Physical Feasibility Factors

The physical characteristics of a site can dictate the feasibility of specific stormwater BMPs. A site's physical characteristics may restrict or preclude the use of certain BMPs or make a particular BMP too costly or ineffective for meeting stormwater management objectives. While every site has its own individual characteristics that need to be evaluated, the primary physical feasibility factors that should be considered for most sites are (Table 8-2):

- Contributing drainage area
- Site slope
- Soil infiltration capacity (Hydrologic Soil Group)
- Depth to seasonal high groundwater and bedrock

These factors are discussed in general terms below, followed by color-coded matrix tables that summarize the factors for each type of stormwater BMP. Chapter 13 - Structural Stormwater BMP Design Guidance contains additional information on physical feasibility and selection considerations for specific BMPs. Chapter 10 provides minimum required horizontal setback distances for stormwater infiltration systems.

Screening-level information may be used to initially evaluate soil characteristics and subsurface conditions at a site for the purpose of stormwater management planning, concept design, and retrofit screening, as described in the Initial Screening step of the soil evaluation guidance in Chapter 10. For final selection and design of stormwater BMPs, soil characteristics and subsurface conditions (soil infiltration capacity, depth to seasonal high groundwater table, and depth to bedrock) should be based on the results of test pits/soil borings and field infiltration testing (if necessary), which is also addressed in Chapter 10 and the BMP-specific design guidance presented in Chapter 13 - Structural Stormwater BMP Design Guidance.

Contributing Drainage Area

The efficiency of many stormwater BMPs decreases with increasing drainage area, runoff volume, and hydraulic load. Other BMPs require a minimum drainage area to maintain a permanent pool, wetlands, or submerged conditions. Table 8-2 indicates the general suitability of stormwater BMPs for various drainage areas, included minimum and maximum drainage areas, where applicable. Table 8-2 also identifies contributing drainage areas that may be suitable under certain conditions or with design restrictions. The minimum and maximum drainage areas presented in Table 8-2 should not be considered inflexible limits and may be increased or decreased slightly where a stormwater BMP supports other management objectives.

Site Slope

The ground slope at and immediately adjacent to the location of a stormwater BMP, as well as the slope of the contributing drainage area and drainage flow paths, are important factors in determining the feasibility of stormwater practices. As summarized in Table 8-3, most stormwater BMPs are limited to sites with slopes less than 10% to 15%, while the use of some

BMPs such as water quality swales and permeable pavement is restricted to slopes of approximately 5% or less.

Soil Infiltration Capacity

The feasibility and effectiveness of stormwater BMPs can be heavily influenced by soil infiltration capacity. As such soil health and soil type are incredibly important factors to the planning and ultimately the success of stormwater design. Table 8-4 summarizes the suitability of various types of stormwater BMPs based on Hydrologic Soil Group (as determined in the field from soil texture class), which is an indicator of the runoff potential and infiltration capacity of the underlying soils.

As described in Chapter 10 - General Design Guidance for Stormwater Infiltration Systems, stormwater infiltration systems are most suitable in soils with infiltration rates of 0.3 inch per hour or greater, at the location of the proposed infiltration system (or within the allowable horizontal testing distances as described above) and at or below the bottom of the system. Soils with infiltration rates of 0.3 inch per hour or greater generally correspond to Natural Resources Conservation Service Hydrologic Soil Group (HSG) A and B soils. Stormwater infiltration systems can also be suitable in soils with lower infiltration rates, including HSG C and D soils, provided the recommended sizing, drain time, horizontal setbacks, and vertical separation criteria are met and the system is designed with an underdrain. Research by the University of New Hampshire Stormwater Center and EPA Region 1 has shown that substantial stormwater infiltration and recharge can occur in lower infiltration rate soils. Ultimately, providing some infiltration is better than none, particularly for retrofit applications.

Other BMPs such as Stormwater Ponds, Stormwater Wetlands, and wet water quality swales rely on a permanent pool or saturated soil conditions and are best suited to sites with poorly drained soils such as HSG C and D soils.

Depth to Seasonal High Groundwater

The depth to the seasonal high groundwater table (SHGT) is a key factor in evaluating the feasibility and ultimately the design of many types of stormwater BMPs. For infiltration systems, adequate vertical separation between the bottom of the system and SHGT (generally 3 feet or more, but as low as 2 feet in some instances) is necessary to ensure adequate pollutant removal in the unsaturated zone and sufficient hydraulic capacity for proper functioning of the system. For filtering systems designed for infiltration, the vertical separation may consist of a combination of the filter layer (e.g., bioretention soil media) and the underlying native soil, provided that the bottom of the system is at least 1 foot above the SHGT. Stormwater BMPs designed with an underdrain and impermeable liner may be used in areas where the required vertical separation to SHGT cannot be met.

For stormwater ponds and wetlands, SHGT should be at or above the bottom of the system to maintain a permanent pool and wetland vegetation. An impermeable liner may be required for stormwater detention basins where SHGT is above the bottom of the basin to maximize the available storage volume within the basin.

