BEST MANAGEMENT PRACTICES

Water Management

Agriculture Canada

Ontario Ministry of Agriculture and Food

Ministère de l'Agriculture et de l'Alimentation

What is a Best Management Practice?

- a practical, affordable approach to conserving your farm's soil and water without sacrificing productivity.

Who decides what qualifies as a Best Management Practice?

- a team of Ontario farmers, researchers, extension staff, and agribusiness professionals.

What are Best Management Practices booklets?

- 8 booklets, from 40 to 150 pages, each with many colour illustrations and photos, and easy-to-use summary charts
- each booklet contains a range of options for any particular environmental concern: you choose the ones that fit your environmental and business objectives
- the titles are:

Farm Forestry and Habitat Management
Field Crop Production
Horticultural Crops
Livestock and Poultry Waste Management
*Nutrient Management**
*Soil Management**
Water Management
*Wildlife Management***

* Available Winter 1994
** Available Summer 1994.

How do I obtain a booklet?

- free at your local office of the Ontario Ministry of Agriculture and Food
- also at some district offices of the Ontario Ministry of Natural Resources, Ontario Ministry of Environment and Energy, and select Conservation Authorities.

We want to hear from you.

After you've read the booklet, please take a minute to complete the attached readership survey (postage is prepaid). We'll use your response to guide us in future Best Management Practices booklets and projects.

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INTRODUCTION

Water is a precious resource. The success of your farm business and the health of your family depend on having a clean and abundant supply.

Water is also a shared resource. Water used on your farm, whether for livestock, laundry, drinking, or mixing with pesticides, has been used by other people, fish, and wildlife before you, and will be used by them again after it leaves your farm.

As a user of water, you have a right to expect an ample supply of clean water to meet your needs.

Likewise, it's expected that water leaving your farm, either through evaporation, infiltration to ground water, or surface runoff, will still be abundant and clean for the next user.

Historically, agricultural technology has allowed us to manipulate the quantity and quality of water supplies to increase productivity. Today, new technology, and a better understanding of natural processes, can help you protect your water while maintaining productivity.

Ontario settlers valued water, establishing their farmsteads along lakes and rivers.

This booklet will show you practical ways to conserve water and safeguard its quality. The following chapters separate the farm operation into four areas:

- the home
- the barn and other farm buildings
- the field
- wetlands, watercourses, woodlots, and ponds.

We recommend that you read this booklet from start to finish: like the water cycle itself, each chapter contains material that has some bearing on the whole!

How you use water affects the quality and quantity of water on your property – and that of your neighbours and community.

But first, a brief look at how water – and the pollutants it can carry with it – pass through our environment. You need to understand the water cycle before you can develop an effective water management plan for your operation.

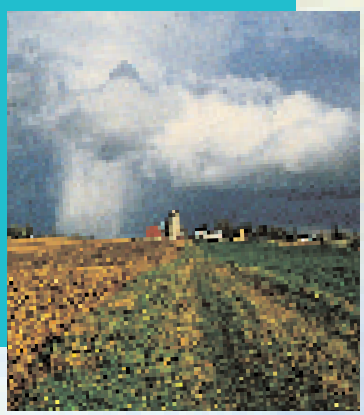
INTRODUCTION

PATHWAYS OF WATER

Water is in constant motion, continually recycling through the environment in a series of pathways called the water cycle.

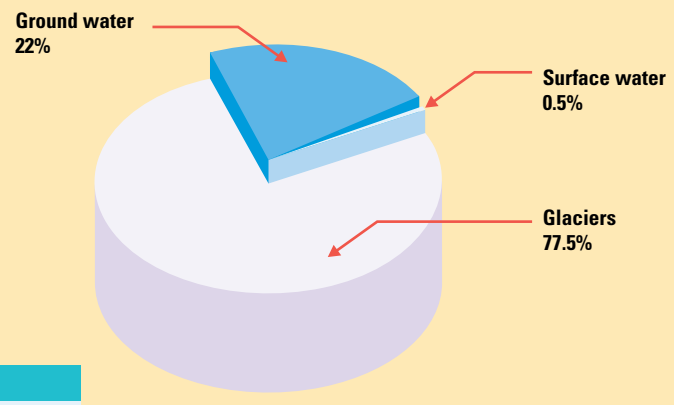
The water cycle establishes a water balance in every hectare of land and kilometre of stream. We can affect this balance, positively or negatively, as we change our land and water use.

The illustration on pages 4 and 5 shows the many ways that water moves on, through, underneath, and out of a typical farm operation.



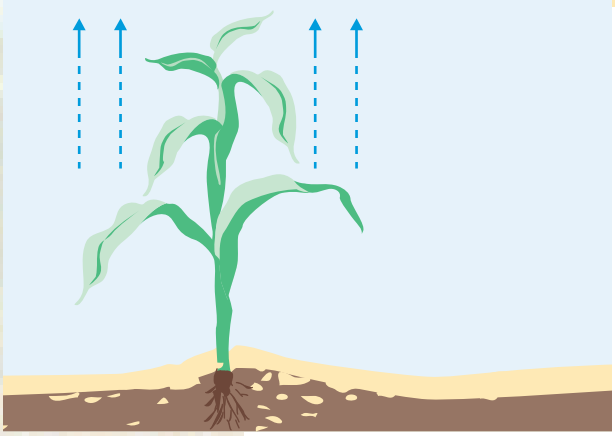
Farming influences the water cycle. Management will affect the amount of precipitation that infiltrates the ground, how much flows over the surface, and will even have an impact on evaporation rates.

COMPOSITION OF EARTH'S FRESHWATER



Water covers more than 70 % of the earth's surface. Only about 3.5 % is freshwater; the remainder is saltwater seas and oceans.

TRANSPIRATION FROM A CORN PLANT



A single corn plant transpires 1.25 litres/day of moisture to the atmosphere. When fully grown this transpiration can increase to 3.8 litres/day.

INTRODUCTION

PATHWAYS OF POLLUTION

Water is a universal carrier. Its properties enable it to dissolve many substances, and carry them with its flow. Pollutants can be carried with water through all phases of the water cycle.

Your farm is part of the overall water cycle, having an impact on both the surface water that runs over it and the ground water that runs beneath it.

Normal farming practices involve the use of many substances that can potentially contaminate water: pesticides, fuel, fertilizers, manure, to name a few.

These substances can move into surface water, either by being attached to sediment eroded from agricultural land, or dissolved in runoff. They can infiltrate soil to contaminate ground water supplies.

Many strategies for protecting water resources have economic benefits. Proper management of the water that flows over and beneath your farm will help to ensure productive agriculture along with a healthy environment.

Over 25% of Canada's agricultural production and more than 25% of Canada's population are within the Great Lakes – St. Lawrence River watershed.

ONTARIO PERSPECTIVE

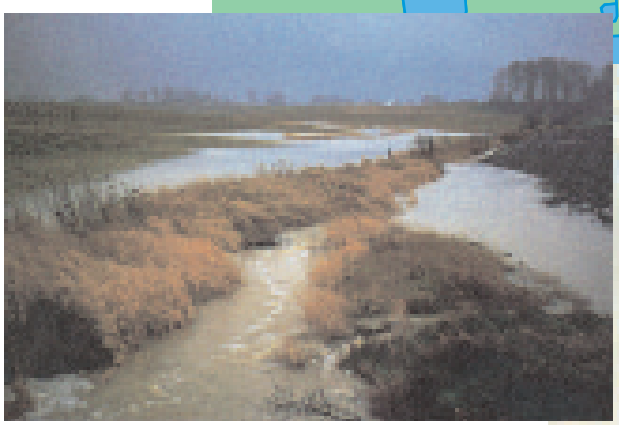
Most of Ontario's agricultural production lies within the Great Lakes – St. Lawrence River basin. This is the largest fresh surface water system in the world. It holds 20 percent of the world's available fresh water.

As the number of water users in Ontario continues to increase, there are greater demands on our water supplies. When planning for the future we must ensure that water is used as efficiently as possible and protected from pollution.

Did you know that water is the common property of all Ontario citizens? To protect our water resources and all who use them, a variety of laws and regulations is in place.

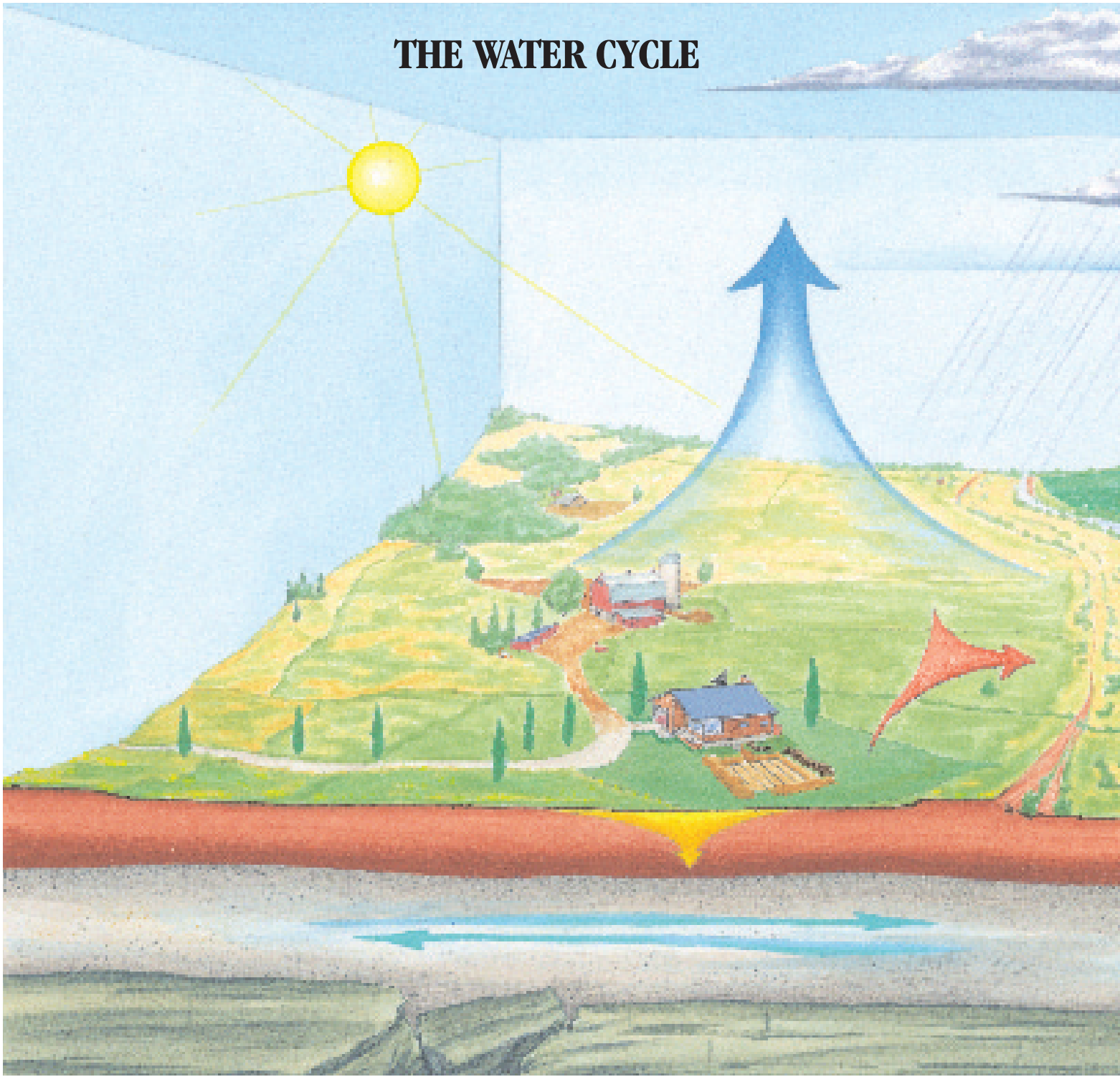
Read over the summary of acts and regulations starting on page 91. It will help you understand the goals of each, and the implications of them for you as a rural landowner.

Your farm is part of a drainage basin called a watershed. Water moves within watersheds, eventually flowing to larger bodies of water – in this case, the Great Lakes.



Pollutants carried off the farm eventually reach the main sources of Ontario's drinking water – the Great Lakes and the St. Lawrence River.

THE WATER CYCLE



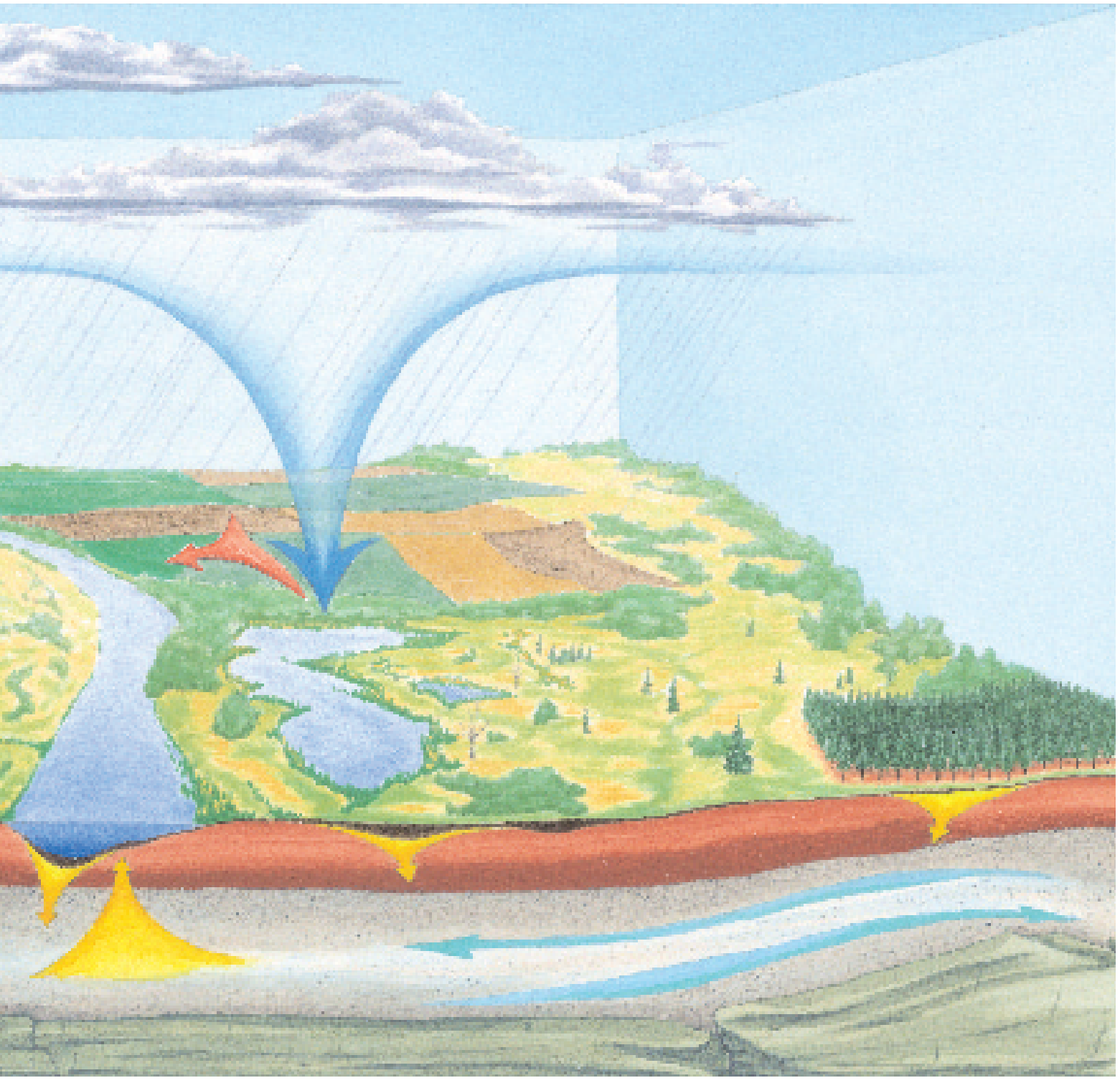
The water cycle establishes a balance in every part of your property. The arrows in the illustration above show you the many ways water moves onto, through, underneath, and out of a typical farmstead. You can also see the many opportunities you have to affect the quality and quantity of this precious resource.

Precipitation, mostly in the form of rain or snow, falls on land, buildings, and bodies of water. Precipitation can be temporarily stored in ponds, lakes, and rivers, held by snow and vegetation, or stored as ice and snow.

Some of the water falling on land and buildings flows overland as runoff to bodies of **surface water** (e.g. lakes and rivers). Some of the water that's held by soil or vegetation will **infiltrate** through soil materials, to be stored as **ground water**. Ground water can then move to lakes, rivers, ponds, wetlands, or to the soil surface.

At the soil surface, water can be **evaporated** directly to the atmosphere, or **transpired** when plants release moisture to the air.

Ground water flowing to the surface, or small surface water bodies (such as wetlands, ponds, and creeks), form part of a larger surface water system called a **watershed**. Water from this area will move to ever-larger bodies of water, such as large rivers and lakes.



Precipitation

Runoff

Evaporation and Transpiration

Ground water flow

Infiltration (uncontaminated)

Infiltration (potentially contaminated)

Ground water recharge

THE HOME

A survey conducted in 1992 of 1300 rural wells in Ontario found:

- **25% with fecal bacteria contamination**
- **15% with unacceptable levels of nitrates**
- **12% with detectable levels of pesticides (less than 1% over the maximum acceptable level).**

Older wells (over 60 years) and dug or bored wells had the highest frequency of contamination.

Plenty of clean drinking water is something most of us in Ontario take for granted. Each day, greater demands are being made on our water supplies. In fact, 15,000 to 20,000 new wells are installed each year in Ontario.

A recent survey of rural wells in Ontario raised some concerns about the quality of the water we're drinking.

Wise management of your home's water will help to ensure ample and safe water for everyone. You'll also realize some energy savings, and help your septic system function properly.

This chapter takes a look at:

- water sources
- water uses
- water disposal.

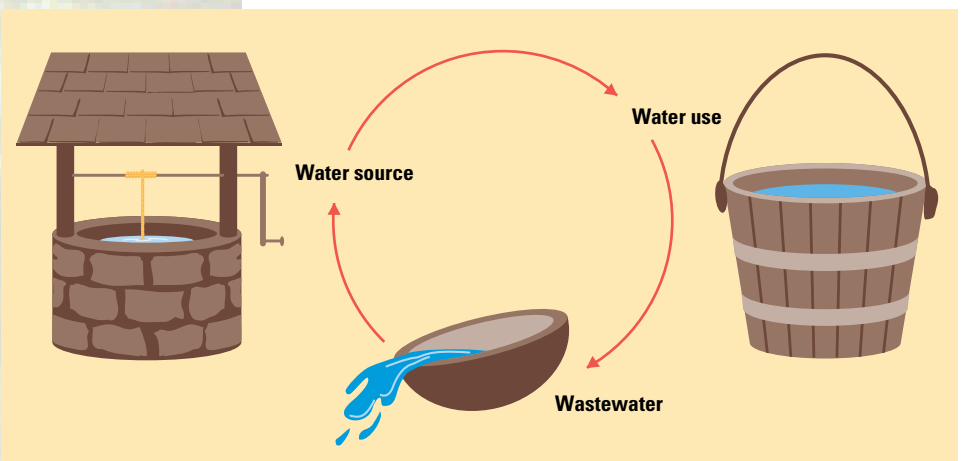
The last part of the chapter describes best management practices for:

- the well
- home water efficiency
- the septic system
- household hazardous wastes.

PATHWAYS OF WATER

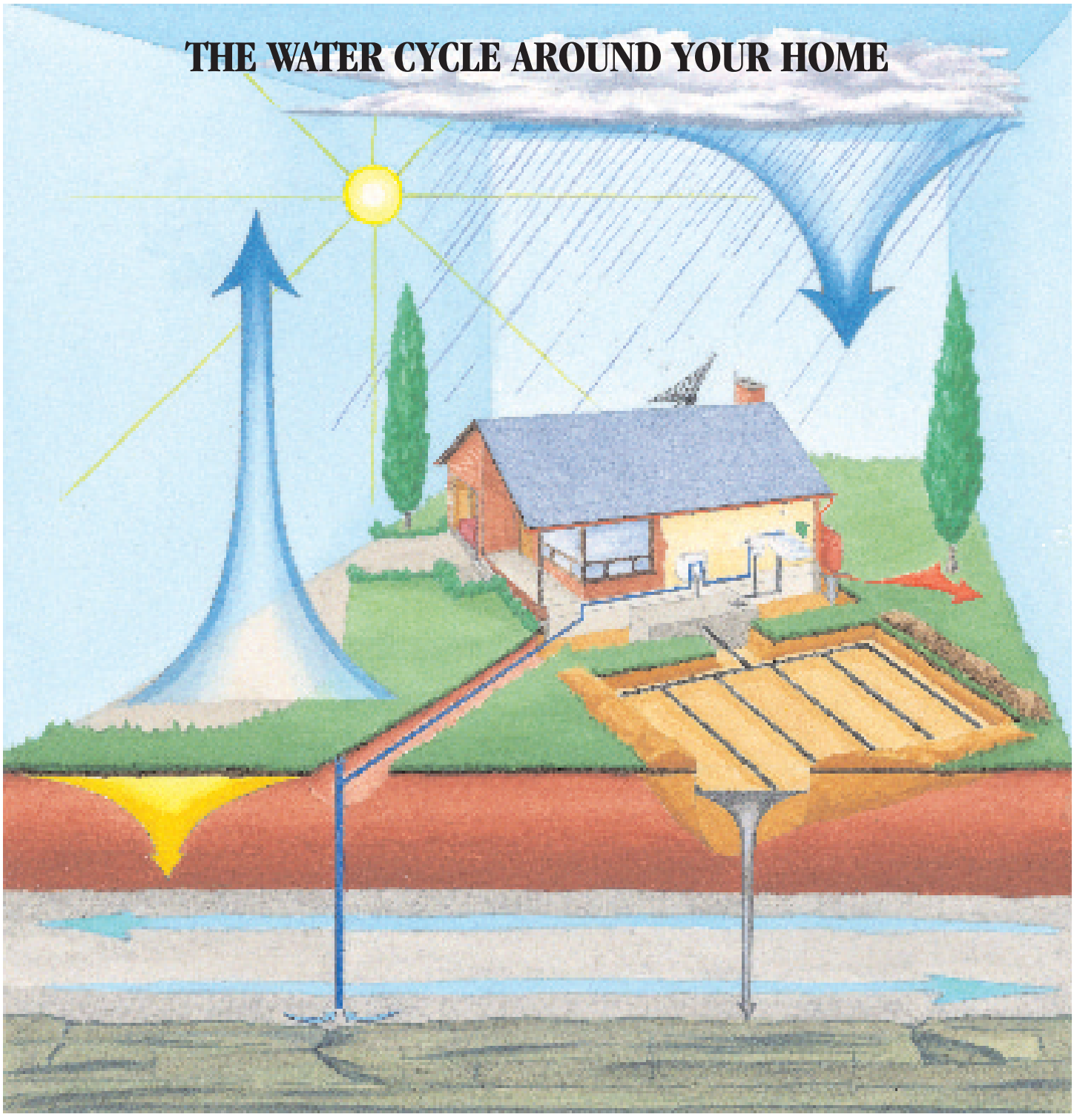
Every time a tap is turned on and water goes down the drain, the water cycle is affected. There's a direct link between the wastewater you create and the water you pump into your home.

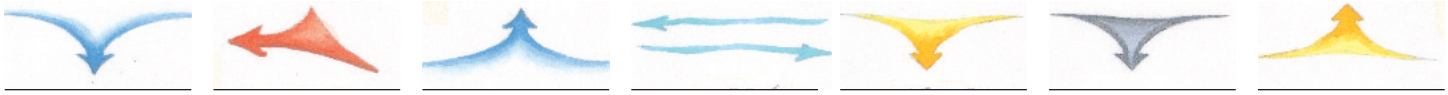
What you do with your home's water can have an impact on both the quantity and quality of ground and surface water.



Following the cycle of water from water source to water use to wastewater helps to identify the potential pathways of contaminants and water inefficiencies at your home.

THE WATER CYCLE AROUND YOUR HOME





Precipitation | **Runoff** | **Evaporation and Transpiration** | **Ground water flow** | **Infiltration (uncontaminated)** | **Infiltration (potentially contaminated)** | **Ground water recharge**

Around the home, the water cycle is concentrated in a very small area. The source of your family's water (usually a well) is often close to the wastewater system.

Unless properly managed, sources of contaminants, such as the septic system, concentrated runoff from paved driveways and eavestroughs, or fuels and pesticides used around the home, can infiltrate ground water and harm your drinking water. And the more water you use, the greater the potential for contaminants to reach ground water.

Best management practices will help you safeguard and conserve water resources.

THE HOME

WATER SOURCE

WATER SOURCES

Surface water from lakes and rivers is sometimes used as a water source for rural homes. Its quality is variable and it generally requires treatment. Many urban water supplies come from treated surface water.

Cisterns are used as a water source in some homes, but the water is usually not fit for drinking and must be treated. Rainfall collected from the roof is stored in concrete tanks in the basement. It should only be used for watering the lawn and garden or for laundry.

Wells supply drinking water to most rural homes. With proper management, ground water is normally of more consistent quality, temperature and quantity than surface water.

LOOKING BENEATH THE SURFACE: GROUND WATER AND YOUR WELL

Ground water is formed by rain and snowmelt that infiltrate the ground. Infiltration varies according to soil type and conditions.

In materials such as sand or gravel, 40 to 50% of rain and snowmelt can readily move through to form ground water. However, in clay soils, or when soil is frozen, or in compacted areas around the home and farmyard, you'll find less infiltration and greater surface runoff.

