Nutrient Credits Wetland Design Guide

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Prepared by :

Nutrient Credits Limited
71 - 75 Sheldon Street
Covent Gardens
London
WC2H 9 JQ

1.0 Introduction

Wetlands are areas of land that are saturated with water or are covered by shallow water for long periods of time. They are important ecosystems that provide a variety of benefits, including:

- Water quality improvement: Wetlands can remove pollutants from stormwater runoff, such as sediment, nutrients, and bacteria. This helps to improve the quality of water in rivers, lakes, and oceans.
- Habitat for wildlife: Wetlands provide habitat for a variety of wildlife, including birds, fish, amphibians, and reptiles.
- Flood mitigation: Wetlands can help to mitigate flooding by storing floodwaters and releasing them slowly.
- Education and recreation: Wetlands can be used for education and recreation, such as birdwatching, fishing, and hiking.

Constructed wetlands are wetlands that are created artificially. They are often used to treat stormwater runoff or to provide habitat for wildlife.

1.1 Special Thanks

We would like to thank the authors of Guidance Manual for Constructed Wetlands R&D Technical Report P2-159/TR2 J. B. Ellis, R.B.E. Shutes and D.M. Revitt. Who wrote an excellent guide on this topic however, this report has been withdrawn for use. Despite being one of the best available.

2.0 Design Standards

The design of a constructed wetland should be based on the specific goals of the project. For example, if the wetland is being designed to treat stormwater runoff, it will need to be large enough to handle the volume of runoff from the area it is serving. The wetland should also be designed to remove the pollutants that are commonly found in stormwater runoff, such as sediment, nutrients, and bacteria.

Here are some of the design standards that should be considered when designing a constructed wetland:

2.1 Site Selection

The site for a constructed wetland should be carefully selected. It should be located in an area that receives adequate rainfall or groundwater recharge, and it should be accessible for construction and maintenance. The site should also be free of contaminants that could pollute the wetland.

2.2 Size

The size of the wetland will depend on the specific goals of the project. For example, a wetland that is being designed to treat stormwater runoff from a small residential development will need to be much smaller than a wetland that is being designed to treat stormwater runoff from

a large industrial complex. The width of the wetland should be at least 3 meters, but it can be wider if desired. The length of the wetland will depend on the amount of stormwater runoff that needs to be treated. For example, a wetland that is being designed to treat stormwater runoff from a small residential development will need to be much shorter than a wetland that is being designed to treat stormwater runoff from a large industrial complex.

2.3 Shape

The shape of the wetland will also affect its performance. A wetland with a long, narrow shape will have a greater surface area than a wetland with a short, wide shape, and it will therefore be more effective at removing pollutants from stormwater runoff.

2.4 Depth

The depth of the wetland will affect the types of plants that can grow in it. A shallow wetland will be able to support a variety of plant species, while a deep wetland will be limited to a few species of deep-water plants. The depth of the wetland should be between 60 and 120 centimeters.

2.5 Water Flow

The water flow through the wetland will affect the way that pollutants are removed. A wetland with a slow water flow will allow more time for pollutants to be removed, while a wetland with a fast water flow will remove pollutants more quickly. The water flow through the wetland should be slow. A water flow rate of 0.03 to 0.06 meters per second is ideal.

2.6 Soil Type

The soil type in the wetland will affect the types of plants that can grow in it and the way that pollutants are removed. A wetland with a sandy soil will be able to support a variety of plant species, while a wetland with a clay soil will be limited to a few species of plants that can tolerate wet conditions.

2.7 Vegetation

The vegetation in the wetland will play a key role in removing pollutants from stormwater runoff. The types of plants that should be planted in the wetland will depend on the specific goals of the project. For example, if the wetland is being designed to treat stormwater runoff, it will need to be planted with a variety of wetland plants that can remove pollutants from water.

2.8 Monitoring

Once a constructed wetland is constructed, it will need to be monitored to ensure that it is functioning properly. This includes checking the water quality, monitoring the growth of plants, and removing sediment and debris from the wetland.

3.0 Construction

The construction of a constructed wetland should be done by a qualified contractor. The contractor will need to follow the wetland design plan and use the appropriate materials.

The construction process will vary depending on the specific design of the wetland. However, some of the common tasks that will need to be performed during construction include:

3.1 Site Preparation

The site will need to be cleared of debris and graded to create the desired shape of the wetland.

3.2 Excavation

The wetland will need to be excavated to the desired depth.

