

## Chapter 4.0 Watershed Best Management Practice (BMP) and Solutions Toolbox

This section presents a brief illustrated overview of a variety of site planning and stormwater and landscaping best management practices (BMPs). The BMPs are integrated into the East Branch South Branch Kishwaukee River Watershed-Based Plan action items and recommendations presented in Chapter 5. Following the brief descriptions, more detailed information including guidance on applicable scale and land use, benefits and effectiveness, and design considerations are included on BMP Fact Sheets.

### 4.1 Planning Process BMPs

Planning process BMPs are policy goals used to maintain high environmental quality as a watershed develops and/or restore environmental quality during redevelopment. Significant natural features can be created and/or preserved by open space requirements and other standards. Open space preservation/restoration and riparian buffer standards are tools used to preserve natural resources during development and/or restore natural resources during redevelopment. Impervious area reduction is a critical site-level planning and design strategy used to achieve stormwater management and water quality goals.

**Flow Path Analysis:** A flow path analysis involves the development of an idealized representation of how water would flow assuming that all the sewers are full and all lakes, depressional areas and other low-lying areas are full of water. This tool is useful for identifying areas where green infrastructure and other storage BMPs could be placed in order to reduce the potential for flooding.

**Impervious Area Reduction:** Impervious area reduction can be achieved in a variety of ways including adding rain garden “bump outs” to neighborhood streets, increasing pervious areas in large parking lots by installing depressed parking lot islands and use of permeable pavement.

**Open Space:** Protection or re-establishment of open space and/or natural areas as greenways, in order to preserve and connect significant water quality and habitat features and improve aesthetic, recreational and/or alternative transportation uses.

**Riparian Buffer:** A riparian buffer is a vegetated area next to a stream or wetland that protects water resources from pollution, stabilizes the stream bank, and offers aquatic and wildlife habitat.

### 4.2 Stormwater BMPs

Stormwater BMPs are site-specific practice, techniques, methods, or structural controls that are designed to manage the quantity and improve the quality of stormwater runoff in a cost-effective manner. Commonly, stormwater BMPs minimize onsite and offsite hydrologic and water quality impacts from stormwater runoff by incorporating and re-establishing natural hydrologic processes into an urbanized area. Stormwater BMPs can be both integrated into new development or retrofitted into existing developments.

**Bioswales:** Bioswales are filtration and infiltration systems planted with grasses, shrubs, and wetland plants designed to filter, retain, evapotranspire, and infiltrate stormwater. Typically, bioswales are constructed with an underdrain and infiltration trench comprised of engineered soil and gravel. The infiltration trench provides additional stormwater storage and facilitates infiltration of water into the surrounding soils and groundwater.

**Permeable Pavement:** Permeable pavement is pavement that is designed to allow for the infiltration of rain and snowfall. Permeable pavement is constructed with an underdrain and infiltration trench bed comprised of gravel underneath the permeable pavement. Rain that falls on the permeable pavement infiltrates into the gravel and then into the soil and/or groundwater below. Runoff that is not infiltrated is slowly released from the trench into a second BMP as part of a stormwater BMP “treatment train” or into the storm sewer system.

**Rain Gardens:** Rain gardens are landscaped gardens designed to filter, retain, evapotranspire, and infiltrate stormwater from roofs, driveways, or lots.

**Vegetated Swales:** Vegetated swales are stormwater features that convey, retain, and infiltrate stormwater. Water quality benefits of vegetated swales are enhanced by the planting of native vegetation in the swale.

**Bioinfiltration Basins:** Bioinfiltration basins are used to temporarily store stormwater runoff and release it at a rate designed to protect stream health and provide water quality treatment. Bioinfiltration basins are planted with native wetland and prairie vegetation to provide additional water quality benefits and provide habitat for aquatic and terrestrial species. The bioinfiltration basins can be designed both as shallow wetland systems with little to no open water or as open water wetland ponds with a wetland fringe and prairie sideslopes.

**Rain Barrels/Cisterns:** Rain barrels and cisterns are storage vessels used to capture and temporarily store rainfall for landscape irrigation.

#### 4.3 Landscaping BMPs

Landscaping has many properties that make it an important BMP to integrate into watershed planning action plans. Landscaping improves biodiversity, aesthetics, and habitat and cools ambient air. Native landscaping can also improve water quality through increasing infiltration and filtration of stormwater runoff.

**Stormwater Trees:** Trees can reduce stormwater runoff from impervious areas such as parking lots, roads, and buildings. Trees have an effect on stormwater above the ground surface, at the ground surface, and below the ground surface by slowing, storing, and infiltrating runoff.

**Native Landscaping:** Native vegetation uses the plants that were endemic to a specific geographical region prior to settlement for a variety of purposes including habitat improvement and increasing stormwater infiltration and water quality treatment.

**Soil Amendments:** A soil amendment is any material added to a soil to improve its physical properties, such as water retention, permeability, water infiltration, drainage, aeration and structure.

**Stream/Wetland Management and Restoration:** Landscape restoration practices designed to maintain existing remnant landscapes and/or restore streams and wetlands to their natural state.

**Streambank Stabilization:** Streambank stabilization includes the use of bioengineering techniques to address streambank erosion and protect private property, roadways, and utilities from damage caused by streambank erosion.

#### 4.4 Flood Reduction BMPs

**Non-Structural Flood Control:** Non-structural flood control measures include floodproofing, acquisition and demolition of flood damaged buildings, and elevating or relocating buildings out of the floodplain.

**Structural Flood Control:** Structural flood control measures include reservoirs, levees, floodwalls, diversions, stream channel conveyance improvements, and stormsewer improvements. These measures are generally designed to reduce the risk of flood damage in urbanized areas. Structural flood control projects are frequently cost prohibitive for municipalities to implement without some type of financial assistance through cost sharing or grants.

The following Fact Sheets include guidance on applicable scale and land use, benefits and effectiveness, and design considerations of stormwater BMPs and solutions that are recommended as Action Items in Chapter 5 of this watershed-based plan. The general layout of the Fact Sheets is described below.

**BMP Description:** Provides a description of the BMP, how it works, and water quality and stormwater management benefits provided by the BMPs.

**Applicability:** Where and how each BMP is applicable addressed by scale, application, and effectiveness:

##### Scale

- **Watershed/County:** Applied at a regional scale in the watershed or county-wide.
- **Town/Village:** Applied at a municipal level.
- **Neighborhood:** Applies at development or other sub-municipal level.
- **Lot:** Applied on individual residential, commercial, or industrial lots.

##### Application

- **Retrofit:** Applied to existing development, infill, and redevelopment.
- **New:** Applied to new development.
- **Roofs:** Applied on roofs or to treat roof runoff.
- **Streets:** Applied on or used to treat runoff from streets and roads.
- **Driveways:** Applied on or used to treat runoff from driveways.
- **Parking Lots:** Applied on or used to treat runoff from parking lots.
- **Lawns:** Applied on or used to treat runoff from lawns that are planted with turf grass.
- **Sensitive Areas:** Applied to ecologically important areas such as floodplains, wetlands, and highly erodible soils.

##### Effectiveness

- **Runoff Rate Control:** BMPs that control or reduce runoff rates.
- **Runoff Volume Control:** BMPs that control or reduce runoff volumes.

- **Physical Habitat Preservation/Creation:** BMPs that preserve, restore, or provide wildlife habitat.
- **Sediment Pollution Control:** BMPs that reduce the amount of suspended sediment in runoff.
- **Nutrient Control:** BMPs that reduce the amount of nutrients in runoff.
- **BOD Control:** BMPs that remove constituents that cause BOD in runoff.
- **Other Pollutant Control:** BMPs that reduce the amount of metals, petroleum-based compounds, and other pollutants in runoff.

**Design Consideration:** Design recommendation that should be considered when designing and implementing the BMP.

**Additional Benefits:** Other positive effects that the BMP provides beyond its stormwater and water quality benefits.

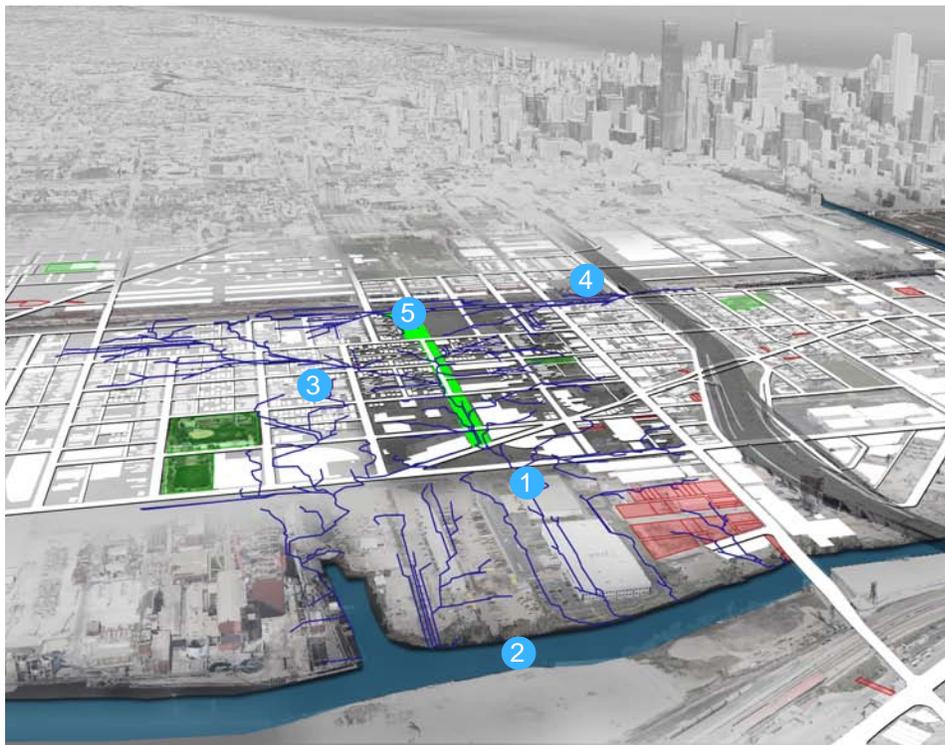
**Maintenance:** Recommendation on maintenance practices necessary to keep the BMP functioning as designed.

# FLOWPATH ANALYSIS

## PLANNING PROCESS BMP

Stormwater Flowpath Analysis is used to identify primary infiltration opportunities based on LiDAR topographic data and other key elements.

- Stormwater Runoff (Flowpath) 1
- Point of Collection (River) 2
- Impervious Drainage Area 3
- Surface Flow Obstruction (Metra) 4
- Infiltration Opportunities 5



### SCALE

- Watershed / County
- Town / Village
- Neighborhood
- Lot

### APPLICATION

- Retrofit  New
- Preventative  Remedial
- Parking Lots  Streets
- Driveways  Roofs
- Lawns  Sensitive Areas

### EFFECTIVENESS

- Runoff Rate Control
- Runoff Volume Control
- Habitat Preservation / Restoration
- Sediment Control
- Nutrient Control
- BOD / COD Control
- Other Pollutant Control

- High
- ◐ Moderate
- Low

### DESCRIPTION

Stormwater flowpath analysis identifies key features such as significant outfalls, inlets to large diameter pipes and obstructions such as buildings, rail lines, and roads while incorporating LiDAR topographic data in order to model stormwater surface runoff.

