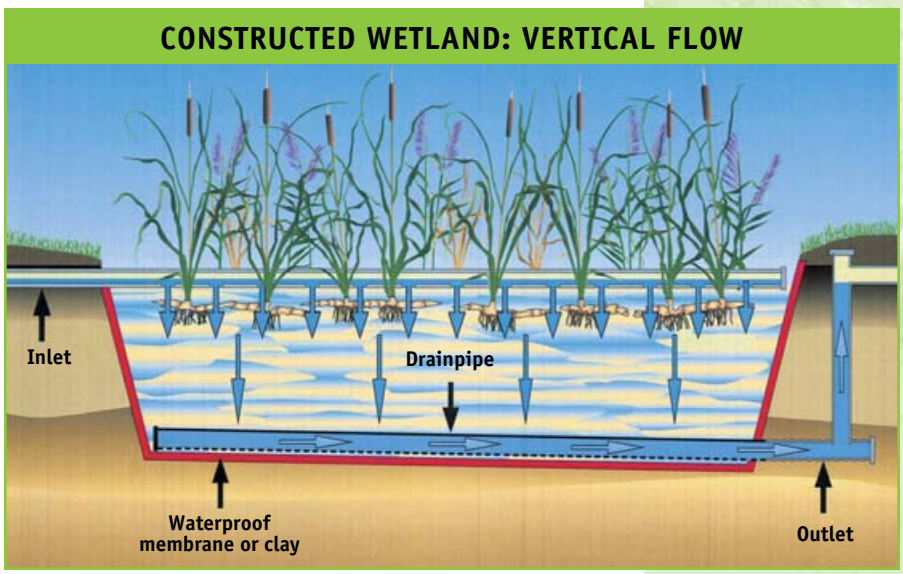
- greenhouse and container-nursery nutrient solutions
- fruit and vegetable washwaters
- livestock yard runoff and milking centre washwaters.

Note: Constructed wetlands require professional design by a qualified engineer. These projects also require approval by the Ministry of the Environment or the local building department.

There are two forms of constructed wetlands: horizontal flow and vertical flow. In horizontal flow, wastewater flows over the top of the system, and nutrients are removed largely by plant uptake and associated microflora.



A vertical-flow wetland directs the flow downward through the substrate. Depending on the nature of the contaminants to be removed, it can be run aerobically or anaerobically.



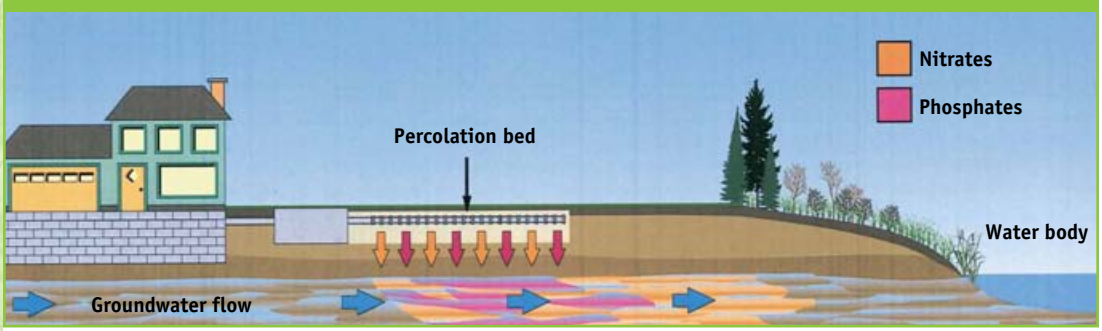
ON-SITE WASTEWATER TREATMENT SYSTEMS

Tank and treatment trench systems are onsite treatment units that eliminate the need for storage or transfer to wastewater treatment plants in rural areas. These systems use the filtering and biological action of soils to remove phosphorus and other contaminants.

There are two key applications of this BMP in rural areas:

- domestic septic systems – for the treatment of household black and grey waters that contain phosphorus compounds
- milking centre washwaters – usually from smaller, tie-stall operations producing solid manure.