As water seeps down (technically, "percolates"), the soil and organisms in your soil help to filter and purify the water. Farther below, water stockpiles in a saturated zone. The top of this zone is called the **water table.**

The water table will rise and fall depending on water infiltration and water use. It can be significantly lowered locally when we remove excessive amounts of water.

Depending on the depth of your well, different zones of underground water can be accessed to supply your home's water. Each of these depths of ground water has a specific surface infiltration area, or recharge area, that supplies its water.

In terms of quality, a shallow well is affected by local contamination. A deeper well may be affected by distant pollution sources.

In terms of quantity, generally deeper drilled wells have more dependable supplies of water because of the larger recharge area.

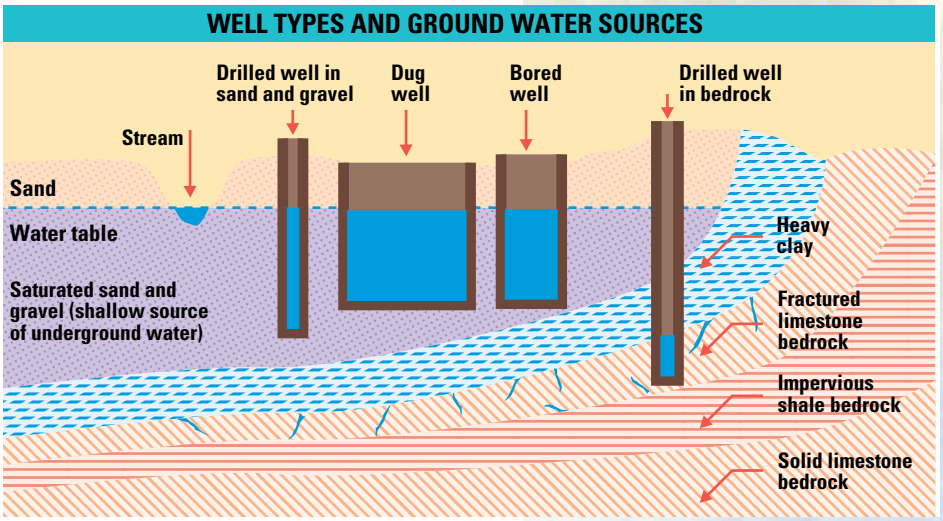
The flow rate from any well will be greater if the material surrounding it is porous, allowing water easy access to the well.

Infiltration to ground water is greatest in the spring and fall when the ground is not frozen. There is less evaporation by the sun, and plants use less water in these seasons.

THE HOME

Here are three common well types:

BORED	large-diameter wells constructed by using specialized earth-boring equipment. Casing material is usually concrete or steel.
DRILLED	wells not dug or driven, normally 10-20 centimetres (4-8 in) across.
DUG	large-diameter wells often constructed by power shovel, back-hoe, or by hand.



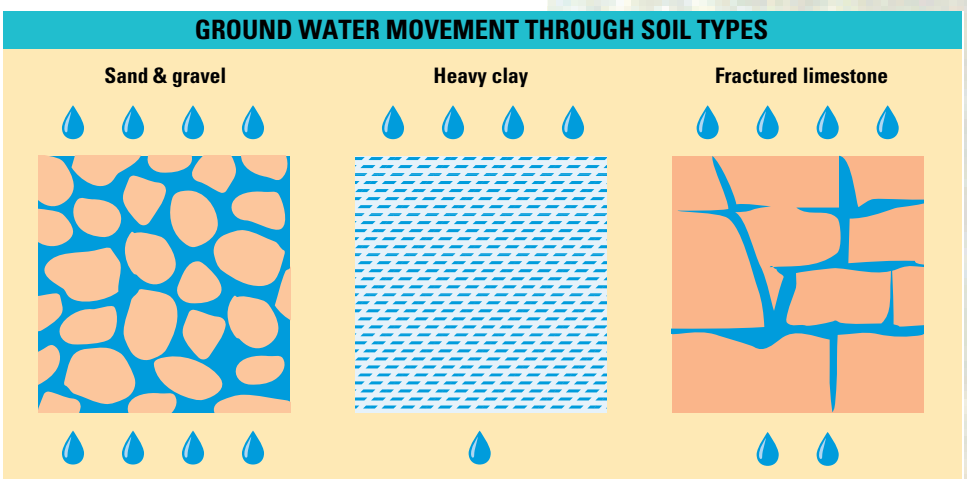
The type and depth of your well determine the water you can access.

THE FLOW OF GROUND WATER

Ground water flows fastest through coarse sands and gravels and through large cracks in bedrock. Fast-flowing ground water may travel laterally a few metres a day.

Slower-moving ground water, in tight clay soils for example, may travel a few centimetres to a few metres in a year.

This means that the water you are using today may have been precipitation or part of your neighbour's wastewater several years ago. It also means that the effects of long-lasting contaminants may be delayed, but will not go away.



Ground water moves more slowly in clay soils than in sands, gravels, or shallow soils over fractured bedrock.

THE HOME

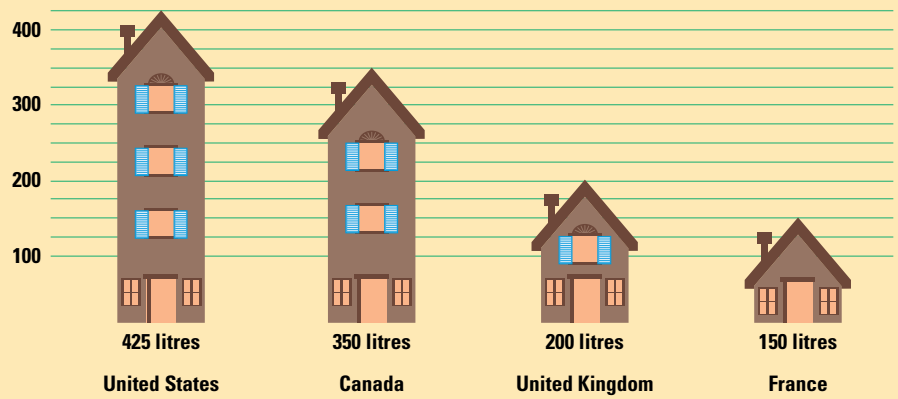
WATER USE

WATER USE

Ground water is accessed by your well for many household uses, such as cooking, bathing, laundry, and outdoor watering.

Because water has been a plentiful and inexpensive resource for Ontarians, we're accustomed to using a lot of water. Many of our water-using appliances were not designed for water efficiency.

AVERAGE DAILY HOUSEHOLD WATER USE (PER CAPITA)



The average Canadian uses over twice as much household water per day as a European.

Times are changing. With a growing population in many rural areas and greater demands on ground water supplies, increased water efficiency is becoming a necessary part of everyday life.

The benefits of using water efficiently are many:

- less wastewater volume to the septic system reduces the risk of overloading the system, allowing it to function better
- less risk of a water shortage
- less draw from ground water, which reduces the risk of distant contaminants moving toward the well
- less energy used to pump and heat the water
- less local transport of contaminants to the water supply (e.g. overwatering a lawn after a pesticide application can carry contaminants to your water supply).

Determining the amount of water used in the home will help you identify target areas for your water efficiency efforts. Household water use rates and suggestions for using less water are outlined on page 23.

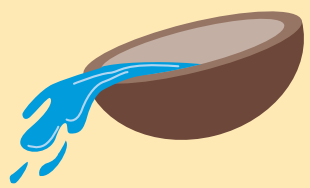
THE HOME

WASTEWATER

Water used in and around the house is put back into the water cycle as wastewater. Since much of it was used for washing and waste disposal, it will carry a number of contaminants.

Minimizing the harmful contaminants that are added to your water supply reduces the risk of polluting well water, lakes, and rivers.

WASTEWATER



THE FLOW OF WASTEWATER

AREA OF CONCERN	POTENTIAL CONTAMINANTS	POTENTIAL PATHWAY TO A WATER SOURCE
Septic Systems (includes grey water)	• bacteria, viruses and other disease organisms • nitrates • phosphorus (soaps) • chlorine • organic compounds	• infiltration below filter bed • illegal connections to field tile • seepage from leaking tank • surface ponding and runoff
Household Hazardous Waste	• paints, solvents • cleaners • furniture polish • medicine • disinfectants	• improper disposal to septic system • infiltration or runoff through improper disposal • contamination directly at the well
Lawn/Garden Products	• insecticides • herbicides • other chemicals • fertilizer nutrients	• infiltration, runoff • contamination directly at the well
Fuel Oil Storage	• petroleum products	• spills, leakages • infiltration, runoff • improper disposal
Used and Abandoned Wells	• bacteria • organic compounds • pesticides • fertilizer nutrients • petroleum products	• improper disposal • contamination directly at the well

THE HOME

One gram of the common lawn-and-garden herbicide, 2,4-D, can render 10-million litres of water unfit for drinking – equal to the amount of water used by 78 Canadians in one year.

A properly designed septic system should adequately treat traditional household wastes such as washroom and laundry wastewater. Your septic system was not designed to handle hazardous household wastes.

As water moves overland or seeps into soil, some filtering action and contaminant breakdown will occur naturally. However, hazardous wastes are less likely to be purified by biological processes. Once contaminants reach the water table, they are very difficult and extremely costly to clean up.

Yearly testing of your water supply will help to ensure the safety of your drinking water. And if tests show a problem, you can consider changing the way you manage your water supply and wastewater.

Here are some sample guidelines from the Ontario Ministry of Environment and Energy. (The following figures are taken from the 1992 Ontario Drinking Water Objectives: please note these are subject to change at any time. Some standards are stricter in the U.S.A. and Europe at time of publication.)

SELECTED DRINKING WATER OBJECTIVES – 1992

PARAMETER	DRINKING WATER MAXIMUM ACCEPTABLE LEVELS*	PROBABILITY OF CONTAMINATION	TESTING
BACTERIA Total coliforms Fecal coliforms	5 per 100 ml (no more than 2 consecutive samples should show the presence of coliforms) 0 per 100 ml	most common form of contamination is bacterial	available at local Public Health Unit, free of charge
INORGANIC PARAMETERS Nitrates Lead Sulphate	10 mg/L .01 mg/L 500 mg/L	occasional	private lab for moderate fee
PESTICIDES Atrazine 2,4-D Metribuzin Metolachlor	.005 mg/L** .1 mg/L .08 mg/L .05 mg/L	rare unless spills	private lab for high fee

***milligrams per litre = parts per million**
****as of 1994**

THE HOME

Wastewater from showers, baths, dishwashers, and washing machines is called **grey water**. Wastewater from toilets is known as **black water**.

You may be surprised to learn that grey water is as harmful to the environment as black water. Both contain similar amounts of fecal bacteria. These bacteria can cause diarrhoea, stomach cramps, and eye, ear, and nose infections if consumed by humans in drinking water.

Both black and grey water must be treated through a septic system as required by the Environmental Protection Act. This regulation is in place to protect your water supply, downstream water users, and the environment.

Reducing the volume of wastewater will enable the filtering process in the septic bed to do a better job.

Clean water should be diverted away from the septic system through careful placement of eavestroughs.

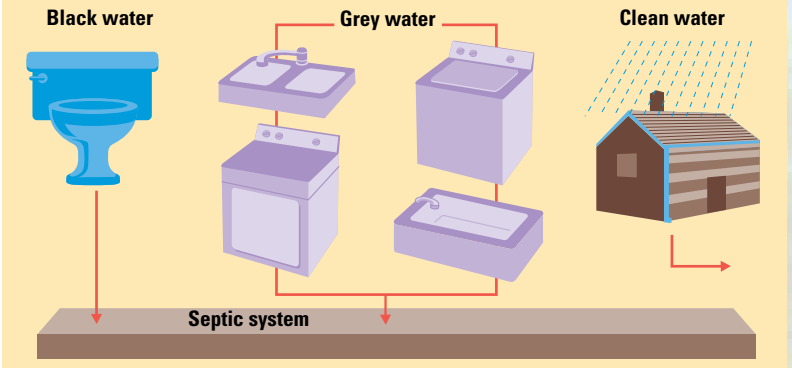
High nitrate levels in your drinking water can be a health threat, particularly for infants. The Ontario Drinking Water Objectives for nitrates in drinking water set a maximum acceptable level of 10 milligrams (or 10 ppm) per litre. Excess nitrates in infants under six months of age can cause blue baby syndrome, in which the blood loses its capacity to carry essential oxygen.

Ontario research has indicated that nitrate contamination (plumes) can be a problem. Concentrated areas of nitrate contamination move with the flow of ground water below septic systems. Nitrates, which come from septic waste, food waste, and soaps, move easily with water flow.

Ground water was monitored below a septic system at a rural home in Simcoe County. Contaminant discharge to a river 20 metres away occurred after the septic system was used for a year and a half.

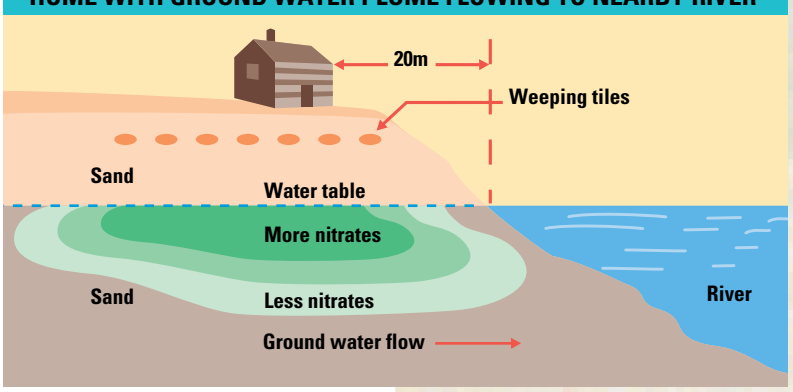
In a septic system, phosphorus-based soaps can have less impact on the environment than nitrate-based soaps. Nitrates are water soluble and tend to move easily with water. Phosphorus will tend to attach to the soil in the filter bed.

WASTEWATER AND THE SEPTIC SYSTEM



It's important to know which wastes to treat in a septic system...and which ones to keep out.

HOME WITH GROUND WATER PLUME FLOWING TO NEARBY RIVER



THE HOME

Approximately 500,000 rural homes in Ontario use private wells as a source of drinking water; 14% of these homes are on farm operations.

BEST MANAGEMENT PRACTICES

THE WELL

Your well is a direct access point to ground water. As such, the way it's constructed and how you use it can directly affect ground water quality and quantity.

WELL CONSTRUCTION

Best management practices for well construction are intended to protect the water supply from contamination at or below the soil surface.

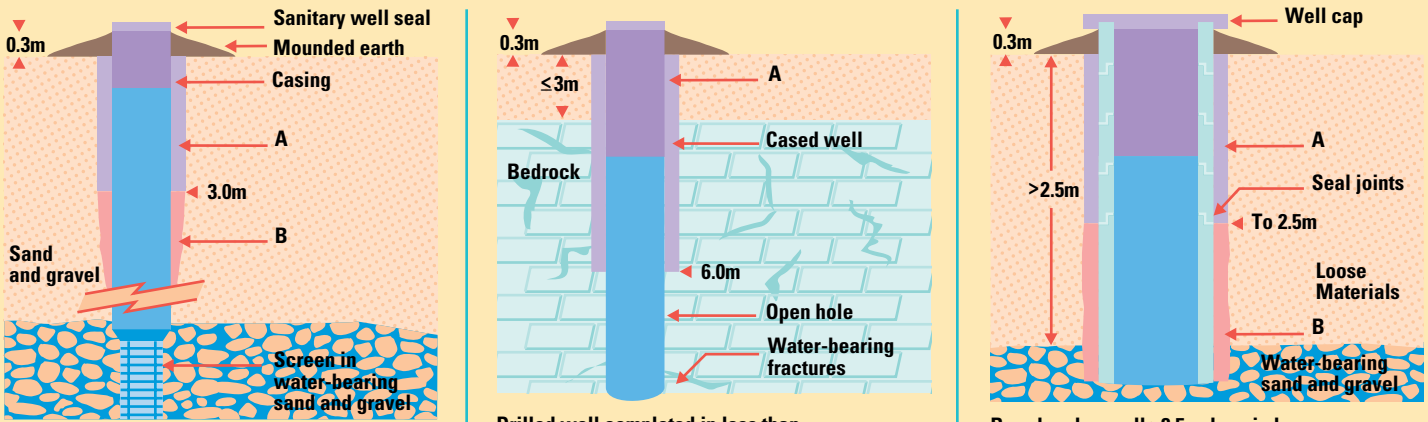
To prevent contamination from the surface, your well:

- ► must be capped and sealed
- ► should divert surface water away from the well head and avoid ponding around the well
- ► must be properly located.

To prevent contamination below ground level, your well must be:

- ► enclosed
- ► sealed in the space outside the tile casing (see diagram).

THREE WELL TYPES & THEIR CONSTRUCTION



A. Formation seal in space between hole and casing **B.** Formation stabilizer in space between hole and casing

Shown here are best management practices for the construction of three well types.

THE HOME

COMPONENTS	MATERIALS	WELL TYPE	REASON
SANITARY WELL SEAL	rubber disk between 2 metal plates, bolted to make watertight seal	drilled	to prevent contamination from surface
FORMATION SEAL	non-porous material in space between hole & casing (clay, cement grout, concrete, bentonite)	drilled bored dug	to prevent contaminated surface and shallow sub-surface waters from infiltrating the well
FORMATION STABILIZER	porous material in space between bore hole and casing (sand, gravel, clean soil, or well cuttings)	drilled (not in bedrock) bored dug	to stabilize the formation seal where well is located in loose material (not bedrock)

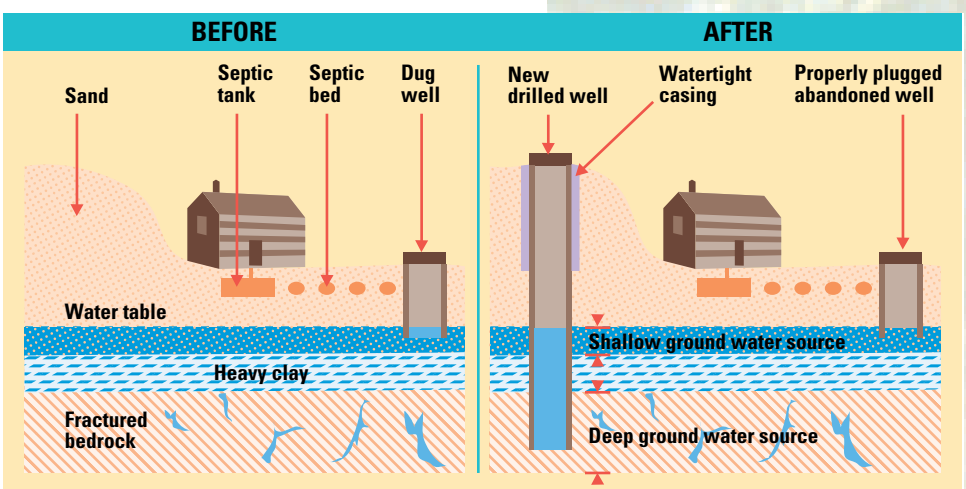
Remember that if you're a installing a well, it must meet standards established by the Ontario Ministry of Environment and Energy. Contact your local licensed well driller.

LOCATION

Your well should be located upslope and away from any potential contamination sources, such as:

- ▶ household septic systems
- ▶ pesticide storages
- ▶ manure storages
- ▶ fuel tanks
- ▶ roads and highways
- ▶ silos.

In general, the Ontario Environmental Farm Plan Worksheets recommend at least a 91-metre (300 ft) distance from potential contaminants. (This may not be practical at your farmstead.)



Locate your well upslope and away from any potential contaminants.

THE HOME

Your local Public Health Unit and your licensed well driller can help you choose a safe site for your well.

Here are some minimal legislative requirements for new wells.

New drilled wells:

- should have a watertight casing to a depth greater than 6 metres (20 ft) below the ground surface
- must be located at least 15 metres (50 ft) from any part of a sewage disposal system.

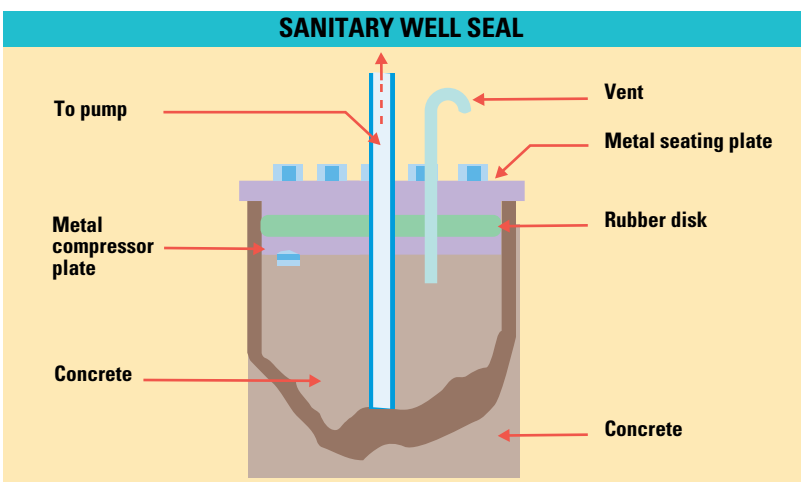
New dug or bored wells:

- should have a watertight casing to a depth greater than 2.5 metres (8 ft)
- must be located at least 15 metres (50 ft) from the septic tank and 30 metres (100 ft) from the leaching bed, or any other source of contamination.

MAINTENANCE

Check the well head every spring to ensure that the well seal is intact, the vent is screened, and the casing is not cracked or rusted through. Many cases of well contamination result from surface water infiltrating a poorly sealed well.

Every year you should check that the sanitary seal and well cap are secure and watertight.



A common type of well seal is a rubber disk sandwiched between two metal plates with a number of holes to allow the pump discharge pipes, cables, and a vent pipe to pass through.

THE HOME

CHECKLIST FOR YOUR WELL

Each year make sure that:

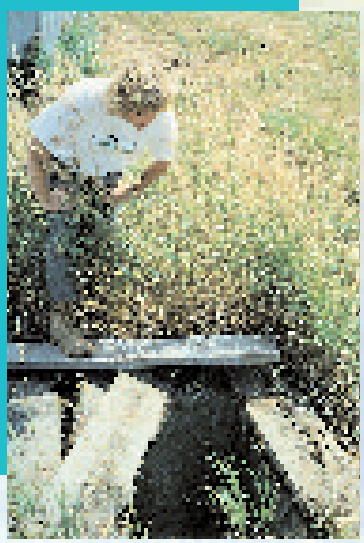
- ▸ surface drainage around your well is directed away from the well casing
- ▸ water doesn't pond on the ground near the well
- ▸ the sanitary seal and well cap are securely in place and watertight
- ▸ the well cap is at least 30 centimetres (12 in) above normal ground level
- ▸ all joints, connections, or cracks in the well casing are sealed with cement, grout, or other commercial materials
- ▸ well pump and distribution systems are in good condition
- ▸ a permanent grass buffer of a minimum 4-metre (12 ft) width is maintained around the well head
- ▸ water is tested for bacteria (contact your local Health Unit office – see the blue pages of your telephone directory for the phone number).

OTHER TIPS

- ▸ never allow vehicles and other equipment over the well head. They can damage the well casing, and wheel ruts can alter the drainage pattern.
- ▸ never handle or dispose of any hazardous chemicals or pollutants near the well
- ▸ keep the application of pesticides and fertilizers as far from the well as possible. Never treat the area around your well. Follow label directions for proper application rates.
- ▸ install backflow prevention devices on your faucets with hose connections to prevent water from draining back into the well
- ▸ ensure your records clearly note the location and status of all wells on your property.

An anti-backflow device (such as a check valve) on a faucet prevents water from drawing back into the well and causing contamination. If you don't have one, get one!

THE HOME



Unprotected wells are a high risk location for contaminated surface water to directly pollute the ground water through surface runoff.

ABANDONED AND UNUSED WELLS

If you have an unused or abandoned well on your property, it is your legal responsibility to ensure it is properly plugged. Grout and cement are commonly used. A licensed well contractor can do the job to meet Ontario Ministry of Environment and Energy regulations.

Be sure to keep an accurate record of the location of the plugged well for reference if water supply problems occur in the future.

WATER TESTING

Get your drinking water tested every year. It's the only way to ensure the safety of your water.

If your drinking water tastes poorly, smells badly, or is coloured, you know you have a water quality problem.

Unfortunately, taste, odour, and colour don't tell the whole story. Some unsafe levels of contaminants cannot be detected by the senses.

Your local Public Health Unit will help you test your water for bacterial contamination.

To test for other contaminants, contact your local office of the Ontario Ministry of Environment and Energy for information.

BACTERIA

The best time for testing for bacterial contamination is late spring, when surface water infiltration is most likely to occur. Your local Public Health Unit will provide sample bottles, advice on how to sample, and an explanation of the test results. The service is free (at time of publication).

THE HOME

Your local Public Health Unit will help you interpret water test results.

Your water sample will be tested for total coliform and fecal coliform bacteria. Fecal coliform bacteria originate in animals and humans.

Should your water test positive for these bacteria, have your water tested a second time, just to make sure.

If retesting proves positive, this may mean that your water was contaminated by a source such as a faulty septic system or manure runoff. It also indicates a risk of disease organisms.

The best treatment is locating and cleaning up the pollution source.

Here are some additional considerations:

- if you have a short-term problem, you might be able to improve your water quality with a single application of chlorine
- if your problem is long-term, you'll need a continuous water treatment system, or you may have to consider a new well
- check the condition of your well
- how long it will take to improve your well water quality depends on many factors – particularly the nature of the problem and the amount of water used
- consult your local Public Health Unit for help in solving problems with your well.

