



# Roadside GUIDE CLEAN WATER

RECOGNIZING GOOD PRACTICES IN YOUR COMMUNITY



PennState Extension



## INTRODUCTION

Water is an abundant resource in Pennsylvania. There are nearly 86,000 miles of rivers and streams and thousands of lakes, ponds, and wetlands. We have lots of water for drinking, recreation, agriculture, and industry. However, over a third of those lakes and a fifth of those streams are classified as impaired. They are unable to support aquatic life or be used for recreation, fish consumption, or drinking water.

The biggest source of water pollution in Pennsylvania is stormwater runoff. It is difficult for rainwater and melting snow to soak into the ground due to all the developed surfaces we have created. This causes excess stormwater to run downhill and into our streams, lakes, and rivers. Runoff water doesn't travel alone. It picks up pollutants like salt, soil, manure, and chemicals. Those pollutants come from rural, urban, and suburban places alike—parking lots, construction sites, farms, lawns, or any other land the water flows over. Contaminated water harms aquatic habitat, takes away opportunities for fishing and boating, creates hazards to human

health, and makes water more difficult and expensive to treat and use.

Your neighbors and your community may already be taking big steps to help reduce water pollution. Farmers, townships and cities, businesses, and homeowners are using practices on their land to help protect our waterways. Many of these practices may look unfamiliar and go unnoticed. Recognizing what to look for is a first step to appreciating the good work being done for water all around you.

In this book, you will discover some of the most popular practices being used in urban, suburban, and rural areas. By noticing and appreciating the progress being made, we can all be part of protecting our local water.

You can learn even more about best practices for protecting water by visiting the online version of this book at [extension.psu.edu/roadside-guide-to-clean-water](http://extension.psu.edu/roadside-guide-to-clean-water).

## Using This Guide

This guide includes 10 of the most popular best management practices for water quality. You can read about them in advance or flip through them while you are out and about and wondering what you are seeing. Pictures of each practice from different perspectives and in different settings will help you narrow it down. But

every site is unique and what you find in your community may look different from what you see in the book.

To help you navigate the book, the following symbols are used to tell you if you can expect to find a certain practice in rural, suburban, or urban settings:

### URBAN



Practices with this symbol can be found in cities or other highly populated areas.

### SUBURBAN



Practices with this symbol can be found in suburban or residential areas.

### RURAL



Practices with this symbol can be found on farms and in other rural areas.

Many of the practices included in this guide have benefits beyond improving water quality. The symbols below will be used to note the many benefits that these practices contribute to your community:



### GROUNDWATER

Recharges groundwater



### STORMWATER

Reduces stormwater runoff



### POLLUTION

Reduces pollution



### FLOODING

Mitigates flooding



### CLIMATE CHANGE

Promotes climate change resiliency



### HABITAT

Provides wildlife habitat



### SAVINGS

Provides cost savings



### LANDSCAPE

Beautifies the landscape

# COVER CROPS



CASEY GUINDON

## How to Recognize Cover Crops



NICOLE SANTANGELO

Cover crops planted after plowing a field will quickly establish to reduce soil loss during the fallow period.



NICOLE SANTANGELO

Cover crops are often used at the same time as reduced-till or no-till practices where soil isn't plowed between crop plantings.



NICOLE SANTANGELO

The taproots of radishes make them a helpful cover crop because they also break up compacted soil before decomposing at the end of winter.



NICOLE SANTANGELO

The remnants of a terminated cover crop act as mulch, as seen here under an actively growing tobacco crop.



NICOLE SANTANGELO

Ryegrass and cereal rye are both used for cover crops. Cereal rye, unlike lawn-grass-type ryes, can grow up to 3–6 feet tall.



LANCE CHEUNG, USDA NATURAL RESOURCES CONSERVATION SERVICE

Cover crops are killed using herbicides or other techniques so that crops can be planted without plowing, reducing soil erosion and sediment pollution.