SEPTIC SYSTEM



Septic systems have a tank, a network of pipes, and billions of organisms that break down household wastewater. The tank prevents the solids and fats from damaging the tile bed. Soil bacteria in the tile bed and surrounding soil treat pathogens, nitrates and phosphates in the septic effluent. However, some nitrates and phosphates will move through the soil profile. Risks to surface water and groundwater can be reduced with proper attention to soil suitability, separation distances, and regular cleanouts.

Grey water from domestic laundry, kitchens and bathrooms contains soap and detergent-based phosphorus. Black water from toilets is a source of organic P. Improperly functioning systems or illegal systems hooked up to pipes that discharge to rivers, ponds or lakes are a point source of phosphorus for surface water.

Waste milk contains organic P, and milking centre washwaters can contain detergents with P compounds.

✔ To reduce P from washwaters, remove milk from the pipelines (and feed to calves), and use phosphate-free detergents.

Septic systems don't last forever – all systems need to be replaced eventually.

✔ Have your tank inspected for sludge and scum buildup on a regular basis (3–5 years).

✔ Clean it out when a third of the depth of your tank is full of sludge and scum.

✔ Look for signs of septic failure: slow drainage, septic smells, spongy beds, and sewage backups and breakouts.

See **Septic Smart!**, a 12-page booklet available from OMAFRA.

BMPi

See this BMP book for more info.

Manure Management

REDUCTION OF PHOSPHORUS AT THE SOURCE

REDUCE P CONTENT IN MANURE

There are BMPs for livestock nutrition and feeding practices that reduce phosphorus intake or reduce phosphorus in excrement.

✔ Don't overfeed phosphorus in livestock rations or supplements.

BMPi

See this BMP book for more info.

Manure Management

✔ Choose low-phosphorus protein supplements for dairy cattle to reduce manure P levels. Feed a balanced ration to dairy cattle.

Feed supplements can reduce phosphorus in manure. Most of the phosphorus in grains fed to livestock (i.e., corn and soybeans) is phytate-P – which is not readily available to animals, particularly monogastric animals like poultry and swine. Phytase-supplemented diets will result in 15–25% less manure P than conventional diets.

✔ Feed livestock phytase-supplemented diets to reduce manure P.

"Green Lawn, Green Lake... Break the Link!" Poorly timed applications, excessive rates, and poor storage practices can lead to P runoff.

PHOSPHATES AND WATERFRONT ACTIVITIES

Cottages, estate properties, marinas and other waterfront private properties can be sources of phosphate pollution.

Manicured lawns and ornamental plants require considerable annual additions of fertilizers to maintain strong root growth and vigour. Shoreline alterations can lead to increased erosion, contributing particulate P to the near-shore zone.

Poor waste management at marinas can lead directly to phosphate loading at shoreline waters. This is especially true with poor plumbing-sanitation practices from large pleasure craft. Grey and black water discharged directly from boats into lakes is also a source of phosphorus pollution. Preventative measures include adding a tank for grey water, and using phosphate-free detergents while boating.

✔ Plant naturalized vegetated buffers along the shore to stabilize shorelines and to reduce the requirement for fertilization near shoreline areas and aquatic ecosystems. Naturalized vegetation is also less attractive to geese and other waterfowl, reducing the P loading from bird feces.

✔ Plant naturalized vegetated buffers between intensively managed lawns and shorelines. Buffers trap P fertilizer runoff before it reaches lakefront aquatic ecosystems.

BMPs FOR ON-FARM NON-POINT SOURCES OF PHOSPHORUS

While many of the BMPs in this section benefit multiple areas of the farm, for our immediate purpose they are grouped as follows:

- nutrient management planning – knowing what you've got, and testing materials for nutrient levels
- crop nutrient management – focussing on the 4 Rs of nutrient management: right product, right rate, right time, and right place
- keeping P in the soil, on the field, and out of natural areas with BMPs for:
    - cropland drainage to remove excess soil water and reduce P loss from erosion and runoff
    - soil management to improve soil quality and resilience
    - soil conservation to reduce soil erodibility
    - field structures to reduce cropland erosion and runoff
    - riparian areas to prevent P from entering surface waters.