THE HOME

DETECTING WATER QUALITY PROBLEMS

PROBLEM	POSSIBLE CAUSE	POSSIBLE TREATMENT OF WATER SUPPLY
ILLNESS • diarrhoea • stomach cramps	• fecal bacteria • viruses • parasites	• chlorination (filtration unit) • ultraviolet system (water passes through an ultraviolet light to kill bacteria) • chlorination (injector unit)
INFANT ILLNESS • blue baby syndrome	• nitrates	• reverse osmosis units (removes chemicals by passing the water through a selective membrane)
POOR ODOUR AND TASTE • rotten egg odour	• hydrogen sulphide gas	• chlorination (filtration unit) • greensand filters • aeration • charcoal filters
CLOUDY WATER	• clay particles	• filters • alum treatment (settles out particles in water)
RUSTY BLACK STAINS • on fixtures and laundry	• iron and/or manganese	• filtration • greensand filters • water softeners • chlorination (filtration)
IRON STAINING • red/brown coating in toilet tank • poor taste and odour • slime buildup in well	• iron bacteria	• chlorination (filtration unit) • iron filters
SCALE BUILDUP IN KETTLES AND WATER HEATERS	• hard water	• water softener*
SALTY TASTE • corrosive	• chloride	• reverse osmosis
GAS SMELL AND GAS BUBBLES IN WATER	• methane gas	• aeration • activated carbon filter (filters out chemicals in the water)

***Note: You should leave 1 tap off the softened supply to provide drinking water that isn't elevated in sodium content.**

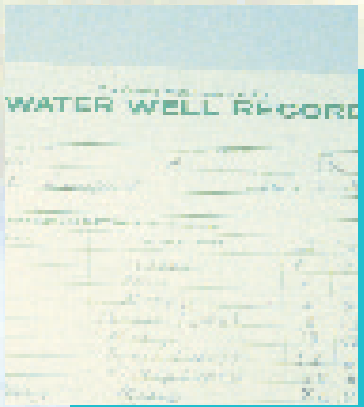
Adapted from *How Well is Your Well,* Waterloo Regional Health Unit.

THE HOME

WELL WATER SUPPLY

Ensure that your well has enough water to accommodate your needs. Overpumping can ruin a well by drawing sediment into it.

Check your Water Well Record to determine the pumping capacity of your well, or have it tested by a licensed contractor.



If you need a copy of your Water Well Record, contact the Ontario Ministry of Environment and Energy's Water Well Records Division, or a local licensed water well technician.

BEST MANAGEMENT PRACTICES

HOME WATER EFFICIENCY

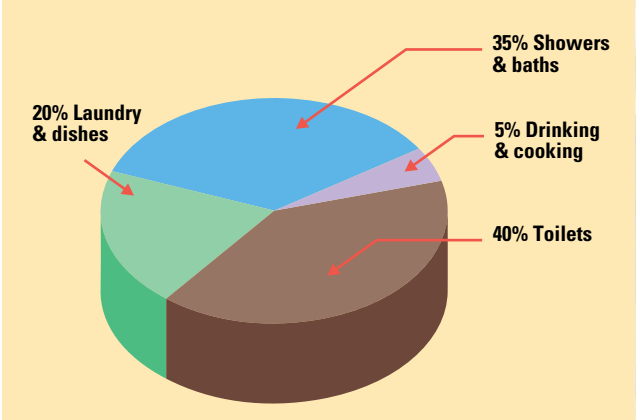
Using too much water can lower surface and ground water levels. This affects all water users, including aquatic life in streams and wetlands. Lower water levels also mean there's less water to dilute contaminants.

Many older septic systems were not sized for the additional water used in today's households. Keeping the volume of wastewater to a minimum may be all that is needed to keep a septic system working.

WATER USE

Keeping track of household water use for one week can help to identify the main areas of water use and where to target water efficiency efforts.

AVERAGE CANADIAN HOME WATER USE



THE HOME

It's estimated that 25% of households have leaking toilets. One leaking toilet can waste 200,000 litres of water in a single year.

REPAIRING WATER LEAKS

Most water leaks in a home's plumbing system are simple to find and easily repaired at little or no cost. Inspect each water-using facility to identify wasted water.

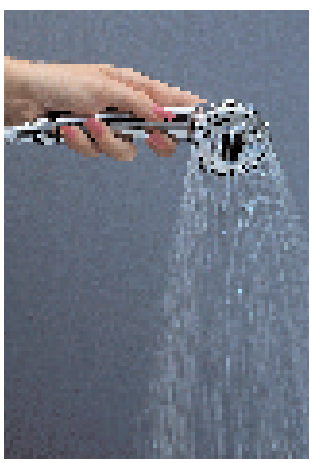
A leaking toilet can be detected by adding food colouring to the holding tank. If, after 10 minutes, it spreads to the toilet bowl without flushing, you have a leak.

Often, leakage results from a worn or misaligned flapper valve at the bottom of the toilet tank. The valve can be cleaned or inexpensively replaced. The float setting may also need some adjusting to prevent slow leaks.

A leaking tap is easily detected; replacement of a worn-out washer or cartridge will usually solve the problem.

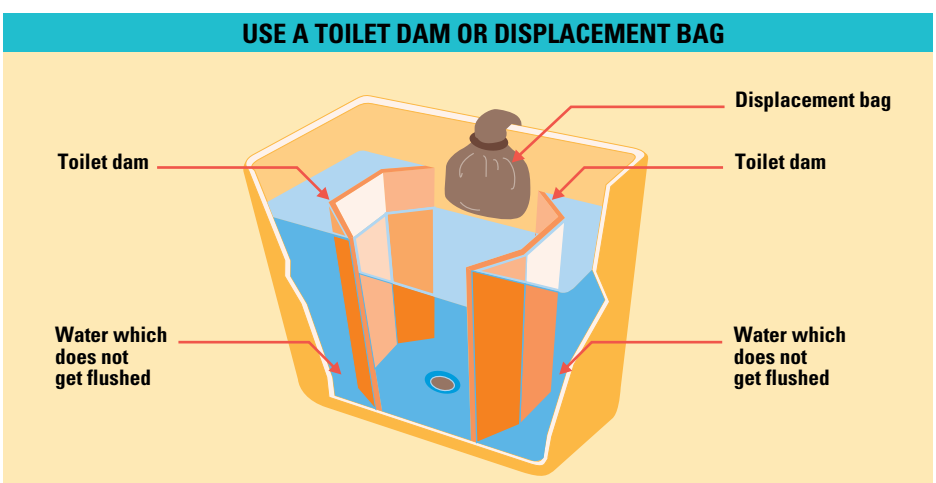
A timer for your lawn sprinkler is a convenient way to save water, time and money.

Low-flush toilets and toilets with dams and displacement bags will use less water.



Install a water-saving low-flow shower head.

USE A TOILET DAM OR DISPLACEMENT BAG



This diagram shows the proper placement of both a toilet dam and displacement bag. In real life, you would choose one or the other.

THE HOME

Here are some water-saving ideas for your home.

FIXTURE	AVERAGE WATER USE PER PERSON PER DAY	WATER-EFFICIENT MEASURE	WATER SAVINGS PER PERSON PER DAY
SHOWER	85 litres	• install a water-efficient shower head (cost $10 to $40)	35 litres
TOILET	114 litres	• install a toilet dam in a toilet. (saves 4 litres per flush; approx $7) • install a water-efficient toilet that uses 6 litres per flush (cost $150-$300)	24 litres 78 litres
DISHWASHER	9 litres	• wash full loads only	
WASHING MACHINES	45 litres (assumes a family of 4 does 5 loads of laundry per week)	• do one less load of laundry per week • use a 'suds saver' feature that allows rinse water to be reused (saves 50% of water used on second load)	10 litres
KITCHEN FAUCET	40 litres	• install a kitchen faucet aerator that maintains spray while using less water (cost $3)	15 litres
BATHROOM FAUCET	26 litres	• install a bathroom faucet aerator (cost $3)	9 litres
LAWN WATERING	36 litres per minute	• don't water your lawn • water in evening or early morning • choose grass varieties or ground cover that are drought-tolerant • use drip or trickle method • install a timer to avoid overwatering (cost $12 to $60)	

THE HOME

Faulty septic systems accounted for one-third of the bacterial contamination to surface water in a recent study of the Upper Thames River Watershed in Southwestern Ontario.

BEST MANAGEMENT PRACTICES

THE SEPTIC SYSTEM

Faulty septic systems pose significant pollution problems to our water in Ontario.

Common causes of malfunctioning septic systems include old and undersized systems, and a lack of maintenance of both new and old systems.

Treatment trench leaching bed installation.

Raised beds are installed over shallow bedrock in many areas in Eastern, Northern, and Central Ontario as well as in areas with heavy clay soils.

ALL wastewater produced in the house must be disposed of through the septic system. This includes toilets, showers, baths, dishwashers, and washing machines.

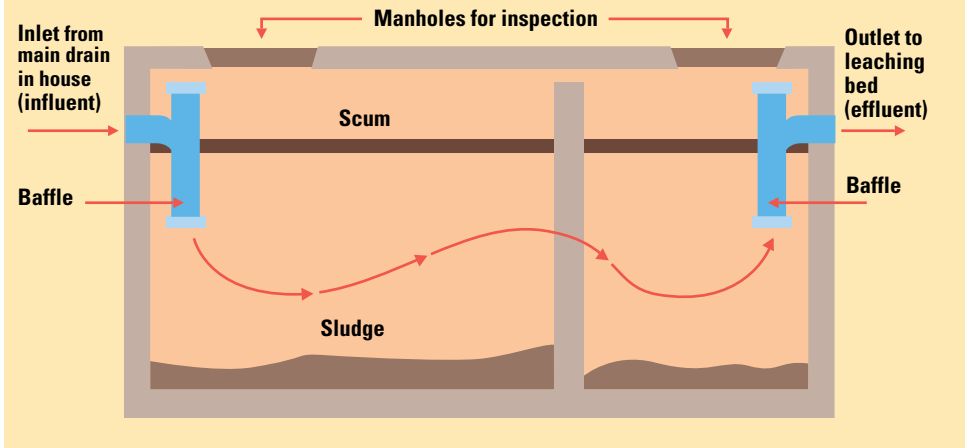
Water softener backwash should be diverted away from the septic system and treated in a separate leaching pit. Otherwise, if your water softener malfunctions, it can cause a total malfunction of the septic system.

Keep storm or drainage water out of the septic system. Eavestroughs, foundation drains, and footing drains should be drained away from the septic system.

Keep household hazardous wastes out of the septic system. It is not designed to treat these wastes. (Refer to page 28 for ways to dispose of household hazardous wastes.)

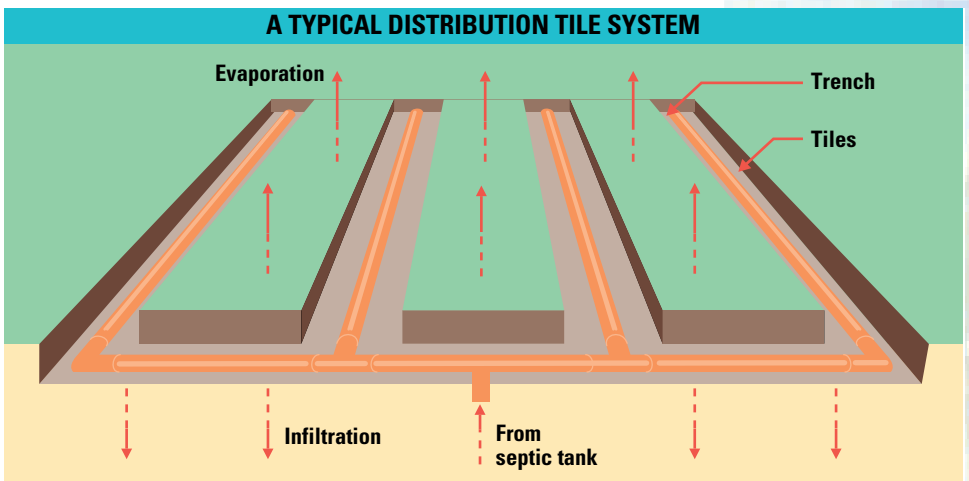
THE HOME

HOW A SEPTIC SYSTEM WORKS



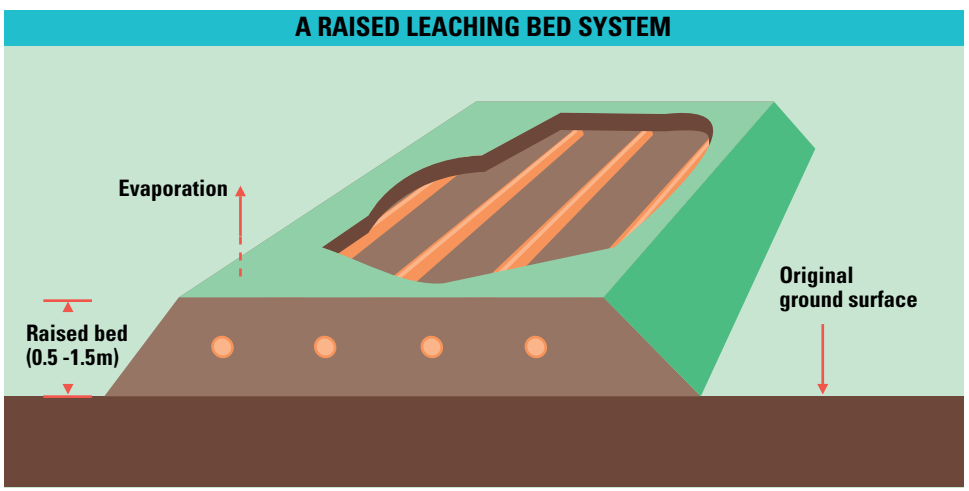
Solids settle out and bacteria work to break down the sewage. Liquids flow to the leaching bed.

A TYPICAL DISTRIBUTION TILE SYSTEM



How a leaching bed works: liquids from the septic tank flow through the perforated tile and into the soil.

A RAISED LEACHING BED SYSTEM



Raised bed septic systems provide suitable soil for the liquid from the septic tank to disperse over a large area. This encourages evapo-transpiration and seepage into the local soil.

THE HOME

LOCATION

Your septic tank must be at least:

- 15 metres (50 ft) away from a well, lake, stream, watercourse, tile drain inlet, pond, or spring
- 1.5 metres (5 ft) from your house, deck, swimming pool, or any other building or structure – this prevents structural damage to the system.

Your leaching bed must be at least:

- 15 metres (50 ft) away from a lake, stream, watercourse, tile drain inlet, pond, swimming pool, or spring not used as a source of potable water
- 30 metres (100 ft) from a dug or bored well, a spring used as a source of potable water, or any well with a watertight casing less than 6 metres (20 ft) below the ground surface
- 15 metres (50 ft) away from a drilled well with a watertight casing to at least 6 metres (20 ft) below ground
- 5 metres (16 ft) away from your house or any other building or structure. This allows maximum sunlight for evaporation from the bed and prevents seepage under buildings.

Note: the Ontario Environmental Farm Plan Worksheets recommend that a septic system be more than 91 metres (300 ft) from a well and 152 metres (500 ft) from a watercourse to better protect water supplies.

The greater the depth between the bottom of the treatment trench and saturated soil or bedrock, the better the treatment potential of your system. Greater than a .9-metre (3-ft) distance is required.

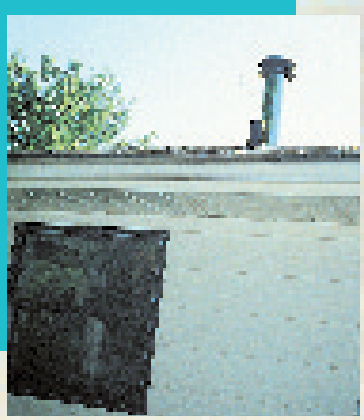
A good grass cover over the bed will help to use up excess water and nutrients. But, watch for excessive and rapid grass growth over the tile lines. It could be an indication that the system is not performing properly, and is possibly overloaded.

HOW TO LOCATE YOUR SYSTEM

Look for the main drain in the basement (100 mm or 4-inch pipe), the pipe stack (100 mm or 4-inch pipe running up through the floor), and the main roof vent. These will normally be on the same side of the house. The septic tank is generally 1.5 to 3.0 metres (5 to 10 ft) from the foundation and will usually line up with the roof vent pipe.

The leaching bed is most evident in dry summer periods when grass may be greener over the tile runs. These runs are generally 1.6 metres (5 to 6 ft) apart.

To locate the septic tank and leaching tiles, you can use a metal rod (carefully) to tap below ground.



The septic tank will generally be located in line with the main roof vent on your house.

THE HOME

TROUBLESHOOTING	POSSIBLE PROBLEM
Odours	• holes or leaks in the septic tank • air currents over roof vent • surface outbreaks in leaching bed area
Ponding or Wet, Spongy Areas	• overloading of the tank or leaching bed caused by overuse or adding facilities • poor surface drainage • high water table
Backed-Up Toilet	• septic tank full of sludge • blockage in tile bed (e.g. tree roots) • blocked intake pipes to septic system

CARE, MAINTENANCE AND USE

- ▸ have your septic tank pumped out once every three years by a licensed contractor (this is the average length of time for solids to accumulate in the tank to a level where pumping is necessary)
- ▸ if the access port to your tank is completely buried, you may consider a more convenient cap to allow easier periodic inspection and pumping
- ▸ use water efficiently in the home and repair all leaks
- ▸ keep storm and drainage water out of the septic system: eavestroughs, foundation drains, and footing drains should be diverted from the septic system
- ▸ keep trees and shrubs away from the leaching bed
- ▸ keep hazardous household wastes as well as fats and food wastes out of the septic system
- ▸ reduce your use of harmful solvents and cleaners – switch to environmentally friendly products
- ▸ inspect your septic system to see whether it's connected to any field tile drainage system – such connections are illegal
- ▸ make sure there's a good grass cover over the leaching bed – never add fill over the leaching bed or use the area as a garden.

Have your septic tank pumped every three years.

BEFORE YOU START

Before constructing, installing, or altering a septic system or building in any way, a Certificate of Approval is needed. You can get one from your local Public Health Unit, Ontario Ministry of Environment and Energy, or Conservation Authority. (Phone numbers of the first two are in the blue pages of your telephone book.)

Before using a new or altered septic system, a Use Permit is needed. Contact your Local Health Unit, Conservation Authority, or the Ontario Ministry of Environment and Energy.

THE HOME

CORROSIVE: Substances that eat and wear away at many materials.

FLAMMABLE: Flammable vapours produced by liquids that can ignite.

EXPLOSIVE: Pressurized aerosol containers that may explode if incirated or stored above 50°C

POISON: Materials that are poisonous or lethal to you, your children and your pets, even in small quantities.

Be aware of the danger symbols on products. Products such as pesticides are designed to kill specific pests. They can also be toxic to people.

Don't flush hazardous wastes down your toilet. Your septic system isn't designed to dispose of them.

BEST MANAGEMENT PRACTICES

HOUSEHOLD HAZARDOUS WASTE DISPOSAL

Many products used daily in the home can be harmful to the environment. They contain a wide array of chemicals. If not disposed of properly, they can end up in your water supply – and have very serious impacts on your family's health.

Hazardous wastes used around the home include:

PESTICIDE AND GARDEN PRODUCTS	fertilizers, insecticides, weed killers, rat poisons, mothballs, flea collars and sprays
HEALTH PRODUCTS	unused medicine
VEHICLE PRODUCTS	batteries and battery acid, transmission fluid, antifreeze, car wax with solvents, motor oil
PAINTS AND GLUE PRODUCTS	brush cleaners, enamel or oil-based paints, paint strippers, primers, stains/finishes, thinners, turpentine, wood preservatives
CLEANING PRODUCTS	chlorine bleach, disinfectants, floor and furniture polish, oven cleaners, metal cleaners, rug and upholstery cleaners
OTHER WASTES	dry-cell batteries, butane lighters and cylinders, lighter fluid, swimming pool chemicals

WASTE MANAGEMENT

Common sense prevails in properly managing household hazardous wastes:

- ► never dispose of hazardous wastes down a drain or a toilet
- ► use alternatives to hazardous products
- ► buy only the amount you will use
- ► don't over-water your lawn after using pesticides and fertilizers. Runoff to streams or infiltration to ground water can occur.
- ► securely store any excess in a well-ventilated place for transport to a Hazardous Waste Collection Depot.

THE HOME

DISPOSAL

Take excess household hazardous products to your recycling depot (for specific products such as batteries, paints, or oil), or to a Hazardous Waste Depot.

Many communities are holding special collection days for hazardous wastes. Contact your municipality for information. If there is no collection program in place, encourage your municipality to apply to the Ontario Ministry of Environment and Energy's Household Hazardous Waste Collection Program (as of July 1993). Contact:

Program Co-ordinator
Household Hazardous Waste Collection Program
Program Development Branch
Ontario Ministry of Environment and Energy
40 St. Clair Avenue West, 11th flr.
Toronto, Ontario M4V 1M2
(416) 314-7878 in Toronto, 1-800-268-4483 toll free

SOME SAFE ALTERNATIVES

COMMON HOUSEHOLD PRODUCT	SAFER ALTERNATIVES FOR IN AND AROUND THE HOME
CLEANERS	
All-Purpose Cleaner	• mix 250 ml ammonia, 250 ml white vinegar, 125 ml baking soda, 2 litres water
Disinfectant	• 250 ml of borax with 4 litres of water
Floor and Furniture Polish	• a spray bottle with one part lemon juice and two parts olive or vegetable oil
Window Cleaner	• a mixture of vinegar (1/4) and water (3/4)
Laundry Bleach	• borax or washing soda instead of chlorine bleach
PESTICIDES	
Insecticides	• insecticidal soap, diatomaceous earth products for indoors, spray plants with mild dishwashing liquid in water (1/2 capful in 500 ml)
Herbicides	• hoeing or hand weeding
Fertilizer	• use well-composted manure or bonemeal
Mothballs	• cedar chips, newspaper
Roach Killers	• traps or baking soda and powder sugar mix
Ant Killers	• chili powder to hinder entry

Adapted from *Hazardous Wastes in Your Home,* Environment Ontario

THE BARN AND OTHER FARM BUILDINGS

The water you use around farm buildings can directly affect the quality and quantity of your water supply.

Nearly 34,500 Ontario farms water livestock. This accounts for 57% of agricultural well water use. Other typical uses around farm buildings include:

- barn and milking equipment washing
- chemical mixing
- greenhouse irrigation.

Keeping surface and ground water clean is beneficial to:

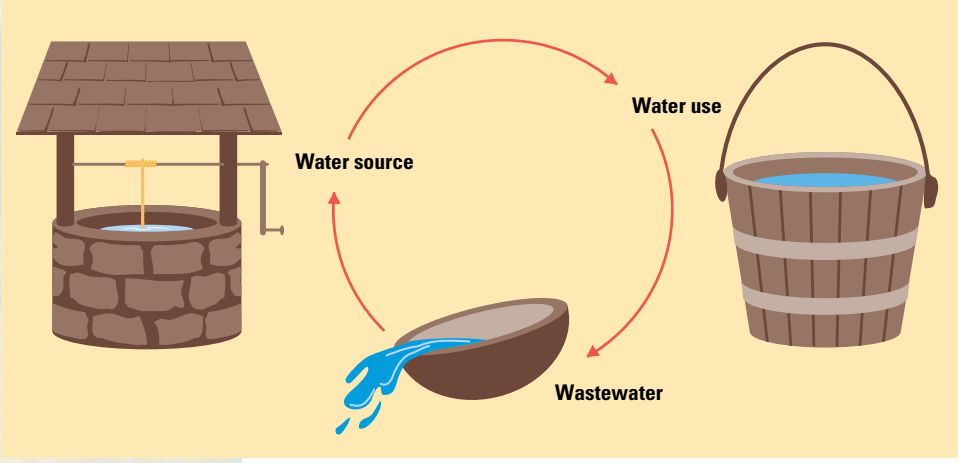
- family health
- livestock health
- neighbours, community, and all downstream water users
- aquatic environment and wildlife
- public perception of agriculture
- your bottom line: nutrients and pesticides are most cost-effective when they remain on their target crop.

You should expect the same regard for water protection from other water users.

