Scheduling Maintenance for Bioretention (Rain Gardens)

1) Has visual inspection been conducted on this location before?

It is important to determine whether this location has been previously assessed so that assessment efforts are cost effective (i.e., neither duplicated nor wasted). If previous assessment has occurred, the current assessment should verify that actions suggested by the previous assessment were completed and are effective.

2) Has it rained within that last 48 hours at this location?

Many bioretention practices are designed to drain the design storm volume (i.e., water quality volume, maximum storage volume) within 48 hours (Minnesota Stormwater Manual). Assessment within 48 hours of a rainfall event may provide performance clues. Additionally, rainfall within the last 48 hours at a location will alter the interpretation of answers to other questions.

3) Does this bioretention practice utilize any pretreatment practices upstream?

Pretreatment practices are required by the MPCA in some MS4 construction permits for bioretention practices. If this practice does not have any pretreatment upstream, it may be in violation of this code.

4) Access

Access to the areas upstream and downstream of the site as well as the site itself is needed in order to properly assess the practice. This is true regardless of the level of assessment applied.

5b) Are any of the inlet structures clogged?

Inlet structures should be free of any debris, sediment, vegetation, and other obstructions so that stormwater runoff can easily enter the bioretention practice. If an inlet structure is even partially clogged, suspended solids may be deposited in the upstream conveyance system or upstream areas may flood because the conveyance systems are limited by such obstructions. Any obstructions should be removed immediately to ensure proper operation of the bioretention practice.

5c) Are any of the inlet structures askew or misaligned from the original design or otherwise in need of maintenance?

Misaligned inlet structures often allow stormwater runoff to enter or exit a bioretention practice by means other than those intended by design or prevent stormwater runoff from entering the practice at all. This condition can result in erosion, channelization, or flooding of surrounding areas, which can further exacerbate the misalignment or create other problems.

Inlet structures can become misaligned for several reasons, including frost heave of the soil, vehicular collision, and geotechnical failure. Misaligned inlet structures should be repaired or replaced as soon as possible to reduce detrimental impact. Any obstructions should be removed immediately to ensure proper operation of the bioretention practice.

Other issues requiring maintenance include large cracks in concrete structures, corrosion, dents or malformation of the structure, etc.

6) Is there standing water in the bioretention practice?

Standing water in a bioretention practice is the result of one of three possibilities: (1) rainfall has occurred recently such that stormwater runoff has not had 48 hours to infiltrate, (2) the infiltration rate of the bioretention practice is slow such that stormwater runoff does not pass through the bioretention practice within 48 hours, but does pass through the bioretention practice given enough time, or (3) the soil media is clogged and does not allow any stormwater runoff to infiltrate. If it has rained in the last 48 hours (Question 2) , then the bioretention practice may be functioning properly and requires additional assessment (level 2 or higher) to determine whether the soil media is clogged. If, however, it has not rained in the last 48 hours, it is likely that the bioretention practice is either option (2) or (3).

Surface sheen is caused by hydrocarbon substances such as automotive oil or gasoline and may indicate illicit discharges. If hydrocarbons are not illegally discharged into the bioretention practice, then a surface sheen may indicate that stormwater runoff is stored in the bioretention practice such that the small amounts of hydrocarbons typically found in stormwater runoff are accumulating. If this is happening, then the bioretention practice is failing. There are several illicit discharge manuals available for identifying, locating, and eliminating illicit discharges (e.g., Brown et al. 2004).

Stormwater runoff with a murky color is evidence of a large suspended solids concentration that is most likely made up of fine particle sizes such as clays and silts because sand particles settle out of standing water very rapidly (as discussed in Sedimentation). Stormwater runoff with a murky color can indicate that the watershed is a significant source of fine particle suspended solids, which can quickly clog a bioretention practice. Murky stormwater runoff in a bioretention practice may indicate that stormwater runoff has recently entered the bioretention practice such that fine particles have not had time to settle out.

Stormwater runoff with a green color from algae has been stored in the bioretention practice for a long period of time such that microorganisms have developed. Stormwater runoff is not passing though the bioretention practice properly and therefore the practice is failing.

7) Is there evidence of illicit storm sewer discharges?

An illicit discharge manual (e.g., Brown et al. 2004) should be consulted for identifying and locating illicit stormwater discharges.

8) Does the bioretention practice smell like gasoline or oil?

If a bioretention practice smells like gasoline or oil it is possible that hydrocarbon substances such as automotive oil or gasoline are being illicitly discharged into the practice or upstream in the watershed. If hydrocarbons are not illegally discharged into the bioretention practice, then an oil/gasoline smell may indicate that stormwater runoff is stored in the bioretention practice such that the small amounts of hydrocarbons typically found in stormwater runoff are accumulating. For more information on identifying, locating, and eliminating illicit discharges, refer to a manual such as Brown et al. (2004).