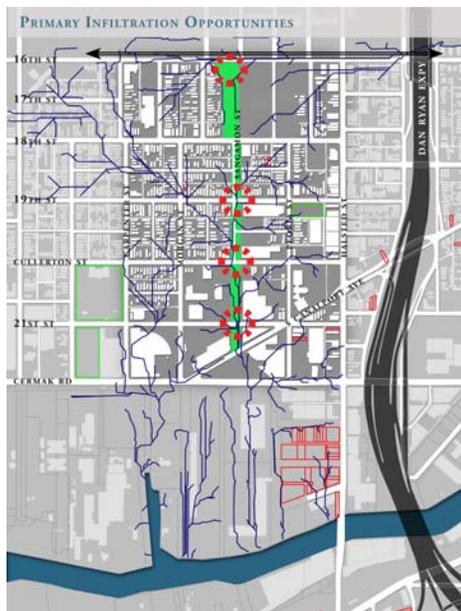
Flowpath analysis is most useful on a large scale to help identify surface flow patterns and major collection points. The patterns observed can be used as a watershed planning tool to help prioritize primary opportunities to infiltrate stormwater runoff before entering the sewer system, streams, rivers, and lakes.

The hydrologic modeling tools in the ArcGIS Spatial Analyst extension toolbox provide methods for describing the physical components of a surface. The hydrologic tools allow you to identify sinks, determine flow direction, calculate flow accumulation, delineate watersheds, and create stream networks. The image above is of a resulting network derived from an elevation model.

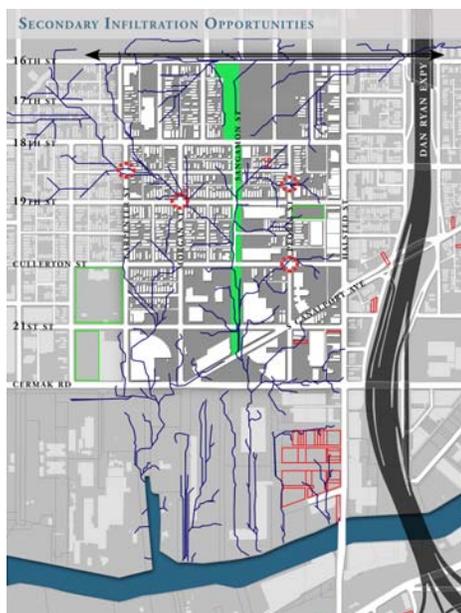
This data is compiled into a GIS data base that is used to develop a comprehensive understanding of the surrounding land use. This process is used to indicate ideal areas to incorporate stormwater BMP's that will function as an overall system and aid in the planning process to establish interconnected greenways that connect open space, sensitive habitats, and recreational uses in a sustainable and responsible manner.

# FLOW PATH ANALYSIS

## PLANNING PROCESS BMP



Primary Infiltration Opportunities



Secondary Infiltration Opportunities

### ADDITIONAL BENEFITS

- Allows for public input / awareness by providing comprehensive analysis exhibits.
- An excellent resource for understanding basic hydrology on a site specific scale.
- Helps to identify and prioritize areas that would be most beneficial for stormwater infiltration
- Flowpath analysis is best utilized when added to other GIS layers such as lots, rights-of way, streets, structures, stream, rivers, wetlands etc. to gain a comprehensive understanding of the watershed.



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# FLOWPATH ANALYSIS

## PLANNING PROCESS BMP

Stormwater Flowpath Analysis is used to identify primary infiltration opportunities based on LiDAR topographic data and other key elements.

- Stormwater Runoff (Flowpath) 1
- Point of Collection (Bioswale) 2
- Impervious Drainage Area 3
- Surface Flow Obstructions (Roads) 4
- Combined Sewer Overflow Area 5



### SCALE

- Watershed / County
- Town / Village
- Neighborhood
- Lot

### APPLICATION

- Retrofit  New
- Preventative  Remedial
- Parking Lots  Streets
- Driveways  Roofs
- Lawns  Sensitive Areas

### EFFECTIVENESS

- Runoff Rate Control
- Runoff Volume Control
- Habitat Preservation / Restoration
- Sediment Control
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- Other Pollutant Control

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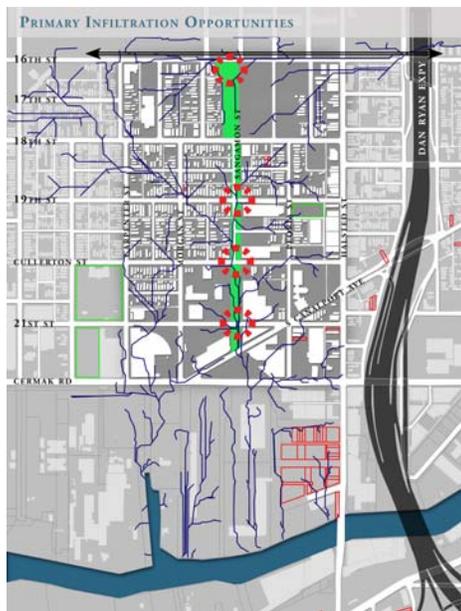
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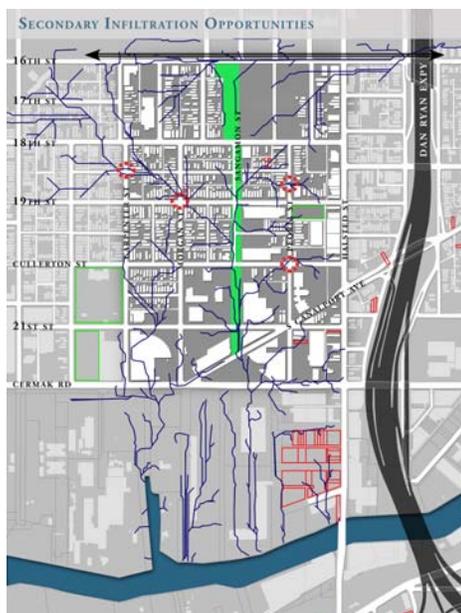
This data is compiled into a GIS data base that is used to develop a comprehensive understanding of the surrounding land use. This process is used to indicate ideal areas to incorporate stormwater BMP's that will function as an overall system and aid in the planning process to establish interconnected greenways that connect open space, sensitive habitats, and recreational uses in a sustainable and responsible manner.

# FLOW PATH ANALYSIS

## PLANNING PROCESS BMP



Primary Infiltration Opportunities



Secondary Infiltration Opportunities

### ADDITIONAL BENEFITS

- Allows for public input / awareness by providing comprehensive analysis exhibits.
- An excellent resource for understanding basic hydrology on a site specific scale.
- Helps to identify and prioritize areas that would be most beneficial for stormwater infiltration
- Flowpath analysis is best utilized when added to other GIS layers such as lots, rights-of way, streets, structures, stream, rivers, wetlands etc. to gain a comprehensive understanding of the watershed.



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# IMPERVIOUS AREA REDUCTION

## PLANNING PROCESS BMP

Site-level planning and design strategy used to achieve stormwater management and water quality goals by incorporating BMP's into new development or as a retrofit to existing impervious design.

- Permeable Pavement 1
- Sub-base Gravel Storage 2
- Underdrain (if necessary) 3
- Overflow to Stormwater BMP 4



### SCALE

- Watershed / County
- Town / Village
- Neighborhood
- Lot

### APPLICATION

- |  |  |
|--|--|
| <input checked="" type="checkbox"/> Retrofit     | <input checked="" type="checkbox"/> New      |
| <input checked="" type="checkbox"/> Preventative | <input checked="" type="checkbox"/> Remedial |
| <input checked="" type="checkbox"/> Parking Lots | <input checked="" type="checkbox"/> Streets  |
| <input checked="" type="checkbox"/> Driveways    | <input type="checkbox"/> Roofs               |
| <input type="checkbox"/> Lawns                   | <input type="checkbox"/> Sensitive Areas     |

### EFFECTIVENESS

- Runoff Rate Control
- Runoff Volume Control
- Habitat Preservation / Restoration
- Sediment Control
- Nutrient Control
- BOD / COD Control
- Other Pollutant Control

- High
- Moderate
- Low

### DESCRIPTION

Impervious area reduction can be achieved in a variety of ways including adding rain garden 'bump outs' to retrofitting neighborhood streets, increasing pervious areas in large parking lots by installing depressed parking lot islands and use of permeable pavement.

Permeable pavements refer to paving materials that promote the absorption of rainfall and snowmelt. There are four main types of permeable pavements: porous concrete, porous asphalt, permeable grid pavers, and permeable pavers. See detailed descriptions of each paving system below.

**Porous Concrete:** Porous concrete looks very similar to regular concrete. Porous concrete typically consists of specialty formulated mixtures of Portland cement, coarse aggregate and water that has been manufactured to have gaps through which water can flow into an infiltration bed of uniformly graded gravel.

**Porous Asphalt:** Porous asphalt looks very similar to regular asphalt. Porous asphalt consists of coarse aggregate bonded together by asphalt cement with sufficient gaps through which water can flow into an infiltration bed of uniformly graded gravel.

**Permeable Grid Pavers:** Permeable grid pavers are modular plastic pavers that fit together with funnel-like openings installed over an infiltration bed of gravel. Depending on the site, grass or rock is used to fill in the funnel-like openings. Using plastic for the grids makes them very flexible and they can be used on uneven surfaces.

**Permeable Pavers:** Permeable pavers are modular concrete pavers that fit together with funnel-like openings installed over an infiltration bed of uniformly graded gravel. Depending on the site, grass or rock is used to fill in the funnel-like openings.

# IMPERVIOUS AREA REDUCTION

## PLANNING PROCESS BMP



Permeable Paver Circulation Node



Permeable Paver Parking Lot with Depressed Islands



Rain Garden Bumpout Under Construction

## ADDITIONAL BENEFITS

Impervious area reduction such as permeable pavement removes suspended solids through filtration. Dissolved pollutants such as nutrients and metals are removed and/or transformed as runoff infiltrates into the soil. Utilizing the Illinois EPA's Estimating Pollutant Load Reductions for Nonpoint Source Pollution Control BMPs worksheets, the permeable pavement can remove approximately 75% of the total phosphorous, 90% of total suspended solids, and 100% of lead and zinc.

Impervious Area Reduction provides more than just stormwater management.

- Reduces urban heat island effect and thermal impacts to waterbodies.
- Reduces development and maintenance costs.
- Provides paving options for site specific applications.
- Increases green space for habitat and recreational uses.
- Provides opportunities for greenways and open space linkages

## DESIGN CONSIDERATIONS

- Site conditions such as adjacent land uses, soil type, and slopes should be assessed to determine if / which BMP solutions are appropriate to reduce impervious areas.
- The drainage area or local watershed will need to be determined in order to design for appropriate storage requirements.
- Policy goals should be established to maintain a high environmental quality standard as a watershed is developed.

## OPERATIONS AND MAINTENANCE

All impervious area reduction measures taken need to be maintained and will vary depending on the BMP method designed, which is described in detail on the accompanying fact sheets.