NUTRIENT MANAGEMENT PLANNING – KNOWING WHAT YOU'VE GOT

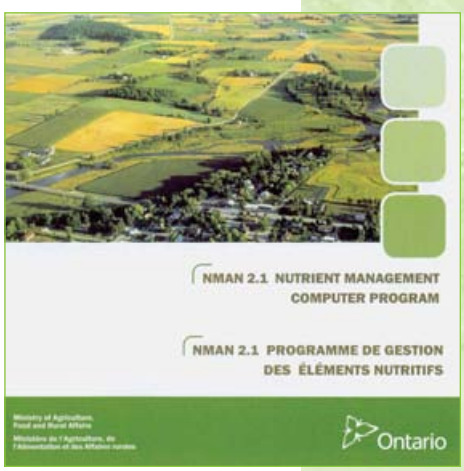
Building a nutrient management plan (NMP) is a 10-step process that helps you achieve a sustainable on-farm crop and manure nutrient management program.

A NMP accounts for soil fertility levels, all nutrient sources, site features, management practices, and risk factors. The key outputs of this program are:

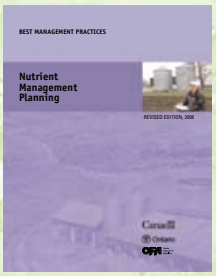
- optimized application rates and timing
- analysis of any need for additional crop nutrients
- identification of appropriate setback distances
- establishment of application setback values.

A NMP will also indicate environmental limitations, land-base requirements, and annual manure volumes.

The P Index is a critical component of this analysis.



A NMP accounts for fertility levels, all nutrient sources (including phosphorus), site features, management practices, and risk factors.



BMPi

See these BMP books for more info.

Nutrient Management Planning

Manure Management

Managing Crop Nutrients

Steeply sloping cropland is at a greater risk for erosion and runoff. The P Index is higher on steeply sloping fields.

Many components of your NMP will help you protect surface water from phosphorus loading. It will specify N and P application rates, liquid-loading limits, application separation distances, setbacks, and land-base requirements.

NUTRIENT LEVEL TEST

Nutrient level tests will tell you the fertility levels of a given growth medium, nutrient source, or crop tissue. Knowing the level of fertility can help make nutrient applications more effective and less wasteful, which can prevent the risk of phosphorus loss.

There are several types of nutrient level tests for:

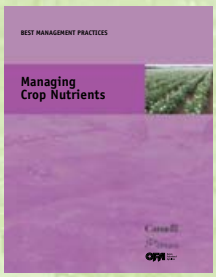
- soil
- manure
- sewage biosolids
- nutrient solution
- tissue
- soil-less media.

✔ Frequent and regular nutrient solution analyses will help you maintain proper phosphorus levels and reduce P concentrations in used nutrient solutions.

"Applying fertilizer every year without taking a soil test is like adding a litre of oil to the crankcase before you start the tractor each time. At best, you'll waste some dollars... at worst, you'll damage the engine (your soil), or spill the excess somewhere we don't want it. Don't guess – soil test!" – Keith Reid, OMAFRA Soil Fertility Specialist

In the year of application, manure P is considered 40% as available as fertilizer P. And at least 80% will become available over the longer term, adding to the total available phosphorus pool. Combine soil test results with manure test information. This will help prevent the buildup of soil P to levels that would restrict application rates in subsequent years.

✔ Test manure for phosphorus (nutrient) levels.



BMPi

See these BMP books for more info.

Manure Management

Managing Crop Nutrients

Nutrient Management Planning

CROP NUTRIENT MANAGEMENT

These BMPs help growers maximize the effectiveness of applied nutrients and reduce phosphorus loss.

RIGHT PRODUCT OR SOURCE OF CROP NUTRIENTS

✔ Match the nutrient source and product to crop needs and soil properties. Be aware of nutrient interactions: balance nitrogen, phosphorus, potassium, and other nutrients according to soil analysis and crop needs.