9) What is the approximate percentage of vegetation coverage in the practice?

Vegetation in the bottom of a bioretention practice is designed to dry out the soil in between storms and to maintain the infiltration effectiveness. Plants can lose 30% of their root structures annually which produces macropores. Macropores in a bioretention practice can increase the infiltration rate of the practice so that more stormwater runoff is infiltrated. Additionally, vegetation can reduce overland flow velocities and can therefore reduce erosion and re-suspension of captured solids.

Vegetation can also be an indication of the drain time of a bioretention practice. Terrestrial vegetation often cannot withstand long periods of inundation, and some cannot withstand short periods of inundation. If a bioretention practice has an abundance of terrestrial vegetation, it is likely that the practice infiltrates stormwater runoff quickly (< 48 hours) and is therefore operating properly. If, however, the bioretention practice has signs of aquatic vegetation or has little vegetation, it is likely the practice is not adequately infiltrating stormwater runoff and is therefore failing.

9a) Does the current vegetation match the original design?

Species of vegetation in planting plans for bioretention practices are selected based on desirable characteristics that a particular species of plant may exhibit. During the construction and throughout the operational life of a bioretention practice, the vegetation may deviate from the original design and thus possibly affect the performance of the bioretention practice. If planting designs are available, compare the currently existing vegetation to the vegetation designated in the design plans. Particular things to look for are certain species that are not surviving and/or have disappeared as well as introduction of weeds, wetland vegetation, and/or other invasive vegetation. For guidance on vegetation identification please refer to Plants for Stormwater Design: Species Selection for the Upper Midwest (Schmidt and Shaw, 2003).

9c) Does the vegetation appear to be healthy?

The health of vegetation can indicate conditions that may be too wet/dry, too sunny/shady, lack of nutrients, compacted soil, presence of toxic pollutants, etc. The survival of the vegetation is critical to maintaining proper function of a bioretention practice. During the growing season assess the apparent visual health of the vegetation in the bioretention practice. Some indications of unfavorable conditions are: wilted leaves/stem, discoloration of leaves, lack of flowering buds developing, stunted growth, and a decrease in the number of plantings present. For guidance on vegetation identification please refer to Plants for Stormwater Design: Species Selection for the Upper Midwest (Schmidt and Shaw, 2003).

9d) Is the vegetation the appropriate density/size?

Under optimal site conditions the vegetation should have an appropriate size and density for that particular species. Under development can be an indication of poor health while over development can hinder the development of other species in the bioretention practice. For guidance on vegetation identification please refer to Plants for Stormwater Design: Species Selection for the Upper Midwest (Schmidt and Shaw, 2003).

10) Are there indications of any of the following in the bottom of the bioretention practice?

Sediment deposition may indicate that pretreatment devices have reached sediment storage capacity, are not efficiently removing settable solids or are not present. Sediment deposition may also indicate a significant source of sediment in the watershed that may require remediation to prevent downstream pollution. Sediment deposition reduces the bioretention practice surface area available for infiltration and therefore can reduce the stormwater runoff volume that is infiltrated.

Erosion or channelization indicates that flow velocities entering, or in, the bioretention practice are large or that stormwater runoff is entering the practice by means other than those intended by design. In either case, stormwater runoff is not stored in the bioretention practice such that there is significant infiltration in the areas where erosion and channelization are occurring.

Vegetation, especially with deep roots, can increase and maintain infiltration rates in bioretention practices that do not have impermeable surfaces (e.g., concrete). If the surface of the bioretention practices becomes clogged or sealed, vegetation can provide pathways for stormwater runoff to penetrate the surface and subsequently infiltrate into the underlying soils, increasing runoff volume reduction by the bioretention practices. Excessive vegetation, if greater than the optimal vegetative density, can negatively impact the performance of the system. Thus, vegetation in bioretention practices should only be controlled to reduce the plant density or if it is undesirable for aesthetic or nuisance reasons.

Litter and debris in a bioretention practice are indications that pretreatment practices are failing or not present. Litter and debris may limit the effectiveness of bioretention practice by reducing the surface available for infiltrating stormwater runoff.

11) Are there indications of any of the following on the banks of the bioretention practice?

Erosion or channelization on the banks of a bioretention practice indicates that stormwater runoff is entering at a large velocity by means other than those designed. Erosion and channelization on the banks can fill the bioretention practice with sediments from the bank and subsequently reduce the practice's effectiveness by clogging the soil or sealing the surface and reducing the volume available for stormwater storage.

Soil slides or bulges indicate that the soil is, or potentially will be, unstable and further sliding or bulging may lead to complete bank failure. If this occurs the filtration unit could become completely clogged and the collapsed soil could be washed downstream.