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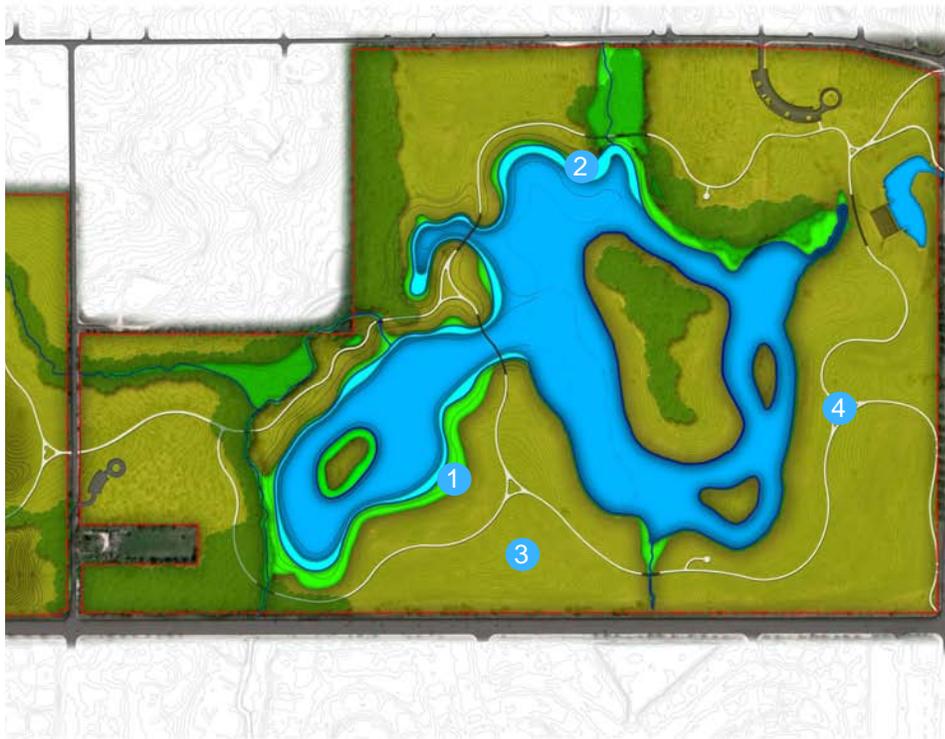
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# OPEN SPACE

## PLANNING PROCESS BMP

Establishment of open space and natural areas that provide for greenways in order to preserve and connect significant water quality and habitat features, while accommodating recreational uses.

- Restored Wetland 1
- Restored Emergent Zone 2
- Restored Upland 3
- Recreational Trail 4



### SCALE

- Watershed / County
- Town / Village
- Neighborhood
- Lot

### APPLICATION

- Retrofit       New
- Preventative    Remedial
- Parking Lots    Streets
- Driveways       Roofs
- Lawns           Sensitive Areas

### EFFECTIVENESS

- Runoff Rate Control
- Runoff Volume Control
- Habitat Preservation / Restoration
- Sediment Control
- Nutrient Control
- BOD / COD Control
- Other Pollutant Control

- High
- Moderate
- Low

### DESCRIPTION

Open space is an essential planning tool used to preserve natural resources during development activities. The purpose of open space is to protect or re-establish natural areas as greenways that preserve and connect significant water quality and habitat features, while improving aesthetic, recreational and / or alternative transportation uses.

Planning for open space requires coordination between numerous community agencies to develop an integrated plan for open space protection and development. An open space plan should look at all public open space, regardless of ownership, including non-traditional open spaces such as vacant lots, community gardens, cemeteries, greenways, trails, and thoroughfares, as well as the traditional parks, playgrounds, squares, and malls. It should also examine open lands under private ownership, such as non-profit institutions, so as to understand their role in the overall open space system.

Open space planning should investigate the communities population to understand demographic and socio-economic trends of the residents and open space users. A plan should identify play space opportunities for newly emerging sports and other recreational activities. Public input on existing open space successes as well as failures is valuable knowledge during the planning process.

# OPEN SPACE

## PLANNING PROCESS BMP



Open Space Adjacent to Wetlands and Recreational Trails



Open Space Incorporating Recreational Water Front Activities



Open Space Re-Establishment

### ADDITIONAL BENEFITS

- Provides greenspace for local residents to enjoy.
- Provides open space to effectively plan for and treat stormwater runoff.
- Improves enhanced aesthetics as well as social, cultural, and environmental resources for the local community.

### DESIGN CONSIDERATIONS

- Open space planning should involve public input whenever possible to encourage involvement in the process, which will lead to a sense of ownership and pride in the community.
- Open space should focus on providing enhanced environmental functions as well as recreational uses.
- Existing conditions such as land uses, soil type, and slopes should be assessed to determine open space requirements as well as uses.

### OPERATIONS AND MAINTENANCE

The operations and maintenance requirements for any open space will require ongoing efforts not only for maintenance, but also programming in order to continually enhance the functionality of the intended purpose. This will require coordination efforts between numerous community groups, agencies, and departments to help manage and maintain open space lands.



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# RIPARIAN BUFFER

## PLANNING PROCESS BMP

Vegetated area next to a stream or wetland that protects water resources from pollution / sediment, bank failure, and provides aquatic and wildlife habitat.

- Lowland Buffer Zone 1
- Upland Buffer Zone 2
- Woodland Buffer Zone 3
- Stream / River 4
- Recreational Opportunities 5



### SCALE

- Watershed / County
- Town / Village
- Neighborhood
- Lot

### APPLICATION

- Retrofit       New
- Preventative    Remedial
- Parking Lots    Streets
- Driveways       Roofs
- Lawns             Sensitive Areas

### EFFECTIVENESS

- Runoff Rate Control
- Runoff Volume Control
- Habitat Preservation / Restoration
- Sediment Control
- Nutrient Control
- BOD / COD Control
- Other Pollutant Control

- High
- ◐ Moderate
- Low

### DESCRIPTION

A riparian buffer is a vegetated area next to a stream or wetland that protects water resources from pollution, stabilizes the stream bank, and provides aquatic and wildlife habitat.

Properly designed riparian buffers protect stream water quality by naturally intercepting and filtering pollution from runoff. Streams that are protected by well-established riparian buffers tend to be more resistant to negative impacts from erosion, flooding, and pollution from nutrients, sediment, organic matter, pesticides and other harmful substances.

Riparian buffers can also improve the health of animals and fish that live in or near the stream by providing food, shelter and clean water. Riparian buffers are not public access ways to private property

In developed areas, even narrow bands of vegetation can make significant improvements in water quality, habitat, and the environmental health of a stream. Urban buffers are especially effective when coupled with pollution and flooding control technologies. Additionally riparian buffers bring a natural character to developed settings, improving the quality of life and scenic nature in an urban setting.

# RIPARIAN BUFFER

## PLANNING PROCESS BMP



Agricultural Riparian Buffer



Agricultural Drainage Without a Riparian Buffer



Riparian Buffer in a Park Setting

### ADDITIONAL BENEFITS

Riparian buffers provide more than just stormwater management.

- Enhances the aesthetics of the local landscape
- Provides habitat for wildlife
- Buffers reduce stream bank erosion, which helps keep valuable acreage from washing away.

### DESIGN CONSIDERATIONS

- Riparian buffer width should be dependent on stream or wetland quality, ground slope, and quality of feature.
- Buffer should be planted with native riparian vegetation.
- Buffers are often established and protected through municipal ordinances.

### OPERATIONS AND MAINTENANCE

The maintenance requirements for riparian buffers are minimal. The buffers just need to be inspected periodically to remove litter and invasive species. Sparse areas may also need to be reseeded or replanted as necessary.



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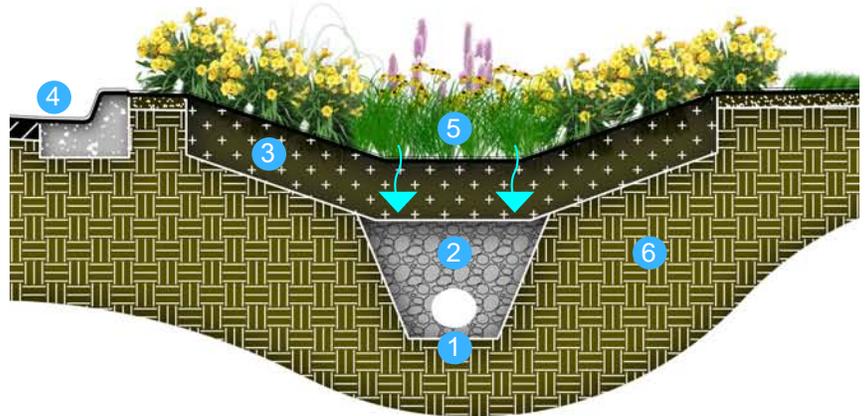
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# BIOSWALE

## STORMWATER BMP

Filtration and infiltration systems planted with grass, shrubs, and wetland plants designed to filter, retain, evapotranspire, and infiltrate stormwater.

- Perforated Underdrain set in gravel 1
- Infiltration Trench 2
- Engineered Soil 3
- Impervious Drainage Area 4
- Wet and Dry Tolerant Vegetation 5
- Native Soils 6



### SCALE

- Watershed / County
- Town / Village
- Neighborhood
- Lot

### APPLICATION

- Retrofit  New
- Preventative  Remedial
- Parking Lots  Streets
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### EFFECTIVENESS

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- Other Pollutant Control

- High
- Moderate
- Low

### DESCRIPTION

Bioswales are stormwater treatment systems that provide an alternative to traditional curb-and-gutter and storm sewers. Bioswales are broad, vegetated channels that reduce the rate and volume of runoff from a site. They are commonly planted with wet-tolerant species and will remain wet for a few days following a storm.

Bioswales differ from traditional vegetated swales in that the bioswales are primarily used for storage of stormwater while a vegetated swale is utilized for conveying water. In order to increase the storage capacity of the bioswale, the bioswale can be constructed with an underdrain and infiltration trench comprised of engineered soil and gravel, while a traditional vegetated swale is constructed on native soils. The infiltration trench provides additional stormwater storage and facilitates infiltration of water into the surrounding soils and groundwater. Once the storage capacity of the infiltration trench has been reached, the underdrain will convey the water into the storm sewer system.

The bioswales remove suspended solids through settling and filtration. Dissolved pollutants such as nutrients and metals are removed and/or transformed as runoff infiltrates into the soil. Based on published pollutant removal efficiencies, bioswales can remove approximately 100% of the total phosphorous, 94% of total suspended solids, and 83% of biochemical oxygen demand (the degree of organic pollution in water leading to the depletion of oxygen).

# BIOSWALE

## STORMWATER BMP



Bioswale adjacent to a Parking Lot



Terraced Bioswale



Bioswale Under Construction

### ADDITIONAL BENEFITS

Bioswales provide more than just stormwater management.

- Enhances the aesthetics of the local landscape.
- Provides habitat for wildlife.
- Can be used for snow storage during winter months.

### DESIGN CONSIDERATIONS

- Bioswales must be sized and designed to account for drainage area and soils.
- Infiltration storage should be designed to drain in 24-72 hours.
- Filtration benefits can be improved by planting native deep-rooted vegetation.
- Salt tolerant species should be used if the swale is to receive runoff from parking lots and roads.
- Topsoil should be amended with compost and/or sand as a means of improving organic content for enhanced filtering and to achieve adequate infiltration.

### OPERATIONS AND MAINTENANCE

The maintenance requirements for bioswales are minimal. The bioswales should be inspected periodically to remove litter and blockages. Sparse areas may need to be reseeded or replanted.