## Cover Crops at a Glance

A cover crop is grown during the off-season (or fallow) after the harvest of a primary production crop, like corn or soybean, and before the next production crop is planted. Typically, cover crops are planted in the fall, after harvest, and they grow over the winter months. Some cover crops are harvested in the spring, but others are simply killed off, or terminated, before the main crop is planted. Some farmers may also be able to plant cover crops during summer fallow. Without cover crops, the soil would be bare at this time and exposed to rain, snow, and wind. Cover crop plants can include legumes like red clover, small grains like winter rye, and other plants like forage radish. Cover crops are typically fast-growing and short-lived plants. Cover crops provide benefits on any barren soil from backyard gardens to large crop fields.



ELIZABETH SMITH

Cover crops aren't just for farmers; they provide many benefits to backyard gardeners, too.

## How Cover Crops Work

Cover crops reduce soil erosion by keeping the soil surface covered. The leaves of the plants protect the soil from rain drops that otherwise would splash and blast tiny soil particles from the land. The roots of the cover crops also assist in holding the soil in place, preventing sediment pollution in nearby streams and other water bodies. Cover crops also help reduce nutrient pollution by using any fertilizer and manure left over from the last production crop sea-

son. They can even bring nutrients found deeper in the soil back to the soil surface. After the cover crop is terminated, the nutrients and carbon that are stored in the cover crop will be available to help the next production crop grow. Cover crops also improve soil health and add organic matter to the soil. This helps improve water infiltration and storage in the soil, reducing the volume of stormwater running off the field.

Community Benefits  
of Cover Crops



# MANURE STORAGE AND APPLICATION



ROBERT MEINEN

## How to Recognize Manure Storage and Application



ROBERT MEINEN

This beef farm stores manure behind a gate in a concrete barnyard. Manure liquids and any contaminated rain runoff drain to an engineered liquid containment system.



ROBERT MEINEN

This solid manure spreader is loaded and heading to the field to place the manure nutrients where the crop can utilize them for growth.



ROBERT MEINEN

All applications, like this liquid manure application, must be conducted within the guidance of regulations that allow economic crop production while protecting water.



ROBERT MEINEN

Liquid manure is being transferred to a manure spreader from this aboveground manure storage.





## Manure Storage and Application at a Glance

Manure is a normal product of agricultural animal production. Manure is a great resource for farms because it contains valuable nutrients that benefit growing crops. Manure storage structures are carefully designed and engineered to enable farmers to contain manure in an environmentally safe manner until the appropriate time to apply it to their cropland. Every farm that produces manure must follow state guidelines that ensure the nutrients can be used for crop production in a way that also protects the environment.

## How Manure Storage and Application Works

Manure comes in both liquid and solid forms. Both should be stored properly to protect the environment because manure nutrients can become water pollutants. Manure storage structures are built with rigorous standards to protect against leaks. There are many different types of manure storages—from earthen structures with liners made of concrete, bentonite, or plastic membranes, to aboveground steel or concrete structures. Storing manure allows it to be used as a crop fertilizer at



JENNIFER FETTER

Dogs and cats may be smaller than cows, but pet waste can impact our waterways, too. Visit [extension.psu.edu/roadside-guide-to-clean-water](https://extension.psu.edu/roadside-guide-to-clean-water) to find out more.

times when weather conditions are better for keeping the nutrients on the cropland. Regulations state that a plan is to be used for manure application. The plan ensures manure nutrients stay where they were placed and includes items such as the maximum manure application rates for each type of crop and setback maps that highlight areas near streams, lakes, ponds, wells, and sinkholes. Setbacks are places where manure application cannot occur so the risk of polluting water is minimized.

Community Benefits of Manure Storage and Application



# NATIVE MEADOWS



JIM WELLENDORF

## How to Recognize Native Meadows



MARLIN JOHNSON

Plants that are native to your area will grow best and provide maximum benefits.



KRISTEN KYLER

Native meadows provide an excellent habitat for pollinators such as butterflies, hummingbirds, and bees.



ERNST SEEDS

Native meadow seed mixes might contain flowering plants, grasses, or both.



ERNST SEEDS

This newly planted meadow will reduce the need for mowing on this hillside and help reduce the impacts of stormwater runoff from the parking lot.



ERNST SEEDS

Here is the same native meadow after one year of growth.



KRISTEN KOCH

Meadows planted along stream edges can act as buffers and save you the frustration of getting your lawn mower stuck in the mud.