Animal burrows may also lead to soil failure and clogging of the filter as described in the previous paragraph.

Seeps and wet spots indicate subsurface flow into the bioretention practice and could lead to soil slides or erosion and channelization on the banks of the practice.

Poorly vegetated areas can lead to increased erosion, which can clog the bioretention system and lead to the collapse of the bank.

Trees on constructed slopes can damage the bioretention practice and the loss of leaves in the autumn can lead to clogging of the system. Also, the root system, if extensive enough, cannot only provide pathways for stormwater to bypass the soil media, but it can also damage the subsurface collection system, if present.

12) Is the overflow or bypass structure clogged?

Bioretention practices typically have overflow structures instead of outlet structures. Outflow for a bioretention practice is intended to go into the soil such that deep percolation or evaporation occurs. The overflow structure should be free of any debris, sediment, vegetation, and other obstructions so that stormwater runoff can easily exit the bioretention practice in the event of a large storm event. If the overflow structure is partially or completely clogged, surrounding areas may be flooded by stored stormwater runoff. Any obstructions should be removed immediately to ensure proper operation of the bioretention practice.

12b) Is the overflow structure askew or misaligned from the original design or otherwise in need of repair?

Misaligned inlet or overflow structures often allow stormwater runoff to enter or exit a bioretention practice by means other than those intended by design or prevent stormwater runoff from entering the practice at all. This condition can result in erosion, channelization, or flooding of surrounding areas, which can further exacerbate the misalignment or create other problems.

Inlet and overflow structures can become misaligned for several reasons, including frost heave of the soil, vehicular collision, and geotechnical failure. Misaligned inlet or overflow structures should be repaired or replaced as soon as possible to reduce detrimental impact. Any obstructions should be removed immediately to ensure proper operation of the infiltration practice.

Other issues requiring maintenance include large cracks in concrete structures, corrosion, dents or malformation of the structure, etc.

13) Inspector's Recommendations. When is maintenance needed?

Maintenance is needed "before the next rainfall" for:

- Completely clogged inlet or overflow
- Standing water more than 48 hours after runoff has entered the practice (determine the cause)
- Significant erosion on the banks or within the basin
- Damaged/misaligned/askew inlet or overflow such that flooding or structural instability of adjacent roadways or infrastructure may result

Maintenance is needed "before the next rainy season" for:

- Partially clogged inlet or overflow
- Misaligned inlet or overflow structures that have resulted in some erosion
- Vegetation coverage less than 50% of the design coverage
- Significant sediment deposition (capacity testing for scheduling)
- Litter, large debris, and solid waste
- Sediment deposition downstream of the practice
- Erosion downstream of the practice
- Evidence of illicit discharge
- Excessive or invasive vegetation

Maintenance is needed "within a year or two" for:

- Misaligned inlet/outlet structures that have not resulted in erosion
- Some sediment deposition (capacity testing for scheduling)

References

Brown, E., D. Caraco, and R. Pitt. 2004. Illicit Discharge Detection and Elimination: A Guidance Manual for Program Development and Technical Assessment. Center for Watershed Protection, Ellicott City, MD.

Minnesota Stormwater Steering Committee. 2005. The Minnesota Stormwater Manual. Developed by Emmons and Olivier Resources for the Stormwater Steering Committee, Minnesota Pollution Control Agency, St. Paul, MN. http://www.pca.state.mn.us/pyria84

Shaw, D. and R. Schmidt. 2003. Plants for Stormwater Design: Species Selection for the Upper Midwest. Minnesota Pollution Control Agency, St. Paul, MN.

Scheduling Maintenance for Constructed Wetlands

1) Has visual inspection been conducted on this location before?

It is important to determine whether this location has been previously assessed so that assessment efforts are cost effective (i.e., neither duplicated nor wasted). If previous assessment has occurred, the current assessment should verify that actions suggested by the previous assessment were completed and are effective.

2) Has it rained within the last 48 hours at this location?

Many constructed wetlands are designed to drain the design storm volume (i.e., water quality volume, maximum storage volume) and return to previous water level within 48 hours (Minnesota Stormwater Manual). Assessing a wetland within 48 hours of a rainfall event may provide performance clues. Additionally, rainfall within the last 48 hours at a location will alter how answers to other questions in this assessment are interpreted.

3) Does this constructed wetland utilize any pretreatment practices upstream?

If any pretreatment practices exist they should also be inspected and maintained on a regular basis.

4) Access

Access to the areas upstream and downstream of the site as well as the site itself is needed in order to properly assess the practice. This is true regardless of the level of assessment applied.

5b) Are any of the inlet structures clogged?