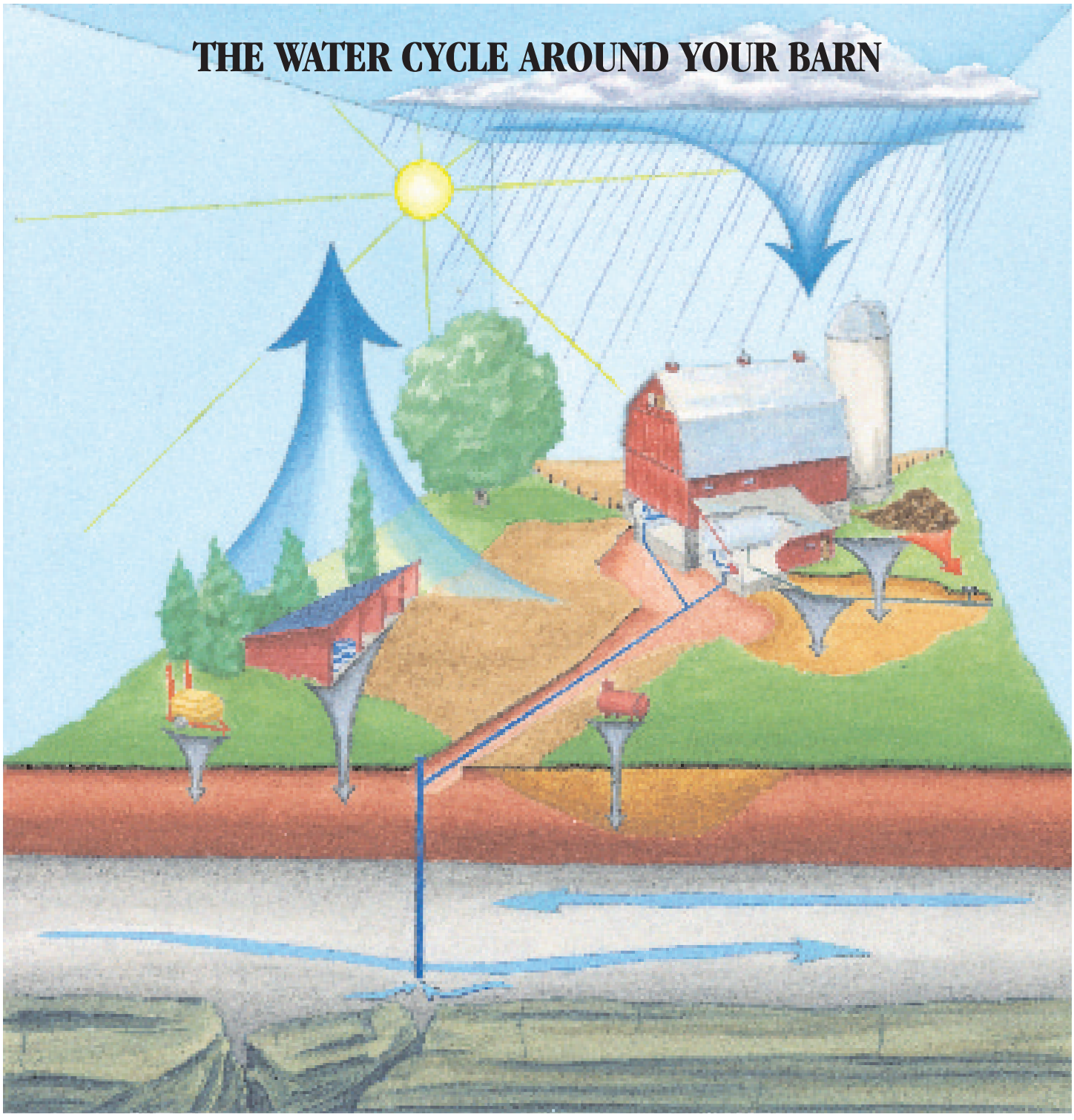
PATHWAYS OF WATER

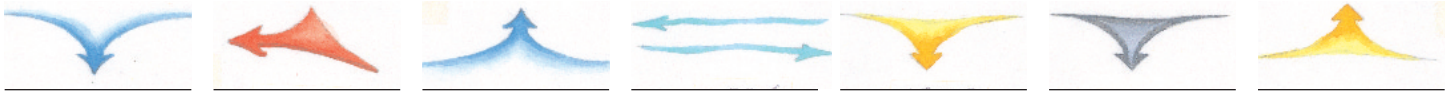
The components of your farmyard – buildings, feedlots, laneways, and concrete areas – significantly alter the natural pathways of water. Your farmyard has great potential to impact your water supply because it very likely contains the most concentrated area of contaminants.

Look at how water is used and disposed of around your farm buildings. This is the best way to determine how your operation affects the water cycle.



THE WATER CYCLE AROUND YOUR BARN





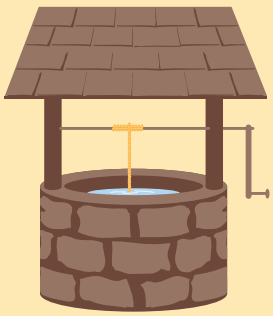
Precipitation | **Runoff** | **Evaporation and Transpiration** | **Ground water flow** | **Infiltration (uncontaminated)** | **Infiltration (potentially contaminated)** | **Ground water recharge**

Like the home, the water cycle around the barnyard is concentrated in a relatively small area. It's especially important here to control contaminated runoff. Any contaminants picked up by runoff around the farmyard can directly pollute ground water. Potential contaminants include many farm inputs stored here, such as fertilizers, pesticides, fuels, manure, etc. Surface runoff potential is increased due to the number of compacted soil and concrete areas (laneways, feedlots, etc.).

Runoff can flow overland to surface bodies of water, such as drainage ditches, or to catch basins and tile drainage systems. Precipitation can also infiltrate soil in concentrated areas, such as sandy/gravelly soils around buildings. Best management practices store potential contaminants safely, and divert contaminated water from water sources.

THE BARN AND OTHER FARM BUILDINGS

WATER SOURCE



WATER SOURCES

Over 80% of the water used in and around farm buildings is supplied by ground water through the farm well. Generally, ground water is of more consistent temperature, quality, and supply than the surface water of farm ponds, streams, and rivers.

Another water source around your farm buildings is precipitation. This clean water should be diverted from the farmyard before it picks up contaminants from areas such as a barnyard or feedlot.

Roofing, eavestroughs, and water diversions around the farmyard will reduce the amount of contaminated liquids that will run off overland.

Once precipitation lands, its path is determined by ground cover, ground compaction, natural drainage, and the amount of precipitation.

Compacted soil and concrete areas increase surface runoff and prevent uniform seepage to ground water. Proper management of this surface runoff will lessen the transport of contaminants to streams or ground water.

Treed and grassed areas around farm buildings help to filter out contaminants in runoff water.

THE BARN AND OTHER FARM BUILDINGS

WATER USE

Ground water is accessed by the well to service livestock, greenhouse irrigation, milkhouse and barn cleanup, and sprayer filling. This may be the same well that supplies the family with water for drinking, cooking and washing.

AVERAGE DAILY WATER USE	LITRES PER DAY
milking cow	90
beef cow or dry cow	45
dairy heifer	30
horse	42
hog	7
sheep	7
100 hens and pullets (<20 weeks)	20
100 hens and pullets (20 weeks)	27
100 turkeys	50
milkhouse wash	500-1500
1-cm (0.4-in) hose with nozzle	900 L/hour
2-cm (0.8-in) hose with nozzle	1400 L/hour
family member (kitchen, laundry, bath)	350
dairy operation with 40 milkers	6000

(Data supplied by *Farm Water Supply,* Publication 476.)

Water efficiency in your operation will help to prevent water shortages. It will also reduce your energy bills and wastewater volume.

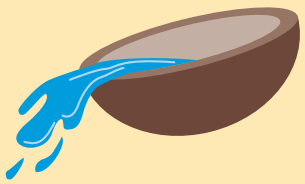
WATER USE

The months of June, July, and August have less than 12% of Ontario's annual streamflow, yet 51% of agricultural water use.

A dairy farmer in Oxford County helped develop and install an innovative water-efficient sink in his milkhouse and reduced total washwater use by 51%, saving $216 per year on his water-heater electricity bill and $288 per year on cleaning chemicals. The retail cost of the sink was $470.

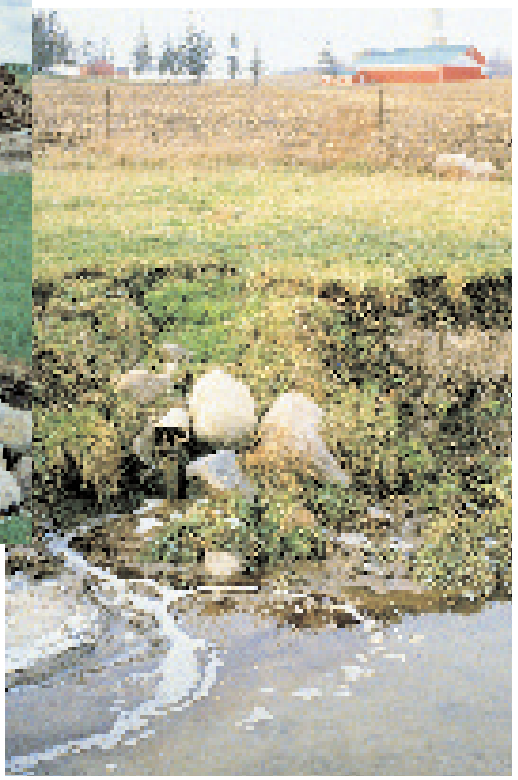
THE BARN AND OTHER FARM BUILDINGS

WASTEWATER



WASTEWATER

Wastewater carries contaminants. Preventing contaminants from reaching your washwater, rainfall, or snowmelt will reduce risks to ground and surface water.



It's important to prevent contaminated water from entering streams through overland flow to a catch basin or drainage ditch, or through a direct connection to tile drainage.

Ponded, contaminated water on low, coarse-textured land, or on shallow, fractured bedrock, poses a high risk of polluting ground water.

THE BARN AND OTHER FARM BUILDINGS

The following sources can contaminate your ground water. Remember that most wastewater associated with these sources will move through the water cycle and return to the water source (ground or surface water).

SOURCES OF CONTAMINANTS	POTENTIAL CONTAMINANTS	POTENTIAL PATHWAY TO WATER SOURCE
FUEL STORAGE	• diesel fuel, gasoline • used engine oil, lubricants • breakdown products (eg. benzene)	• spills, leakages • infiltration to ground water • runoff to surface water
FERTILIZER AND PESTICIDE STORAGE AND HANDLING	• chemical products • breakdown products	• backsiphoning into the well or water supply • spills, leakages • infiltration, runoff
MANURE STORAGE	• nitrates and other nutrients • bacteria	• storage overflow, spills • runoff, infiltration
SILAGE LEACHATE	• nitrates and other nutrients • acids • organic matter, bacteria	• infiltration, runoff, spills
MILKHOUSE WASHWATER	• phosphorus, nitrates • chlorine • bacteria • degraded milk solids	• illegal connection to tile drainage • runoff, infiltration
GREENHOUSE WASTES	• pesticide products • organic matter • phosphorus, nitrates	• runoff, infiltration
DEADSTOCK AND OTHER HAZARDOUS WASTES	• bacteria, disease organisms • medicines • disinfectants • paints, cleaners, oils • batteries	• infiltration, runoff from improper disposal

As water moves overland or infiltrates soil, some filtering action and contaminant breakdown will naturally occur.

THE BARN AND OTHER FARM BUILDINGS

Petroleum products also pose a health risk. Just one litre of oil can render up to 2-million litres of water unfit for drinking.

The potential for a contaminant to harm your water source depends on:

MOBILITY	► some contaminants, such as nitrates, dissolve easily in water and will readily be transported by water to water sources.
PERSISTENCE	► some forms of pesticides will remain in the water supply for many years. (Atrazine and Simazine are examples of herbicides used in Ontario that are particularly persistent in water.) ► many bacteria found in manure or sewage will survive for only up to a couple of months in a water supply. (If fecal bacteria are found in a sample of your well water, it's likely the result of recent contamination.)
TOXICITY	► some contaminants pose a health risk in very small amounts. One example is the mercury in car or disposable batteries. Low levels of mercury that are below detectable limits in streamwater can accumulate in fish.

A water management plan for your farm will help to reduce the risk of harming your own water supply, and protect the water supply of downstream water users.

BEST MANAGEMENT PRACTICES

PESTICIDE STORAGE AND HANDLING

Crop protection chemicals are an important part of many cropping systems in Ontario. By using these efficiently and carefully, you are helping to ensure:

► personal safety
► financial savings
► a safe environment.

Approximately 120 pesticides are licensed for use in Ontario. These are in the form of herbicides, fungicides, nematocides, rodenticides, insecticides, and growth regulators.

THE BARN AND OTHER FARM BUILDINGS

SAFETY CONCERNS

Pesticides, by design, are toxic to plants or animals, and in most cases, insects. If mishandled or misused, they can also be toxic to people.

Those with the greatest risk of harm from accidents or misuse of crop protection chemicals at the farm buildings are:

- the pesticide handler
- the farm family
- other water users, including neighbours, animals, and aquatic life.

The health effects from pesticide contamination depend on the type of chemical and the amount of exposure.

An accidental spill or backsiphoning of a chemical into your well can severely impair drinking water. Immediate health problems can result. There have been few reported cases.

Trace levels of pesticides that seep to your water supply can have delayed effects. The effects of repeated exposure to these low levels of pesticides are unknown, but may produce health problems many years after the exposure.

The following best management practices will help you to store and handle your pesticides safely. And remember that using chemicals as efficiently as possible – through tillage practices, crop rotations, and careful pest monitoring – is a positive step toward ensuring our safe water supplies.

Triazine herbicides are the most commonly reported pesticide contaminants in ground water. Atrazine, for example, can persist for more than a year in the environment and has been found in surface and ground water in many sites in Southern Ontario.

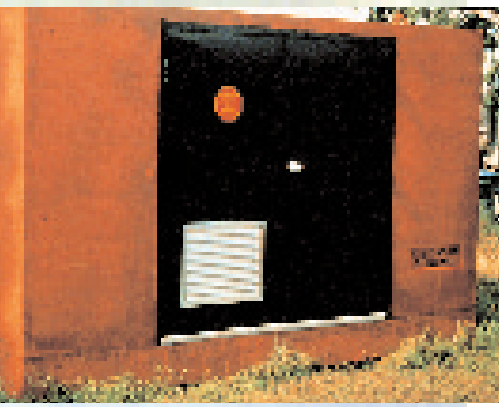
A recent survey of 1300 rural wells found 12% with detectable levels of pesticides. One well exceeded the safe level for the herbicide Metolachlor as a result of a spill at the well.

STORAGE

AMOUNT STORED

- minimize the amount of pesticides stored at any one time. (The Ontario Environmental Farm Plan Worksheets recommend less than 20 kilograms or 20 litres.)
- return unopened containers to the supplier
- only store partly used containers on the farm
- use custom applicators
- use line injection systems
- use bulk containers (to minimize the number of containers).

THE BARN AND OTHER FARM BUILDINGS



Pesticides should be stored in a separate building or room used only for storing pesticides. A separate building is preferred. If the storage is within another building, the interior walls of the storage should have a fire-resistant rating of at least one hour.

STRUCTURE

Pesticides should be stored away from humans, livestock, feed, produce, and clothing. Other considerations include:

- ► area should be dry, heated, and insulated to protect the stored chemicals. For small quantities of pesticides stored over winter, an insulated and heated cabinet is adequate.
- ► floor should be sealed and curbed to contain any spills or leaks within the storage. There should be no floor drain.
- ► area outside of the storage should be well-drained
- ► storage should be located as far from any water source as possible. (The Ontario Environmental Farm Plan Worksheets recommend storing pesticides at least 91 metres [300 ft] from a well.)

For personal safety, the storage should contain:

- ► a locked door – accessible from outdoors only
- ► a "Warning: Chemical Storage" sign on all doors
- ► ventilation to the outside
- ► original labelled containers
- ► posted emergency telephone numbers for the ambulance, doctor, poison control centre, fire department, and Spills Action Centre of the Ontario Ministry of Environment and Energy
- ► protective clothing and respiratory equipment readily available
- ► an updated list of all stored chemicals.

Before building a storage, check the requirements of the Pesticides Act and the Canadian Farm Building Code.

A pesticide storage should have a Warning sign on all doors.

A pesticide storage should be designed to store chemicals, prevent spillage, and contain spills if they occur. For these reasons, the building should be dry, heated, well-ventilated, and have a curbed floor, locked door, and signs posted.

THE BARN AND OTHER FARM BUILDINGS

MIXING AND LOADING PRACTICES

Here are some tips and considerations:

- ▶ locate the area where you mix and load as far away as is practical from any water source – the Ontario Environmental Farm Plan Worksheets recommend a distance of 91 metres (300 ft) from any well or other water source
- ▶ a mixing/loading area with a curbed concrete pad and runoff containment will contain any spilled chemical or rinsate
- ▶ use a separate water tank as the water supply
- ▶ use an anti-backflow device and/or a 15-centimetre (6-in) air gap above the sprayer tank when drawing water – it will prevent water in the spray tank from draining back into the water source
- ▶ keep constant supervision to ensure there are no overflows
- ▶ follow label directions when mixing and using pesticides
- ▶ wear the proper protective clothing as shown on label directions
- ▶ put a roof/cover over the area to minimize the potential amount of contaminated water you have to deal with
- ▶ any leftover solution should be applied to the same sprayed field. Application should be carried out away from a well or any surface water – the Ontario Environmental Farm Plan Worksheets recommend more than 60 metres (200 ft) from a well and 9 metres (30 ft) from surface water or a tile inlet.

It makes economic and environmental sense to plan ahead and mix the exact amount of spray required for the area. Consider using the line injection systems that mix only what is used.

A chemical mixing/loading area should be designed to contain any spillage.

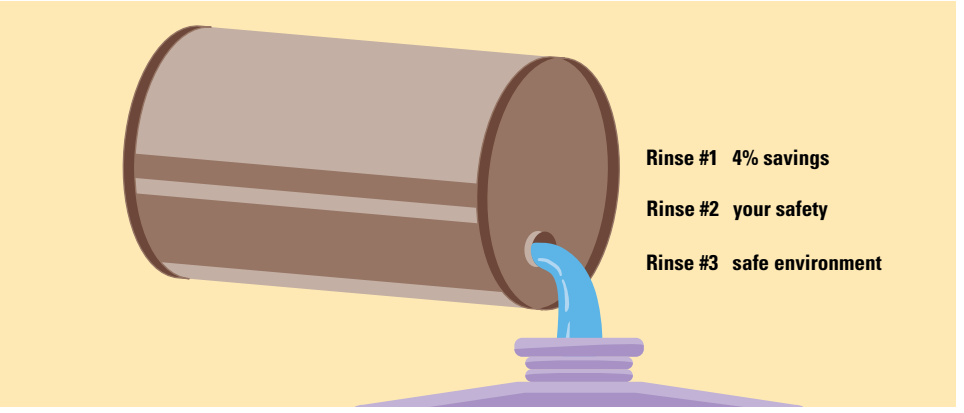
Seventy percent of skin exposure to pesticides is through the hands. Always wear impermeable gloves!

THE BARN AND OTHER FARM BUILDINGS

RINSING

All containers must be triple rinsed or pressure rinsed into a spray tank. This will help prevent water contamination through seepage at disposal sites.

Rinsing also means savings. Between $2- and $10-worth of chemical can be in the first rinse of a 10-litre container.



Triple rinse or pressure rinse all pesticide containers into a spray tank. (Taken from *Water in Trust*, Crop Protection Institute.)

CONTAINERS

- returnable containers and bulk containers should be used where possible
- punctured, empty pesticide containers should be taken to a recycling depot
- if the container cannot be recycled or reused, dispose of it at a licensed landfill.

Currently, 500,000 small pesticide containers are used by Ontario farmers each year. Many counties now have at least one drop-off location for recycling pesticide containers. Containers must be triple rinsed or jet sprayed. Contact your local Ontario Ministry of Agriculture and Food office for drop-off locations and dates.

Please note: old, unused pesticides cannot be disposed of at these locations. Some household hazardous waste collection sites will take some unused pesticides. Contact your municipality.

EMERGENCY PLAN

Develop a written emergency plan for accidental exposure and spills. In the event of an emergency, it will help you minimize danger to you and the water supply.

If your well is accidentally contaminated with a pesticide:

- it must be pumped immediately
- do not use it until the water is proven safe
- consult a specialist from the nearest Ontario Ministry of Environment and Energy office for advice on necessary procedures and water testing.

Absorbent material such as dry sawdust, soil, or dry straw should be stored for immediate cleanup of any spills or container leakages to prevent movement to the water supply. This material can then be spread on the sprayed field.

THE BARN AND OTHER FARM BUILDINGS

BEST MANAGEMENT PRACTICES

SILAGE STORAGE

Silage can be made from corn, cereal grains, alfalfa, and canning company wastes such as processed sweet corn waste.

Under good harvesting and storage conditions, silage should be of little risk to your water supply. However, without proper containment, excess silage juices can contaminate ground and surface water. Too much water or pressure in the silo will cause these liquids to seep out.

The liquids from this silage contain high amounts of:

- nitrates
- ammonia
- iron
- acidity
- organic compounds.

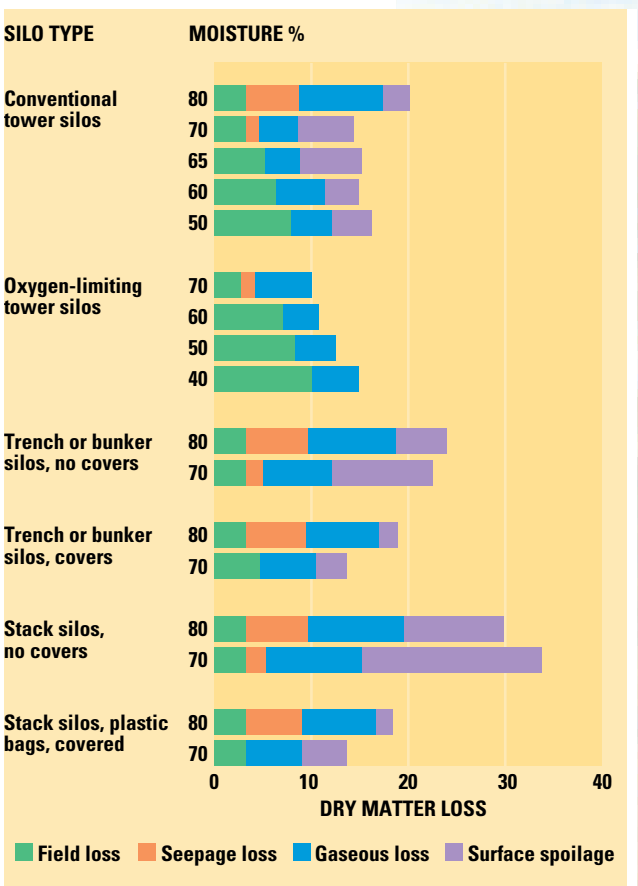
These nutrient-rich liquids, if allowed to reach a stream, can decrease the oxygen in the water – affecting fish and other stream life.

In terms of moisture, silage under 12 metres (40 ft) in depth should have a moisture content below 65%. Above this depth, the moisture content should be below 60%.

STORAGE LOCATION

- store your silage away from any water source, at least 91 metres (300 ft) from a well and at least 152 metres (500 ft) from surface water
- impermeable surface soil (heavy clay) around the storage will help to prevent seepage to ground water.

Any silage stored at over 65% moisture content will produce a leachate. Most leaching will occur in the first three weeks of storage. Grass silage can produce a trickle of leachate at 75% moisture and 353 litres per tonne (79 gal/ton) at 85% moisture.



Estimated silage storage losses

THE BARN AND OTHER FARM BUILDINGS

STRUCTURE

To help prevent seepage from and early deterioration of your storage, the floors, walls, and foundations should have no cracks. Reline the storage when cracks are present.

Excess moisture can seep away, carrying valuable nutrients. Cover storage to prevent unwanted precipitation in the silage.

A seepage collection system should be in place for collection and spreading of the runoff. This may be the same collection and spreading system used for stored manure and barnyard runoff.

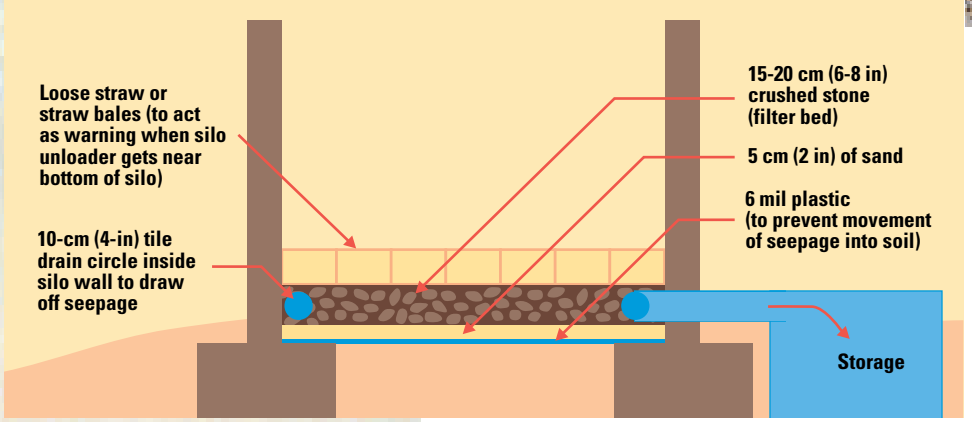
Clean water should be diverted away from the storage area to reduce the transport of silage leachate.

To preserve the quality of livestock feed as well as your water supply, keep excess moisture out of the silage.

Silage acids will deteriorate the concrete in silos. Both concrete pre-cast stave silos and cast-in-place silos will be affected by acids in silage. Careful inspection, maintenance, and repair are necessary to protect the silo's structural stability.

A horizontal silage storage can be covered with a strong plastic material to maintain quality feed and prevent leachate runoff.

TOWER SILO SEEPAGE COLLECTION SYSTEM



THE BARN AND OTHER FARM BUILDINGS

BEST MANAGEMENT PRACTICES

FUEL STORAGE

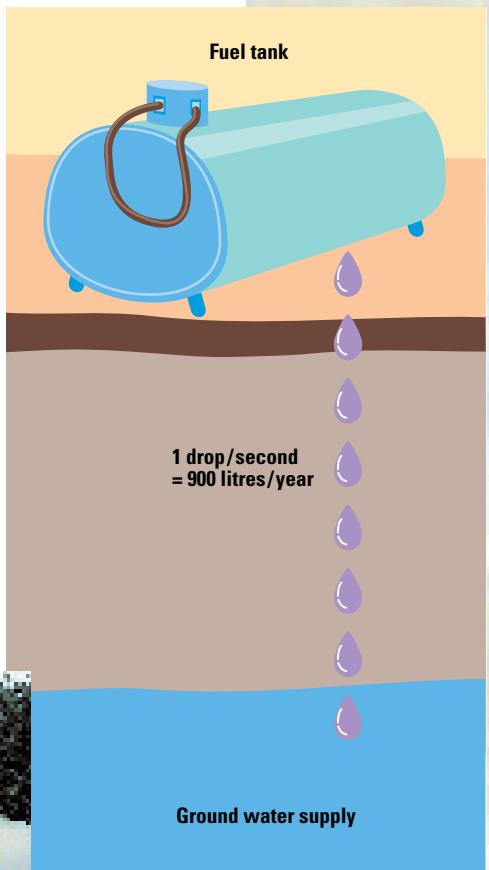
Motor fuel and heating fuel are stored on many rural properties. Leaking storage tanks and fuel spills can pose a great threat to both ground and surface water.