## Native Meadows at a Glance

A native meadow is an area that is planted with flowers and grasses that are native to the local area, which is mowed very infrequently. Native meadows are often planted in place of traditional mowed lawn areas. A variety of flowering perennial plants and grasses can be used, and that list may be different depending on where the meadow

is planted. Native meadow plantings are meant to be low maintenance and, once established, only need to be cut back once or twice a year. Meadows don't require as much maintenance as lawn areas do. It might require some weeding or control of invasive species.

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## How Native Meadows Work

Native meadow vegetation grows much taller than turfgrass. This extra growth is better at slowing down water so that pollutants can settle out. Taller vegetation also grows deeper roots, which create a more spongelike soil that can absorb water and trap pollutants. In turn, it will reduce the sediment and pollutants flowing into local waterways. Native meadows also improve the soil by increasing the amount of decomposing organic matter

and allowing more rainwater infiltration. Increased infiltration not only reduces stormwater runoff but also recharges groundwater supplies. A meadow area can provide a beautiful flowering landscape and a habitat for butterflies, birds, and local wildlife. This practice reduces the amount of lawn that needs to be mowed, which can save time and money as well as reduce emissions once the meadow is fully established.

Community Benefits  
of Native Meadows



# POROUS AND PERMEABLE PAVING MATERIALS



SCOTT SJOLANDER

## How to Recognize Porous and Permeable Paving Materials



SCOTT SJOLANDER

Pervious surfaces like porous concrete can provide drainage in low-traffic areas such as parking spaces.



SCOTT SJOLANDER

Pervious surfaces can be designed to drain into vegetated areas such as rain gardens.



ANNE DUGGAN, KEVCON, INC.

Under the pavers, pervious systems also include a stone drainage bed. Further engineered storage and piping may lie below.



ANDY YENCHA

Permeable pavers rely on the spacing between the pavers to allow water to drain into a storage or conveyance system below.



SCOTT SJOLANDER

The pervious paver system on the right side of this roadway collapsed under heavy truck traffic that it wasn't designed for, unlike the conventional concrete.



KRISTEN KYLER

Some pervious pavers are meant to almost disappear into the landscape but allow cars to park in the grass without mud and erosion issues.



## Sediment Barriers at a Glance

Sediment barriers, sometimes also called sediment filters, are temporary structures that are typically used around the edge of construction sites or other locations with bare soil. They are meant to separate any

potential sediment pollution from stormwater that might flow off the site. They allow the stormwater to flow through while trapping sediment behind or inside them.

## How Sediment Barriers Work

“Sediment” is a word used to describe soil that has been detached from the land by a process called erosion. The force of a rain drop falling from the sky is powerful enough to dislodge soil particles when they are bare or uncovered. This is common on construction sites and other disturbed areas. Rain that does not soak into the ground will flow downhill, carrying that loose soil with it. Unless stopped, this now dirty water will eventually reach our lakes, rivers, and streams. Many different

materials are used as sediment barriers, such as fabric, compost, straw bales, or rocks. Each of these materials can act like a filter, allowing water to pass through pore spaces but capturing the soil. This filtering cleans the water leaving a construction site, therefore reducing pollution to our waterways. Typically, sediment barriers and filters are temporary; they are removed once grass or other plants start to grow and cover the bare soil.



# RAIN GARDENS



ANDY YENCHA

## How to Recognize Rain Gardens



ANDY YENCHA

Stormwater is sometimes directed to rain gardens from the street or sidewalks.



ANDY YENCHA

Rain gardens are bowl shaped so that they can hold water during storms. Deep-rooted vegetation and the right soil mix encourage water infiltration.



ANDY YENCHA

Stormwater is sometimes carried to rain gardens by way of buried pipes or similar underground structures.



JODI SULPIZIO

Rain gardens are often built in areas that naturally collect stormwater runoff, as illustrated by this rain garden under construction.



JODI SULPIZIO

Finished rain gardens do not hold permanent water and blend in as landscape features.



KRISTEN KYLER

Stormwater can also enter rain gardens through cuts made in a street curb. Grated storm drains may be installed as a safety feature to manage overflow and prevent flooding during storms.