Inlet structures should be free of any debris, sediment, vegetation, and other obstructions so that stormwater runoff can easily enter the constructed wetlands. If an inlet structure is even partially clogged, suspended solids may be deposited in the upstream conveyance system or upstream areas may flood because the conveyance systems are limited by such obstructions. Any obstructions should be removed immediately to ensure proper operation of the constructed wetlands.

5c) Are any of the inlet structures askew or misaligned from the original design or otherwise in need of maintenance?

Misaligned inlet structures often allow stormwater runoff to enter or exit constructed wetlands by means other than those intended by design or prevent stormwater runoff from entering the constructed wetlands at all. This condition can result in erosion, channelization, or flooding of surrounding areas, which can further exacerbate the misalignment or create other problems.

Inlet structures can become misaligned for several reasons, including frost heave of the soil, vehicular collision, and geotechnical failure. Misaligned inlet structures should be repaired or replaced as soon as possible to reduce detrimental impact. Any obstructions should be removed immediately to ensure proper operation of the constructed wetlands.

Other issues requiring maintenance include large cracks in concrete structures, corrosion, dents or malformation of the structure, etc.

6) How many cells are in the wetland system?

Constructed wetlands may be designed as multi-cell systems to increase treatment and retention time. It is important to recognize multi-cell systems and perform this visual inspection on each of the cells in the system to ensure the entire practice if functioning properly.

6) Is there standing water in the constructed wetland?

Constructed wetlands are designed to have a permanent pool of water. The absence of standing water in constructed wetlands is the result of one of three possibilities: (1) rainfall has not occurred in a length of time such that all stored stormwater runoff has evaporated (i.e., drought conditions) , infiltrated, or both, (2) the outlet structure is damaged or malfunctioning such that stormwater runoff is allowed to drain out of the constructed wetlands, or (3) the inlet structure is clogged or misaligned such that stormwater runoff is not entering the constructed wetlands. If it has rained in the last 48 hours (question 2) , then the constructed wetlands should have received or will soon receive stormwater runoff and therefore drought conditions are not occurring. If approximately 48 hours has passed since the last rainfall event and standing water is not present in the constructed wetlands, it is likely that possibility (2) or (3) is occurring.

Surface sheen is often caused by hydrocarbon substances such as automotive oil or gasoline and may indicate illicit discharges. Natural and constructed wetlands, however, can produce hydrocarbons through the chemical and biological processes that occur within the wetland. If hydrocarbons are not illegally discharged into the constructed wetlands, then remediation may be necessary to maintain the water quality of the stored runoff and prevent downstream pollution. There are several illicit discharge manuals available for identifying, locating, and eliminating illicit discharges (e.g., Brown et al. 2004).

Stormwater runoff with a murky color is evidence of a high suspended solids concentration that is most likely made up of fine particle sizes, such as clays and silts, because sand particles settle out of standing water very rapidly (as discussed in Sedimentation). Stormwater runoff with a murky color also indicates that the watershed may be a significant source of fine particle suspended solids or that erosion is suspending fine sediments from within the constructed wetlands. Murky color in constructed wetlands further indicates that significant turbulence may be preventing suspended particles from settling. If a rainfall event has occurred in the last 48 hours, this may not be a problem. If rainfall has not occurred in the last 48 hours, murky color may be an indication of illicit discharge.

Stormwater runoff with a green color from algae or biological activity is not uncommon in constructed wetlands. Constructed wetlands with excessive algal or biologically activity may require maintenance to prevent pollution of downstream receiving waters. Invasive, tolerant fish species like carp (*Cyprinus carpio*) or shiner minnows (*Notropiscornutus*) are indications of poor water quality in the constructed wetlands (low dissolved oxygen, turbid, limited habitat) such that tolerant and invasive species are present. More information should be gathered to determine the cause of the poor water quality, and remediation should be performed.

7) Is there evidence of illicit storm sewer discharges?

An illicit discharge manual (e.g., Brown et al. 2004) should be consulted for identifying and locating illicit stormwater discharges.

8) Does the constructed wetland smell like gasoline or oil?

If constructed wetlands smell like gasoline or oil, it is possible that hydrocarbon substances such as automotive oil or gasoline are being illicitly discharged into the practice or upstream in the watershed. If hydrocarbons are not illegally discharged into the constructed wetlands, then an oil/gasoline smell may indicate that small amounts of hydrocarbons typically found in stormwater runoff are accumulating in the constructed wetlands. For more information on identifying, locating, and eliminating illicit discharges, refer to a manual such as Brown et al. (2004).

9) What is the approximate percentage of vegetation coverage in the practice?

Vegetation in constructed wetlands should be consistent with native or design-specified wetland vegetation. The absence of vegetation anywhere in or around constructed wetlands may be an indication of poor water quality or excessive infiltration that will dry the wetland.