Don't try to meet all of your nitrogen requirements with manure. The nitrogen won't be available at the right rate and right time, and you risk over-applying phosphorus. It's better to use manure to supply the right rate of phosphorus, using timing and placement to capture as much of its nitrogen as possible, and then supply the remainder of the crop's nitrogen need with fertilizer.

RIGHT RATE FOR APPLYING CROP NUTRIENTS

The right rate meets crop needs and minimizes environmental risk. The key principles for right rate are:

- know what you've got in your soil – soil test
- account for all sources of nutrients
- apply according to science-based recommendations – see your soil test results.

The "right rate" approach is an attempt to balance crop needs with reduced environmental risk.

✔ Calibrate all nutrient application equipment to ensure actual rate is being applied.

To turn "waste" into "resource," maximize nutrient availability from organic sources (manure and sewage biosolids), and account for these nutrients in your fertilizer program.

RIGHT TIME FOR APPLYING CROP NUTRIENTS

Apply crop nutrients when the actively growing crop requires them and at a time when the risk of loss is minimal. Applying phosphorus when there is no crop, no cover, or just before a forecasted storm event risks the loss of phosphorus from erosion and runoff.

✔ Apply fertilizer at the time the crop needs it. Some nutrients such as nitrogen can move easily in the soil. Other nutrients such as phosphorus tend to get bound to soil particles, and are relatively immobile in the soil.

For most crops, the best season to apply most fertilizers is at planting time for early season growth and, if necessary, in late spring for the remainder of the requirement.

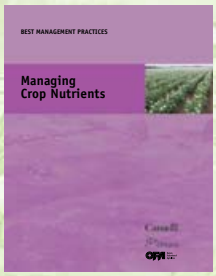
✔ Apply most fertilizers at planting time.

Winter application is not a best management practice. There is no crop to absorb the nutrients, and too great a risk of manure or sewage biosolid runoff to surface water.

✔ Avoid winter application.

For more information on requirements for winter application, please see BMP *Manure Management*.

Soil is a good filter and soil flora compete with many potentially harmful bacteria and pathogens. However, there are conditions when the risk is higher for liquid manure/biosolid to reach the subsurface drainpipe. Risk is elevated when high rates are applied to crack-prone soils during a dry summer or on moist soils in the spring or fall, and when water is running in the drainpipe.



BMPi

See these BMP books for more info.

Manure Management

Managing Crop Nutrients

RIGHT PLACEMENT FOR CROP NUTRIENT APPLICATION

Fertilizers and manures can be broadcast, side-dressed, injected or dribbled. P fertilizer or manure on the surface is subject to rapid loss as dissolved reactive P (DRP) with runoff. Subsurface banding or incorporation reduces this risk.

✔ Incorporate surface-applied solid or liquid manure soon after application. Otherwise it can run off from steeply sloping cropland to surface inlets.

The right source, right rate, right time, and right place help you meet your goals for sustainable production: optimum yields with minimal risk to the environment.

Methods that place P fertilizer below ground make the compounds more available and less prone to loss caused by erosion and runoff.

✔ Band phosphate fertilizer to place it where the crop can access it.

✔ Inject or incorporate manure immediately after application to reduce the risk of nutrient loss.

CROPLAND DRAINAGE

These BMPs reduce phosphorus loss from runoff by improving cropland soils' ability to store water.

SUBSURFACE DRAINAGE

Subsurface drainage – also known as tile drainage – involves plastic perforated pipe placed below the soil surface to remove excess water from the root zone. Drained croplands are at a lower risk of erosion, surface runoff of contaminated water, and soil compaction.

Some of the nutrients applied for crop growth can reach tile outlets. What goes on, can go through.

BMPs such as nutrient management planning and crop nutrient management should be in place to reduce this risk.

Rain and snowmelt will not readily soak into (infiltrate) saturated soils. Saturated soils are prone to runoff and P loss. Subsurface drainage systems remove enough soil water to alleviate saturated soils. Drained soils are less prone to erosion and runoff.