A fuel oil, gasoline, or diesel leakage can move easily through soil to ground water. Once there, it will float on the surface of the water table and will usually not travel far from the leakage site. This can pose a threat to your farm's well water.

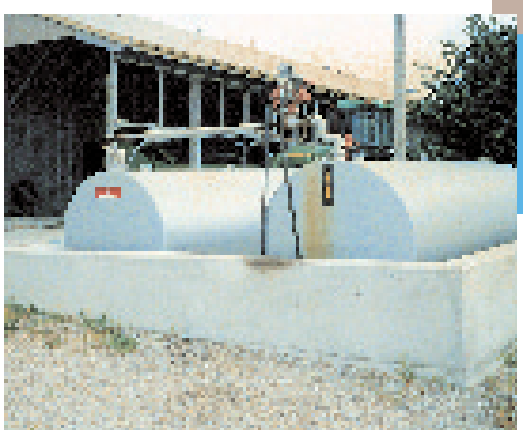
As the fuel breaks down, some contaminants may travel in ground water for many kilometres. This can pose a threat to your neighbours' wells and nearby drains, streams, or lakes.

As we noted in "The Home" section, water that seems pure may be contaminated. If you suspect fuel leakage, take a water sample to a private lab to test for fuel products. It's for your family's protection.

Take steps to prevent fuel leaks. It is very difficult and extremely costly to restore ground water contaminated by fuel.



A small fuel leak of one drop per second can mean a loss of 900 litres of fuel in a year. Your farm's water supply can be polluted by just a few litres of gasoline in the ground water.



An above-ground fuel tank should be diked and sized to contain 110% of its volume.

STRUCTURE AND LOCATION

On most rural properties the gasoline and diesel fuel tanks are located above ground. Fuel storage tanks are also located below ground or in a basement, e.g. for home fuel oil.

▶ all fuel storage tanks must be installed and serviced by a registered contractor.

THE BARN AND OTHER FARM BUILDINGS

ABOVE-GROUND TANKS

Your tank should be steel and covered with a protective coating to prevent rusting, i.e. Underwriters Laboratory Canada (ULC)-approved tanks. Here are additional considerations:

- ► locate an above-ground tank far enough away from buildings to create a fire break – must be at least 3 metres (10 ft) from any building
- ► must be at least 7.5 metres (25 ft) from a source of ignition
- ► must be at least 0.9 metres (3 ft) from another fuel tank
- ► to protect your water supply, locate the fuel storage at least 91 metres (300 ft) from a well
- ► dike the area around the tank to contain spills. The diked area should be sized to contain at least 110% of the tank volume. Rainwater should be removed to maintain the capacity of the diked area. (For more information on what constitutes a dike, see Environmental Farm Plan Worksheets.)
- ► make sure the fuel is pumped through the top of the tank, not gravity fed, to prevent fuel leakage. Fuel tanks on stilts or stands are illegal – hoses and nozzles can leak.
- ► paint the tank white to reduce evaporation losses.

Steel underground tanks can last from 15 to 20 years.

UNDERGROUND TANKS

An underground fuel tank must be registered and approved by the Fuels Safety Branch of the Ontario Ministry of Consumer and Commercial Relations. Some of the stipulations are:

- ► should be located at least 91 metres (300 ft) from a well
- ► must be located at least 1 metre (3 ft) from a building
- ► must be located at least 0.6 metre (2 ft) from another fuel tank
- ► if unused, must be removed according to regulations and reported to the Fuels Safety Branch.

For your personal safety and the safety of your water supply, post a Warning on your fuel storage tank.

MAINTENANCE AND SAFETY PRECAUTIONS

Regular annual servicing should be done by a registered contractor. Also,

- ► for security, the fuel nozzle should be locked when not in use
- ► fuel nozzle should automatically shut off either when it's released or the tank is full (ULC-approved nozzles). There should be constant supervision while pumping.
- ► rainwater should be removed from diked areas
- ► above-ground and underground tanks require inventory control – contact the Fuels Safety Branch, and see the Ontario Environmental Farm Plan Worksheets for more information
- ► you must have an emergency plan readily available at storage site
- ► check all equipment regularly to ensure that all equipment is in good working order. Hoses, nozzle valves, and fittings should be properly tightened.
- ► post Warning signs, and have a fire extinguisher readily available.

THE BARN AND OTHER FARM BUILDINGS

BEST MANAGEMENT PRACTICES

FERTILIZER STORAGE AND HANDLING

Common sense when handling and storing fertilizer will do much to protect water supplies and prevent costly losses.

Fertilizers contain nutrients including nitrogen, phosphorus, potassium, and other micronutrients that help to improve or maintain crop yields.

Runoff of these same nutrients can accelerate plant growth in streams.

Spilled fertilizer can leach to ground water and harm your water supply. Nitrate contamination of well water is of particular concern.

In most cases, small amounts of fertilizer are stored on the farm and with proper management should not affect water quality.

Algae and other aquatic plants can clog a stream and deplete its oxygen, thereby harming the stream's aquatic life.

STORAGE

- ▶ store only small amounts of fertilizers for short periods, prior to application
- ▶ make sure containers are clearly labelled and well-maintained with no holes, tears, or punctures
- ▶ restrict access to the storage area
- ▶ protect stored dry fertilizer (bulk or bagged) from the weather. Cover and store on a solid surface such as sealed concrete.
- ▶ contain and store liquid fertilizer on a solid surface with a separate, adequately-sized runoff containment area. This will prevent water contamination if a spill occurs.

MIXING AND LOADING PRACTICES

- ▶ where possible, locate a fertilizer mixing and loading area away from the well. A distance greater than 91 metres (300 ft) is suggested by the Ontario Environmental Farm Plan Worksheets.
- ▶ use an anti-backflow device and/or a 15-centimetre (6-in) air gap above the sprayer tank to prevent any back-siphoning into the water source
- ▶ use a separate water tank for your water supply where possible
- ▶ use a mixing/loading area with a curbed solid pad (such as sealed concrete) and runoff containment to contain any spilled fertilizer.

THE BARN AND OTHER FARM BUILDINGS

CLEANUP, DISPOSAL AND SAFETY

Use a mixing/loading area with a curbed solid pad and runoff containment to contain spilled fertilizer.

Taking the proper safety precautions when handling fertilizers will help prevent unnecessary exposure:

- clean up any spilled dry fertilizer on the pad. Store it or use it as soon as possible.
- clean up any fertilizer spill immediately
  - dry, absorbent material such as sawdust, soil, or straw will help to absorb and contain liquid spills. This material can then be spread on the same field.
- apply any rinse water from cleaning equipment to the same field
- application should be more than 61 metres (200 ft) from a well and 9 metres (30 ft) from a surface water source or a tile drain inlet.

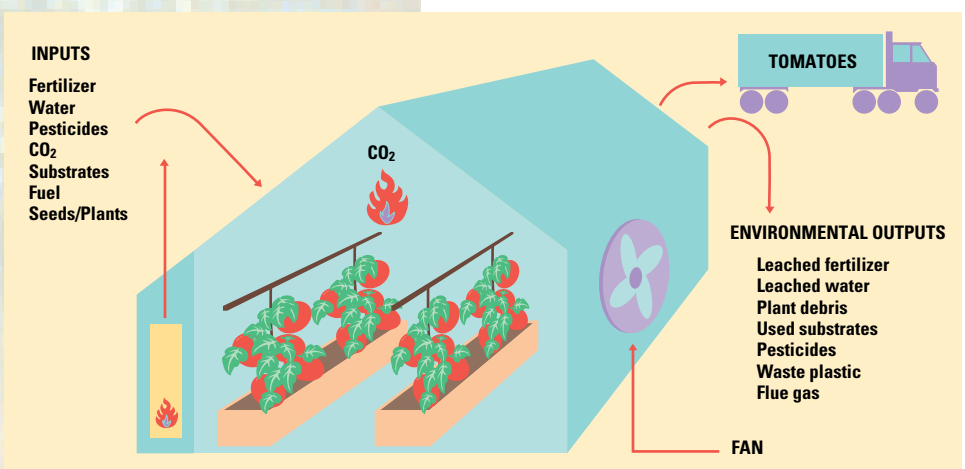
BEST MANAGEMENT PRACTICES

GREENHOUSE WASTE

Greenhouse production is very intensive. You need high inputs to generate large amounts of produce in a relatively short period.

Some greenhouse operations also generate a considerable amount of waste materials.

Potential contaminants to your water supply include:



- pesticide chemicals
- fertilizer nutrients
- substrate waste
- petroleum products.

You can reduce greenhouse waste through reducing, recycling, and proper disposal to protect ground and surface water supplies.

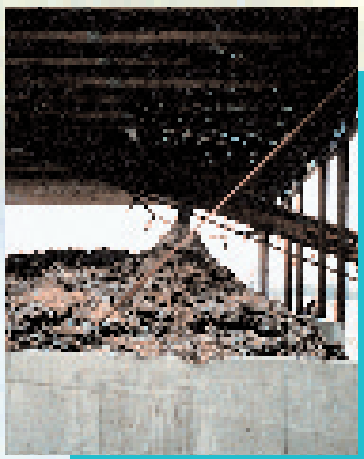
Refer to the Best Management Practices booklet, *Horticultural Crops,* for practical advice in greenhouse production.

THE BARN AND OTHER FARM BUILDINGS

BEST MANAGEMENT PRACTICES
MANURE STORAGE AND HANDLING

Manure contains valuable nutrients and organic matter that are beneficial to your growing crops. But these same nutrients can be harmful to your water supply. Proper storage and handling of manure will protect water quality and provide valuable crop fertilizer benefits.

Refer to the Best Management Practices booklet, *Livestock and Poultry Waste Management,* for a guide to manure handling, storage, and application on your farm.



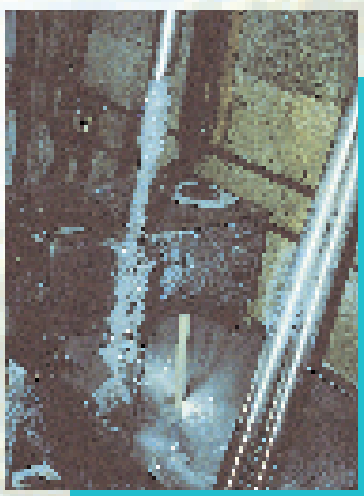
Diverting clean water away from stored manure will reduce the amount of contaminated water.

BEST MANAGEMENT PRACTICES
MILKHOUSE WASTE MANAGEMENT

Milkhouse washwater may appear harmless, but it can contaminate water with:

- phosphorus
- bacteria
- degraded milk solids
- disease-causing organisms.

For a guide to milkhouse waste management on your farm, refer to the Best Management Practices booklet, *Livestock and Poultry Waste Management*.



Each Ontario dairy farm produces an average of 35 kilograms of phosphorus annually. High amounts of phosphorus in a stream cause excess algae growth.

Many dairy farmers have installed a treatment/disposal system to prevent milkhouse washwater from directly polluting streams.

THE BARN AND OTHER FARM BUILDINGS

BEST MANAGEMENT PRACTICES

FARM WATER EFFICIENCY

Efficient water use means achieving the same or better level of production with less water.

Make water efficiency efforts part of your overall farm plan. Make sure any action you plan is feasible. Common sense remains one of your best resources. Here are some additional tips:

- ▶ monitor water needs, water use, and water waste throughout your operation, and target areas where efficiency can be improved
- ▶ plan your water use to ensure adequate water supplies for your own operation, while taking into account others using the same water source
- ▶ ensure that your water use is not harming the quality or quantity of water for downstream water users
- ▶ understand the legal requirements for water use and obtain any permits required (see page 91 for laws and regulations that affect water use).

Agriculture is the fourth largest water user in Canada (9%). The first three are: thermal power (60%), manufacturing (19%), and urban use (11%).

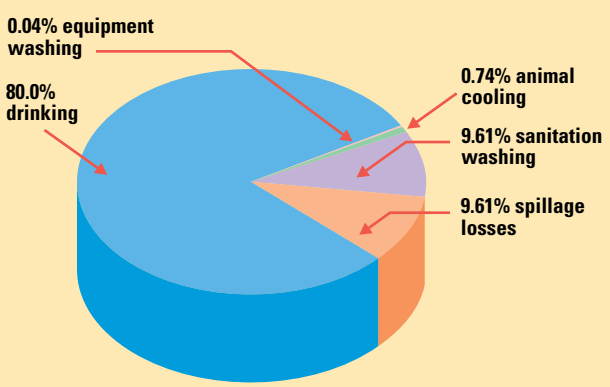
A water meter can be installed to measure water use. You can buy it through a plumbing or pump retailer for less than $100.

USE AND OPERATION

LIVESTOCK DRINKING WATER

- ▶ maintain watering equipment floats and seals to prevent leakage, spillage, or overflows
- ▶ install watering facilities that reduce livestock competition
- ▶ reduce livestock water needs by reducing heat stress in summer months (provide shading, ventilation)
- ▶ for swine operations:
  - ▷ reduce water pressure on nipple waterers to reduce spillage when drinking
  - ▷ install modern wet/dry feeding systems for swine. These will reduce wastewater by 30%.

WATER USE FOR A LIVESTOCK OPERATION



THE BARN AND OTHER FARM BUILDINGS

WASHING AND CLEANUP

Milkhouse washwater reduction methods on dairy farms include:

- ▶ feeding the first rinse from the pipeline and bulk tank cleanup to calves
  - ▷ will also help a treatment trench system for washwater disposal function better
- ▶ install a water-conserving sink for equipment washing
  - ▷ saves heating and washing chemical costs
- ▶ install a pressure washer that uses air in the cleaning process
- ▶ use the acid rinse water for floor cleanup.

In swine operations, reduce the need for mist cooling by designing barns that reduce heat stress. Clean the barn with compressed air pressure washers.

A water-conserving sink can reduce milkhouse washwater use by up to 45% and cut hydro costs by 35%.

IRRIGATION

- ▶ use properly designed and maintained irrigation equipment to prevent losses due to spills or leaks
- ▶ where possible, store rainwater and snowmelt for irrigation during dry periods
- ▶ use fully automated irrigation systems on timers to reduce accidental over-watering
- ▶ recycle excess irrigation water (e.g. greenhouse)
- ▶ time your irrigation to periods when evaporation by the sun will be minimal
- ▶ coordinate with neighbouring water users to prevent water shortages
- ▶ get a Permit to Take Water from the Ontario Ministry of Environment and Energy (see the blue pages of your telephone book) or at your local Conservation Authority.

Use micro-irrigation systems where possible. Drip, trickle, or micro-spray systems use 30 to 60% less than an overhead irrigation system.

Irrigation uses over 98% of the water pumped from a water source for crop production (including sod, nursery, and greenhouse production).

BEST MANAGEMENT PRACTICES

DEADSTOCK AND OTHER FARM WASTE DISPOSAL

Like most business enterprises, every farm produces some waste material. Many seemingly harmless products can impair a water supply if not properly disposed of. Waste materials include:

- ▶ dead animals
- ▶ contents of a farm dump site
- ▶ livestock medication
- ▶ packaging
- ▶ paints, cleaners, lubricants, oils
- ▶ farm materials and equipment.

THE BARN AND OTHER FARM BUILDINGS

DEAD ANIMALS

Proper disposal of dead animals is extremely important to protect the health of both people and livestock. An animal carcass can contain harmful bacteria and other disease organisms that can contaminate you or others directly, or through leaching to your water supply.

Deadstock must be disposed of within 48 hours – either buried under 0.6 metres (2 ft) of earth or picked up by a licensed Dead Animal Collector. This is a requirement under the Dead Animal Disposal Act.

Pickup by a licensed collector is the preferred method to prevent any contamination of your water supply by decomposing animals.

Animals that can be picked up by a licensed collector include:

- production animals (swine, cattle, sheep, horses, goats, poultry)
  - poultry (chickens, turkeys, ducks, geese) can be temporarily stored in freezers for pickup
- pets
- wild animals.

To protect ground and surface water, any burying of deadstock should be done in accordance with the law: away from a well or surface water source and in soils that restrict seepage.

ON-FARM DUMPSITES AND HAZARDOUS WASTE DISPOSAL

Traditionally, many farm wastes were disposed of at a dumpsite on the farm. Depending on the contents, this disposal site can be leaching dangerous contaminants to the ground water.

Farm waste material should be reused or recycled wherever appropriate.

No hazardous substances should be disposed of on the farm. Here are some common farm materials that should be taken to a hazardous waste disposal site:

- livestock medication and other veterinary products
- paints, cleaners, lubricants, oils and their containers
- used motor oil for lubricating equipment
  - recycle where possible
- used materials such as insulation, asbestos materials, pressure-treated lumber, and batteries.

THE FIELD

How you manage crops in the field directly affects water quantity and quality. This chapter will help you develop a water management plan that:

- ▶ will help sustain ideal soil moisture levels
- ▶ keeps ground water impacts to a minimum
- ▶ reduces soil erosion, by managing overland runoff.

But first, back to basics: how water moves (or doesn't move) through a field, and the influences of soil types, seasons, cropping practices, and drainage on its movement. You need to be aware of these interrelationships before you can develop an effective plan.

Throughout the remaining chapters, we'll be referring you to other booklets in the Best Management Practices series that address related topics – soil, nutrient, crop, manure, and woodlot and wildlife habitat management. In them are more background and best management practices to help you protect your soil and water resources.

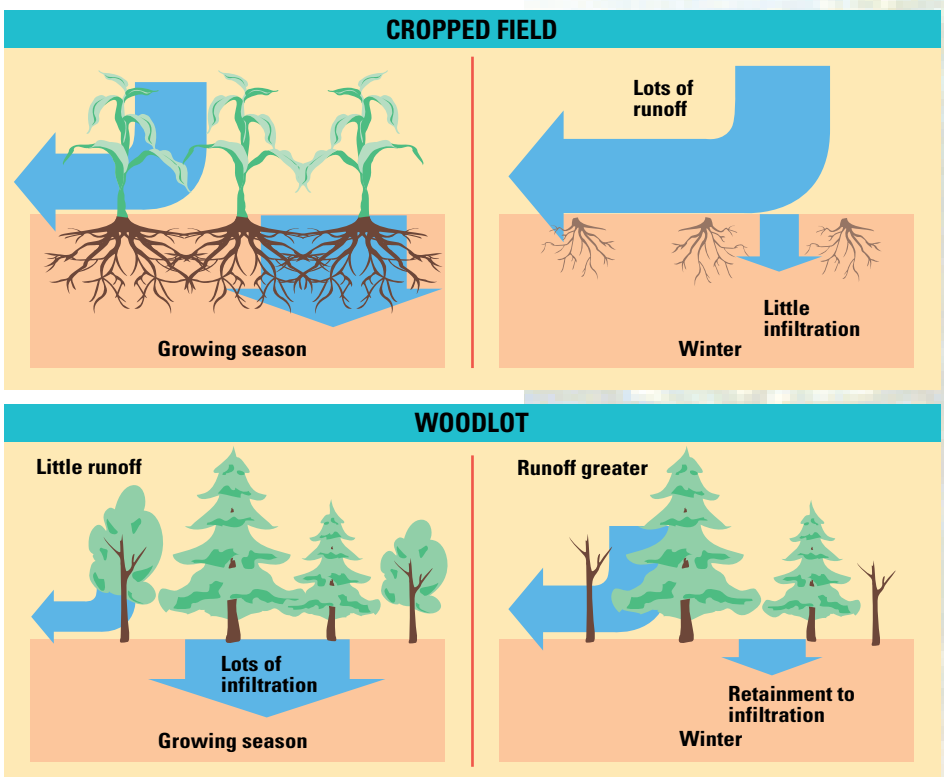
Typically, when water falls on a bare field, 66% is evaporated back to the atmosphere, 25% runs off to ponds, watercourses, lakes, and other depressional areas, and the remaining 9% infiltrates the soil.

PATHWAYS OF WATER

Prior to agricultural settlement, the Ontario landscape was covered in forest, wetlands, and natural meadow. Clearing and logging made farming viable. But they also increased the amount of surface runoff from farm fields.

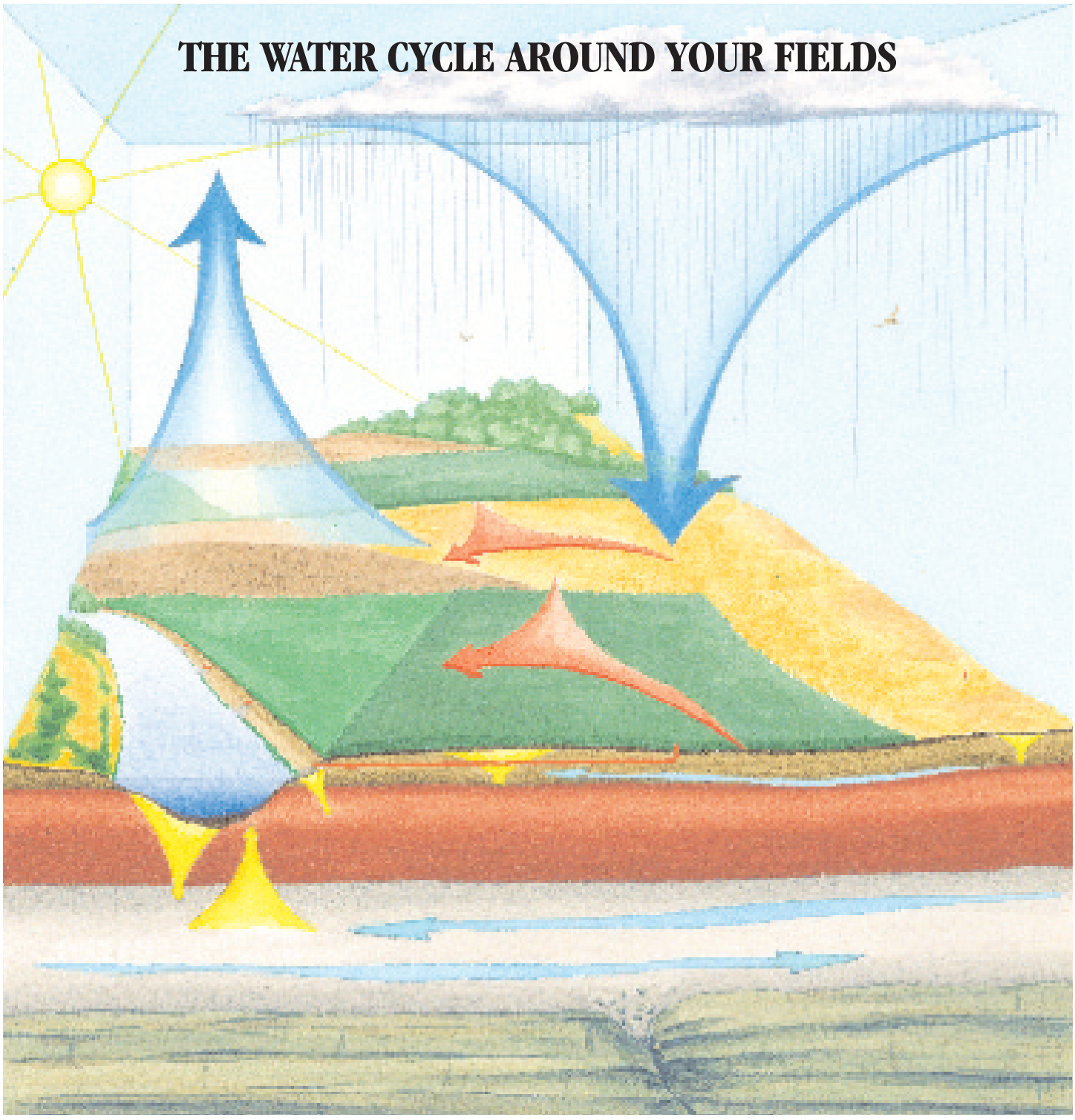
Runoff can carry with it sediment, nutrients, and pesticides, and is of particular concern when we look at the cycle of water in the field.

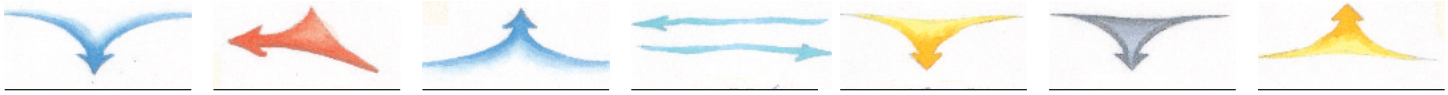
Water movement will vary, according to the season.



Regardless of season, there is more runoff from one hectare of a cropped field without residue management than from one hectare of woodlot. In a woodlot, more water infiltrates or is stored as snow.

THE WATER CYCLE AROUND YOUR FIELDS





Precipitation | **Runoff** | **Evaporation and Transpiration** | **Ground water flow** | **Infiltration (uncontaminated)** | **Infiltration (potentially contaminated)** | **Ground water recharge**

In your fields, precipitation can: be stored as snow or ice, be stored in the soil to be used by crops, evaporate at the soil surface, infiltrate the soil, or, if precipitation exceeds the soil's infiltration capacity, run off overland. The proportion of water in any of these areas depends on soil conditions, the length and degree of slope, time of year, and how you manage the fields.

