Permeable Trenches

Introduction

This sheet presents the use of permeable trenches to improve surface drainage and reduce erosion problems in fields. The information it contains makes it possible to size and install permeable trenches in simple cases.

Source: Mikael Guillou (MAPAQ)

Definition

Permeable trenches are structures that allow surface runoff and the resurgence of subsurface runoff or unconfined groundwater to drain through underground piping (Figure 1). These structures are generally elongated in shape. They do not have a direct inlet at ground level, but rather promote infiltration via the placement of porous material between the surface of the soil and the piping. In most cases, this practice allows the soil above the trench to be tilled.

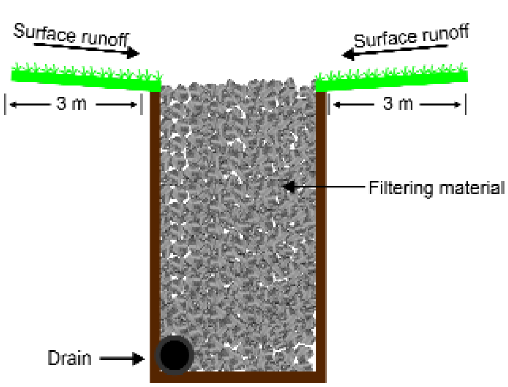


Figure 1: Permeable trench

Trenches can be backfilled with rock, coarse wood chips or straw bales. Rock is the most durable material, but it is also the most costly. Straw is the most economical material, but it decomposes quickly: under certain conditions, more than half of the material can decompose within five years. Because of their higher carbon/nitrogen ratio and the nature of their fibres (rich in lignin), wood chips decompose much more slowly than straw. Furthermore, wood chips do not cost as much as rock. Wood chips are therefore an attractive material, but their availability varies greatly by region.

Coarse wood chips are an economical and relatively durable backfilling material. The chips must be sufficiently large to allow water to infiltrate fairly rapidly. Branches and logs can also be used, but excessively fine wood chips or sawdust is not recommended.

Source: Jacques Goulet (MAPAQ)

Wood chips

When can permeable trenches be useful?

- **Poor drainage of elongated depressions**

- **Linear resurgence of subsurface runoff or unconfined groundwater**

Note : Short trenches can also be made with straw bales to resolve more localized drainage and erosion problems. These short trenches can be considered infiltration wells without a coiled drain. A separate sheet is devoted to infiltration wells; the reader can refer to it for more information on this subject.

> **WARNING**
>
> Permeable trenches, infiltration wells and inlet wells are preferred means of draining areas between fields and watercourses. Surface runoff drained using these structures is less filtered than water that enters drains after filtering through the soil profile or that runs through abundant vegetation cover. This lower level of filtration increases the risk of surface water contamination by soil particles, nutrients (phosphorus, nitrogen, etc.), pesticides and agricultural microorganisms. Consequently, these structures must be used wisely and, when they are installed, be accompanied by preventive measures, such as balanced fertilization, limited pesticide use and, ideally, the creation around the structures of a buffer zone where the soil is not worked and no fertilizers or pesticides are applied.

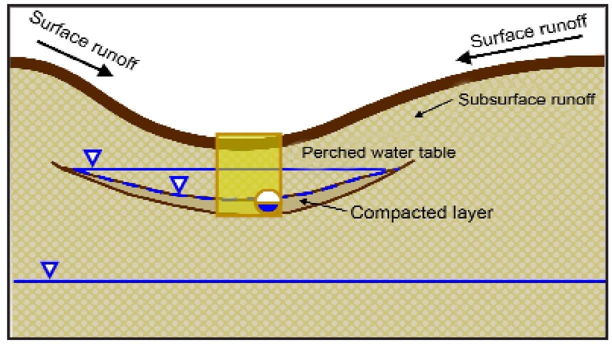
How to determine where to place permeable trenches

- **Poor drainage of elongated depressions**

Permeable trenches used to drain depressions must be installed at the lowest point of the depressions (Figure 2). Levelling work can be done to concentrate the surface runoff at the bottom of the depressions in order to facilitate water drainage.