9a) Does the current vegetation match the original design?

Species of vegetation in planting plans for constructed wetlands are selected based on desirable characteristics that a particular species of plant may exhibit. During the construction and throughout the operational life of a wetland, the vegetation may deviate from the original design and thus possibly affect the performance of the wetland. If planting designs are available, compare the currently existing vegetation to the vegetation designated in the design plans. Particular things to look for are certain species that are not surviving and/or have disappeared as well as introduction of weeds, wetland vegetation, and/or other invasive vegetation. For guidance on vegetation identification please refer to Plants for Stormwater Design: Species Selection for the Upper Midwest (Schmidt and Shaw, 2003).

9c) Does the vegetation appear to be healthy?

The health of vegetation can indicate conditions that may be too wet/dry, too sunny/shady, lack of nutrients, compacted soil, presence of toxic pollutants, etc. The survival of the vegetation is critical to maintaining proper function of a constructed wetland. During the growing season assess the apparent visual health of the vegetation in the wetland. Some indications of unfavorable conditions are: wilted leaves/stem, discoloration of leaves, lack of flowering buds developing, stunted growth, and a decrease in the number of plantings present. For guidance on vegetation identification please refer to Plants for Stormwater Design: Species Selection for the Upper Midwest (Schmidt and Shaw, 2003).

9d) Is the vegetation the appropriate density/size?

Under optimal site conditions the vegetation should have an appropriate size and density for that particular species. Under development can be an indication of poor health while over development can hinder the development of other species in the constructed wetland. For guidance on vegetation identification please refer to Plants for Stormwater Design: Species Selection for the Upper Midwest (Schmidt and Shaw, 2003).

10) Are there indications of any of the following in the constructed wetland?

Sediment deposition may indicate a significant source of sediment in the watershed that may require remediation to prevent downstream pollution, or that the constructed wetlands have not been recently maintained. Sediment deposition reduces the stormwater storage volume of constructed wetlands and can allow sediments to become resuspended during subsequent storm events.

Vegetation, especially with deep roots, can increase and maintain infiltration rates in constructed wetlands that do not have impermeable surfaces (e.g., concrete). If the surface of the constructed wetlands becomes clogged or sealed, vegetation can provide pathways for stormwater runoff to penetrate the surface and subsequently infiltrate into the underlying soils, increasing runoff volume reduction by the constructed wetlands. Excessive vegetation, if greater than the optimal vegetative density, can negatively impact the performance of the system. Thus, vegetation in constructed wetlands should only be controlled to reduce the plant density or if it is undesirable for aesthetic or nuisance reasons.

Litter and debris in constructed wetlands are indications that pretreatment practices are failing or not present. Litter and debris may reduce the stormwater storage volume and therefore the retention time.

11) Are there indications of any of the following on the banks of the constructed wetland?

Erosion or channelization on the banks of constructed wetlands indicates that stormwater runoff is entering at a large velocity by means other than those intended by design. Erosion and channelization on the banks can fill the constructed wetlands with sediments from the bank and subsequently reduce the volume available for stormwater storage and treatment.

Soil slides or bulges indicate that the soil is, or potentially will be, unstable and further sliding or bulging may lead to complete bank failure. If this occurs the filtration unit could become completely clogged and the collapsed soil could be washed downstream.

Animal burrows may also lead to soil failure and clogging of the filter as described in the previous paragraph.

Seeps and wet spots indicate subsurface flow into the constructed wetland and could lead to soil slides or erosion and channelization on the banks of the practice.

Poorly vegetated areas can lead to increased erosion which can adversely impact plant life and transport sediment downstream.

Trees on constructed slopes can damage the constructed wetland and lead to slope failure.

12) Are any overflow or outlet structures clogged?

Like an inlet structure, overflow and outlet structures should be free of any debris, sediment, vegetation, and other obstructions so that stormwater runoff can easily exit the constructed wetlands. If the outlet structure is partially or completely clogged, the treatment rate may be limited and stormwater runoff may not pass through the constructed wetlands in less than 48 hours, which can result in flooding or untreated stormwater runoff passing as overflow. Any obstructions should be removed immediately to ensure proper operation of the constructed wetlands.

12b) Is the outlet structure askew or misaligned from the original design or otherwise in need of maintenance?

Misaligned outlet structures often allow stormwater runoff to enter or exit constructed wetlands by means other than those intended by design or prevent stormwater runoff from entering the constructed wetlands at all. This condition can result in erosion, channelization, or flooding of surrounding areas, which can further exacerbate the misalignment or create other problems.

Outlet structures can become misaligned for several reasons, including frost heave of the soil, vehicular collision, and geotechnical failure. Misaligned outlet structures should be repaired or replaced as soon as possible to reduce detrimental impact. Any obstructions should be removed immediately to ensure proper operation of the constructed wetlands.