Runoff is of particular concern, since it can potentially take soil and crop inputs in the soil (such as phosphates from applied commercial fertilizers or manure, and some pesticides) with it to pollute surface water.

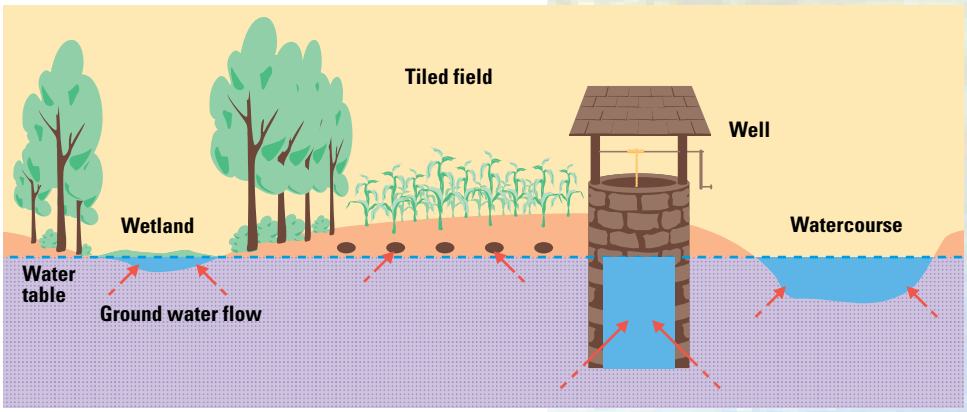
Sandy and gravelly soils, soils with a high water table, and shallow soils over bedrock are vulnerable to ground water contamination by nitrate-nitrogen and some pesticides that leach through the soil. Best management practices will help you control runoff and preserve soil and water quality.

THE FIELD

GROUND WATER AND YOUR SOIL

Water enters soil through pores and cracks or holes and tunnels created by dead plant material, earthworms, insects, and animals. How much water enters will depend on your field's natural characteristics and your management choices.

Water moves down slowly in fine-textured soils, making them more sensitive to runoff and surface water contamination. Downward movement is faster in coarser-textured soils, which can lead to a greater potential for ground water contamination.



Ground water can resurface in drains, watercourses, wetlands, or other low areas on and off the farm, or may be drawn back up to the surface through wells.

Several natural characteristics affect the amount of water in soils, namely: soil type and structure, slope, depth to water table, precipitation, season, and weather.

Management practices also affect soil moisture content. Soils with high amounts of crop residue will allow more infiltration and higher soil moisture. The same is true for soils with high organic matter content.

NATURAL CHARACTERISTICS	MANAGEMENT IMPACTS
• soil type and structure	• residue management practices
• slope	• cropping practices, including type, rotation, cover crops, and direction relative to slope
• wetness of the soil depth to water table	• compaction
• amount and intensity of precipitation	• organic matter levels
• time of year	• other management practices, such as: strip cropping, terraces, windbreaks
• weather (freezing/thawing,wetting/drying)	

The type of soil determines how much water is held in your soil, and how much is available for use by your plants.

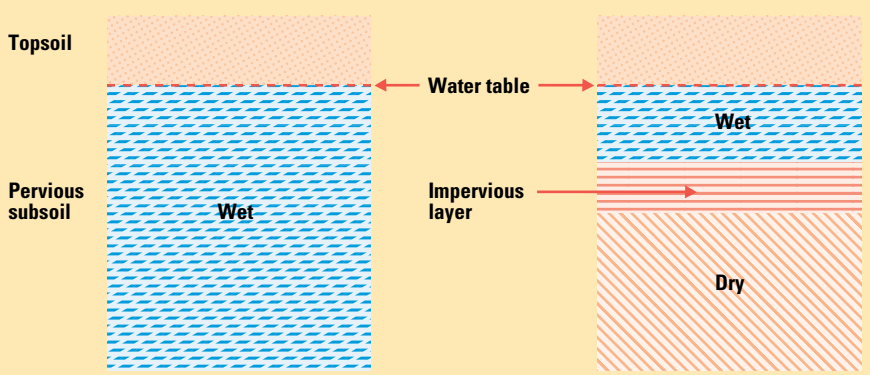
THE FIELD

Your soil's water-holding capacity will also depend on the amount of organic matter and the number of soil layers. Many of Ontario's soils are stratified, that is, they have layers of various-textured soils overlying each other. These features will significantly affect your field's wetting and drying characteristics.

In uniform soils the water table will move up and down with the seasons. If a layer of soil occurring naturally or caused by cultivation restricts water movement, a perched water table may be present. Knowing your soil types is the first step to maintaining and improving them, and managing water effectively.

SOIL TYPE	RATE OF WATER MOVEMENT INTO SOIL		mm OF WATER AVAILABLE IN A METRE OF SOIL	
	ON BARE SOIL	ON CROPPED SOIL	IN SATURATED SOIL	AVAILABLE TO PLANTS
sand	fast	fast	100	75
silt loam	medium	fast	267	167
loam	medium	fast	283	167
clay loam	medium	medium	317	167
clay	slow	slow	325	117

STRATIFIED SOILS' EFFECTS ON WATER TABLE



THE FIELD

SURFACE WATER

Monoculture, specialized livestock production, a decrease in forage-based cropping systems, and large equipment can contribute to soil compaction, which reduces water's ability to percolate through your soil. This can result in excess surface water in your fields.

Leaving surface water unmanaged can lead to rill and gully erosion. Erosion affects your water quality because it can transfer high sediment loads to watercourses. That sediment will include topsoil, chemicals, nutrients, and bacteria.

Some of the ways excess surface water can be removed are:

- natural or constructed channels
- infiltration to ground water or a tile drainage system
- surface inlets into a tile drainage system
- evaporation and transpiration.

Remember that any method you use to remove surface water will have implications for land and nearby watercourses.

Tillage practices affect the volume of surface runoff. Working your field in wet conditions, or leaving it bare of residue or other vegetation, will reduce your soil's ability to accept water.

Too often, surface runoff is left unmanaged and can result in high sediment loads to the watercourse. High sediment loads can destroy fish habitat.

Tillage practices should be adopted that allow as much infiltration as possible. No-till retains maximum amounts of crop residue on the soil surface to buffer raindrop and runoff impacts.

CHEMICAL MOVEMENT

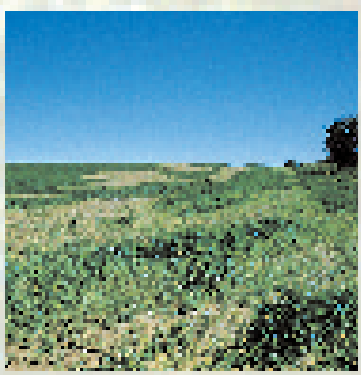
Any chemicals you apply to a field may be:

- intercepted by plants or residue
- attached to soil particles
- dissolved in water
- drained into ground or surface waters
- decomposed or vaporized
- taken up and used by plants.

The factors that help decide where chemicals go in the field include:

- solubility – how easily a chemical dissolves in water to become a solution
- persistence – how long it takes a chemical to break down
- adsorption – the ability of a chemical to attach itself to soil particles.

The following table provides ratings for the solubility, persistence, and adsorption of common chemicals used in field crop production. Clearly, a chemical that is highly soluble, persistent, and has strong adsorption potential is most likely to get into surface water.



Over-application of atrazine can reduce crop yields.

THE FIELD

SOLUBILITY, PERSISTENCE, AND ADSORPTION POTENTIAL OF CROP PROTECTION CHEMICALS

CHEMICAL	SOLUBILITY	PERSISTENCE	ADSORPTION POTENTIAL
2,4-D	low	low	moderate
Atrazine	low	high	moderate
Cyanazine	moderate	low	strong
Diazinon	low	low	strong
Linuron	low	high	strong
Metolachlor	high	high	strong
Metribuzin	high	moderate	weak

A chemical spill during mixing and filling operations, or excessive application, not only reduces your land's ability to grow crops, but will also directly impact ground and surface water.

Time of year influences the movement of crop protection chemicals into surface water. After 15 years of sampling, Atrazine was recorded in numerous surface water samples. Listed in the following table is a breakdown of when these samples were taken.

TIME OF YEAR	% CHEMICAL LOAD MEASURED	REASON
JANUARY - APRIL	54	high precipitation and snowmelt
MAY - AUGUST	32	period of pesticide use
SEPTEMBER - DECEMBER	14	less runoff pesticides not being applied pesticide adsorption

Times of heavy rainfall and drought can lead to periods of water surplus and shortage. You can remove excess water through tile and surface drainage (such as grassed waterways) in ways that reduce erosion and flooding. Water conservation and irrigation can be used to make up for a lack of water.

SUBSURFACE DRAINAGE

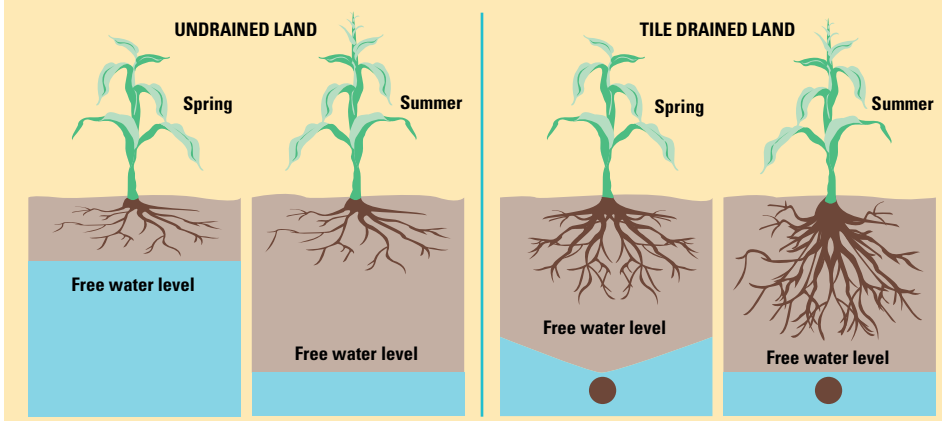
Through most of the year, Ontario farmland has a surplus of water falling on it. Subsurface or tile drainage is a proven method of removing excess water and is a best management practice in crop production. If you have capital available, tile drainage is a sound investment. The following table presents some points to consider:

THE FIELD

TILE DRAINAGE

ADVANTAGES	DISADVANTAGES
• reduces surface runoff of contaminated water	• can increase risk of nutrient flow through tile to watercourses
• reduces soil compaction	• might increase springtime flooding downstream
• increases crop yields	• can damage wetlands or destroy small wetlands
• enhances timing of field operations	• disrupts the flow of ground water to watercourses
• can extend growing season	• high capital costs
• can provide more crop options for rotation	• some maintenance requirements

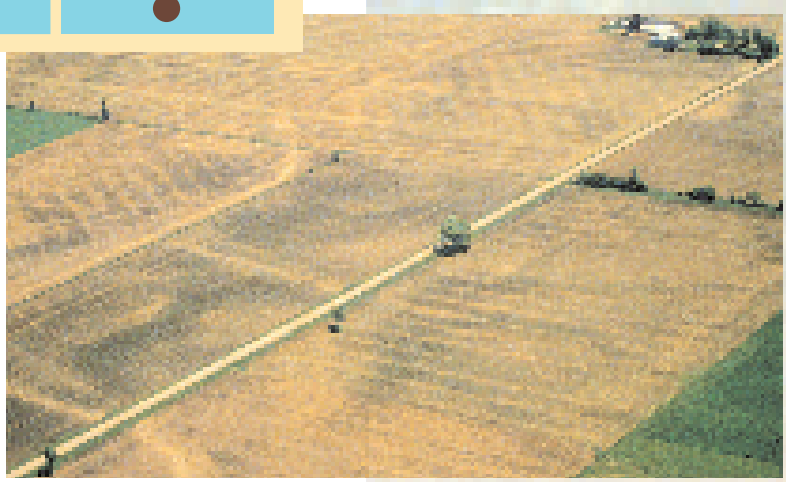
CROP ROOT DEVELOPMENT ON DRAINED VERSUS UNDRAINED LAND



A low water table in the spring allows maximum root growth. In the drier summer months, the crop will better withstand droughts and support yields.

New systems are being designed so that tile drains can do double duty as drainage and irrigation systems. By controlling the tile outlet, water can be released or held in the tile, depending on crop needs. Nutrients contained in the water are also available to the crop.

Aerial view of land drying over tile drains.



THE FIELD

BEST MANAGEMENT PRACTICES

NUTRIENT MANAGEMENT

A sound nutrient management program will maintain or increase yields while saving you money and protecting the environment. We urge you to read *Nutrient Management* and *Livestock and Poultry Waste Management* for more details. Here is a snapshot of best management practices:

- consider risks to water resources before application
  - make sure crops can use fertilizers or manures at time of application. (Coarse-textured soil can't absorb them in the fall; excessively drained or shallow soils on fractured bedrock need extra care.)
- consider cover crops to use nutrients in periods when potential leaching is greatest, or on extensively drained fields
- consider cultivation to break up preferential flow paths on the soil surface and within the soil before applying liquid fertilizer or liquid manure
- monitor irrigation and tile systems carefully, especially if applying fertilizers or manures
- rotate crops to use residual nutrients
- don't store manure in field if it can threaten water resources
- avoid winter manure application, especially on sloping land
- don't apply manure on saturated soils
- test your soil for nutrient levels before planting (or a minimum of every 3 years)
  - soil test for phosphorus and potassium
  - for corn, soil test for nitrogen levels as near as possible to nitrogen application
- test manures for nutrient values
- apply fertilizers at rates recommended for crop production in Ontario
  - base fertilizer rates on soil tests, and on what the plant can use
  - set realistic yield goals
  - account for contributions from manure, cover crops, previous crops, and other applied wastes such as sewage sludge
  - time your fertilizer application to maximize crop uptake and growth
- apply fertilizer in a band after crop is established
- consider using inter-row cultivation to help control weeds
- calibrate manure applicators and spread uniformly.

THE FIELD

BEST MANAGEMENT PRACTICES
PEST MANAGEMENT

Adopting an Integrated Pest Management system for your operation will help you use chemicals efficiently and effectively, while protecting your water quality. The IPM program considers weed, insect, and disease control.

The booklets, *Field Crop Production* and *Horticultural Crops,* outline more fully what's involved. In this booklet, "The Barn and other Farm Buildings" chapter reviews pesticide mixing, storage, and disposal.

In addition to the recommendations there, remember to evaluate the types of soils on your property, and assess the vulnerability of your water supplies.

BEST MANAGEMENT PRACTICES
IRRIGATION MANAGEMENT

If you're planning an irrigation system, bear in mind:

- the effects on crop production
- the amount of water needed
- sources of water (distance, suction height)
- water quality
- impacts on water source
- laws affecting water taking.

The type of system you choose will in part depend on:

- slope
- soils
- crops
- energy requirements
- wind action
- methods of application (sprinkler, trickle, surface, or subirrigation).

Choose an irrigation system that gets as much water back to the plant as is needed and minimizes water losses to evaporation and/or runoff.

It's a good idea to do a cost-benefit analysis before you buy. Remember to factor in:

- expected yield increase based on crops to be grown
- water demands of soil and crop
- annual operating costs (including energy, materials, labour, maintenance, and annual depreciation).

Some best management practices for irrigation include:

- scheduling irrigation to maximize energy and water conservation
- being conscious of water table levels and the effect your actions have on them
- moisture-testing soil to ensure crops do need water
- if fertilizers are being applied, making sure the job's done safely and only when necessary
- installing an anti-backflow device, such as a check valve.

THE FIELD

BEST MANAGEMENT PRACTICES

DRAINAGE MANAGEMENT

Drainage works are a large capital investment. Management of an artificial drainage system requires effective:

- **planning** of the system prior to construction, and
- **maintenance,** i.e. inspection and repair.

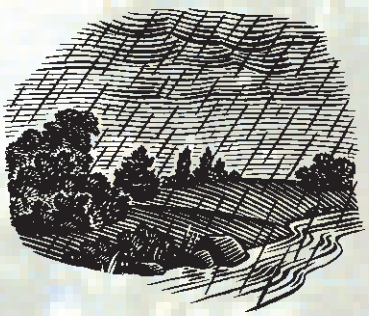
In this section, we'll look at the overall picture, then specifically at tile outlets, surface inlets, tile lines, surface drainage systems, and runoff management.

For more information, read Ontario Ministry of Agriculture and Food Publication 73, *Handbook of Drainage Principles.*

PLANNING A SUBSURFACE DRAINAGE SYSTEM

Here are some determining factors in your choice of system:

- crop types
- soil types and topography
- availability of an outlet
- system design
- location of manure, chemical, and fuel storage areas
  - all drains, including surface inlets, should be located away from contaminant sources.



Also,

- don't use your drains to discharge contaminated wastes
- keep a detailed record of all drainage works you install, and update the record as you make changes
- if you're planning to buy a farm, get a record of any tile drainage and then investigate the system
  - consider both water flow and water quality.

Finally, remember that not all land should be drained. If you have significant wetlands or other sensitive areas, the damage done to the environment may outweigh the benefits of a larger land base. (The next chapter on wetlands outlines your legal responsibilities vis-à-vis wetlands.)

THE FIELD

MAINTENANCE

Properly installed subsurface drains are low-maintenance. Regular visual inspections of your fields, tile lines, and outlets will show you whether water is draining properly. Key times for inspecting are:

- springtime
- after heavy rains
- the first few years after installation.

Licensed drainage contractors assist landowners with planning and installing tile drainage systems.

TILE OUTLETS

A good outlet will consist of a rigid pipe with a hinged rodent gate and be properly protected with rip rap that has filter cloth underlay. Your pipes should not in any way obstruct channel flow.

Ensure there is an adequate clearance between the tile outlet and the receiving drain or stream bottom.

Marking outlets with stakes or posts will make outlets easy to find.

Your maintenance program should include a regular inspection at the drain outlet:

- ensure it's clear of debris and sediment
- check quality of discharged water
- check that the pipe is not damaged by ice
- check that the rodent gate is working properly
- keep the rip rap in good condition, and replace any material that may have moved.

A properly installed tile outlet.

THE FIELD

SURFACE INLETS

There are three basic types of inlets:

- ► concrete, steel, and plastic catchbasins
- ► perforated vertical pipe intakes
- ► blind inlets.

Maintaining surface inlets includes:

- ► inspecting all surface entry points
  - ▷ look for washouts around the inlet and repair immediately
- ► clearing the inlet of trash and debris
- ► removing soil as often as needed, if catchbasin is designed with a sump to trap sediment
  - ▷ especially important in newer drains located on highly erodible soils
- ► not spreading manure close to open inlets
  - ▷ incorporate manure as soon as possible.

If you have a terrace system, where sediment may be trapped on the field adjacent to inlets, you should develop a long-term plan to minimize impacts.

Sediment removal may be necessary periodically with bulldozers or other equipment.

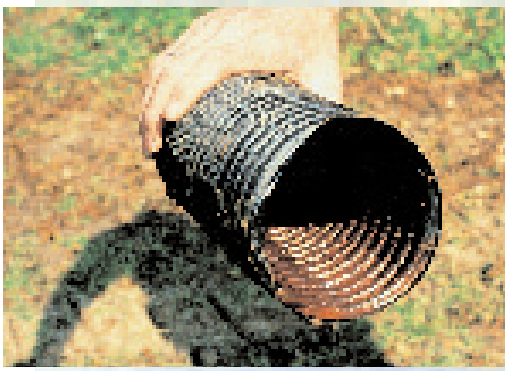
The most effective means to reduce this sedimentation is adopting conservation cropping and tillage.

Regular maintenance of your tile drainage system will help to ensure it works properly year after year.

THE FIELD

TILE LINES

As with tile outlets and surface inlets, regular inspections are an excellent early-warning system to help you troubleshoot. In the next chart, you'll see that some of the problems are a result of poor planning.



Red organic matter, "iron ochre", is occasionally a problem in tile drains.

TROUBLESHOOTING TILE LINES

ITEM	WHAT TO LOOK FOR	POSSIBLE CAUSES	SOME REMEDIAL ACTIONS
• blow-outs, wash-ins, and other broken tile	• holes in soil above or around tile lines • water not draining	• defects in tile • high pressures in drains • faulty connections • shallow cover over drain – collapsed by equipment • damaged tile	• repair immediately • replace damaged tile • if high pressures persist, vent as necessary • relocate drain where sufficient cover can be achieved
• tree roots	• tile line near trees • water not draining	• roots of some tree species can clog drain • problem is greatest in continuous flowing tile	• replace plugged section • consider solid tile in problem area • rotary cutters
• sediment & mineral deposit	• decreased flow capacity • excess sediment in tile	• lack of filter	• filter may eliminate most sediment • high-pressure cleaners (but watch for additional sediment)
• iron ochre	• reddish/orange slime or discoloration at outlet • crusting over of joints or perforations of tile • gelatinous growth inside tile	• soil microbes in oxygen-deprived conditions • usually in an area that hasn't been drained before	• no guaranteed solutions • consult experienced drainage contractor or engineer • replace tile
• damage to soil structure	• water ponding above drain	• compaction by farm equipment, cultivation, or livestock • tile installed in too wet conditions • excess manure application, which seals soil	• install rigid pipe under laneways or traffic areas • restrict livestock from drained areas when ground is saturated • change tillage and cropping if plough pans or layers are noticed • apply manure at proper rates, and when land is suitable • stay off wet soils

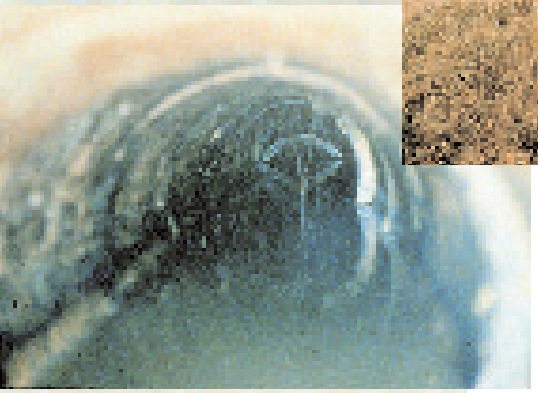
Continues on next page...

THE FIELD

TROUBLESHOOTING TILE LINES... continued

ITEM	WHAT TO LOOK FOR	POSSIBLE CAUSES	SOME REMEDIAL ACTIONS
• grassed waterways	• erosion damage at channel centre, tile exposed	• tile drain too close to channel centre	• move drain (or preferably, plan in advance and locate drain away from channel centre)
• loss of organic soils*	• excessive drying of organic soils where thick organic layer is underlain by a shallow impermeable soil (silty clay, clay, marl or non-waterbearing sand)	• organic soils have been exposed to oxygen • drain installed close to underlying impermeable soils	• install drain sufficiently above underlying soils so that water can be retained, or added to the root zone system, i.e. subirrigation • in some cases, getting soils to accept water again will be impossible
• poor water quality**	• odours or solid waste in drain	• manure, milkhouse, septic or other wastes	• take immediate action: locate source and eliminate if possible
• manure leaching	• manure leaching through soil	• poorly timed manure application; direct flow paths from root or worm tunnels are present	• improve timing of manure application; break up flow paths prior to application

***Draining organic soils (peat or muck) takes special care. Before you begin draining organic (peat or muck) soils:**
▶ consult a local drainage expert
▶ consider the environmental impacts: these soils are often in areas close to wetlands.
****Refer to *Livestock and Poultry Waste Management, Nutrient Management,* and the "Barn and other Farm Buildings" chapter of this booklet.**



Sediment buildup in a tile drain can be eliminated through proper planning and installation.

A well-constructed and maintained municipal drain.

A tile blowout or wash-in indicates immediate attention is needed to repair the tile drain.

THE FIELD

SURFACE DRAINAGE SYSTEMS ON THE FIELD

There are times when water collects and flows on the surface of fields. Managing your surface water in a manner that reduces erosion and the transportation of sediment, nutrients, and chemicals is an important aspect of your field management.

The following sections list a number of structural runoff management techniques, and cropping and tillage management techniques that reduce runoff impacts.

STRUCTURAL PRACTICES

BEST MANAGEMENT PRACTICE	DESCRIPTION	BENEFITS & CONSIDERATIONS
terrace	• construct earthen berms to shorten slope lengths	• holds water and soil on the field • releases water slowly to a stable outlet through tile drains or grassed waterways
water and sediment control basin (where terraces aren't practical)	• build short earthen embankments across draws or gullies	• will act like terraces to pond water on the field and release it slowly • reduces downslope erosion and flooding impacts, and controls soil erosion • settles some eroding materials out
diversion	• build channels and berms across slopes to intercept and carry runoff water to a stable outlet	• reduces erosion • allows water to move off field at a flatter grade in a controlled manner, thereby reducing sheet erosion downslope
grassed waterway	• develop properly sized and shaped channel with protective vegetation	• transports surface runoff safely
drop pipe inlet	• install a large diameter pipe or pipes to convey water down steep slopes or high drops	• conveys water safely
rock chute spillway	• construct rock chute underlaid with filter cloth to accommodate anticipated flows	• conveys water safely

THE FIELD

▲ Prefabricated vertical pipe intakes virtually eliminate plugging and are best suited to cropland conservation systems. Orifices used to regulate flows reduce tile requirements and costs.

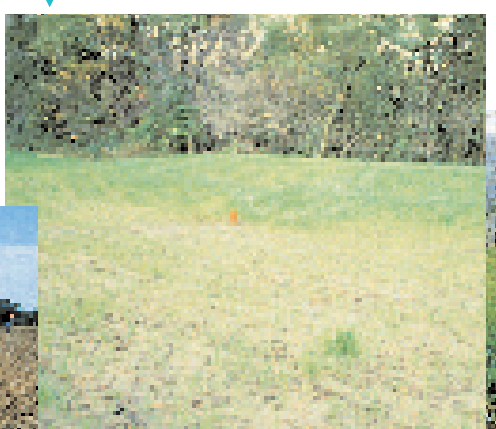
▼ A diversion is an earthen embankment combined with a grass channel that diverts water from a certain area.