- The process of excavating a wetland can be complex and challenging, and it is important to follow the correct procedures to avoid damaging the wetland ecosystem. Here are some general steps involved in excavating a wetland:
- Obtain the necessary permits and approvals. Before any work can begin, it is important to obtain the necessary permits and approvals from the appropriate regulatory agencies. This process can take several weeks or even months, so it is important to start early.
- Conduct a site survey. It is important to conduct a site survey to assess the wetland's condition and to identify any potential hazards. This information will be used to develop a safe and effective excavation plan.
- Install erosion control measures. Erosion control measures are essential to prevent soil and sediment from being washed away during the excavation process. These measures may include the installation of silt fences, straw bales, or geotextile fabric.
- Excavate the wetland. The wetland can be excavated using a variety of methods, including excavators, backhoes, and bulldozers. It is important to excavate the wetland carefully to avoid damaging the wetland's ecosystem.
- Regrade the wetland. Once the wetland has been excavated, it is important to regrade the wetland to create a suitable habitat for wetland plants and animals. This may involve creating shallow water areas, planting wetland plants, and adding organic matter to the soil.
- Monitor the wetland. Once the wetland has been excavated and regraded, it is important to monitor the wetland to ensure that it is functioning properly. This may involve monitoring the water quality, the plant health, and the presence of invasive species.
- By following these general steps, you can excavate a wetland safely and effectively. However, it is important to note that every wetland is different, and the specific excavation procedures may vary depending on the wetland's size, condition, and location. It is always best to consult with a qualified wetland professional to develop a customized excavation plan.

Here are some additional tips for excavating a wetland:

- Use the right equipment. The type of equipment used to excavate a wetland will depend on the size and condition of the wetland. For small wetlands, a backhoe or excavator may be sufficient. For larger wetlands, a bulldozer may be necessary.
- Be careful not to damage the soil. The soil in a wetland is often very delicate, so it is important to be careful not to damage it during the excavation process. This can be done by using the right equipment and by working slowly and carefully.

- Remove all debris. Once the wetland has been excavated, it is important to remove all debris, including rocks, trees, and other vegetation. This will help to create a clean and open space for wetland plants to grow.
- Plant wetland plants. Once the debris has been removed, it is time to plant wetland plants. Wetland plants are essential for creating a healthy wetland ecosystem. They help to filter water, provide food and shelter for wildlife, and improve the overall appearance of the wetland.
- Monitor the wetland. Once the wetland has been planted, it is important to monitor it regularly to ensure that it is functioning properly. This includes checking the water quality, the plant health, and the presence of invasive species.

By following these tips, you can excavate a wetland safely and effectively and create a healthy and sustainable wetland ecosystem.

3.3 Installation of a Liner

A liner will need to be installed to prevent water from seeping into the soil and contaminating the groundwater.

There are a few different types of liners that can be used for wetlands, each with its own advantages and disadvantages.

- HDPE (High-Density Polyethylene) is a durable and long-lasting material that is resistant to UV rays and chemicals. It is also relatively inexpensive, making it a popular choice for wetland liners. However, HDPE can be difficult to install and may not be suitable for wetlands with sharp rocks or other debris.
- EPDM (Ethylene Propylene Diene Monomer) is a rubber-like material that is very flexible and easy to install. It is also resistant to UV rays and chemicals, making it a good choice for wetlands with exposed roots or other sensitive plants. However, EPDM is more expensive than HDPE and may not be as durable in cold climates.
- Bentonite Clay is a natural material that is very effective at preventing leaks. It is also relatively inexpensive and easy to install. However, bentonite clay can be difficult to find and may not be as durable as synthetic liners.

The best type of liner for a wetland will depend on the specific needs of the wetland and the budget available. If you are unsure which type of liner to choose, it is best to consult with a wetland expert.

Here are some additional tips for choosing a liner for a wetland:

- Consider the size of the wetland. Larger wetlands will require a larger liner, which will be more expensive.
- Consider the climate. Wetlands in cold climates will need a liner that is resistant to freezing.
- Consider the type of plants and animals that live in the wetland. Some plants and animals may be sensitive to certain types of liners.
- Consider the budget. Liners can range in price from a few hundred dollars to several thousand dollars.
- By following these tips, you can choose the best type of liner for your wetland and help ensure its long-term health and sustainability.

3.4 Installation of a Gravel Bed

A gravel bed will need to be installed to provide a stable foundation for the wetland plants.

There are many different types of gravel that can be used for a wetland, but the best type will depend on the specific wetland's design and purpose. Some general factors to consider when choosing gravel for a wetland include:

- Size: The gravel should be small enough to allow water to flow through it easily, but large enough to support wetland plants. A good size range for gravel in a wetland is 1/4 to 1 inch in diameter.
- Shape: The gravel should be rounded or smooth to prevent erosion. Angular gravel can cause the wetland to become clogged with sediment.
- Color: The gravel should be a neutral color, such as gray or brown, to blend in with the surrounding environment. Brightly colored gravel can be visually distracting and can interfere with the wetland's natural beauty.
- Cost: Gravel can be a relatively inexpensive material, but the cost can vary depending on the type of gravel and the quantity that is needed. It is important to compare prices from different suppliers to find the best deal.

Here are some specific types of gravel that are commonly used in wetlands:

- Limestone gravel: Limestone gravel is a good choice for wetlands because it is porous and allows water to flow through it easily. It is also relatively inexpensive and easy to find.
- River rock: River rock is a type of gravel that is smooth and rounded. It is a good choice for wetlands because it is less likely to cause erosion than angular gravel.
- Crushed stone: Crushed stone is a type of gravel that is made from broken rocks. It is a good choice for wetlands because it is strong and durable.