CONTROLLED DRAINAGE

The water table can be controlled by keeping water in drainpipes at times of year when the soil doesn't need to be dry for planting or harvest. This reduces the volume of drainage water, and also the amount of phosphorus and other nutrients that leave the field and enter surface water. It also provides water to the roots of the crop (which is less expensive than overhead irrigation), and reduces the risk of spreading leaf diseases.

Organic soils such as muck or peat are very high – 30–98% – in organic matter content. The organic matter begins to break down as soon as soils are exposed to air by drainage. This process is known as *subsidence*. Nitrogen, phosphorus, and other nutrients are released through mineralization as the organic matter breaks down, and can be lost through the subsurface drains. By keeping as much of the soil profile as possible under water, mineralization decreases.

Controlled Drainage

By using water table management devices (pictured) and the ditches and pipes of the existing drainage system, water table levels can be kept at depths that will supply water and reduce subsidence rates. Soils must have an impermeable layer at depth, and grades must be very level for controlled drainage to be an option.

DRAINPIPE OUTLET PROTECTION

Ditchbank scouring and erosion are controlled by placing erosion-resistant materials around subsurface drainage outlet pipes.

Drainpipe Outlet Protection

Soils around drainpipe outlets are prone to erosion and sediment P loss. This is due to the combined effects of outfall waters on the soil below the outfall and the scouring effects of high-flow conditions along ditch and stream banks.

- ✔ Replace end pipes with corrugated metal (rigid) pipe to prevent breakage.
- ✔ Place angular rock (riprap) underlaid by erosion-resistant fabric in an apron-shaped configuration to prevent scouring from high-flow conditions.

- ✔ Inspect pipe outlets. Look for bank erosion and take measures to correct and prevent further loss.

Constructed Wetlands

Subsurface drainage systems with many surface inlets may lead to sediment-bound P loss. By discharging subsurface drainage outflow into a constructed wetland, the wetland plants will help to remove most of the sediments and phosphates in the drainpipe outflow.

MONITORING DRAINPIPE OUTLETS AND SURFACE INLETS

Unless precautions are taken, high application rates of liquid manure can enter subsurface drainage systems.

- ✔ Pre-till to break up cracks, and apply lower rates.
- ✔ Monitor drainage inlets and outlets to prevent manure P from entering surface water systems.

Monitoring studies have shown that in certain conditions, manure can reach outflow subsurface drainpipes in spring and fall, when the pipe is running. If manure in the outflow is observed (as shown in the sample bottles on the right), cease operations and reschedule when drainpipe is not running.

BMPi

See these BMP books for more info.

Buffer Strips

Streamside Grazing

Cropland Drainage

Soil Management

Water Management

Fish and Wildlife Habitat Management

SOIL MANAGEMENT

The following BMPs improve soil quality, water infiltration, and resilience to degradation caused by erosion or compaction.

COVER CROPS

Cover crops are used to cover the soil when a crop is not being grown.

Most horticultural and field crops provide reasonable protection from wind and water erosion when mature. However, cropland soils can be exposed and vulnerable to erosive forces after harvest in the fall, throughout the winter (especially if there is minimal snow cover), and in the spring before there is full crop canopy.

✔ Sow cover crops such as spring cereals, broadleaf non-legumes or legumes to keep soils covered. Consider over-seeding cover crops following tillage, aerial seeding before harvest, or planting as soon as possible after harvest.

Cover Crops

Cover crops such as spring cereals, broadleaf non-legumes, or legumes can be sown to keep soils covered. Early establishment in the fall will provide better cover over winter.

CROP ROTATION

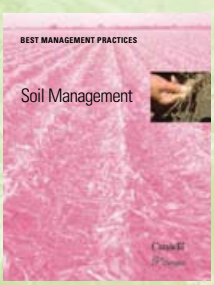
Growing the same annual crop year in, year out degrades the soil and decreases yields. A combination of tillage practices, minimal organic matter input, and exposed soil will lead to poor seedbed quality and erosion.