▲ A water and sediment control basin assists other conservation practices by controlling surface runoff along drainageways.

▲ A grassed waterway includes shaping and seeding an overland drainageway to carry runoff safely.

Refer to the Best Management Practices booklet, *Field Crop Production*, "Non-Tillage Options", for details on these alternatives and others. Best management practices for watercourses are found on page 75 in this booklet.

Shown below is a drop pipe inlet used with a short earthen dam built across a natural drainageway. Water is released underground to a stable outlet. ▼



▲ A narrow-based terrace outlets surface runoff to a tile drainage system.

▲ Rock underlain with filter cloth carries excess surface water safely to watercourse.

THE FIELD

CROPPING AND TILLAGE MANAGEMENT

BEST MANAGEMENT PRACTICE	DESCRIPTION	BENEFITS & CONSIDERATIONS
residue management	• no-till, mulch-till, and ridge-till that leave at least 30% of previous year's crop residue	• protects soil from raindrop impact • limits downslope movement by reducing runoff • cost savings from reduced number of passes across field • reduced chemical loss to water • improved long-term soil and crop productivity • reduced soil compaction and crusting • improved soil conditions
contour farming	• carry out all field operations on a level or nearly level contour	• creates a series of small dams to slow runoff
contour strip cropping	• alternate strips of row crops, small grains, and forages on the contour level	• close-growing crops act as vegetated filters that reduce erosion • results in greater water infiltration
buffer strip cropping	• use in combination with contour farming on longer slopes • permanent strips of grass or forage break up the slope	• slows water flow by increasing infiltration • grass acts as vegetated filter to reduce soil movement
cover crops	• plant oats, oilseed radish, wheat, rye, vetch, or clover where annual crop doesn't cover sufficiently	• reduces soil erosion • provides buffer for raindrop impact • improves water infiltration • improves soil tilth and fertility
rotations	• change crops grown in a given field year-by-year	• improves soil tilth and fertility • reduces erosion • improves water infiltration • also assists in herbicide and nutrient management programs
pasture management	• use efficiently: assess pasture for food, water, and herd size • rejuvenate vegetation as required • erect fences to keep livestock from watercourses	• improves livestock performance • requires more management • improves downstream water quality • helps prevent stream contamination by manure, soil erosion, and degradation • reduces manure handling
marginal and fragile land retirement	• retire fields where farming is unprofitable and risk to the environment is great • leave to pasture, permanent grasses, or plant trees	• benefits environment • reduces risk of soil erosion • increases small farm yield averages • increases net profitability of operation

WETLANDS, WATERCOURSES, WOODLOTS, AND PONDS

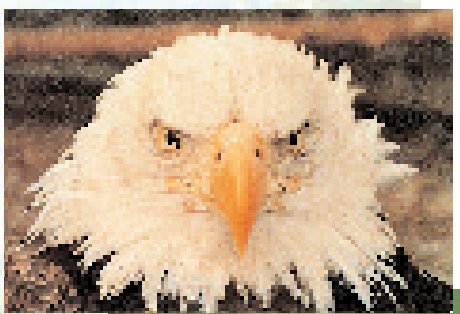
A good water management plan must consider wetlands, watercourses, woodlots, and ponds.

Whether they're natural or artificial, wetlands, watercourses, woodlots, and ponds play pivotal roles in the wellbeing of your farm and the local environment.

What were once seen as nuisances or of little value are now recognized for their benefits to agricultural production. Depending on the type of on-farm water body, it can benefit your operation by:

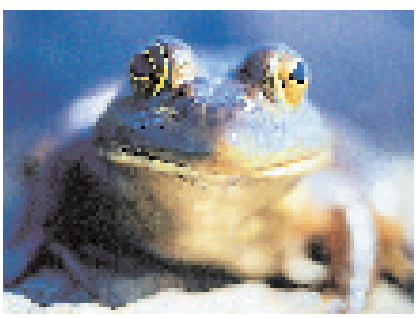
- ► limiting flooding by storing runoff and acting like reservoirs
- ► helping water flow continuously
- ► purifying water
  - ▷ vegetation in wetlands is very efficient in removing nutrients and sediment
- ► reducing soil erosion by acting as a buffer against flowing water, either into or through the system
- ► returning water to atmosphere, stream base, and ground water sources
- ► offering habitat for species that help control insect and rodent infestations
- ► providing fish habitat, including spawning, rearing, and feeding areas
- ► providing opportunities for farm forestry (fencing materials and fuel wood)
- ► providing a source of water in case of fire
- ► providing recreational opportunities.

Bald Eagle



Spotted Turtle

Wetlands provide critical habitat for plants and animals, many of which are rare species.



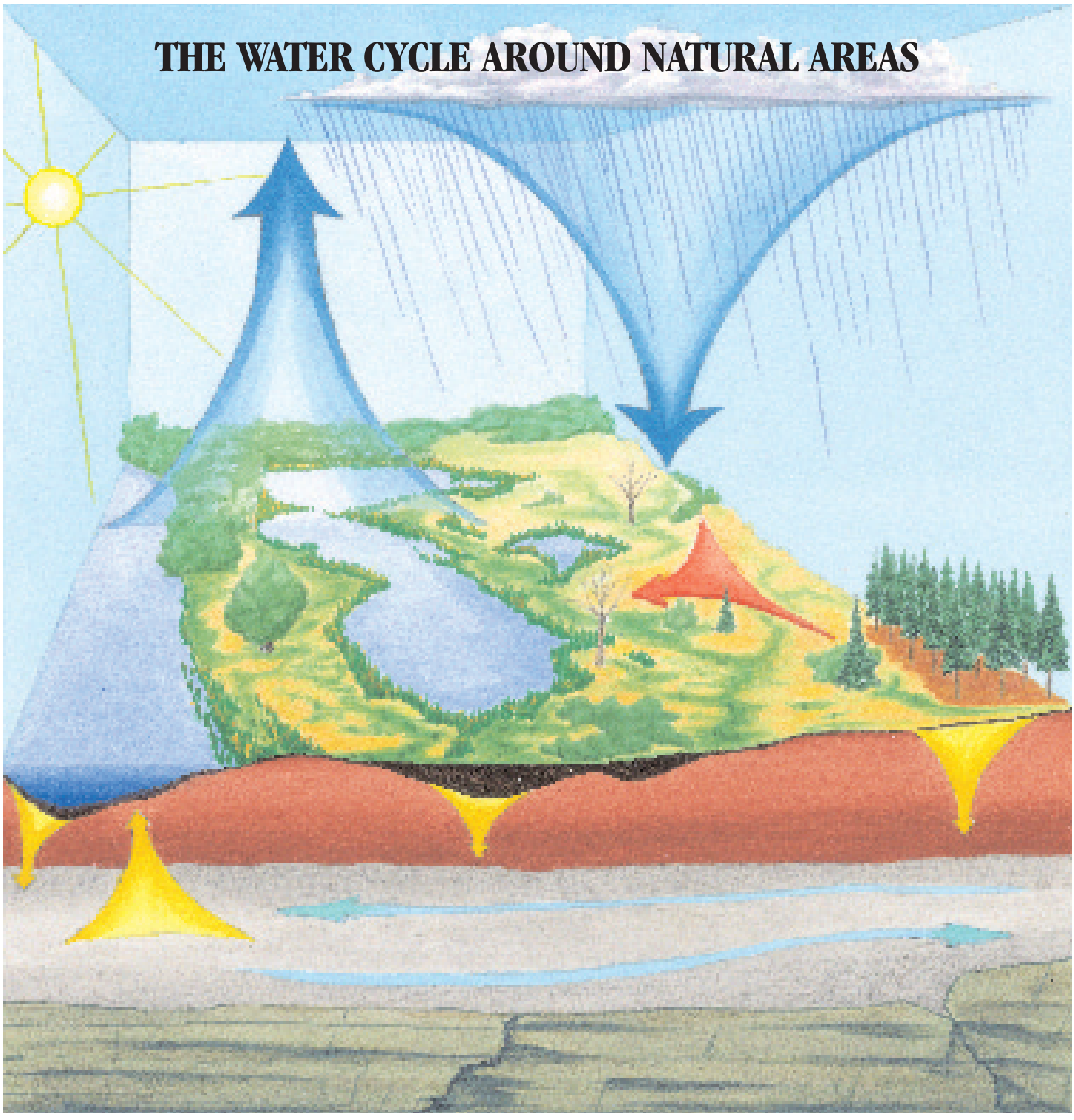
Bullfrog

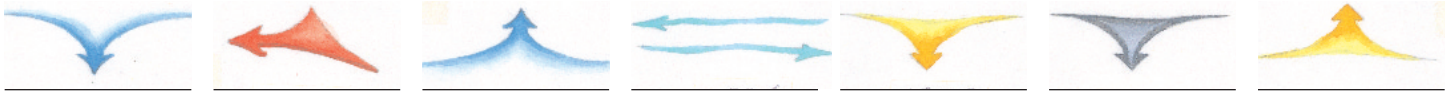
Blue-flag Iris

PATHWAYS OF WATER

Land that is not used for agricultural production is also important to the water cycle. Wetlands, watercourses, woodlots, and ponds have a *natural* ability to conserve water by slowing its movement and removing pollutants.

THE WATER CYCLE AROUND NATURAL AREAS





Precipitation | **Runoff** | **Evaporation and Transpiration** | **Ground water flow** | **Infiltration (uncontaminated)** | **Infiltration (potentially contaminated)** | **Ground water recharge**

Most of the precipitation that falls on wetlands, watercourses, woodlots, and ponds is stored as surface water or infiltrates the soil. Runoff is rarely a problem. The water that infiltrates soil may play key roles in recharging ground water aquifers and discharging clean water to wetlands and ponds, or transpire from plants.

The ground water that doesn't resurface in wetlands or ponds may flow laterally to streams and creeks. Trees can tap into the lateral flow.

These natural areas provide habitat for a broad range of plants and wildlife.

WETLANDS, WATERCOURSES, WOODLOTS, AND PONDS

BEST MANAGEMENT PRACTICES

WETLANDS

In Ontario, the term "wetlands" can be used to describe marshes, swamps, bogs, and fens. Any wetland can be one or a combination of these four types.

For part or all of the year, all wetlands are covered by shallow water, and the water table is at or near the surface. A wetland is home to water-tolerant plants (see Wetland Types table for types of vegetation).

Wetlands are found where land meets water, as inland marshes, along lakes and streams, or as peatland.

WETLAND TYPES

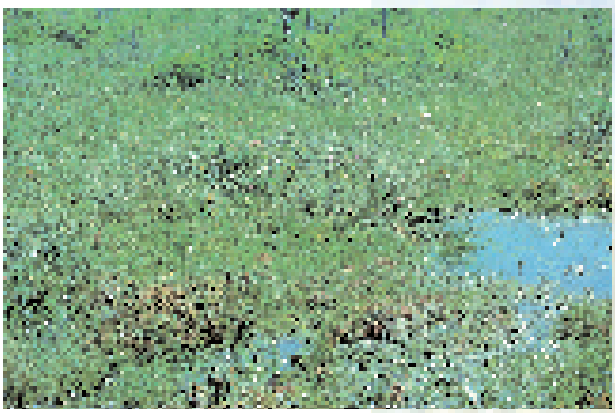
TYPE	VEGETATION	WATER	SOIL	LOCATION
MARSH	• cattails, sedges, rushes	• very efficient at supplying water and nutrients to vegetation • occasional flooding • maintain some open water, less than 2 metres depth • will dry out during extended droughts	• mineral • high organic matter content near surface	• Southern Ontario
BOG	• sphagnum moss	• water from runoff and precipitation only	• thick layer of peat (decomposed sphagnum moss), which is highly acidic, extends beneath bog	• common to Northern Ontario, but some in south
SWAMP	• shrubs and trees, e.g. soft maple and cedar	• occasional flooding	• organically rich mineral soils	• most common wetland in Southern Ontario
FEN	• grasses, sedges	• some flow-through	• neutral and alkaline	• rare in Ontario

WETLANDS, WATERCOURSES, WOODLOTS, AND PONDS

Hillman Marsh, Essex County

Golspie Swamp, Oxford County

Alfred Bog



Alfred Bog – Fen area

Before you decide to drain a wetland, remember that it's providing critical habitat for plants and animals, many of which are rare species, not seen in other places. Wetlands are necessary habitats for many types of wildlife, including amphibians, which are currently showing a decline in numbers in Ontario.

Wetlands are protected by Ontario's Wetland Policy and should not be drained. If you have difficulty distinguishing between wetlands and wet agricultural land, contact your local office of the Ontario Ministry of Natural Resources, Ontario Ministry of Agriculture and Food (see the blue pages of your telephone directory), or Conservation Authority. (Other legislation is outlined on pages 91 to 93.)

Soils are a combination of mineral and organic solids, water and open-air space. Organic soils usually contain more than 30% organic matter. They are often acidic. Mineral soils will have considerably less organic matter, and their acidity will depend on the bedrock materials they were derived from.

WETLANDS, WATERCOURSES, WOODLOTS, AND PONDS

Since European settlement, agricultural activity has accounted for up to 85% of wetland losses – 31,769 hectares (78,500 acres) – in Southern Ontario. Nowadays, many activities and land uses, including agriculture, can damage or destroy remaining wetlands. These activities include:

- removing peat and muck soil for commercial sale
- using wetlands as dumpsites for landfill, sewage, and other wastes
- dredging wetlands for ponds, beaches, harbours, marinas and boat access areas
- allowing livestock to graze wetlands
  - animals may eat and trample vegetation, cause erosion, and add excessive nutrients and bacteria
- allowing clearcutting in a wetland
  - clearcutting removes vegetation, raises the water table, and reduces habitat
- removing buffering areas around wetlands
  - impairs filtering ability, allowing increased nutrient and sediment input
- depositing high levels of contaminants including nutrients, pesticides, and heavy metals
  - hazardous to all wetland users including plants, animals, and humans
  - can pollute local surface and ground water
- taking excessive amounts of water from watercourses and wells, which dries wetland
- filling in wetlands
- constructing new drains through wetlands.

Wetlands hold a great deal of water. A hectare (2.5 acres) of wetlands with .3 metres (1 ft) of water would hold approximately 3-million litres (660,000 gallons). Much of this water will go for ground water recharge.

As mentioned earlier, wetlands are protected by Ontario's Wetland Policy. The policy includes an inventory and classification of remaining wetlands, based on their role in providing fish and wildlife habitat, assisting in flood control, and improving water quality.

Activities that are permitted in Ontario wetlands vary according to their designation. There are seven classifications. Classes 1, 2, and 3 designate wetlands that are either regionally or provincially significant. Classes 4, 5, 6, and 7 are not formally protected, but their conservation is still encouraged.

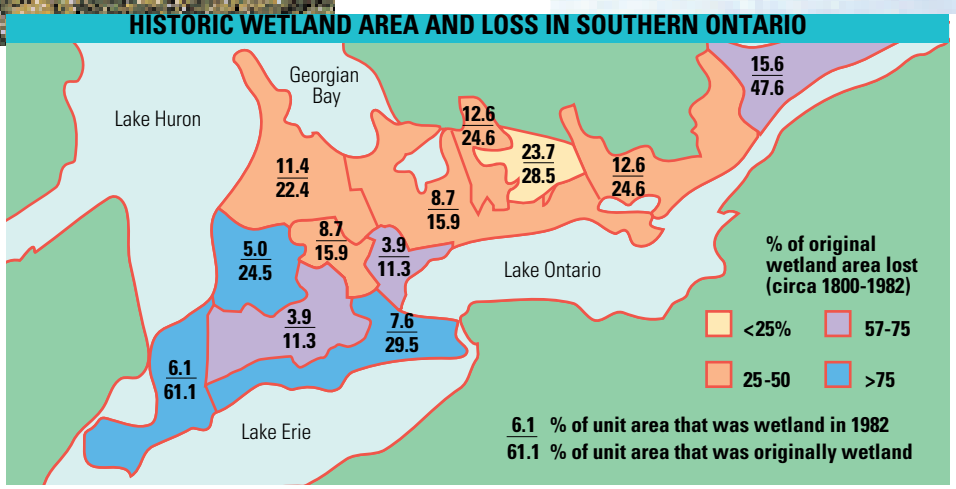
Other legislation, such as the Fisheries Act and the Endangered Species Act, may also have some bearing in your case.

Contact your local office of the Ontario Ministry of Natural Resources to see whether your wetlands have been surveyed, and what can be done to protect them. (See the blue pages of your telephone directory.)

WETLANDS, WATERCOURSES, WOODLOTS, AND PONDS

Many fish species require shallow water and aquatic vegetation for some stage of their life cycle.

Livestock damage wetlands by eating and trampling vegetation and adding excessive nutrients.



MAINTAINING, PROTECTING, ENHANCING, RESTORING, AND CREATING WETLANDS

If you want to maintain and protect your wetland, often the best method is to do nothing. Don't burn, fill, or drain them – or do any of the other activities listed in the previous section.

Buffer strips are excellent filters around wetlands. If you have a buffer strip, maintain it. If there is none, create one. Vegetated buffers will trap sediments and nutrients, and stabilize and reduce erosion, thereby ensuring wetlands receive cleaner ground and surface water. They're usually made of grass, shrubs, and trees, or a combination of each.

The establishment and maintenance of vegetated buffers around wetlands will help to preserve and protect them.

WETLANDS, WATERCOURSES, WOODLOTS, AND PONDS

The desired width of a buffer should take into account:

- ► the slope of your land
- ► the length of slope
- ► soil type
- ► land use
- ► classification rating of the wetland.

Buffer strips will require some maintenance:

- ► inspect regularly for erosion, areas void of vegetation, or other irregularities
- ► avoid fertilizer, pesticide, and other chemical use on the buffer
- ► avoid excessive vehicular traffic
- ► if trees are harvested, leave any tops and other branches as brush piles
- ► if mowing, try to delay until July to protect nesting areas
- ► plant trees or wildlife shrubs
- ► reestablish disturbed trees and other vegetation.

Restoring and creating wetlands involves planning. The steps include:

- ► compiling site background information on soils, land uses (existing/adjacent and compatibility), hydrology of site, drainage systems, and other utility corridors
- ► assessing the reason for restoration
- ► determining whether water cycle can be restored, including water sources above and below ground
- ► comparing to other nearby wetlands and natural areas
- ► determining what type of wetland is suited to site
- ► determining site access for machinery, if necessary
- ► analysing costs and benefits
- ► determining the availability of native plant materials.

Destroying wetlands can leave areas vulnerable to the invasion of non-native nuisance plants, such as purple loosestrife and garlic mustard.

Often wet areas can be restored to wetlands by simply letting them change naturally, so your best bet is to select areas that were once wet. Occasionally, tile drainage systems may be have to be rerouted or plugged.

Field Crop Production describes best management practices for an adjacent field. They reduce the delivery of sediment, nutrients, and pesticides to wetlands. *Wildlife Management*, together with *Farm Forestry and Habitat Management* (which describes buffer strip areas, residue management, and erosion control structures on adjacent areas), will also be helpful to you.

WETLANDS, WATERCOURSES, WOODLOTS, AND PONDS

BEST MANAGEMENT PRACTICES

WATERCOURSES AND LAKES

A healthy, clean watercourse is a measure of your farm's wellbeing. It serves many purposes: removing excess water, and providing water for humans, livestock, crops, fish and wildlife, and recreation. It also provides habitat for fish and other dependent wildlife.

Watercourses and lakes receive water from ground and surface water sources.

GROUND WATER SOURCES	SURFACE WATER SOURCES
• bank seepage	• runoff from precipitation and snowmelt
• tile drains with no surface inlets	• tile drains with surface inlets
• ground water resurfaces to a watercourse	• direct precipitation
• springs	• wetlands, lakes, ponds, or reservoirs

Water can be lost and taken from watercourses and lakes in many ways, including:

- ▶ evaporation
- ▶ infiltration through the ground
- ▶ irrigation, livestock, and other farm uses
- ▶ municipal, commercial, industrial, and residential water-taking
- ▶ flowing downstream to a receiving water body.

Streams and watercourses on farms are sometimes widened, straightened, or deepened. These changes can detract from a stream's ability to move water and sediment. Generally, altering a natural watercourse is not recommended: any work involving stream channels or shorelines requires a work permit from the Ontario Ministry of Natural Resources.

In natural systems, a stream will find a pattern based on its watershed. Unless disturbed, it will maintain a meander pattern, both through the land and within its own banks.

A riffle/pool or step/pool pattern will also be maintained. In other words, water is speeding up and slowing down as it goes from shallower, steeper gradients, to deeper, flatter areas.

If you widen a stream, its velocity will be reduced, and less sediment will be moved through. Slower-moving water may mean you'll have to clean out drains more frequently, and may be damaging wildlife habitat. The unmoved sediment is deposited as bars, especially during low-flow periods.

A ditch will naturally create a low-flow channel after it has been straightened, as indicated here by the sediment bars and meandering pattern.

Straightening a stream will sometimes cause more problems than it appears to solve.

WETLANDS, WATERCOURSES, WOODLOTS, AND PONDS

In some parts of Ontario, almost every watercourse has been constructed into a drainage ditch designed for quick removal of excess surface water.

If you straighten a stream, the slope is increased, thereby increasing the stream's velocity. This will cause erosion along the straightened section, and sedimentation and increased risk of flooding downstream.

Straightening also removes habitat diversity, making the stream less suitable for fish, amphibians, reptiles, and other wildlife.

It is possible to construct or alter a watercourse with minimal negative impacts. Sound planning and design, with consideration to natural channel functions, will produce a good, stable, and efficient drainage system and ensure habitat for fish and other species.

In the farming community, watercourses are either natural, municipal drains, agreement drains, or private ditches. Permission is required from your local municipality and the Ontario Ministry of Natural Resources to work on natural watercourses. Municipalities are responsible for work on municipal drains. See pages 91 to 93 for a summary of relevant legislation.

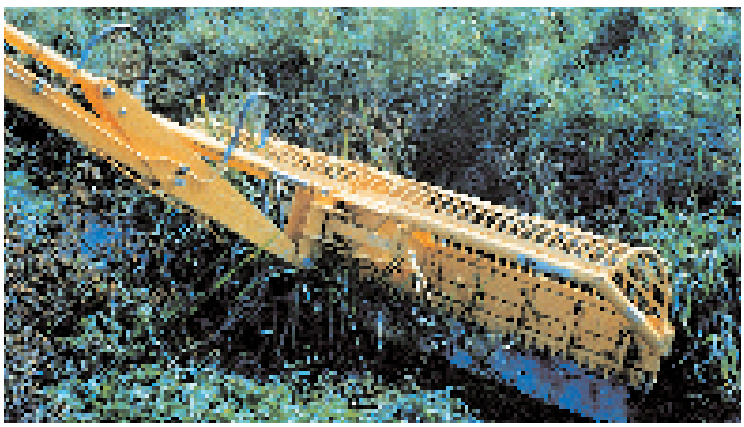
If you're considering improving drainage on your property, and you do not have an adequate or legal outlet, you should consider the Drainage Act. (The Fisheries Act and the Lakes and Rivers Improvement Act may also be relevant.) The Drainage Act provides a procedure whereby landowners can obtain an improved outlet. Each landowner in the watershed is considered, and the local municipality is responsible for following the procedures, and constructing and maintaining the system.

Some key features of the Drainage Act include:

- initiating drainage work through a petition
- having a drain designed by a drainage engineer with Ontario Ministry of Natural Resources and Conservation Authority consultation
- allowing the petitioner's concerns to be heard
- having an engineer determine the costs to be assessed to each landowner involved
- making provincial grants available for work carried out under the Act
- providing an appeal process to address landowner concerns both before and after construction
- providing for ongoing maintenance by the municipality.

For further information, contact your local municipality or office of the Ontario Ministry of Agriculture and Food. (Look up the blue pages of your telephone book.)

WETLANDS, WATERCOURSES, WOODLOTS, AND PONDS



Maintenance is necessary to keep these systems functioning. Here, a specially designed bucket removes excess vegetation and sediment from the bottom. The banks are left untouched.

A well-constructed and maintained open ditch. Grass buffers are left to provide stability to the drain bank and filter out soil moving in runoff.

WATERCOURSE MANAGEMENT

Protecting streams and drains begins on adjacent land.

Vegetated buffer strips should be established and maintained between your cropland and watercourses. The benefits are many:

- stabilize drain banks, reducing need for costly maintenance
- filter excess nutrients from surface and ground water runoff
- impede runoff (containing animal wastes, pesticides, and sediment) to watercourses
- reduce soil erosion
- provide habitat for wildlife
- improve water quality and habitat for aquatic life.

There are some downsides to buffer strips, namely:

- maintenance costs
- potential source of weeds
- increased potential for crop damage by wildlife
- loss of productive land.

Research in the United States has shown it takes at least a 15-metre (50-ft) wide buffer of grass, trees, and shrubs to remove most of sediment from entering a stream. This assumes best management practices for soil erosion control and fertilizer and pesticide application are in place, and surface runoff is not concentrated.

Ground water seepage can cause slumping of streambanks. To control slumping, install tile drains along a drain bank.

WETLANDS, WATERCOURSES, WOODLOTS AND PONDS

A buffer strip made up of grass and trees protect this drain. Nutrients deposited in buffer strips are used by the vegetation.