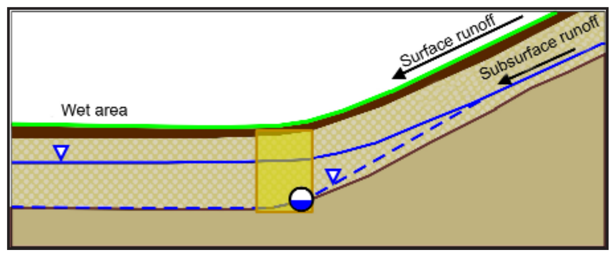
- **Linear resurgence of subsurface runoff or unconfined groundwater**

The resurgence of subsurface runoff or unconfined groundwater occurs frequently in fields with long slopes, with a low slope or a bench that follows a steeper slope (Figure 3), or with irregular subsoil (Figures 4 and 5). It is important to identify the cause of the resurgence, which depends on the morphology of the land and can sometimes be located several metres upstream from the point where the water breaches the surface of the soil. The trench should be located so as to prevent water from rising to the surface rather than simply holding and draining the water at the resurgence point.



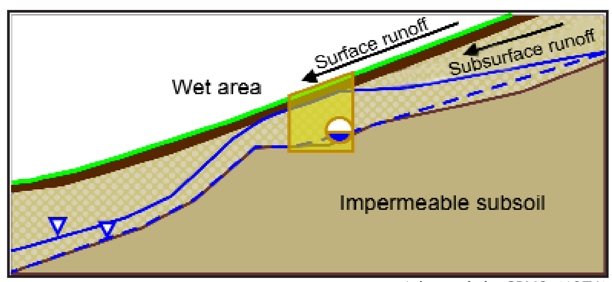
Adapted de CPVQ (1976)

Figure 2: Permeable trench in an elongated depression



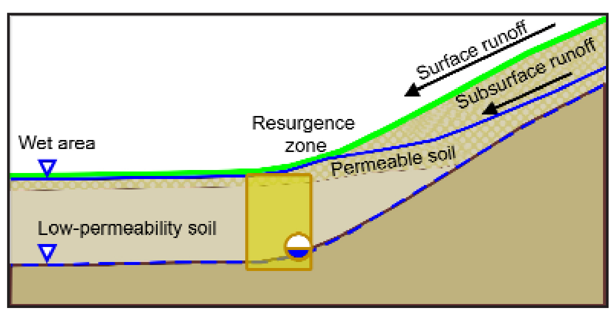
Adapted de CPVQ (1976)

Figure 3: Permeable trench at the foot of a slope or in a bench



Adapted de CPVQ (1976)

Figure 4: Permeable trench upstream from a localized rise in the impermeable subsoil



Adapted de CPVQ (1976)

Figure 5: Permeable trench meeting two soils of different permeability

It is important that permeable trenches not be installed in areas where water drainage is rapid. Since permeable trenches have a low infiltration capacity, the drainage rate will be insufficient and will not make it possible to reduce the risk of erosion.

How to size permeable trenches

Since permeable trenches are most often installed in simple cases where flow is limited, a drain measuring 10 cm (4 inches) in diameter is generally used. However, if the drain is also used to drain the water from one or more inlet wells, its sizing will depend on the inlet well or wells and not on the permeable trench.

How to construct a permeable trench

• **Piping**

If the field has an underground drainage system with sufficient capacity to drain the water from the trenches, the trenches will be connected to the existing system, thus reducing the scope and cost of the installation work. The existing drain is cut to install a T-connection, then a new section of piping is installed along the depression or the resurgence, with the desired minimum slope maintained (minimum slope: 0.1%).

If it is not possible to connect a permeable trench to existing piping, a separate drain and drain outlet must be installed to drain the surface runoff into the closest outflow. The drain slope will follow the general slope of the land, without being under 0.1%. Because of the often extended length of trenches, it is generally preferable to use a hydraulic shovel or mini-excavator to construct the trenches. The excavation slope should be controlled with a laser guidance system. The procedure is the same as the one described in the "Inlet and Drainage Wells" sheet.

• **Excavating and laying the drain**

The width of the excavation should not exceed 60 cm. This width minimizes the quantity of soil excavated and the quantity of filtering materials required. A narrow trench also minimizes the area of soil load-bearing deficiency resulting from the work, therefore making it easier for farming equipment to pass over the trench and reducing the risk of the drain being crushed. For all these reasons, using a trapezoidal elevator bucket is not recommended for the excavation of permeable trenches.

The drain is laid out along the bottom of the trench as the excavation moves forward. It is recommended that the drain be installed against one of the trench walls in order to improve the lateral support provided by the trench. Small quantities of loose, rocky soil are placed on the drain at regular intervals to keep it in place temporarily. Once the drain is installed, the trench is backfilled with the chosen material.