Other issues requiring maintenance include large cracks in concrete structures, corrosion, dents or malformation of the structure, etc.

13) Is there evidence of any of the following downstream of the outlet structure?

Conditions downstream of a constructed wetland can provide evidence of the function of the wetland itself. Properly designed and functioning constructed wetlands should remove most sand-size particles (0.125 to 2 mm) from stormwater runoff. Sediment deposition downstream of a constructed wetland indicates that erosion is occurring between the wetland and the sediment deposition or that sediments are present in the wetland effluent. If sediments are present in the effluent such that downstream deposition is occurring, the wetland is likely failing.

Erosion downstream of a constructed wetland practice indicates that flow velocities are larger than the conveyance channel can withstand. The conveyance channel should be resized to accommodate the amount of flow exiting the constructed wetland, or the channel should be augmented with energy dissipaters or riprap to reduce or eliminate the impact of erosion.

14) Inspector's Recommendations. When is maintenance needed?

Maintenance is needed "before the next rainfall" for:

- Completely clogged inlet or overflow
- Significant erosion on the banks or within the basin
- Damaged/misaligned/askew inlet or overflow such that flooding or structural instability of adjacent roadways or infrastructure may result

Maintenance is needed "before the next rainy season" for:

- Partially clogged inlet or overflow
- Misaligned inlet or overflow structures that have resulted in some erosion
- Significant sediment deposition (capacity testing for scheduling)
- Litter, large debris, and solid waste
- Sediment deposition downstream of the practice
- Erosion downstream of the practice
- Evidence of illicit discharge
- Excessive or invasive vegetation

Maintenance is needed "within a year or two" for:

- Misaligned inlet/outlet structures that have not resulted in erosion
- Some sediment deposition (capacity testing for scheduling)

References

Brown, E., D. Caraco, and R. Pitt. 2004. Illicit Discharge Detection and Elimination: A Guidance Manual for Program Development and Technical Assessment. Center for Watershed Protection, Ellicott City, MD.

Minnesota Stormwater Steering Committee. 2005. The Minnesota Stormwater Manual. Developed by Emmons and Olivier Resources for the Stormwater Steering Committee, Minnesota Pollution Control Agency, St. Paul, MN. http://www.pca.state.mn.us/pyria84

Shaw, D. and R. Schmidt. 2003. Plants for Stormwater Design: Species Selection for the Upper Midwest. Minnesota Pollution Control Agency, St. Paul, MN.

Scheduling Maintenance for Filter Strips and Swales

1) Has visual inspection been conducted on this location before?

It is important to determine whether this location has been previously assessed so that assessment efforts are cost effective (i.e., neither duplicated nor wasted). If previous assessment has occurred, the current assessment should verify that actions suggested by the previous assessment were completed and are effective.

2) Has it rained within the last 48 hours at this location?

Assessing a filter strip or swale within 48 hours of a rainfall event may provide additional performance clues. Additionally, rainfall within the last 48 hours at a location will alter how answers to other questions in this assessment are interpreted.

3) Does this filter strip or swale utilize any pretreatment practices upstream?

If any pretreatment practices exist they should also be inspected and maintained on a regular basis.

4) Access

Access to the areas upstream and downstream of the site as well as the site itself is needed in order to properly assess the practice. This is true regardless of the level of assessment applied.

5b) Are any of the inlet structures clogged?

Inlet structures should be free of any debris, sediment, vegetation, and other obstructions so that stormwater runoff can easily enter the filter strip or swale. If an inlet structure is even partially clogged, suspended solids may be deposited in the upstream conveyance system, or upstream areas may flood because the conveyance systems are limited by such obstructions. Any obstructions should be removed immediately to ensure proper operation of the filter strip or swale.

5c) Are any of the inlet structures askew or misaligned from the original design or otherwise in need of maintenance?

Misaligned inlet or outlet structures often allow stormwater runoff to enter or exit a filter strip or swale by means other than those intended by design or prevent stormwater runoff from entering the filter strip or swale at all. This condition can result in erosion, channelization, or flooding of surrounding areas, which can further exacerbate the misalignment or create other problems.

Inlet and outlet structures can become misaligned for several reasons including frost heave of the soil, vehicular collision, and geotechnical failure. Misaligned inlet or outlet structures should be repaired or replaced as soon as possible to reduce detrimental impact. Any obstructions should be removed immediately to ensure proper operation of the filter strip or swale.

Other issues requiring maintenance include large cracks in concrete structures, corrosion, dents or malformation of the structure, etc.

6) Is there standing water in the filter strip or swale?