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# PERMEABLE PAVEMENT

## STORMWATER BMP

Paving materials designed to allow for the infiltration of rain and snowmelt consisting of highly porous paving surfaces as well as sub-base storage layers.

- Permeable Pavement 1
- Sub-base Gravel Storage 2
- Underdrain (if necessary) 3
- Overflow to Stormwater BMP 4



### SCALE

- Watershed / County
- Town / Village
- Neighborhood
- Lot

### APPLICATION

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- Preventative     Remedial
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### DESCRIPTION

Permeable pavements refer to paving materials that promote the absorption of rainfall and snowmelt. There are four main types of permeable pavements: porous concrete, porous asphalt, permeable grid pavers, and permeable pavers. See detailed descriptions of each paving system below.

**Porous Concrete:** Porous concrete looks very similar to regular concrete. Porous concrete typically consists of specialty formulated mixtures of Portland cement, coarse aggregate and water that has been manufactured to have gaps through which water can flow into an infiltration bed of uniformly graded gravel.

**Porous Asphalt:** Porous asphalt looks very similar to regular asphalt. Porous asphalt consists of coarse aggregate bonded together by asphalt cement with sufficient gaps through which water can flow into an infiltration bed of uniformly graded gravel.

**Permeable Grid Pavers:** Permeable grid pavers are modular plastic pavers that fit together with funnel-like openings installed over an infiltration bed of gravel. Depending on the site, grass or rock is used to fill in the funnel-like openings. Using plastic for the grids makes them very flexible and they can be used on uneven surfaces.

**Permeable Pavers:** Permeable pavers are modular concrete pavers that fit together with funnel-like openings installed over an infiltration bed of uniformly graded gravel. Depending on the site, grass or rock is used to fill in the funnel-like openings.

By infiltrating the majority of the stormwater that falls onto the permeable pavement, the amount of water and pollution flowing into storm sewers or directly into streams is greatly reduced.

# PERMEABLE PAVEMENT

## STORMWATER BMP



Permeable Paver Circulation Node



Permeable Paver Parking Lot



Porous Asphalt

### ADDITIONAL BENEFITS

Permeable pavement removes suspended solids through filtration. Dissolved pollutants such as nutrients and metals are removed and/or transformed as runoff infiltrates into the soil. Utilizing the Illinois EPA's Estimating Pollutant Load Reductions for Nonpoint Source Pollution Control BMPs worksheets, the permeable pavement can remove approximately 75% of the total phosphorous, 90% of total suspended solids, and 100% of lead and zinc.

Permeable pavement provides more than just stormwater management.

- Permeable pavements can be engineered to be just as stable as conventional methods and provide the same functionality of traditional concrete and asphalt.
- Reduces urban heat island effect and thermal impacts to waterbodies.
- Reduces development and maintenance costs.
- Provides paving options for site specific applications.

### DESIGN CONSIDERATIONS

- Site conditions such as adjacent land uses, soil type, and slopes should be assessed to determine if a permeable paving solution is appropriate.
- A pretreatment system of surface runoff is beneficial to maintain the functionality of the permeable paving system to avoid large sediment loads.
- In large storm events the surface flow will exceed storage capacity of the permeable system. Thus, a series of overflow systems will need to accommodate the influx of surface runoff such as rain gardens, bioswales or other applicable BMP's.
- The drainage area or local watershed will need to be determined in order to design for appropriate storage requirements.

### OPERATIONS AND MAINTENANCE

Permeable pavements should be inspected annually and after large storm events to assure the pavements are still fully functioning. Permeable pavements should be maintained with vacuum-type street sweeping equipment periodically to remove any accumulated sediment and leaves. Polymeric jointing sand, commonly used with traditional pavers, should never be used with permeable pavers as it will prevent infiltration.



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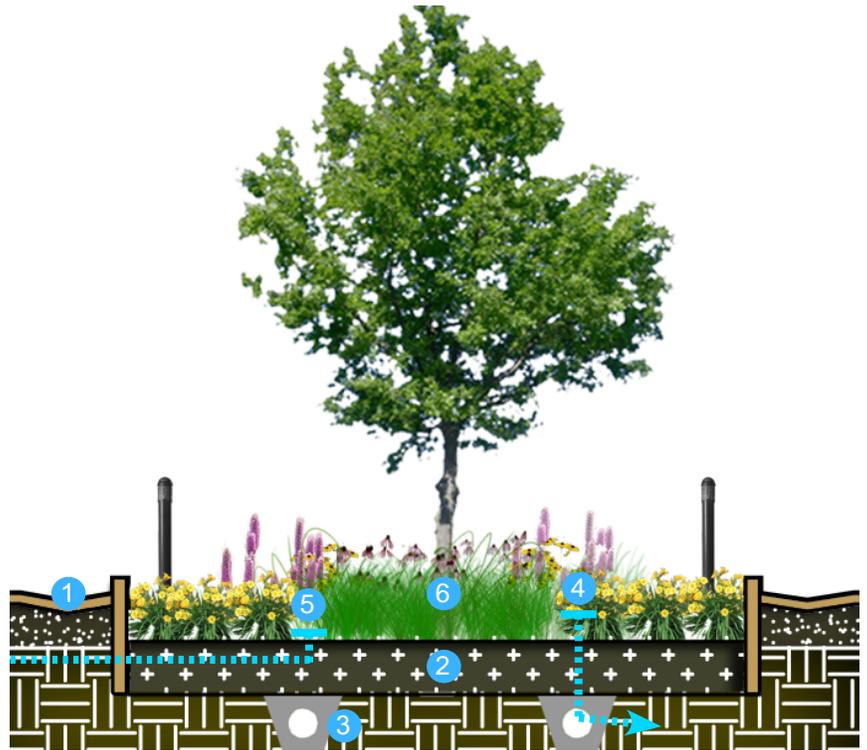
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# RAIN GARDEN

## STORMWATER BMP

Landscaped gardens designed to filter, retain, evapotranspire, and infiltrate stormwater from roofs, driveways, streets, or lots.

- Surface Area Runoff to BMP 1
- Engineered Soil 2
- Underdrain (if necessary) 3
- Overflow to Storm Sewer or BMP 4
- Stormwater Input 5
- Wet and Dry Tolerant Vegetation 6



### SCALE

- Watershed / County
- Town / Village
- Neighborhood
- Lot

### APPLICATION

- Retrofit  New
- Preventative  Remedial
- Parking Lots  Streets
- Driveways  Roofs
- Lawns  Sensitive Areas

### EFFECTIVENESS

- Runoff Rate Control
- Runoff Volume Control
- ◐ Habitat Preservation / Restoration
- Sediment Control
- ◐ Nutrient Control
- ◐ BOD / COD Control
- ◐ Other Pollutant Control

- High
- ◐ Moderate
- Low

### DESCRIPTION

Rain gardens are one of the many BMPs that can be implemented at home to reduce the impacts of stormwater in your watershed. Building a rain garden is one of the most simple and cost effective solutions to protect water quality on a local scale. The purpose of a rain garden is to store and promote the infiltration of rainfall into the groundwater. Without rain gardens, the majority of the rain that falls onto impervious surfaces around your home such as driveways, sidewalks, streets, alleys, and roofs will flow directly into the sewer system or nearby lakes and streams.

When properly constructed a rain garden will reduce the amount of runoff from your property. In addition, the plants in the rain garden will also reduce the amount of pollutants in stormwater runoff. Suspended sediments and attached pollutants such as phosphorus and metals are settled out of the stormwater and captured in the depression. Dissolved pollutants such as nitrogen and organic matter are filtered out and/or transformed by the vegetation as the runoff infiltrates into the underlying soils.

General guidelines and recommendations are listed below:

#### Recommended Plant Species:

- Black-eyed Susan
- Butterfly Weed
- Golden Alexander
- Obedient Plant
- Purple Coneflower
- Spiderwort
- Wild Columbine
- Wild Geranium

#### Considerations:

- Make sure to have utilities marked before digging.
- Avoid building a rain garden over or near septic fields or building foundations
- Plants should be tolerant to both wet and dry conditions.
- Use of fertilizer and pesticides is typically unnecessary.

# RAIN GARDEN

## STORMWATER BMP



Urban Streetscape Rain Garden

### ADDITIONAL BENEFITS

Rain gardens are essentially bioretention systems that provide numerous benefits to a local watershed.

- Wide range of scales and applicability.
- Filters silt, pollutants and debris.
- Reduces peak-flow rates of stormwater from entering the sewer system and can help reduce the occurrences of combined sewer backups.
- Recharges groundwater.
- Provides habitat for birds and other wildlife.
- Provides an aesthetic amenity while performing essential stormwater management.



Curb-Side Rain Garden

### DESIGN CONSIDERATIONS

- Site conditions such as adjacent land uses, soil type, and slopes should be assessed to determine if a rain garden is an appropriate solution.
- Locate rain gardens a minimum of 10 feet from building foundations.
- Determine area of runoff that is directed to the rain garden and make sure it will not affect adjacent properties or land uses.
- Conduct an infiltration test to determine the rate at which water will permeate the soils. A rain garden should be fully drained within 24 hours after a storm event. This will help to determine the size and depth required.
- Rain gardens vary greatly in cost depending on size, shape, depth, plant material and setting (urban vs. residential).



Parking Lot Rain Garden

### OPERATIONS AND MAINTENANCE

Just like any garden, your rain garden needs to be properly maintained in order for it to function properly. After your garden is first built, the plants will need to be watered through the first growing season. After the first season you will only need to water the rain garden during drought conditions. Any debris that may alter the drainage or overflow during large storm events need to be addressed so flooding does not occur.



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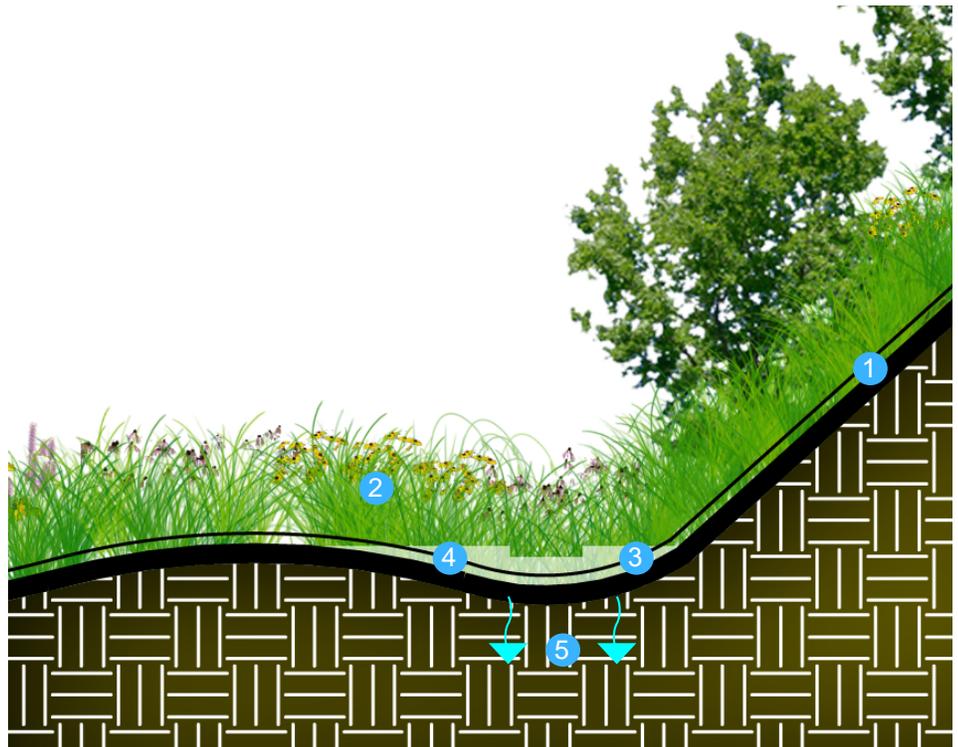
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# VEGETATED SWALE

## STORMWATER BMP

Common stormwater treatment system used to convey and treat stormwater runoff often planted with native vegetation.