• **Backfilling rock trenches**

In sandy and loamy soils, the bottom and sides of the excavation can be covered with a geotextile membrane (of the Texel 7609 or 7612 type) in order to prevent lateral clogging by the rock. The membrane is laid down before the drain is placed, and can be attached to the drain at the ends of the trench with drainage adhesive tape. If the soil above the trench is to be tilled once the work is completed, the membrane must end approximately 30 cm below the surface of the soil to prevent the membrane from being damaged by tilling operations. Otherwise, the geotextile membrane can be installed up to the soil surface.

Clean, 56-mm rock is used to backfill the excavation. Finer stone (such as 19-mm stone) can also be used if no coarser materials are available. If the soil above the trench is to be tilled, the upper part of the trench (the last 30 cm) must be backfilled with material that will not damage the tilling equipment (coarse soil if available, coarse sand, wood chips, clean 19-mm stone). Laying a geotextile membrane between these two zones is not recommended, because it would be quickly clogged by the silt contained in the surface runoff (Figure 6).

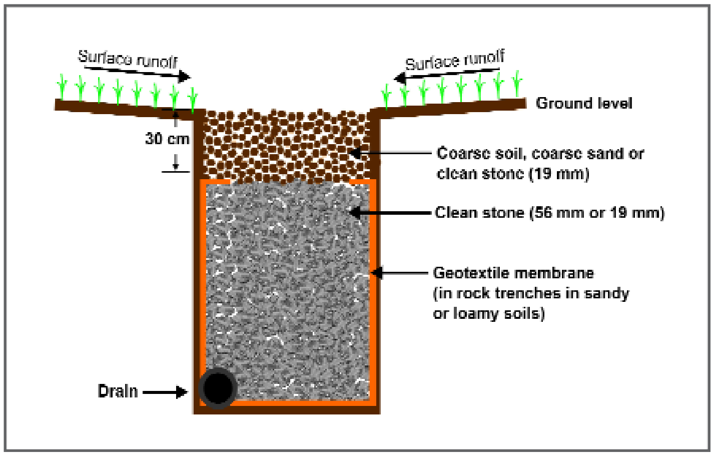


Figure 6: Permeable trench with rock—tilled soil

If the erosion rate is high and the risk of clogging is significant, it is preferable that the soil above the permeable trench not be tilled. On each side of the trench, a grassed strip at least 3 m wide will be maintained in order to filter the soil particles from the tilled soil (Figure 7).

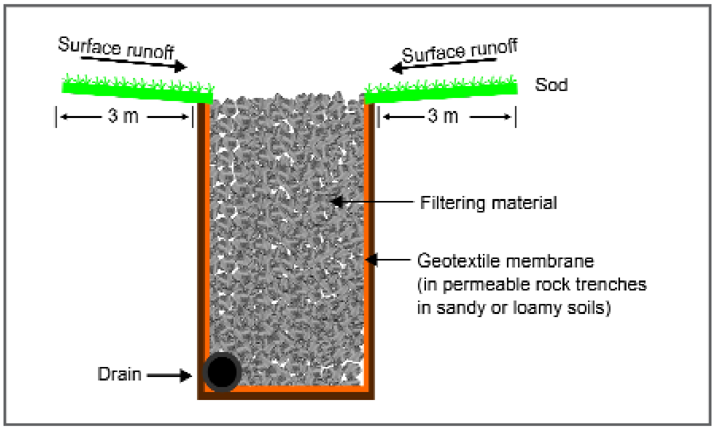


Figure 7: Permeable trench with rock—soil not tilled

• Backfilling wood-chip trenches

The trench is backfilled with wood chips up to the surface of the soil. No geotextile membrane is used in permeable trenches in which wood chips are used as a backfilling material (Figure 8).

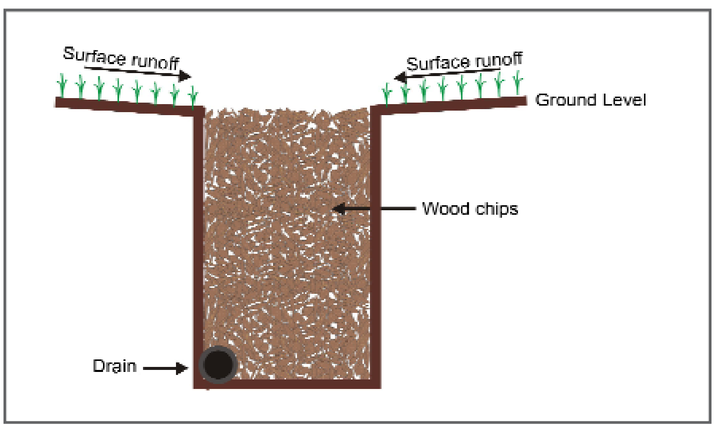


Figure 8: Permeable trench with wood chips—tilled soil

• Backfilling straw trenches

Small rectangular straw bales can also be used to backfill the trench (Figure 9). The bales are laid lengthwise in the trench to promote water infiltration. They are placed beside the drain rather than on it to reduce the risks of the drain being crushed.