Filter strips and swales are designed for stormwater conveyance and not stormwater storage. Standing water in a filter strip or swale is an indication of failure by (1) downstream flooding, or (2) blockage that is preventing stormwater runoff from being conveyed downstream. Areas downstream of the filter strip or swale should be inspected for signs of flooding, and the filter strip or swale should be inspected for any obstructions.

Surface sheen is caused by hydrocarbon substances such as automotive oil or gasoline and may indicate illicit discharges. If hydrocarbons are not illegally discharged into the filtration practice, then a surface sheen may indicate that stormwater runoff is stored in the filtration practice such that the small amounts of hydrocarbons typically found in stormwater runoff are accumulating. If this is happening, then the filtration practice is failing. There are several illicit discharge manuals available for identifying, locating, and eliminating illicit discharges (e.g., Brown et al. 2004).

Stormwater runoff with a murky color is evidence of a high suspended solids concentration that is most likely made up of fine particle sizes such as clays and silts because sand particles settle out of standing water rapidly (as discussed in Sedimentation). Stormwater runoff with a murky color further indicates that the watershed may be a significant source of fine particle suspended solids, which can clog a filtration practice.

Stormwater runoff with a green color from algae has been stored in the filtration practice for a long period of time such that microorganisms have developed. The filtration practice is not filtering stormwater runoff and is therefore failing.

7) Is there evidence of illicit storm sewer discharges?

An illicit discharge manual (e.g., Brown et al. 2004) should be consulted for identifying and locating illicit stormwater discharges.

8) What is the approximate percentage of vegetation coverage in the practice?

Vegetation in the bottom of a filter strip or swale can increase the infiltration rate and remove particulates from stormwater runoff. Plants can lose 30% of their root structures annually, which produces macropores. Macropores in a filter strip or swale can increase the infiltration rate of the practice so that more stormwater runoff is infiltrated. Additionally, vegetation reduces overland flow velocities, which reduces erosion, resuspension of captured solids, and increases suspended solids removal.

8a) Does the current vegetation match the original design?

Species of vegetation in planting plans for filter strips and swales are selected based on desirable characteristics that a particular species of plant may exhibit. During the construction and throughout the operational life of the filter strip or swale, the vegetation may deviate from the original design and thus possibly affect the performance of the filter strip or swale. If planting designs are available, compare the currently existing vegetation to the vegetation designated in the design plans. Particular things to look for are certain species that are not surviving and/or have disappeared as well as introduction of weeds, wetland vegetation, and/or other invasive vegetation. For guidance on vegetation identification please refer to Plants for Stormwater Design: Species Selection for the Upper Midwest (Schmidt and Shaw, 2003).

8c) Does the vegetation appear to be healthy?

The health of vegetation can indicate conditions that may be too wet/dry, too sunny/shady, lack of nutrients, compacted soil, presence of toxic pollutants, etc. The survival of the vegetation is critical to maintaining proper function of a filter strip or swale. During the growing season assess the apparent visual health of the vegetation in the filter strip or swale. Some indications of unfavorable conditions are: wilted leaves/stem, discoloration of leaves, lack of flowering buds developing, stunted growth, and a decrease in the number of plantings present. For guidance on vegetation identification please refer to Plants for Stormwater Design: Species Selection for the Upper Midwest (Schmidt and Shaw, 2003).

8d) Is the vegetation the appropriate density/size?

Under optimal site conditions the vegetation should have an appropriate size and density for that particular species. Under development can be an indication of poor health while over development can hinder the development of other species in the filter strip or swale. For guidance on vegetation identification please refer to Plants for Stormwater Design: Species Selection for the Upper Midwest (Schmidt and Shaw, 2003).

9) Are there indications of any of the following within the filter strip or swale?

Sediment deposition can indicate a significant source of sediment in the watershed that may require remediation to prevent downstream pollution or that the filter strip or swale has not been recently maintained. Sediment deposition reduces the stormwater storage volume of a filter strip or swale and can allow sediments to become resuspended during subsequent storm events.

Erosion or channelization indicates that flow velocities entering, or in, the filter strip or swale are large or that stormwater runoff is entering the filter strip or swale by means other than those intended by design. Erosion and channelization can reduce treatment by sedimentation within a filter strip or swale by reducing the retention time and treatment area. Additionally, previously captured sediments can become entrained by poorly or untreated stormwater and pass through the filter strip or swale with the effluent.

Vegetation, especially with deep roots, can increase and maintain infiltration rates in filter strips and swales. If the surface of the filter strips and swales becomes clogged or sealed, vegetation can provide pathways for stormwater runoff to penetrate the surface and subsequently infiltrate into the underlying soils, increasing runoff volume reduction by the filter strips and swales. Excessive vegetation, if greater than the optimal vegetative density, can negatively impact the performance of the system. Thus, vegetation in filter strips and swales should only be controlled to reduce the plant density or if it is undesirable for aesthetic or nuisance reasons.