## Rain Gardens at a Glance

Rain gardens are shallowly depressed garden areas, usually less than 12 inches deep, planted with a mix of native plants, including flowers, grasses, shrubs, and trees. Most rain gardens are small, covering less than 500 square feet. They can be shaped like rectangles, ovals, crescents, and more. Some are long and narrow, while others are short and wide. Their adaptability makes it possible to fit them on urban and suburban sites where green space is limited. Home rain gardens typically collect stormwater from downspouts, driveways, and patios. City rain gardens receive runoff from streets, sidewalks, and parking lots. Urban rain gardens might also be called "bioretention practices" or "stormwater bumpouts."



DIANE OLESON

Rain gardens and rain barrels are two of the most common water management practices used by homeowners. Learn more about rain barrels at [extension.psu.edu/rain-barrels-in-the-home-garden](http://extension.psu.edu/rain-barrels-in-the-home-garden)

## How Rain Gardens Work

Rain gardens are sometimes described as being "bowl shaped" because they are lower in elevation than the surrounding land. This shape allows stormwater to naturally flow down into them instead of into a nearby storm drain. Despite their name, rain gardens usually don't hold standing water for more than a day or so after it rains. They are meant to have porous soil that acts like a sponge and soaks water in

quickly. Rain gardens capture stormwater runoff before it flows into storm drains, which in turn reduces flash flooding, protects streambanks from erosion, and recharges groundwater. Rain gardens are usually planted with native plants that further enhance the garden's ability to trap sediment, remove water pollutants, and provide habitat for songbirds, insect pollinators, and other wildlife.

Community Benefits  
of Rain Gardens



# STREAMBANK AND FLOODPLAIN RESTORATION



JENNIFER FETTER

## How to Recognize Streambank and Floodplain Restoration



SARAH XENOPHON

Steep, eroding banks like this one are good places to do stream restoration, especially since the road is at risk.



KRISTEN KYLER

Mud sills, which are made with logs, armor the streambank from erosion and extend over the water's surface to create cover for fish.



SARAH XENOPHON

Stream and floodplain restoration work requires a permit, engineering, and earth-moving and construction equipment.



KRISTEN KYLER

Some projects completely remove the streambank by excavating "legacy sediment" and creating a flat wetland that slows down water, filters pollutants, and reduces flooding downstream.



JENNIFER FETTER

Grading streambanks to a gentle slope allows water to escape to the floodplain during storms. Logs protect the banks and create cover for fish. Planting trees provides additional benefits.



SARAH XENOPHON

Creating smooth, gradual bends slows water flow. This V-shaped cross-vane structure directs the flow of water and creates a small waterfall to add oxygen, which supports life in the water.



## Riparian Buffers at a Glance

The word "riparian" is used to describe the area alongside a river or other body of water. A riparian buffer involves planting or retaining trees, shrubs, or tall grasses along the banks of rivers, streams, lakes, and ponds. Riparian buffers exist in both urban and rural areas and can be planted along any body of water capable of supporting plants.

## How Riparian Buffers Work

When plants like meadow grasses and trees are allowed to grow or new trees and shrubs are planted, the soil becomes more porous and allows water to soak in more easily. Riparian buffers act like sponges along a waterway, soaking in precipitation and water running off the land. They also capture sediment, nutrients, and other pollutants that are carried with the water runoff. In addition to helping absorb water and pollution, the deep roots of these



VINCENT COTRONE

Planting trees along streets and other locations in urban areas provides similar benefits to riparian buffers.

Visit [extension.psu.edu/roadside-guide-to-clean-water](http://extension.psu.edu/roadside-guide-to-clean-water) to find out more.

plants are very good at holding stream-banks in place. This further reduces water pollution by preventing the land from caving in and washing downstream. Another benefit of trees and shrubs in a riparian buffer is the shade and wildlife habitat created by the leaves and branches. The wider the riparian buffer extends from the water's edge, the more effective it is at improving water quality.

Community Benefits  
of Riparian Buffers



# SEDIMENT BARRIERS



ARMCHAIRBUILDER.COM ON FLICKR.COM

## How to Recognize Sediment Barriers



CRAIG PALMER, ERIE WATER WORKS

A compost filter sock is a mesh tube filled with a special compost material. It is a highly effective sediment barrier proven to remove many pollutants.



CRAIG PALMER, ERIE WATER WORKS

Inlet filter bags are installed inside storm drains. The mesh fabric traps sediment, but it needs to be cleaned periodically.