- Stormwater Runoff to BMP 1
- Native Vegetation 2
- Check Dams (slopes over 5%) 3
- 3:1 Maximum Channel Slope 4
- Native Soils 5



### SCALE

- Watershed / County
- Town / Village
- Neighborhood
- Lot

### APPLICATION

- |  |  |
|--|--|
| <input checked="" type="checkbox"/> Retrofit     | <input checked="" type="checkbox"/> New      |
| <input checked="" type="checkbox"/> Preventative | <input checked="" type="checkbox"/> Remedial |
| <input checked="" type="checkbox"/> Parking Lots | <input checked="" type="checkbox"/> Streets  |
| <input checked="" type="checkbox"/> Driveways    | <input checked="" type="checkbox"/> Roofs    |
| <input checked="" type="checkbox"/> Lawns        | <input type="checkbox"/> Sensitive Areas     |

### EFFECTIVENESS

- Runoff Rate Control
- Runoff Volume Control
- Habitat Preservation / Restoration
- Sediment Control
- Nutrient Control
- BOD / COD Control
- Other Pollutant Control

- High
- Moderate
- Low

### DESCRIPTION

A vegetated swale is a common stormwater treatment system that is used to convey and treat stormwater runoff by acting as a buffer between impervious areas such as roads, parking lots, and driveways or areas where stormwater runoff may exponentially accumulate. While a roadside ditch is technically a vegetated swale, these are typically referred to as 'grassed swales'. The term vegetated swale most typically refers to swales that are densely vegetated. Vegetated swales function best when constructed with gentle slopes to minimize flow velocities and maximize opportunities for the absorption of runoff and filtering of pollutants.

Vegetated swales will improve the water quality of stormwater by slowing runoff speed, trapping sediment and other pollutants, and providing some absorption. Choosing to plant swales with native vegetation is more effective in managing runoff than if it was planted with short turf grass.

Vegetated swales removes suspended solids through settling and filtration. Dissolved pollutants such as nutrients and metals are removed and/or transformed as runoff infiltrates into the soil. Based on published pollutant removal efficiencies, vegetated swales can remove approximately 20% of the total phosphorous, 65% of total suspended solids, and 50-71% of metals.

# VEGETATED SWALE

## STORMWATER BMP



Vegetated Swale in Open Space



Terraced Vegetated Swale



Terraced Vegetated Swale

### ADDITIONAL BENEFITS

Vegetated Swales provide more than just stormwater management.

- Enhances the aesthetics of the local landscape.
- Provides habitat for wildlife.
- Can be used for snow storage during winter months.
- Low maintenance requirements.

### DESIGN CONSIDERATIONS

- Vegetated swales must be sized to convey design runoff rate.
- Filtration benefits can be improved by planting native deep-rooted vegetation.
- Salt tolerant species should be used if adjacent to a road or parking lot.
- Topsoil should be amended with compost and/or sand as a means of improving organic content for filtering and to achieve adequate infiltration.

### OPERATIONS AND MAINTENANCE

The maintenance requirements for vegetated swales are minimal. The swales need to be inspected periodically to remove litter and blockages. Sparsely vegetated areas should be reseeded or replanted to avoid erosion issues.



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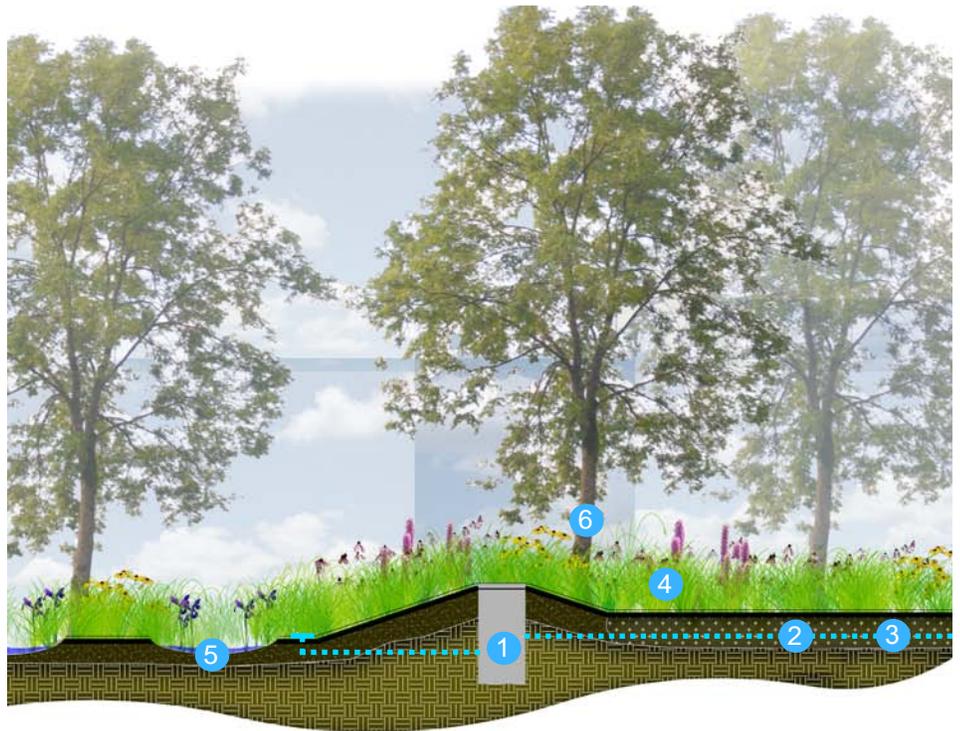
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# BIOINFILTRATION BASIN

## STORMWATER BMP

Shallow, vegetated depressions designed to capture, hold, and infiltrate stormwater runoff to reduce peak flow rates.

- Water Control Structure 1
- Underdrain 2
- Engineered Soil 3
- Native Vegetation 4
- Restored Wetland 5
- Stormwater Trees 6



### SCALE

- Watershed / County
- Town / Village
- Neighborhood
- Lot

### APPLICATION

- |  |  |
|--|--|
| <input checked="" type="checkbox"/> Retrofit     | <input checked="" type="checkbox"/> New      |
| <input checked="" type="checkbox"/> Preventative | <input checked="" type="checkbox"/> Remedial |
| <input checked="" type="checkbox"/> Parking Lots | <input checked="" type="checkbox"/> Streets  |
| <input checked="" type="checkbox"/> Driveways    | <input type="checkbox"/> Roofs               |
| <input type="checkbox"/> Lawns                   | <input type="checkbox"/> Sensitive Areas     |

### EFFECTIVENESS

- Runoff Rate Control
- Runoff Volume Control
- Habitat Preservation / Restoration
- Sediment Control
- Nutrient Control
- BOD / COD Control
- Other Pollutant Control

- High
- Moderate
- Low

### DESCRIPTION

Bioinfiltration basins are shallow, vegetated depressions designed to capture and hold a volume of stormwater runoff and allow it to infiltrate into the underlying soils over several days. The design of bioinfiltration basins is simple and they are used as an “end of pipe” method to catch stormwater from swales or storm sewer systems. Bioinfiltration basins allow the stormwater to infiltrate into the soil and recharge groundwater rather than discharging directly into sewers and rivers.

Bioinfiltration basins are very effective at removing pollutants and reducing the volume of runoff from impervious surfaces such as parking lots. Utilizing the Illinois Environmental Protection Agency’s Estimating Pollutant Load Reductions for Nonpoint Source Pollution Control Best Management Practices (BMPs) worksheets, bioinfiltration basins will remove approximately 65% of the total phosphorous, 60% of the total nitrogen, 75% of total suspended solids, and 65% of metals.

# BIOINFILTRATION BASIN

## STORMWATER BMP



Bioinfiltration Basin in a Neighborhood Setting



Bioinfiltration Collecting Runoff from a Parking Lot



Bioinfiltration in a Park Setting

### ADDITIONAL BENEFITS

Bioinfiltration basins provide much more than just stormwater management.

- Enhances the aesthetics of the local landscape.
- Provides habitat for wildlife.
- Provides open space.

### DESIGN CONSIDERATIONS

- Bioinfiltration basins must be sized and designed to account for drainage area and soils.
- Infiltration storage should be designed to drain in 24-72 hours.
- Filtration benefits can be improved by planting native-deep rooted vegetation.
- Topsoil should be amended with compost and / or sand as a means of improving organic content for filtering and to achieve adequate infiltration.

### OPERATIONS AND MAINTENANCE

The maintenance on bioinfiltration basins include the periodic inspection and cleaning in order to ensure that the system is operating properly. The system should be inspected for clogging of the discharge pipe and sediment accumulation on the basin surface. If a clog is found, rehabilitative maintenance should be conducted immediately to restore its proper operation. In addition, to preventing and repairing clogs, management of the vegetation including mowing, weeding, and replanting sparse areas should also be conducted.



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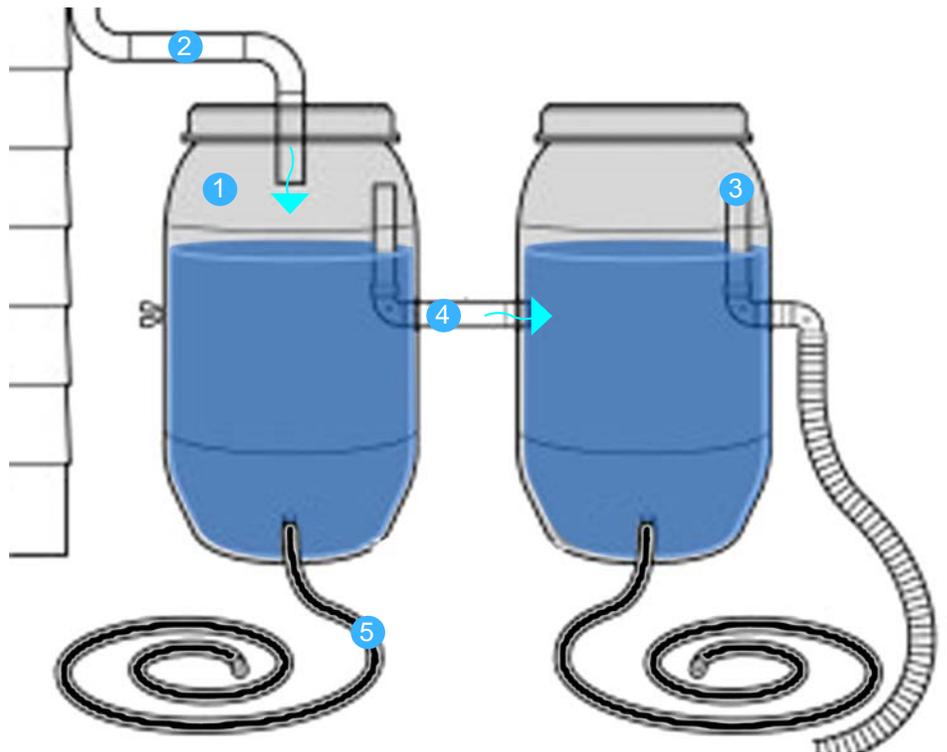
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# RAIN BARRELS

## STORMWATER BMP

Temporary storage for stormwater used to irrigate landscape and garden plants while helping to minimize peak flow rates.