Bare soil or lack of healthy vegetation significantly different from the original design may indicate that filter strip or swale is not operating properly. For example, if the vegetation has died or is unhealthy, it could indicate standing water has remained in the filter strip or swale for excessively long time periods. This may also be indicated if the plants are transitioning from the original vegetation to wetland species.

Litter and debris in a filter strip or swale are indications that pretreatment practices are failing or not present. Litter and debris may limit the effectiveness of filter strip or swale by altering flow paths that may create channelization, erosion, or both.

10) Are there indications of any of the following on the banks of the filter strip (if applicable) or swale?

Erosion or channelization on the banks of a swale indicates that stormwater runoff is entering at a large velocity by means other than those intended by design. Erosion and channelization on the banks can fill the swale with sediments from the bank and subsequently reduce the swale’s effectiveness by reducing the volume available for stormwater conveyance and treatment.

Soil slides or bulges indicate that the soil is, or potentially will be, unstable and further sliding or bulging may lead to complete bank failure. If this occurs the filtration unit could become completely clogged and the collapsed soil could be washed downstream.

Animal burrows may also lead to soil failure and clogging of the filter as described in the previous paragraph.

Seeps and wet spots indicate subsurface flow into the filter strip or swale and could lead to soil slides or erosion and channelization on the banks of the practice.

Poorly vegetated areas can lead to increased erosion, which can clog the filter strip or swale and lead to the collapse of the bank.

Trees on constructed slopes can damage the swale or filter strip and the loss of leaves in the autumn can lead to reduced infiltration.

11) Are any overflow or outlet structures clogged?

Like the inlet structure, the outlet structure should be free of any debris, sediment, vegetation, and other obstructions so that stormwater runoff can easily exit the filter strip or swale. If the outlet structure is partially or completely clogged, the treatment rate may be limited, and stormwater runoff may not pass through the filter strip or swale untreated or flood surrounding areas. Any obstructions should be removed immediately to ensure proper operation of the filter strip or swale.

11b) Is the outlet structure askew or misaligned from the original design or otherwise in need of maintenance?

Misaligned inlet or outlet structures often allow stormwater runoff to enter or exit a filter strip or swale by means other than those intended by design or prevent stormwater runoff from entering the filter strip or swale at all. This condition can result in erosion, channelization, or flooding of surrounding areas, which can further exacerbate the misalignment or create other problems.

Inlet and outlet structures can become misaligned for several reasons, including frost heave of the soil, vehicular collision, and geotechnical failure. Misaligned inlet or outlet structures should be repaired or replaced as soon as possible to reduce detrimental impact. Any obstructions should be removed immediately to ensure proper operation of the filter strip or swale.

Other issues requiring maintenance include large cracks in concrete structures, corrosion, dents or malformation of the structure, etc.

12) Is there evidence of any of the following downstream of the outlet structure?

Conditions downstream of a filter strip or swale can provide evidence of the function of the practice itself. Properly designed and functioning filter strip or swale should remove most sand-size particles (0.125 to 2 mm) from stormwater runoff. Sediment deposition downstream of a filter strip or swale indicates that erosion is occurring between the practice and the sediment deposition or that sediments are present in the filter strip or swale effluent. If sediments are present in the effluent such that downstream deposition is occurring, the filter strip or swale is likely failing.

Erosion downstream of a filter strip or swale indicates that flow velocities are larger than the conveyance channel can withstand. The conveyance channel should be resized to accommodate the amount of flow exiting the filter strip or swale, or the channel should be augmented with energy dissipaters or riprap to reduce or eliminate the impact of erosion.

13) Inspector's Recommendations. When is maintenance needed?

Maintenance is needed "before the next rainfall" for:

- Completely clogged inlet or overflow
- Standing water more than 48 hours after runoff has entered the practice (determine the cause)
- Significant erosion on the banks or within the basin
- Damaged/misaligned/askew inlet or overflow such that flooding or structural instability of adjacent roadways or infrastructure may result

Maintenance is needed "before the next rainy season" for:

- Partially clogged inlet or overflow
- Misaligned inlet or overflow structures that have resulted in some erosion
- Vegetation coverage less than 50% of the design coverage
- Significant sediment deposition (capacity testing for scheduling)
- Litter, large debris, and solid waste
- Sediment deposition downstream of the practice
- Erosion downstream of the practice
- Evidence of illicit discharge
- Excessive or invasive vegetation

Maintenance is needed "within a year or two" for:

- Misaligned inlet/outlet structures that have not resulted in erosion
- Some sediment deposition (capacity testing for scheduling)

References

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