Here are some considerations in the planning stage:

- cropland should be separated from the the top of the ditch or streambank by a minimum of 3 metres (10 ft)
- the Municipal Drainage Superintendent should be contacted if you're planning a buffer strip of trees or shrubs along a municipal drain (access for maintenance vehicles cannot be obstructed)
- to determine buffer widths, consider:
  - type and quantity of potential pollutants
  - sensitivity of the watercourse
  - suitable vegetation
  - soil type
  - slopes
  - ease of access
  - wildlife.

Buffers can be planted to trees, shrubs, grass, or any combination of all three. Refer to *Farm Forestry and Habitat Management* and *Wildlife Management* for more information on suitable species.

Streamside treed buffer strips filter sediment and nutrients from agricultural land.

During runoff events, phosphates attached to sediment are deposited at the surface of treed areas. Trapped phosphates are taken up by tree roots. Leached nitrates from cropland flow with ground water towards the stream.

In the buffer strip, nitrates are taken up by roots, remain in the soil, and are converted to gases for loss to the atmosphere.

Buffer strips require maintenance to ensure their effectiveness. Here are some considerations:

- inspecting annually and after major storms or snowmelt
- limiting farm vehicles, livestock, or excessive pedestrian traffic
- prohibiting fertilizers, pesticides, and other chemicals
- removing trees that may offer future problems such as blockage (otherwise leave undisturbed)
- leaving cuttings from trees on-site as brush piles (tie down if you feel they may pose a problem to watercourse)
- leaving root mass and stumps in place
- trimming grass to promote a dense thick mat and to control weeds, but consider the needs of nesting wildlife. Mowing should be delayed until July.
- reestablishing disturbed grass, trees, and shrubs as necessary
- reducing or eliminating noxious weeds.

Refer to *Farm Forestry and Habitat Management* for additional details.

WETLANDS, WATERCOURSES, WOODLOTS, AND PONDS

Surface water should enter your watercourses as safely as possible. Two surface water entry structures to prevent erosion are:

- ▶ rock chute spillways
- ▶ drop pipe inlet.

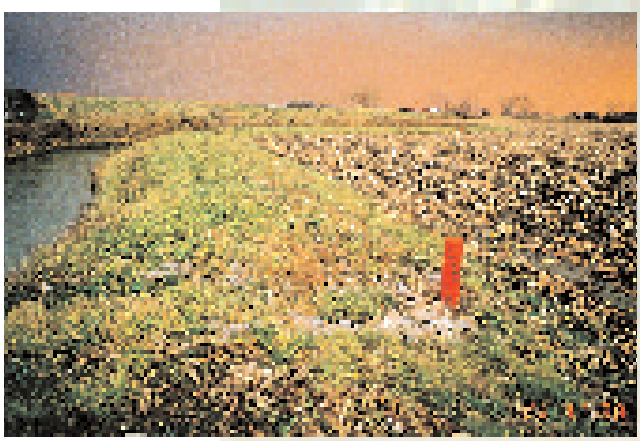
For more suggestions on safely conveying concentrated runoff to your watercourse, read the "Non Tillage Options" section of *Field Crop Production*.

There are a number of methods to control streambank erosion. They include:

- ▶ properly-sized, irregular-shaped rip rap underlaid with filter cloth to protect streambank's lower section
- ▶ vegetation to protect upper bank
- ▶ use of living and dead woody plant materials
  - ▷ some methods use large pieces (tree roots, boulders, logs, live shrubs), which promote fish spawning, feeding and nursery areas, and retreats from predators.

For more information, see *Field Crop Production*.

A proper rock chute conveys cropland runoff to channel.



In this drop inlet system, a diversion constructed along a drain intercepts surface water and directs it to a single drop pipe inlet.

WETLANDS, WATERCOURSES, WOODLOTS, AND PONDS

Another way of rehabilitating fish habitat is to install in-stream "lunkers" or fallen trees. They provide protection from predators and habitat diversity. Both will provide shading to cool the stream, and habitat for wildlife and insects that fish feed on.

Installing lunker structures along a municipal drain.

Above the lunker structures, the remainder of an eroded bank is posted with dogwood, alder, and willow cuttings.

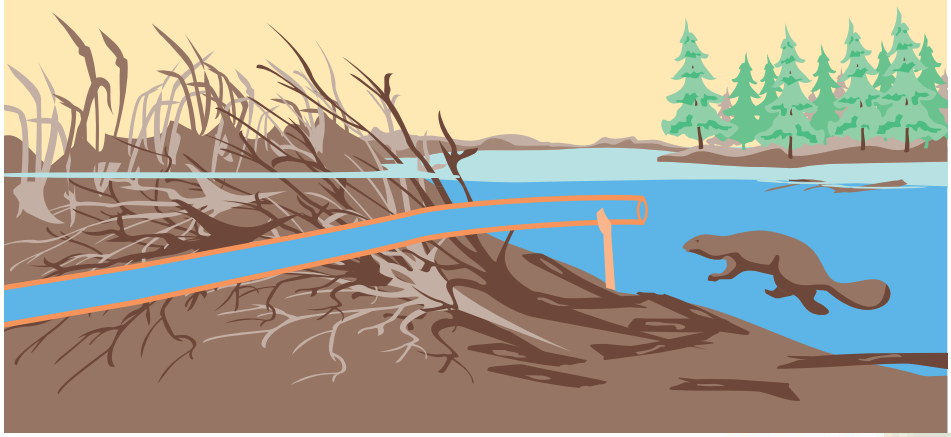
Today's engineering technology makes it possible to restore water channels that will serve both agriculture and nature. A watercourse designed as it would be found in nature will regulate itself to remain more stable over time. Contact Ontario Ministry of Natural Resources staff for appropriate techniques and permits.

Before restoration, this channel flows wide and shallow, offering little opportunity for aquatic life. Following the reshaping of the channel to a natural flow path, the water is deeper and moves faster to provide better flow characteristics and fish habitat.

WETLANDS, WATERCOURSES, WOODLOTS, AND PONDS

Beavers can pose problems to your drainage system. In most cases, humane trapping and removal is the best approach. Another is to install a "beaver baffler", which allows the beaver to remain, while providing a drainage outlet for cropland. Additional management techniques for beavers and other wildlife are available through your local Ontario Ministry of Natural Resources (see blue pages of your phone book), and are described in *Wildlife Management*.

BEAVER BAFFLER



The beaver baffler consists of a pipe extended through the dam, with the inlet a few metres upstream. The beaver has difficulty hearing the flow over water, and therefore can't locate and plug this controlled leak. Water can then be maintained at the pipe inlet level.

In your day-to-day operations, remember that watercourse corridors are not dumping grounds, access lanes, or places to mix and load chemicals. Watercourses are protected by legislation. Here are some management considerations:

- equipment crossing
  - if you need to cross a watercourse with machinery on a regular basis, consider building a stable crossing
  - options include culverts, bridges, bed-level and mid-level crossing systems
  - approvals may be required under the Public Lands Act, the Lakes and Rivers Improvement Act, the Drainage Act and the Federal Fisheries Act

WETLANDS, WATERCOURSES, WOODLOTS, AND PONDS

- ► water-taking
  - ▷ if you're planning to remove water from a watercourse for irrigation, or farm use beyond general household and livestock watering, you'll need a Permit to Take Water from the Ontario Ministry of Environment and Energy
  - ▷ Permit to Take Water program ensures every surface and ground water user gets a fair share while protecting the resource
  - ▷ contact your local Conservation Authority or Ontario Ministry of Environment and Energy
- ► livestock management for intensive pasture management
  - ▷ restrict livestock from watercourses to prevent erosion and water contamination
  - ▷ if fencing around a municipal drain, contact the Drainage Superintendent for setback distances
- ► livestock management for extensive pasture management, i.e. cow-calf operation
  - ▷ restrict livestock where possible from watercourses to prevent erosion and water contamination
  - ▷ locate feed, water, shade, and salt blocks away from watercourse
  - ▷ inspect water channels for erosion and streambanks for slumping, and take appropriate action
- ► livestock watering facilities
  - ▷ when creating watering facilities, decide whether the source offers the quantity and quality of water needed by your livestock
  - ▷ some of the items require high capital costs but need little maintenance
- ► livestock crossings
  - ▷ crossing should restrict stream access at all times
  - ▷ livestock crossing should be at:
    - ▷▷ bank, such as a bridge or culvert, or
    - ▷▷ mid-level
  - ▷ fencing should extend over the crossing
  - ▷ streambank should be stabilized at both ends of the crossing.

WETLANDS, WATERCOURSES, WOODLOTS, AND PONDS

LIVESTOCK WATERING FACILITIES

WATER SOURCE	APPROPRIATE TRANSFER METHOD						
	Electrical Pump	Gasoline Engine	Gravity	Hydraulic Ram	Nose Pump	Solar/ Battery Power	Windmill
Springs & seepage areas (assume gravity collection to spring box)	*	*	*	*	*	*	*
Ponds (surface and ground water fed)	*	*	*	*	*	*	*
Wells	*	*			*	*	*
Watercourses	*	*	*	*	*	*	

Fence types are available that can withstand ice and high-flow damage.

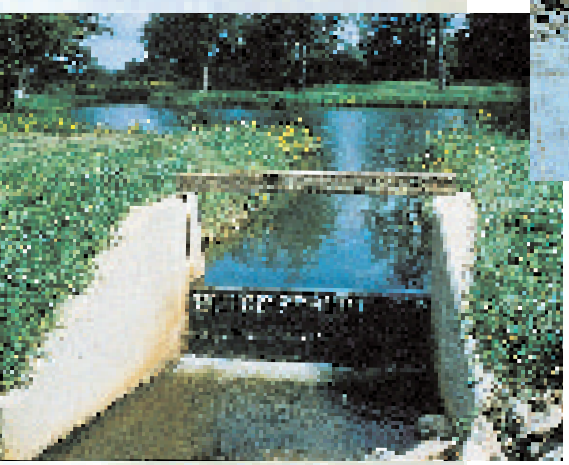
A single nose pump can provide water to 30 animals.

A solar-powered watering system: photovoltaic panels use the sun to charge batteries, which in turn power a pump that distributes water to meet livestock needs.

WETLANDS, WATERCOURSES, WOODLOTS, AND PONDS

Do not crop or cultivate up to the water's edge. A buffer strip:
▸filters contaminants
▸prevents erosion
▸preserves water quality.

A low-flow crossing allows livestock access to pasture on both sides of the watercourse. Fencing is installed to restrict them from the channel.



Dams across watercourses create many problems and will not be approved by the Ontario Ministry of Natural Resources.

Culverts in combination with fencing are suitable for livestock and machinery to cross a drain.

Once livestock are restricted and fencing is installed, the buffer area may be planted to vegetation such as grass, trees, and shrubs.

WETLANDS, WATERCOURSES, WOODLOTS, AND PONDS

BEST MANAGEMENT PRACTICES

WOODLOTS

Farm woodlots range from small woodlots of Southwestern Ontario to larger forests of Eastern and Northern Ontario. All of them benefit agriculture.

While there may be some exceptions, the water cycle changes from forested areas to farming areas.

Farm Forestry and Habitat Management discusses woodlots, and best management practices, in detail. Also, your local Conservation Authority can be of assistance.

ITEM	FORESTED AREA	FARMING AREA
• water quality	• streams run clear	• streams are forced to carry higher sediment and chemical loads
• water quantity	• more water infiltrates into forest floor • floods are localized, and do not impact significantly downstream	• water runs off more quickly, offering less recharge to ground water • sometimes create adverse downstream impacts, such as flooding • rate of runoff is reduced
• habitat	• aquatic life and wildlife will be plentiful	• reduced variety of aquatic life and wildlife

BEST MANAGEMENT PRACTICES

PONDS

Ponds, whether artificial or natural, are a common site on Ontario farms.

If your pond is well designed and maintained, it can provide water for:

- ▶ livestock
- ▶ irrigation
- ▶ chemical mixing
- ▶ aquatic life and wildlife
- ▶ fish production
- ▶ fire protection for farm buildings
- ▶ recreation
- ▶ maintaining water table levels
- ▶ aesthetics.

Pond water quality may not be adequate for swimming.

WETLANDS, WATERCOURSES, WOODLOTS, AND PONDS

If you're constructing or altering a pond on or near a stream, you will probably need approval. Contact your Municipality, the local Conservation Authority, the Ontario Ministry of Natural Resources, and the Ontario Ministry of Environment and Energy before proceeding. A Permit to Take Water may be required to fill the pond.

If you want to stock a pond with fish, a permit is required from the Ontario Ministry of Natural Resources.

There are two basic pond types: embankment and excavated.

EMBANKMENT PONDS

Vertical intake pipes are used to adjust water levels in this embankment pond constructed across a natural drainageway.

Embankment ponds include:

- in-stream ponds, created by constructing a dam across a natural watercourse
- dams constructed across a natural draw or valley.

In-stream ponds or dams across watercourses may harm the stream by:

- reducing fish habitat by:
  - restricting access
  - increasing water temperature
  - altering water levels
  - increased erosion and siltation
  - increased evaporation
  - degraded water quality
- increasing flood risk upstream and downstream
- increasing risk to human life and property downstream.

Always seek approval from the Ontario Ministry of Natural Resources before constructing or repairing. In-stream ponds are rarely approved.

Embankments across natural draws or valleys are common in Ontario. Before going to the expense of constructing, you should plan, survey, and investigate thoroughly. Often the underlying soils will dictate the feasibility and practicality of the proposed site.

Your design must account for capacity, fill material, spillways, erosion, and methods of construction.

WETLANDS, WATERCOURSES, WOODLOTS, AND PONDS

EXCAVATED PONDS

Ponds fed by surface water can be built almost anywhere. You must ensure that the pond's bottom is impervious, assuming it's meant to hold water. Upslope land use will often determine the quality of water in the proposed pond. If proper soil isn't available on-site, options include:

- importing clay
- using imported materials such as bentonite or plastic linings.

A sufficient spillway may be important to this system as over topping can be a risk.

Ponds fed by ground water should be built in areas where the permanent water table is within a metre of the surface. It's important in these systems that an adequate water supply is available. The soil water content must be thoroughly investigated before planning any work. Digging test holes is recommended.

The efficient working of a pond includes regular maintenance.

This spring-fed pond was dug for recreational opportunities and supports a permanent trout population.

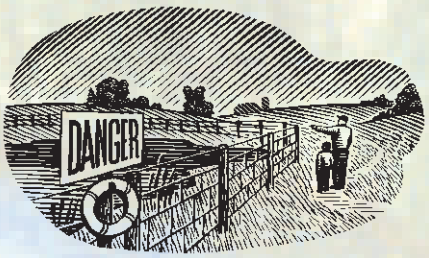
Surface-fed pond located in an expired gravel pit along the valleyside. Water is obtained from intermittent overland flow. A diversion was constructed for this purpose.

POND MAINTENANCE

Pond maintence should include:

- inspecting periodically
  - repair any damage immediately
- maintaining embankments
  - fill any rills, reseed or resod as needed
- using best management practices described earlier to prevent bank erosion and seepage concerns
- keeping outlet structures operating as planned
- discouraging burrowing animals by placing a thick layer of sand, wire mesh, or rip rap 1 metre above and below the water line on the slope of the embankment dam
- planting shoreline vegetation to stabilize the banks and to provide shade, therefore enhancing fish habitat
- diverting contaminated surface and ground water flows away from the pond.

WETLANDS, WATERCOURSES, WOODLOTS, AND PONDS



POND SAFETY

Keep the pond safe for children, pets and livestock:

- ► restrict access with fencing
- ► post danger or warning signs
- ► have rescue equipment readily available
- ► educate children on safe activities around the pond
- ► discourage swimming, unless you test the water regularly.

A fenced pond to restrict access can provide livestock with a clean water source.

LIVESTOCK

Fence livestock to keep them out of your pond. If the pond is used for livestock watering, supply nose pumps or some other watering system. For more information, see the "Watercourse" section earlier in this chapter.

BANK EROSION

Erosion on your pond banks may be caused by waterfowl or wave action. You can consider using:

- ► berms as part of pond's construction
- ► rock (with filter blanket underlay if required)
- ► grass, shrub (conventionally planted as willow branch bundles laid lengthwise on the bank), and tree plantings
- ► piles or cribs of wood or steel, gabion baskets, and other confinement systems
- ► log booms laid lengthwise on the bank.

Rock can protect pond banks from erosion and damage from burrowing animals.

WETLANDS, WATERCOURSES, WOODLOTS, AND PONDS

SEEPAGE CONCERNS

If your pond is experiencing excessive loss to ground seepage, it probably needs a liner. (Thorough soil testing before construction may have prevented this problem.)

If sealing of the pond bottom is insufficient, liner options include:

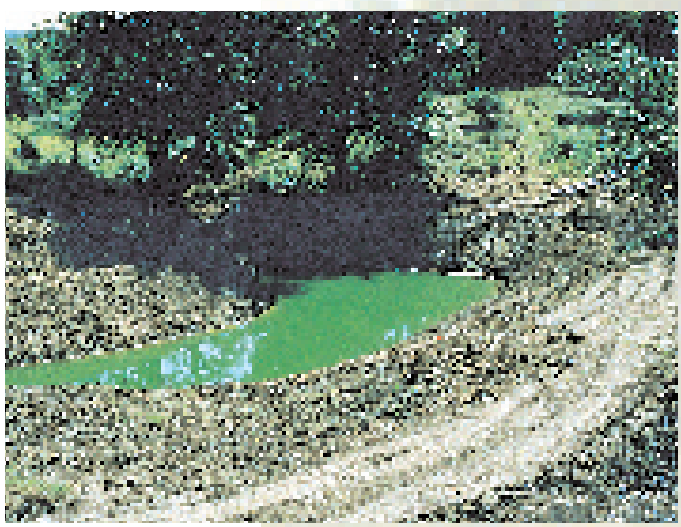
- a compacted layer of clay of at least 30 centimetres (12 in) thick
- granular bentonite as tablets or blanket
- other chemical dispersing agents
- waterproof liners such as those used in swimming pools.

Carry out soil inspections prior to constructing a pond. A polyethylene liner was required for this pond to hold water in sandy soils.

PROTECTION FROM CONTAMINANTS

Keep contaminants out of the pond. Divert runoff containing sediment and chemicals, or consider filtering alternatives such as a constructed wetland. Test the water from your tile drainage to ensure it's suitable for your pond.

In spring-fed ponds, divert surface water away. Do not build ponds near livestock yards, intensive pasture areas, or septic treatment trenches.



If best management practices are not in place, ponds built to collect runoff from agricultural land may show signs of excess nutrient loading – such as these algae blooms.

WETLANDS, WATERCOURSES, WOODLOTS, AND PONDS

Some plant growth is needed for a healthy pond. You must take special care when using chemicals – remember downstream water users.

USING A POND FOR FISH HABITAT AND FISH PRODUCTION

Using a pond for fish will require special planning, design, and construction on your part. Some of your considerations will be:

- adequate quality and quantity of water, relative to numbers of fish
- water temperature
  - shade trees will lower water temperature
  - most fish need cooler water
- spillway structures
  - must keep fish in the pond.

Contact the nearest Ontario Ministry of Natural Resources office for details. (See the blue pages of your phone book.)

WATER QUALITY IMPROVEMENT ALTERNATIVES

Methods to control algae and excessive weed growth include:

- removing dead vegetation and algae by hand and destroying it
- creating aeration by windmills that are either wind or mechanically driven
- adding straw
- applying approved chemical controls
- planting trees for shade.

If problems persist, contact your local Conservation Authority or Ontario Ministry of Natural Resources or Ontario Ministry of Environment and Energy office. (See the blue pages of your phone directory for the latter two.)

A healthy, well-maintained pond offers benefits to all users.

SOME OF THE LEGISLATION AND GUIDELINES PROTECTING WATER RESOURCES

To protect your rights and the rights of future water users, federal, provincial, and local governments have created a number of laws and guidelines to ensure an abundant supply of clean water.

The large number of laws and guidelines protecting your water resources can be confusing. In part, this is the result of all three levels of government attempting to manage water or issues related to water. Control over water resources has never been clearly allocated to any one level of government in our constitution.

Other laws have developed as a response to specific pollution problems. The Pesticide Act evolved from a growing awareness of health risks and water pollution problems associated with the improper use of pesticides. Similarly, the Gasoline Handling Act was a response to problems of inadequate private fuel storage facilities.

This list describes some water-related laws and guidelines that can directly influence a farmer's operation. Please note: additional local zoning bylaws and other legislation may also have a bearing on what you do!

If you have concerns or questions regarding water management on your property, be sure to contact relevant government agencies, and be aware of bylaws in your area.

SOME OF THE LEGISLATION AND GUIDELINES PROTECTING WATER RESOURCES

LAW/GUIDELINE	GOVERNMENT AGENCY	GOAL	RELEVANCE TO LANDOWNER
Agricultural Code of Practice (Certificate of Compliance)	OMAF, MOEE, Ministry of Housing	• to provide guidelines for livestock operations to minimize land, water, and air pollution potential	• best management practices are described to reduce pollution potential associated with livestock operations • if requested by the landowner, an application for a Certificate of Compliance can be made and an inspection of the farming operation performed; if conditions outlined in the Code of Practice are satisfied, a Certificate of Compliance will be issued
Common Law	Provincial Courts	• generally, to protect the rights of the people	• all landowners bordering water are entitled to have water flow through in its natural state (this relates to both water quality and quantity)
Conservation Authorities Act	MNR, Local Conservation Authority	• to manage and conserve natural resources within watershed jurisdiction	• regulations may be in place controlling construction or the placement of fill adjacent to a watercourse
Dead Animal Disposal Act	OMAF	• to provide for the safe disposal of deadstock	• deadstock must be disposed of in accordance with regulations (i.e. within 48 hours, buried under 0.6 metres of earth, disposed of by a licensed collector)
Drainage Act	OMAF	• to allow landowners to obtain an improved outlet for their land drainage	• provides financial assistance for drain construction and maintenance • general prohibition against the discharge of polluting substances into a drain • controls activities in or near a drain and connections to a drain
Environmental Protection Act	MOEE	• to protect Ontario's land, water, and air resources from pollution	• contaminants are not allowed to be discharged into the environment in excess of regulatory limits • farmers are exempt from requiring a Certificate of Approval for agricultural structures or equipment (i.e. manure storage)
Fisheries Act	MNR, on behalf of Dept. of Fisheries and Oceans, MOEE, and Environment Canada	• to protect fish and fisheries habitat	• general prohibitions against discharging pollutants to a watercourse that would harm fish or fish habitat • general prohibitions against stream alterations that would harm fish habitat
Gasoline Handling Act	MCCR	• to protect land, surface and ground water resources from damage by petroleum products	• minimum standards are set regarding farm fuel storage

SOME OF THE LEGISLATION AND GUIDELINES PROTECTING WATER RESOURCES

LAW/GUIDELINE	GOVERNMENT AGENCY	GOAL	RELEVANCE TO LANDOWNER
Health Protection and Promotion Act	MOH	• to minimize situations where human health may be threatened	• landowners whose operations have created a health hazard, i.e. contaminated water, may be required to correct the situation or cease activities causing the contamination
Lakes and Rivers Improvement Act	MNR	• to ensure flow and water level characteristics of lakes and rivers are not altered to the point of disadvantaging other water users	• any work forwarding, holding back, or diverting water must receive prior approval from MNR
Ontario Water Resources Act	MOEE	• to protect the quality and quantity of Ontario's surface and ground water resources	• general prohibitions against discharging pollutants to surface or ground water • permits are required for the taking of large amounts of surface or ground water, i.e. for irrigation
Pesticides Act	MOEE	• to protect Ontario's land, and surface and ground water resources from damage due to improper use of pesticides	• landowners involved in pesticide application as part of a business (farming) are required to take a Grower Pesticide Safety Course • regulations are set regarding pesticide storage, e.g. warning sign identifying the storage site, proper ventilation, no floor drains, concrete impervious floors
Planning Act	MMA, Municipality	• to reduce land use conflicts between neighbours within the township	• minimum setbacks may be established between watercourses and structures • minimum standards may be set for manure storage construction to reduce water pollution potential (check your local zoning by-laws)
Wetlands Policy Statement	MMA/MNR	• to protect wetlands	• wetlands are protected under the authority of section 3 of the Planning Act
Public Lands Act	MNR	• to protect and perpetuate public lands and waters for the citizens of Ontario	• requires a landowner to obtain a work permit for any activity on shorelands adjacent to a navigable water • shorelands include public or private lands as well as areas that are seasonally inundated with water • the bed of a navigable water (below the high water mark) is considered to be public (Crown) land

MNR Ontario Ministry of Natural Resources
MOEE Ontario Ministry of the Environment and Energy
OMAF Ontario Ministry of Agriculture and Food
MCCR Ontario Ministry of Consumer and Commercial Relations
MOH Ontario Ministry of Health
MMA Ontario Ministry of Municipal Affairs

Acknowledgements

The Best Management Practices project is funded by Agriculture and Agri-food Canada through Green Plan, managed by the Ontario Federation of Agriculture and supported by the Ontario Ministry of Agriculture and Food.

Special thanks to all those who have contributed to this publication by lending their expertise and resources.

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Graphic Designer: Neglia Design Inc.

Photography: In addition to the authors the following provided photography used in the booklet: Essex Region Conservation Authority, Ausable Bayfield Conservation Authority, Rideau Valley Conservation Authority, Long Point Region Conservation Authority, Niagara Peninsula Region Conservation Authority, Kingston, Frontenac and Lennox and Addington Health Unit, Ontario Soil and Crop Improvement Association, Ontario Ministry of Agriculture and Food, Ontario Ministry of Natural Resources, Tennessee Valley Authority, Ontario Federation of Anglers and Hunters, Mike Oldham, and Deryl Nethercott.

The printing of this publication has been made possible in part through the generous contribution of the Ontario Ministry of Natural Resources.

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Printed 1994
ISBN 0-7778-2361-6