- Rain Barrel 1
- Downspout Disconnection 2
- Overflow to Rain Garden 3
- Rain Barrel Link Pipe 4
- Garden Hose 5



### SCALE

- Watershed / County
- Town / Village
- Neighborhood
- Lot

### APPLICATION

- Retrofit       New
- Preventative     Remedial
- Parking Lots     Streets
- Driveways       Roofs
- Lawns           Sensitive Areas

### EFFECTIVENESS

- Runoff Rate Control
- Runoff Volume Control
- Habitat Preservation / Restoration
- Sediment Control
- Nutrient Control
- BOD / COD Control
- Other Pollutant Control

- High
- Moderate
- Low

### DESCRIPTION

In many urban locations roof runoff is routed directly into the sewer system or adjacent areas that are designed to carry the flow away as swiftly as possible. By installing a rain barrel, it is possible to disconnect these downspouts from the sewer system or capture the runoff that would otherwise be lost and save the rain water for other uses. A rain barrel is a temporary storage system for stormwater. The water captured by the barrel can then be used to irrigate your lawn, flower beds and garden or wash your car. By using a rain barrel you will save money and water by utilizing an ample supply of free 'soft water'.

### How do I design a Rain Barrel for my home?

Rain barrels are designed to accumulate and store runoff from small to moderate storms. A rain barrel is composed of a large drum, hose, pipe and hose couplings, a screen grate and other off the shelf items. Rain barrels can be purchased from garden supply stores or they can be easily built with supplies purchased from a hardware store. Information on where to purchase a rain barrel or assembling one yourself can easily be found online.

The first step in installing a rain barrel at your home is to decide where to place the rain barrel. Many people place their rain barrels near an existing downspout as it simplifies installation. But also be sure you consider how far the location of the barrel is from your plants, gardens, and flowerbeds. You want to be sure you can easily utilize the water that is captured in the rain barrel.

# RAIN BARRELS

## STORMWATER BMP



Three Tiered Rain Barrel System

Once you have selected the location for your rain barrel, make sure the area is level and free from any rocks, roots, or debris that would cause your barrel to rock from side to side. Also be sure to rake the area in order to remove any leaves that could cause the ground to be soft and unsecure. It is also recommended that prior to placing your rain barrel in its selected location, construct a platform out of cinder blocks, wood, or flat landscape/paver type stones. Raising your rain barrel a few inches off the ground will give you more water pressure when using a hose and make it easier for you to reach the faucet or fill a watering can.

Now that your platform is constructed, place the rain barrel in its location and measure where you need to cut or disassemble your downspout. Often times you can disassemble the downspout at the gutter by removing the bolts or rivets. Replace the portion of the metal downspout removed with a flexible downspout extender. Once securely attached to the gutter, place the downspout extender in the barrel.



Rain Barrel Inlet Filter

### COSTS

Rain barrels vary in cost based on size, material and expected lifetime. You can expect to pay between \$40 and \$150. Purchasing materials and assembling your own rain barrel instead of buying an already assembled rain barrel can reduce this cost.

### OPERATIONS AND MAINTENANCE

There are several easy ways to routinely maintain your rain barrel in order to ensure its usefulness for a long period of time. Your barrel should be covered in the warm months to prevent mosquito breeding and should be drained before winter to prevent freezing that could crack the barrel. A mesh filter at the top of the rain barrel will not only prevent insect entry but will also capture debris such as leaves or twigs.



Recycled Oak Rain Barrel



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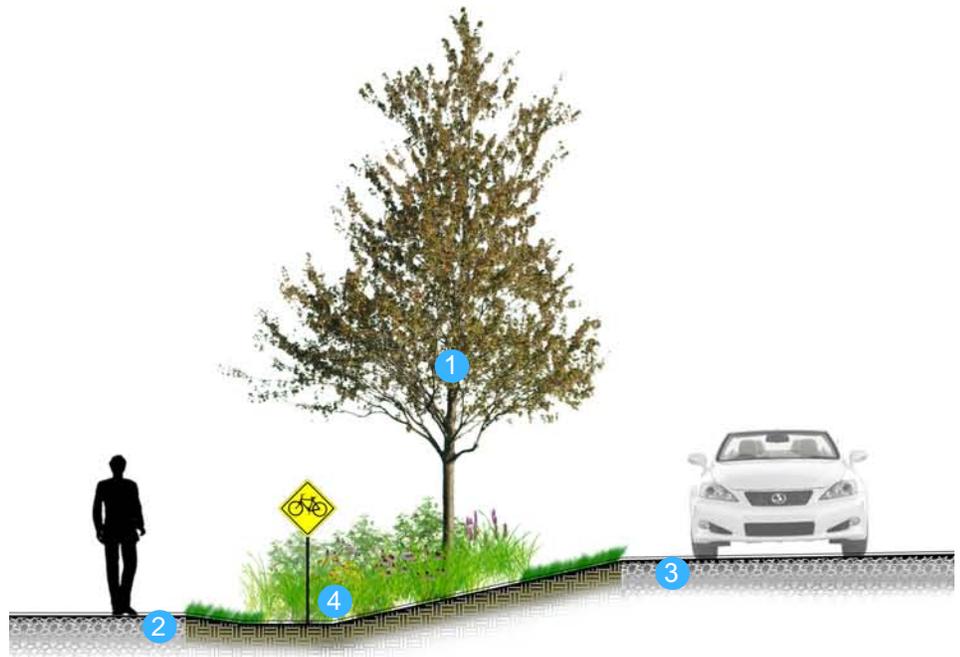
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# STORMWATER TREES

## STORMWATER BMP

Trees help to manage stormwater runoff above the ground surface, at the ground surface, and below the ground surface.

- Stormwater Tree 1
- Shared-Use Path 2
- Road / Parking Lot 3
- Vegetated Swale 4



### SCALE

- Watershed / County
- Town / Village
- Neighborhood
- Lot

### APPLICATION

- |  |  |
|--|--|
| <input checked="" type="checkbox"/> Retrofit     | <input checked="" type="checkbox"/> New      |
| <input checked="" type="checkbox"/> Preventative | <input checked="" type="checkbox"/> Remedial |
| <input checked="" type="checkbox"/> Parking Lots | <input checked="" type="checkbox"/> Streets  |
| <input checked="" type="checkbox"/> Driveways    | <input type="checkbox"/> Roofs               |
| <input checked="" type="checkbox"/> Lawns        | <input type="checkbox"/> Sensitive Areas     |

### EFFECTIVENESS

- Runoff Rate Control
- Runoff Volume Control
- Habitat Preservation / Restoration
- Sediment Control
- Nutrient Control
- BOD / COD Control
- Other Pollutant Control

- High
- Moderate
- Low

### DESCRIPTION

Trees are one of the simplest and most cost effective ways of reducing stormwater runoff from impervious areas such as parking lots, roads, and buildings. Trees have an effect on stormwater above the ground surface, at the ground surface, and below the ground surface.

Above the ground surface, rain is first caught on the trees' leaves, branches, and trunk slowing the movement of the stormwater. A portion of this rainfall is evaporated from the foliage and released back into the atmosphere as vapor. In addition to being evaporated, some of the rainfall caught by the trees is absorbed into the trees' leaves and stems where it is used to sustain health.

Rainfall that makes its way through the tree canopy to the ground surface is absorbed by leaf litter and other organic material commonly located underneath trees, which temporarily reduces peak stormwater runoff rates. In addition, roots and trunks of mature trees create hollows and hummocks on the surface that provides for temporary water storage and ponding.

A small portion of the ponded water is evaporated from the surface while the majority is infiltrated into the soil. The presence of organic matter from leaf litter and other tree detritus and macropores, which are large interconnected pores in the soil created by roots, increases the infiltration rate and the moisture holding capacity of the soils. Once below ground, the stormwater can be taken up by the trees through their roots or percolated into the groundwater. The roots of the trees also act as natural pollution filters removing nitrogen, phosphorous, and potassium from the stormwater before it is able to percolate into groundwater.

# STORMWATER TREES

## STORMWATER BMP



Trees Planted in a Streetscape Designed to Manage Stormwater



Trees Planted in a Detention Area



Trees Planted in an Urban Plaza

### ADDITIONAL BENEFITS

Trees provide more than just stormwater management.

- Reduces air pollution.
- Provides shade.
- Lowers energy costs if planted to proper locations.
- Prevents soil erosion.
- Reduces noise pollution.
- Enhances aesthetics and increases property values.

### OPERATIONS AND MAINTENANCE

Maintenance needs for trees planted for stormwater management is the same for all other trees. Basic tree care should be performed regularly to ensure healthy trees and minimize the risk of damage to people and property.



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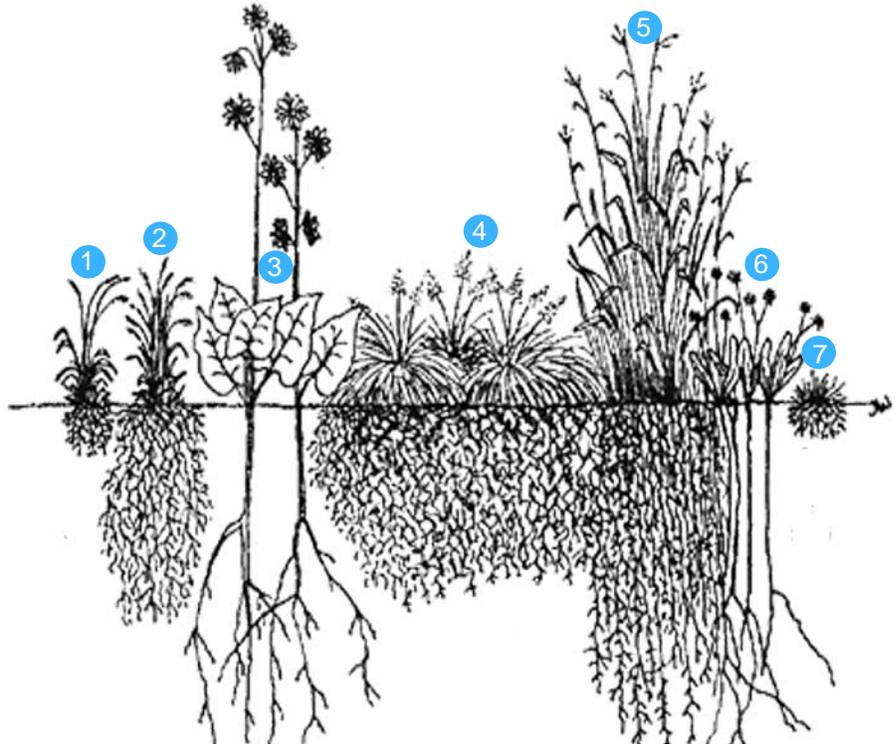
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# NATIVE VEGETATION

## LANDSCAPE BMP

Vegetation historically adapted to a specific geographical region to encourage a healthy and diverse ecosystem.