U.S. ENVIRONMENTAL PROTECTION AGENCY

Silt fencing is a filter fabric attached to stakes and installed in a trench along the edge of a construction site.



CITY OF MEADVILLE

Straw bales can be sediment barriers on small disturbed areas for short periods of time.



DANIELLE RHEA

Rock filters will slow water down to remove any sediment as the water flows through constructed channels during a temporary disturbance.



GREG RAYMOND

Construction site entrances can be stabilized with rock to prevent erosion and prevent sediment from leaving the site on equipment tires.





## Sediment Barriers at a Glance

Sediment barriers, sometimes also called sediment filters, are temporary structures that are typically used around the edge of construction sites or other locations with bare soil. They are meant to separate any

potential sediment pollution from stormwater that might flow off the site. They allow the stormwater to flow through while trapping sediment behind or inside them.

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materials are used as sediment barriers, such as fabric, compost, straw bales, or rocks. Each of these materials can act like a filter, allowing water to pass through pore spaces but capturing the soil. This filtering cleans the water leaving a construction site, therefore reducing pollution to our waterways. Typically, sediment barriers and filters are temporary; they are removed once grass or other plants start to grow and cover the bare soil.



# STORMWATER BASINS



KRISTEN KYLER

## How to Recognize Stormwater Basins



JENNIFER FETTER

Infiltration basins have no outlet but instead drain slowly into the soil, which provides some water quality improvement.



KRISTEN KYLER

Dry basins slowly release water through an outlet pipe. The basin also has an emergency overflow drain at the top of the concrete riser.



JENNIFER FETTER

Wet ponds can provide some water quality benefits by allowing sediment to settle out before stormwater is released.



JENNIFER FETTER

Many dry basins are planted with turfgrass and look like large, depressed lawns. The concrete inlets and outlets are often the only sign that it is a basin.



SARAH XENOPHON

Some basins are planted and maintained as natural areas. They may be bioinfiltration basins.



ANDY YENCHA

This basin is about to get replanted with native flowers instead of turfgrass to help improve its ability to filter pollutants from stormwater.



## Stormwater Basins at a Glance

Stormwater basins are the commonly seen, though perhaps unnoticed, impoundments that are built near developments (residential, commercial, and others) to temporarily hold stormwater during rain and snowmelt events. These basins are meant to prevent high volumes of water from rushing into nearby streams

during storms. After the rain event, the stored water is released slowly, into either a nearby stream or the soils and groundwater. Some stormwater basins hold water at all times, like ponds, while others that drain completely look simply like bowl-shaped areas planted in grass.

## How Stormwater Basins Work

During a storm, rainwater is collected from streets and parking lots and directed into the basin. The stormwater is stored temporarily and then released slowly in order to prevent flooding and erosion. Stormwater basins improve water quality in different ways depending on how they were designed. Dry basins slowly release stormwater directly to a stream through a controlled outlet pipe. Infiltration basins have porous soils so that water can soak in and become groundwater. In both cases, these types of basins are meant to dry out

between storms. There are also retention basins, or wet ponds, that are designed to hold some water at all times and look like typical ponds. For the most part, basins are meant to reduce the volume of water entering a stream during a storm. Infiltration and retention basins may also remove some stormwater pollutants. More recently, bioinfiltration basins have become popular. These basins use plants to help filter the water before it is returned to the environment.

Community Benefits  
of Stormwater Basins



# STREAMBANK AND FLOODPLAIN RESTORATION



JENNIFER FETTER

## How to Recognize Streambank and Floodplain Restoration



SARAH XENOPHON

Steep, eroding banks like this one are good places to do stream restoration, especially since the road is at risk.



KRISTEN KYLER

Mud sills, which are made with logs, armor the streambank from erosion and extend over the water's surface to create cover for fish.



SARAH XENOPHON

Stream and floodplain restoration work requires a permit, engineering, and earth-moving and construction equipment.



KRISTEN KYLER

Some projects completely remove the streambank by excavating "legacy sediment" and creating a flat wetland that slows down water, filters pollutants, and reduces flooding downstream.



JENNIFER FETTER

Grading streambanks to a gentle slope allows water to escape to the floodplain during storms. Logs protect the banks and create cover for fish. Planting trees provides additional benefits.