Given the depth of trenches, most require the installation of two rows of straw bales, one on top of the other.

Source : Mikael Guillou (MAPAQ)

Backfilling a wood chip trench

Source : Mikael Guillou (MAPAQ)

Wood chip trench

The first string on each of the straw bales located nearest to the soil surface must be cut so that the bales are not ripped out by tilling equipment.

Once the bales have been installed, the trench is backfilled with the excavated soil. If necessary, coarse soil can be added on top of the straw bales to level the terrain.

No geotextile membrane is used in permeable trenches in which straw bales are used as a backfilling material.

In all cases, the excess excavated soil must be spread out on each side of the trench in a thin layer in order not to block the flow of water towards the trench.

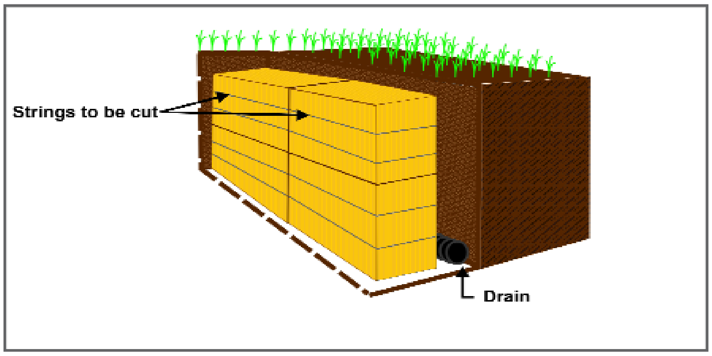


Figure 9: Permeable trench made with straw bales

Source : Georges Lamarre (MAPAQ)
Construction of a trench with straw bales

Maintenance

Generally, it is recommended that minimum tilling practices be adopted to maximize the lifespan of permeable trenches. If a trench gets clogged, the first 30 cm of the porous material is replaced to improve the infiltration capacity.

Source : Mikael Guillou (MAPAQ)
Wood chip trench

Organic filtering materials decompose gradually over time. Because of better oxygenation conditions near the ground surface, decomposition is faster in the upper part of the well. In wood-chip wells, it is generally necessary to add more wood chips every 10 years to compensate for subsidence caused by the decomposition of the material in place. Given its lower carbon/nitrogen ratio and high cellulose content, straw decomposes much faster and must be replaced more frequently. Coarse sand can also be used to replace the decomposed material in both cases.

Lastly, permeable trenches and separate drain outlets must be inspected frequently to evaluate the condition of the structures as well as their efficiency in improving surface drainage and reducing erosion problems.

Source : Jacques Goulet (MAPAQ)
Condition of the backfilling material after 6 years.
Left: Wood chips: slow decomposition;Right: Straw: quick decomposition

References

Brunelle, A. et V. Savoie. 2000. « Problèmes de drainage ». Sheet 7-B in *Guide des pratiques de conservation en grandes cultures*. Conseil des productions végétales du Québec inc. (CPVQ). In partnership with: Canada-Quebec Subsidiary Agreement on Environmental Sustainability in Agriculture; CPVQ; FPCCQ; MAPAQ; MENV; AAFC. Document containing 7 modules and 34 sheets. 500 p.

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Development: Nicolas Stämpfli, Brace Centre for Water Resources Management (McGill University).
Computer graphics: Helen Cohen Rimmer (HCR Photo)

Editorial committee: Robert Beaulieu (MAPAQ), Isabelle Breune (AAC), Mikael Guillou (MAPAQ)

Review committee (MAPAQ) : Bernard Arpin, Émilie Beaudoin, Jacques Goulet, Georges Lamarre, Richard Lauzier, Donald Lemelin, Ghislain Poisson, Victor Savoie

Page lay-out: B. Whissell, AAFC-Science Publishing and Creative Services

For more information:

Agriculture and Agri-Food Canada, Regional Services, Quebec Region, Gare Maritime Champlain,
901 Du Cap-Diamant Street, Suite 350 4, Quebec City, Quebec, G1K 4K1. Telephone: 418-648-3316.

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