- Smooth Brome (non-native) 1
- Little Bluestem 2
- Prairie Dock 3
- Prairie Dropseed 4
- Big Bluestem 5
- Pale Purple Coneflower 6
- Kentucky Bluegrass (non-native) 7



### SCALE

- Watershed / County
- Town / Village
- Neighborhood
- Lot

### APPLICATION

- Retrofit  New
- Preventative  Remedial
- Parking Lots  Streets
- Driveways  Roofs
- Lawns  Sensitive Areas

### EFFECTIVENESS

- Runoff Rate Control
- Runoff Volume Control
- Habitat Preservation / Restoration
- Sediment Control
- Nutrient Control
- BOD / COD Control
- Other Pollutant Control

- High
- Moderate
- Low

### DESCRIPTION

Native vegetation uses plants endemic to a specific geographical region prior to settlement for a variety of purposes including habitat improvement and increasing stormwater infiltration and water quality treatment.

Using vegetation native to a geographical region will encourage a healthy ecosystem which will require less on-going maintenance once established and ultimately be more adaptive to local weather patterns.

When planning a landscape that will incorporate native vegetation it is important to understand the local surroundings of the site. Application of plant material will be different in a urban setting versus a naturalized setting such as a forest preserve. In an urban setting the planting environment is often a very controlled site that must handle rapid water fluctuations, road pollution, visual sight lines, and engineered soils. In a more natural setting the plant application will need to be designed on a broader scale taking the overall watershed and hydrology into account.

# NATIVE VEGETATION

## LANDSCAPE BMP



Native Landscaping in a Park Setting



Native Wetland Vegetation



Controlled Prairie Burn

### ADDITIONAL BENEFITS

- Reduces heating and cooling energy costs if applied appropriately.
- Requires less maintenance than ornamental landscapes once established.
- Reduces urban heat island effect.
- Provides habitat for wildlife.
- Relatively low cost on a per acre basis.

### DESIGN CONSIDERATIONS

- When planting native vegetation a site must be designed in a way to closely reflect the natural conditions that the plant species thrive.
- Hydrology is a key component to understand when planning a native restoration project. It will drive the success or failure of native plant communities.
- In residential settings native landscaping is a preference, but can reduce the amount of ornamental invasive species that get planted.

### OPERATIONS AND MAINTENANCE

The maintenance requirements for native vegetation will require a long-term maintenance plan in order to achieve desired results, but will depend on the size and scope of the planting.

Large scale planting efforts such as a prairie or large wetland will require a multi-year establishment period of on-going maintenance. Once established maintenance activities can be scaled back, but will still need to be programmed for periodic maintenance, which will include herbicide treatments.

Smaller scale, more urban or residential applications will require the same amount of maintenance a traditional landscape requires. Due to the controlled environment of these areas native plants can't be expected to thrive naturally or without any assistance.



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# SOIL AMENDMENTS

## LANDSCAPE BMP

Improves the soil structure to increase water absorption and benefit the health of plant material.

- Turf Aeration 1
- Engineered Soil in a Bioswale 2
- Compost Added to Planting Beds 3



### SCALE

- Watershed / County
- Town / Village
- Neighborhood
- Lot

### APPLICATION

- |  |   |
|--|---|
| <input checked="" type="checkbox"/> Retrofit     | <input checked="" type="checkbox"/> New             |
| <input checked="" type="checkbox"/> Preventative | <input checked="" type="checkbox"/> Remedial        |
| <input checked="" type="checkbox"/> Parking Lots | <input type="checkbox"/> Streets                    |
| <input type="checkbox"/> Driveways               | <input checked="" type="checkbox"/> Roofs           |
| <input checked="" type="checkbox"/> Lawns        | <input checked="" type="checkbox"/> Sensitive Areas |

### EFFECTIVENESS

- Runoff Rate Control
- Runoff Volume Control
- Habitat Preservation / Restoration
- Sediment Control
- Nutrient Control
- BOD / COD Control
- Other Pollutant Control

- High
- Moderate
- Low

### DESCRIPTION

The most common use of soil amendments is to improve the overall soil structure. Soils tend to become compacted over time, which impedes root growth and decreases the ability of plants to take up nutrients and water. Soil amendments add texture and beneficial nutrients to increase the breakdown of organic material and allow for more pore space for water to be stored.

Adding organic materials to the soil composition can result in increased soil moisture for longer periods, stimulate additional microbiological activity, increase nutrient levels and improve plant survival rates. The addition of organic material can greatly improve the water retention abilities of sandy soils and they can be added to adjust the pH of the soil to meet the needs of specific plants or to make highly acidic or alkaline soils more usable.

Soil amendments may be applied in a number of ways. Some are worked into the soil with a tiller before planting. Others are applied after planting, or periodically during the growing season. Soil testing should be performed prior to applying soil amendments to learn more about the composition and structure of the soil. The testing will determine what the current soil is lacking and which supplements to add.

A wide variety of materials are available to improve soil quality. Some examples include: biochar, bone meal, peat, coffee grounds, compost, coir, manure, straw, vermiculite, sulfur, lime, blood meal, compost tea, hydroabsorbant polymers and sphagnum moss. Aerating compacted soil is a temporary solution to increase the health and absorption rates of soils.

# SOIL AMENDMENTS

## LANDSCAPE BMP



Compost



Lawn Aeration



Engineered Soil in a Rain Garden

### ADDITIONAL BENEFITS

Soil amendments provide more than just stormwater management.

- Enhances the growth of vegetation.
- Relatively low-cost benefit.

### DESIGN CONSIDERATIONS

- Soil testing should be done before adding supplements to determine what exactly is needed to improve the soil structure.
- The purpose of amending the soil needs to be kept in mind. Drainage, water retention, and plant health all contribute to mixing ratios.
- If the area being amended is going to be an active use area for recreational activities, absorption and the ability for evaporation need to be considered.

### OPERATIONS AND MAINTENANCE

The maintenance requirements for amended soils is minimal. Once the soil is amended there is not much more maintenance needed. Monitoring of the plant material is necessary to determine if the soil needs to be amended further.



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# STREAMBANK STABILIZATION

## LANDSCAPE BMP

Includes the use of bioengineering techniques to address streambank erosion and protect private property, roadways, and utilities from damage.

Live Vegetation Stakes 1

Cobbles 2



### SCALE

- Watershed / County
- Town / Village
- Neighborhood
- Lot

### APPLICATION

- Retrofit  New
- Preventative  Remedial
- Parking Lots  Streets
- Driveways  Roofs
- Lawns  Sensitive Areas

### EFFECTIVENESS

- Runoff Rate Control
- Runoff Volume Control
- Habitat Preservation / Restoration
- Sediment Control
- Nutrient Control
- BOD / COD Control
- Other Pollutant Control

- High
- Moderate
- Low

### DESCRIPTION

Streambank erosion can be a dangerous and costly problem, especially after large rainfalls or floods. Excess runoff from urbanized areas, and wave action along lakeshores continually erode soil. Erosion can be severe depending on the surrounding watershed and hydrology. Traditional methods of controlling streamflow erosion have relied on structural practices like rip rap, retaining walls, and sheet piles. In some cases, these methods are expensive, ineffective, or unappealing. Structural practices can be combined with plant material to stabilize a streambank in a more appealing and also permanent manner.

An alternative approach is bioengineering, a method of construction using live plants alone or combined with dead or inorganic materials, to produce living, functioning systems to prevent erosion, control sediment, and provide habitat.

Bioengineering uses combinations of structural practices and live vegetation to provide erosion protection for hillslopes, streambanks, and lakeshores. Bioengineering is a diverse and multidisciplinary field, requiring the knowledge of engineers, botanists, horticulturists, hydrologists, soil scientists, and construction contractors.

# STREAMBANK STABILIZATION

## LANDSCAPE BMP



Vegetated Bank Stabilization



Rip-Rap Bank Stabilization



Gabion Bank Stabilization

### ADDITIONAL BENEFITS

Stabilizing streambanks provide more than just stormwater management.

- Prevents the loss of land or damage to utilities, roads, buildings or other facilities adjacent to a watercourse, and prevent the loss of stream bank vegetation.
- Reduces sediment loads to streams.
- Maintains the capacity of the stream channel.
- Improves the stream for recreational use or as habitat for fish and wildlife.
- Controls unwanted meander of a river or stream.

### DESIGN CONSIDERATIONS

- If the banks are eroding due to a natural meander, then it may be best to leave the bank alone. If the banks are eroding due to fluctuations in hydrology, the hydrologic fluctuations should be addressed before the banks are stabilized.
- Determine the goal in stabilizing the stream banks. Some banks are stabilized to protect buildings and land. Others are stabilized to reduce sediment loads into nearby water bodies.
- The purpose for stabilizing the banks and the users of the stream will help determine the type of structures needed.
- Studying the entire watershed will help prioritize bank stabilization efforts.

### OPERATIONS AND MAINTENANCE

A maintenance plan should be prepared by a qualified engineering firm and indicate when inspections of the site will be made and who will be responsible for needed maintenance. Site inspections, conducted to ensure the stream bank structures are staying intact, are particularly important within the first few months of installation and following storm events.



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# STREAM / WETLAND MANAGEMENT & RESTORATION

## LANDSCAPE BMP

Landscape restoration practices designed to maintain existing remnant landscapes and restore streams and wetlands to their natural state.

- Wetland 1
- Upland 2
- Woodland 3
- Stream / River 4
- Recreational Opportunities 5



### SCALE

- Watershed / County
- Town / Village
- Neighborhood
- Lot

### APPLICATION

- Retrofit  New
- Preventative  Remedial
- Parking Lots  Streets
- Driveways  Roofs
- Lawns  Sensitive Areas

### EFFECTIVENESS

- Runoff Rate Control
- Runoff Volume Control
- Habitat Preservation / Restoration
- Sediment Control
- Nutrient Control
- BOD / COD Control
- Other Pollutant Control

- High
- Moderate
- Low

### DESCRIPTION

Stream and wetland restoration is an important component in helping to enhance a watershed's ecological and hydraulic functions. Historically wetlands have been drained and filled to accommodate expanding development and large scale agriculture. These areas typically retain their characteristic soils and hydrology, which allows for their natural state to be reclaimed.

Restoration is a multi-stage process that requires planning, implementation, monitoring, and management on a long-term basis to ensure the vitality and health of the ecosystem. By reclaiming these areas and restoring them back to wetlands it helps to enhance water quality and water quantity that is entering local streams and rivers. This has a profound effect on the local watershed as well as neighboring watersheds.

Developing a watershed plan is the first step in identifying areas that would benefit from restoring and managing stream corridors and wetlands.

# STREAM / WETLAND MANAGEMENT & RESTORATION

## LANDSCAPE BMP



Wetland Restoration



Wetland Restoration



Stream and Wetland Restoration

### ADDITIONAL BENEFITS

- Improves aquatic habitat for fish and other organisms.
- Increases channel stability and streambank protection.
- Riparian establishment.
- Stabilizes water control structures.
- Improves water quality.
- Provides educational and recreational opportunities.