SARAH XENOPHON

Creating smooth, gradual bends slows water flow. This V-shaped cross-vane structure directs the flow of water and creates a small waterfall to add oxygen, which supports life in the water.



## Streambank and Floodplain Restoration at a Glance

Streambank and floodplain restoration is the practice of stabilizing and/or altering the stream channel to slow and direct the flow of water to reduce erosion and flooding. This practice might include regrading streambanks, installing large rocks or logs in the stream channel, or excavating the floodplain to create wetland habitat where the steep banks are located. Streambank and floodplain restoration projects require permits, heavy construction equipment, engineering, and specific expertise. Often this practice is enhanced by planting trees and shrubs next to the stream.

## How Streambank and Floodplain Restoration Works

With increased development, greater volumes of water are directed into our streams when it rains than would occur in a natural setting. Higher-than-natural volumes of water flowing quickly downstream causes streambanks to erode and become unstable. Eroding streambanks contribute to sediment pollution, which makes our streams look chocolate brown during rain events. In addition, when streambanks erode, there is a risk to nearby infrastructure like bridges and culverts as well as a loss of property. To



KRISTEN KOCH

An easy and affordable streambank restoration technique is to use branch cuttings called live stakes. These cuttings grow roots right where they are needed most to help prevent streambank erosion. To learn more, visit [extension.psu.edu/live-staking-for-stream-restoration](https://extension.psu.edu/live-staking-for-stream-restoration) or visit [extension.psu.edu/live-staking-a-how-to-guide](https://extension.psu.edu/live-staking-a-how-to-guide) for a live staking learn now video.

fix this, stream restoration practices can be employed to redirect the water flow into the center of the stream where less erosion will occur. Water is slowed down and streambanks are protected. Additionally, the stream can be connected to the floodplain where water will flow more slowly, letting pollutants settle out and reduce downstream flooding damage. In general, a stream or floodplain restoration project creates a more naturally functioning, stabilized stream.

Community Benefits of Streambank and Floodplain Restoration



# VEGETATED SWALES



JODI SULPIZIO

## How to Recognize Vegetated Swales



JODI SULPIZIO

Grass swales offer less filtering and infiltration than swales planted with deeper-rooted native plants.



KRISTEN KYLER

Check dams can be installed to help keep water in the swale longer, increasing infiltration and filtering.



JODI SULPIZIO

Vegetated swale near York County Prison.



JODI SULPIZIO

Native plants in bioswales provide habitat for pollinators like this eastern tiger swallowtail.





## Vegetated Swales at a Glance

Vegetated swales, sometimes also called bioswales, are contoured land areas or ditches covered in plants. They are designed to collect stormwater runoff and move it away from areas where it can't soak into the ground, such as a road, parking lot, or rooftop. Some look like straight channels, and others like meandering natural streams. Vegetated swales are typically planted with native plants, but sometimes they are covered in only turfgrass. They are often constructed with specialized soils that can naturally treat stormwater runoff. Sometimes barriers called check dams are constructed across the swale to slow water movement into pools and increase infiltration during larger storm events. Bioswales are aesthetically pleasing and can be installed instead of underground storm sewers or as part of a larger stormwater system.



BOB NICHOLS, USDA NATURAL RESOURCES CONSERVATION SERVICE

In agricultural fields, swalelike structures called grassed waterways are often used to help control the movement of excess water that can cause erosion.

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## How Vegetated Swales Work

By intercepting water running off large paved and developed areas, bioswales help improve water quality in many ways. Vegetated swales collect and slow stormwater runoff so the water can be taken in by plants and soak into the soil instead of flowing into the street and down a storm drain. The plants and soil trap, absorb, and filter pollutants found in stormwater runoff. By controlling the movement of the stormwater runoff, bioswales help prevent erosion. This helps prevent sediment and

other pollutants such as nutrients and heavy metals from entering waterways. All of this results in lower water treatment costs and better public health. By restoring groundwater and decreasing water discharged into local creeks and rivers, vegetated swales reduce flooding and improve public safety. The native grasses and perennials in vegetated swales provide habitat for wildlife, including insects and pollinators. The plants also enhance and beautify the area.

## Community Benefits of Vegetated Swales





# Roadside GUIDE to CLEAN WATER

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