Crop rotation is the practice of alternating crop families – in some cases annually – on field and horticultural cropland. Crop rotations can:

- increase soil organic matter – especially if forages are used
- improve seedbed structure – with varied root systems
- protect soil – narrow-seeded cereals plus pasture and hay crops will cover the soil more effectively than regular row crops.

Crop Rotation

✔ Alternate crop families each year (e.g., cereals then broadleaves) to reduce soil degradation.



BMPi

See these BMP books for more info.

Soil Management

Cover Crops (2012)

SOIL CONSERVATION

The following BMPs help reduce phosphorus loss and soil erosion from cropland.

RESIDUE MANAGEMENT

Managing residues from the previous crop can provide soil cover after harvest and until the canopy development of the next crop.

Some grains and oilseeds leave tons of unused biomass on the soil surface.

In conventional systems, crop residues are chopped up and buried. But in conservation tillage systems, they are left on the surface or only partially buried.

The material acts like a mulch to protect the soil, and as it breaks down, it adds organic matter to the soil.

✔ Practise mulch tillage or no-till to minimize soil disturbance, enrich soil, and reduce erosion and runoff.

Bare Soil

Conventional tillage leaves no residue on the surface – increasing the risk of erosion and runoff (with phosphorus attached).

No-Till

In a no-till cropping and tillage system, the soil is undisturbed prior to planting, and well-protected from erosion and runoff. Adding soil conservation structures and surface water management practices will further reduce the risk of erosion, runoff, and loss of phosphorus.

FIELD BUFFERS AND WINDBREAKS

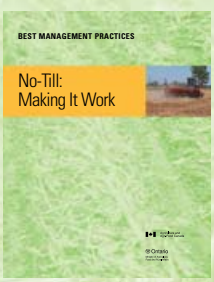
Grassed borders slow down runoff and can filter some sediment and soil-attached P at the edge of fields.

Field Buffers

Cropland perimeters, headlands and fencerows can be converted to buffer strips of permanent sod.

Windbreaks

Wind erosion can transport soil and attached nutrients off site. In some watersheds, windblown sediments can be a source of phosphorus to rivers, lakes and streams. BMPs such as field windbreaks will reduce cropland wind erosion.



BMPi

See these BMP books for more info.

Soil Management

No-Till: Making it Work

CONTOUR STRIP CROPPING

Contour strip cropping involves crops grown in a systematic arrangement of strips across a field along contours. The intent is to reduce soil erosion from water, and therefore reduce the transport of sediment and attached inputs such as phosphates.

Contour Strip Cropping

Strip combinations include alternate rows of:

- forage and row crops
- cereals and row crops.

Crop choice and strip width will depend on field slope, soil erodibility, and machinery widths.

EROSION CONTROL

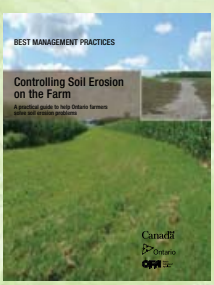
These BMPs are professionally designed structures that help to reduce phosphorus loss caused by cropland runoff and soil erosion.

GRASSED WATERWAYS

Grassed waterways are broad, shallow, vegetated channels. They are designed and constructed to transport the concentrated flow of surface water (runoff) at safe velocities.

Grassed Waterways

When properly constructed, grassed waterways can safely transport large water flows downslope. They decrease flow velocity, thereby minimizing erosion. The vegetation helps remove inputs such as nitrogen, phosphorus, herbicides and pesticides through plant uptake and sorption by soil. Soil is better aerated, and water quality and aquatic habitat are improved.



BMPi

See this BMP book for more info.

Controlling Soil Erosion on the Farm

DIVERSION TERRACES AND WATER AND SEDIMENT CONTROL BASINS (WASCoBs)

Diversion terraces are constructed across field slopes. They reduce erosion and runoff by intercepting, detaining, and safely conveying runoff to an outlet.