### DESIGN CONSIDERATIONS

- Streams and wetlands need to have an existing conditions assessment performed in order to determine future steps to aid in restoration.
- Once the stream network and hydrology has been analyzed, site specific alterations and programming can be determined. This includes draitile re-routing, invasive species control, water control structures, and riparian buffer establishment.

### OPERATIONS AND MAINTENANCE

A long-term maintenance plan should be developed to ensure the health of the restored areas. Establishment of planting enhancements to promote biodiversity will need to be maintained on a regular basis. Continued programming of the restored site is essential as the surrounding environment and hydrology changes.



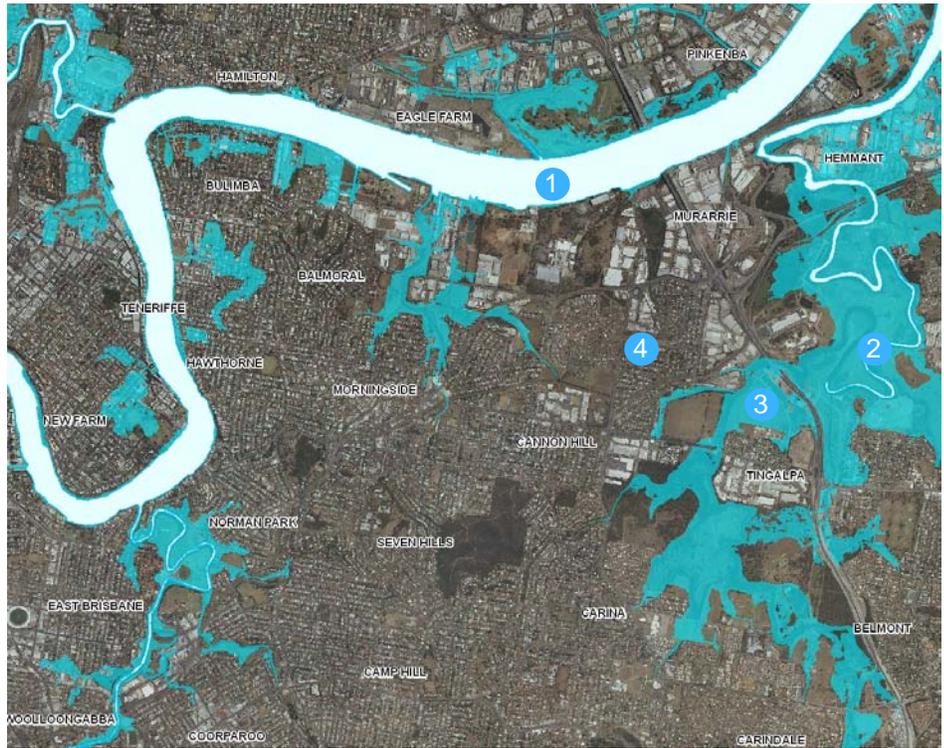
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# NON-STRUCTURAL FLOOD CONTROL FLOOD REDUCTION BMP

Includes floodproofing, acquisition and demolition of flood damaged buildings, and elevating or relocating buildings out of the floodplain.

- River 1
- Tributaries 2
- Floodplain Analysis 3
- Development 4



## SCALE

- Watershed / County
- Town / Village
- Neighborhood
- Lot

## APPLICATION

- Retrofit       New
- Preventative     Remedial
- Parking Lots     Streets
- Driveways       Roofs
- Lawns           Sensitive Areas

## EFFECTIVENESS

- Runoff Rate Control
- Runoff Volume Control
- Habitat Preservation / Restoration
- Sediment Control
- Nutrient Control
- BOD / COD Control
- Other Pollutant Control

- High
- Moderate
- Low

## DESCRIPTION

Non-structural flood control measures include floodproofing, acquisition and demolition of flood damaged building, and elevating or relocating buildings out of the floodplain. Non-structural measures include modifications in public policy, management practice, regulatory policy and pricing policy

### Reducing Hazardous Uses of Floodplains:

Limiting and directing the development that takes place in the floodplain is another approach to mitigating the impacts of a flood.

### Building Codes:

Building codes and construction codes regulate the materials used in construction, site preparation and construction method. Requiring water resistant materials like: metal doors; windows and jambs that do not warp when inundated and raising and protecting utilities are some examples of these measures.

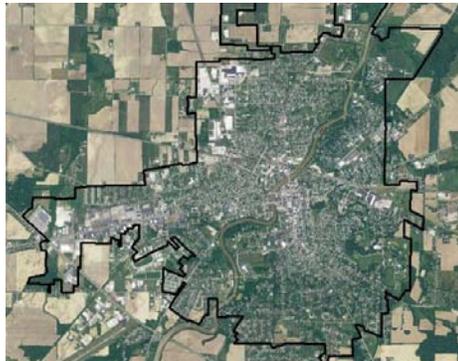
### Design and Location of Services and Utilities:

State and local governments can direct development to low risk areas. Discretion can be used in providing services that spur development. By carefully evaluating the extension of roads and utilities, the locations of schools, libraries, hospitals and the like, future development patterns can be influenced.

### Housing Codes:

Housing codes set minimum standards for the occupancy of residential units. Special standards can be specified for houses occupying flood prone areas. Housing codes affect existing houses whereas building codes affect future houses.

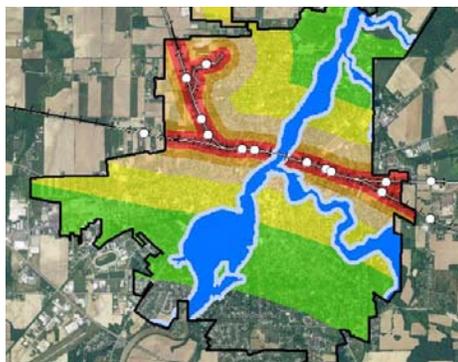
# NON-STRUCTURAL FLOOD CONTROL FLOOD REDUCTION BMP



GIS Analysis



Floodplain Analysis



Combined GIS Layer Analysis

## ADDITIONAL BENEFITS

### Public Acquisition:

Public acquisition is the purchase of floodplain lands, flow easements or development rights to reduce existing or limit future flood damages. Lands, particularly in the floodway, can be purchased to maintain the carrying capacity of existing floodplains.

### Relocation:

Relocation is the permanent removal of structures or other improvements from the floodplain, resituating them on alternative, flood free sites.

### Sanitary and Well Codes:

Sanitary and well codes establish minimum standards for and protect the water supply and wastewater collection systems from contamination and damage from floods.

### Subdivision Regulations:

Subdivision regulations guide the process by which large parcels of land are divided into smaller developable plots. They also control improvements such as roads, sewers, water and recreation areas. By requiring drainage, prohibiting encroachment on floodplains, requiring elevation of structures and locating streets and utilities in low risk areas damages can be minimized.

### Tax Adjustments:

State and local taxes can be used to discourage inappropriate uses of the floodplain and to encourage desirable uses.

### Urban Storm Drainage:

Urban storm drainage systems must be adequately designed, constructed and maintained to allow storm waters to drain from impermeable surfaces. Designing systems with room to grow to accommodate future development and increases in future storm flows can effectively reduce flood damages. Storm water detention and infiltration opportunities may also be provided as part of the system.

### Zoning Codes:

Zoning divides an area into specified areas for the purpose of regulating: (1) the type and use of structures and land, (2) the height and bulk of structures and (3) the size of lots and density of use. Floodways are designated so that any development permitted in the remainder of the floodplain will not result in a stage increase beyond a prescribed amount of a given frequency flood at a specific location.



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# STRUCTURAL FLOOD CONTROL FLOOD REDUCTION BMP

Engineered solutions designed to reduce the risk of flood damage in urbanized areas.

- Underdrained Detention Basin 1
- Stormsewer Outfalls 2
- Stormsewer Improvements 3
- Programmed Recreational Space 4



## SCALE

- Watershed / County
- Town / Village
- Neighborhood
- Lot

## APPLICATION

- Retrofit  New
- Preventative  Remedial
- Parking Lots  Streets
- Driveways  Roofs
- Lawns  Sensitive Areas

## EFFECTIVENESS

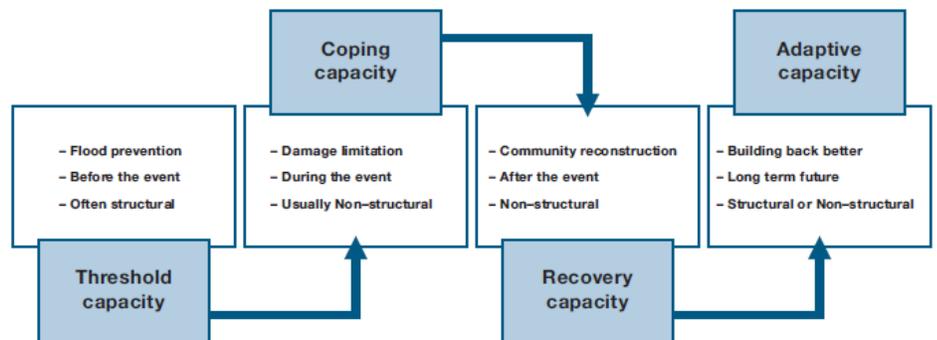
- Runoff Rate Control
- Runoff Volume Control
- Habitat Preservation / Restoration
- Sediment Control
- Nutrient Control
- BOD / COD Control
- Other Pollutant Control

- High
- Moderate
- Low

## DESCRIPTION

Structural flood control measures include reservoirs, levees, floodwalls, diversions, stream channel conveyance improvements, and stormsewer improvements. These measures are generally designed to reduce the risk of flood damage in urbanized areas. Structural flood control projects are frequently cost prohibitive for municipalities to implement without some type of assistance through cost sharing or grants.

Heavily-engineered structural measures can be highly effective when used appropriately, but they tend to transfer flood risk from one location only to increase it in another. In some circumstances this is an acceptable and appropriate approach to flood control, while in others it may not be. The best and most often used methods include an integrated approach combining both structural and non-structural methods.



Four Capacities Towards Increased Resilience (Cities and Flooding: A Guide to Integrated Urban Flood Risk Management for the 21st Century)

# STRUCTURAL FLOOD CONTROL FLOOD REDUCTION BMP



Water Control Structure



Spillway Outlet



Stormsewer Construction

## ADDITIONAL BENEFITS

- Provides protection to existing buildings located in floodplains including residential dwellings.
- Allows for the integration of bioengineering methods to be utilized for an integrated flood control approach.
- Reduces Combined Sewer Overflows from entering residential basements.
- Helps to reduce erosion along high velocity stream and river corridors.

## DESIGN CONSIDERATIONS

- Site conditions such as adjacent land uses, soil type, and slopes should be assessed to determine if a structural flood control solution is appropriate.
- A pretreatment system of surface runoff is beneficial to maintain the functionality of an engineered system to reduce peak low rates.
- In large storm events the surface flow can exceed capacity of the designed system. Thus, a series of overflow systems will need to accommodate the influx of surface runoff.
- The drainage area or local watershed will need to be determined in order to design for appropriate solutions.

## OPERATIONS AND MAINTENANCE

Flood control structures should be inspected annually and after large storm events to assure structures are still fully functioning. Log jams and other debris can often times cause issues along stream and river corridors. Storm Sewers will need routine maintenance to suck out sediment to prevent backups.



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