It is important to note that not all types of gravel are suitable for all wetlands. It is always best to consult with a wetland professional to choose the right type of gravel for your specific wetland.

Here are some additional tips for using gravel in a wetland:

- Spread the gravel evenly: The gravel should be spread evenly over the bottom of the wetland. This will help to create a stable foundation for the wetland plants and will prevent the wetland from becoming clogged with sediment.
- Cover the gravel with a layer of soil: A layer of soil should be placed over the gravel. This will help to keep the gravel in place and will provide a nutrient-rich environment for the wetland plants.

3.5 Planting

The wetland will need to be planted with a variety of wetland plants. There are many different species of plants that can be used in constructed wetlands. The specific species that are used will depend on the climate, the water quality goals, and the desired aesthetic of the wetland.

Some common species of plants that are used in constructed wetlands include:

- Cattails (Typha spp.): Cattails are a tall, reed-like plant that is common in wetlands. They are effective at removing nutrients and sediment from water.

- Sedges (Carex spp.): Sedges are a group of grass-like plants that are common in wetlands. They are effective at removing nutrients and metals from water.
- Rushes (Juncus spp.): Rushes are a group of grass-like plants that are common in wetlands. They are effective at removing nutrients and sediment from water.
- Water lilies (Nuphar spp.): Water lilies are a group of floating plants that are common in wetlands. They are effective at removing nutrients and sediment from water.
- Water hyacinth (Eichhornia crassipes): Water hyacinth is a floating plant that is not native to North America. It is an invasive species, but it can be used in constructed wetlands to remove nutrients and sediment from water.

It is important to note that not all wetland plants are created equal. Some plants are more effective at removing pollutants than others. It is important to choose plants that are well-suited for the specific goals of the wetland.

4.0 Monitoring

The wetland will need to be monitored to ensure that it is functioning properly.

4.1 Generic Requirements

The monitoring requirements for a constructed wetland will depend on the specific goals of the project and the regulatory requirements in the area. However, some common monitoring activities include:

- Water quality: The water quality of the wetland should be monitored to ensure that it is meeting the desired standards. This includes monitoring the levels of nutrients, sediment, and other pollutants.
- Plant health: The health of the wetland plants should be monitored to ensure that they are healthy and growing well. This includes monitoring the growth rate of the plants, the presence of pests and diseases, and the overall appearance of the plants.
- Water flow: The water flow through the wetland should be monitored to ensure that it is within the desired range. This includes monitoring the depth and velocity of the water, as well as the amount of water that is entering and leaving the wetland.
- Sediment: The amount of sediment in the wetland should be monitored to ensure that it is not accumulating too quickly. This can be done by measuring the depth of the sediment in the wetland or by collecting samples of the sediment and analyzing them for the amount of pollutants.
- Invasive species: The presence of invasive species should be monitored and controlled. Invasive species can outcompete native plants and can damage the wetland ecosystem.
- By monitoring the wetland regularly, you can ensure that it is functioning properly and that it is meeting the desired water quality goals.

4.2 Nutrient Credit Specific Requirements

To monitor an outfall from the wetland for the concentration of phosphorus or nitrate, you can use a variety of methods, including:

- Grab sampling: This involves collecting a single sample of water from the outfall at a specific time. This method is simple and inexpensive, but it can be less accurate than other methods.

- Continuous monitoring: This involves collecting water samples from the outfall at regular intervals over a period of time. This method is more accurate than grab sampling, but it is also more expensive.
- Remote sensing: This involves using satellite or aerial imagery to measure the concentration of phosphorus or nitrate in the water around the outfall. This method is less accurate than grab or continuous sampling, but it is also less expensive and can be used to monitor large areas.

The best method for monitoring an outfall will depend on the specific needs of the project. If you are only interested in getting a general idea of the concentration of phosphorus or nitrate in the water, then grab sampling may be sufficient. However, if you need more accurate data, then continuous monitoring or remote sensing may be necessary.

Once you have collected water samples, you can analyze them for the concentration of phosphorus or nitrate using a variety of methods, including:

- Inductively coupled plasma mass spectrometry (ICP-MS): This is a highly accurate method that can be used to measure the concentration of phosphorus or nitrate in very small amounts of water.
- Colorimetric analysis: This is a less accurate method, but it is simpler and less expensive than ICP-MS.

The method you choose for analysing the water samples will depend on the specific needs of the project. If you need highly accurate data, then ICP-MS may be the best option. However, if you need less accurate data, then colorimetric analysis may be sufficient.

By following these steps, you can monitor an outfall for the concentration of phosphorus or nitrate and ensure that the water quality is safe for the environment and human health.

Here are some additional tips for monitoring an outfall:

- Collect samples from multiple locations around the outfall to get a more accurate reading of the water quality.
- Collect samples at different times of day to see how the concentration of phosphorus or nitrate changes over time.
- Keep a record of the data you collect so that you can track changes in water quality over time.
- Share the data you collect with other stakeholders, such as government agencies, environmental groups, and landowners, so that they can take steps to protect the environment.