Water and sediment control basins are erosion control structures commonly installed to prevent bank and gully erosion on farmland. These structures control erosion caused by concentrated water flows, but are not effective in combatting sheet erosion.

Diversion Terraces

Narrow-base terraces have 2:1 slopes on both the front slope and back slope. Both front and back slopes are seeded to perennial grasses.

Water and Sediment Control Basins

A WASCoB consists of a berm and ponded area. The runoff water is temporarily stored behind the berm, eliminating its erosive capabilities further downslope. This ponded water is slowly released through an inlet riser pipe to an underground drainpipe exiting at an adequate outlet.

RIPARIAN AREAS

Riparian areas are the transitional zones between bodies of surface water and upland areas. Think of river and stream banks, floodplains, and ravine slopes. Among their many important functions, well-vegetated riparian areas protect natural areas from the cumulative effects of upland activities.

The BMPs on the next page help to prevent phosphorus from entering directly into watercourses and other surface waters.

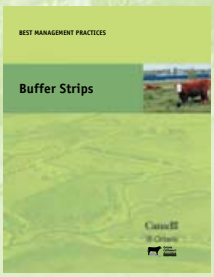
See OMAFRA Factsheet *Grassed Waterways,* Order no. 05-2009.

BMPi

See these BMP books for more info.

Water Management

Buffer Strips



BUFFER STRIPS

Buffer strips are strips of planted permanent vegetation – grass, herbaceous shrubs, trees or a workable combination of any of these – alongside watercourses, ponds, lakes or wetlands.

Buffer Strips

Buffer strips are placed strategically along sensitive natural areas to reduce the impact of cropland runoff. Generally, wider buffers are best. Diversely vegetated buffers are the most effective and provide better habitat value as well.

Narrow Buffers

Narrow buffers filter runoff from flat landscapes, and also help stabilize the ditchbanks. They are often complemented by erosion control structures such as rock chute spillways. These structures prevent gullies from forming when concentrated flow spills into drainage channels.

STREAMBANK PROTECTION

The banks of watercourses can be protected from erosion and slumping by "hard" structures and bioengineering features. Check with your local Conservation Authority for permission and approvals before proceeding with streambank protection projects.

Bioengineering Features

Live, rootable cuttings are planted along eroded banks of small streams to create a living root mass that will stabilize and bind the soil.

LIVESTOCK EXCLUSION FROM STREAMS

In some cases, livestock access to watercourses and other natural aquatic habitats can degrade water quality and destroy habitats. A suite of grazing and streamside BMPs can limit access.

Livestock Exclusion

The nature and extent of the problem depend on the number and type of animals per unit riparian area (density), the time of year, the area's sensitivity, and the grazing BMPs in place. High-risk situations require more permanent solutions. Fencing is the best option to exclude livestock in yards from watercourses.

BMPi

See these BMP books for more info.

Buffer Strips

Streamside Grazing

For More Information

BEST MANAGEMENT PRACTICES

For more detailed information on closely related BMPs, we urge you to see several other BMP books, including:

Buffer Strips
Controlling Soil Erosion on the Farm
Cropland Drainage
Managing Crop Nutrients
Manure Management
Nutrient Management Planning
No-Till: Making It Work
Soil Management.

ONTARIO MINISTRY OF AGRICULTURE, FOOD AND RURAL AFFAIRS

OMAFRA offers many publications on related topics. Of particular relevance:

Soil Fertility Handbook, OMAFRA Publication 611

A complete listing of all OMAFRA products and services is available at www.ontario.ca/omafra

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If you have a question regarding farming, agri-business, or rural business, call the Agricultural Information Contact Centre at 1-877-424-1300 or e-mail ag.info.omafra@ontario.ca

Acknowledgements

The Best Management Practices Program is a partnership of Agriculture and Agri-Food Canada, the Ontario Ministry of Agriculture, Food and Rural Affairs, and the Ontario Federation of Agriculture.

Funding for this publication has been provided by Agriculture and Agri-Food Canada and the Ontario Ministry of Agriculture, Food and Rural Affairs.

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Printed 2011