Table 8-5 summarizes the suitability of stormwater BMPs based on depth to SHGT as determined from test pits or soil borings (refer to Chapter 10 for soil evaluation methods).

Depth to Bedrock

Depth to bedrock is another key consideration in the selection and design of stormwater BMPs. A minimum separation distance of 3 feet between the bottom of the system and bedrock or other impermeable material or subsurface layer is required for most BMPs. This distance can be reduced in some situations.

Table 8-5 summarizes the suitability of stormwater BMPs based on depth to bedrock as determined from test pits or soil borings (refer to Chapter 10 - General Design Guidance for Stormwater Infiltration Systems for soil evaluation methods).

Table 8-2. Physical Feasibility – Contributing Drainage Area

BMP Category	BMP Type	Contributing Drainage Area				
		< 0.5 ac	0.5 - 1 ac	1 - 5 ac	5 - 10 ac	> 10 ac
Infiltration BMPs	Infiltration Trench	💧	💧	💧		
	Underground Infiltration System	💧	💧	💧		
	Infiltration Basin	💧	💧	💧	💧	
	Dry Well	💧	💧	Multiple connected		
	Infiltrating Catch Basin	💧	💧	Multiple connected		
	Porous Asphalt	Not Cost Effective	(1)	(1)	(1)	(1)
	Pervious Concrete	(1)	(1)	(1)	(1)	(1)
	Permeable Concrete Interlocking Pavers	(1)	(1)	(1)	(1)	(1)
Filtering BMPs	Bioretention	(2)	💧	💧		
	Sand Filter	💧	💧	💧		
	Tree Filter	💧	Multiple connected			
Stormwater Pond BMPs	Wet Pond	(4)	(4)	(4)	(4)	💧
	Micropool Extended Detention Pond	(4)	(4)	(4)	(4)	💧
	Wet Extended Detention Pond	(4)	(4)	(4)	(4)	💧
	Multiple Pond System	(4)	(4)	(4)	(4)	💧
Stormwater Wetland BMPs	Subsurface Gravel Wetland	(4)	(4)	(4)	💧	💧
	Shallow Wetland	(4)	(4)	(4)	(4)	💧
	Extended Detention Shallow Wetland	(4)	(4)	(4)	(4)	💧

BMP Category	BMP Type	Contributing Drainage Area				
		< 0.5 ac	0.5 - 1 ac	1 - 5 ac	5 - 10 ac	> 10 ac
	Pond/Wetland System	(4)	(4)	(4)	(4)	♦
Water Quality Conveyance BMPs	Dry Water Quality Swale	(3)	(3)	(3)		
	Wet Water Quality Swale	(3)	(3)	(3)		
Stormwater Reuse BMPs	Rain Barrel	Small roof areas only				
	Cistern	♦	♦	Larger systems based on water demand		
Proprietary BMPs	Manufactured Treatment System	♦	♦	♦	Larger systems if allowed by manufacturer	
Other BMPs and BMP Accessories	Green Roof	♦	♦	♦	♦	♦
	Dry Extended Detention Basin			(5)	(5)	♦
	Underground Detention (no infiltration)	♦	♦	♦	♦	Max 25 AC

Notes:

(1) Contributing drainage area should not exceed 3 times area of permeable pavement.

(2) Rain gardens and other small-scale bioretention systems. For curb inlet planters, the recommended maximum ratio of contributing impervious drainage area to planter bed area is 10:1.

(3) No limit if runoff enters swale as sheet flow. May be suitable for larger areas, but limitations are most often associated with linear projects. The aid of a level spreader and larger filter strips will enhance these practices.

(4) Smaller drainage areas may be suitable if intercepting groundwater or with sufficient surface runoff to support permanent pool, required wetland depths, or submerged gravel bed. An impermeable liner may be required if the system is located in permeable soils and the bottom of the system does not intercept groundwater.

(5) Drainage areas smaller than 10 acres may require an excessively small outlet structure susceptible to clogging.

Legend	♦	Suitable
	(See notes)	Suitable under certain conditions or with design restrictions as noted
		Generally not suitable

Table 8-3. Physical Feasibility – Site Slope

BMP Category	BMP Type	Site Ground Slope (1)		
		Less than 2%	2% - 6%	6% - 10%
Infiltration BMPs	Infiltration Trench	●	●	●
	Underground Infiltration System	●	●	●
	Infiltration Basin	●	●	●
	Dry Well	●	●	●
	Infiltrating Catch Basin	●	●	●
	Porous Asphalt	●	5% max	
	Pervious Concrete	●	5% max	
	Permeable Concrete Interlocking Pavers	●	5% max	
Filtering BMPs	Bioretention	●	●	●
	Sand Filter	●	●	●
	Tree Filter	●	●	●
Stormwater Pond BMPs	Wet Pond	●	●	(2)
	Micropool Extended Detention Pond	●	●	(2)
	Wet Extended Detention Pond	●	●	(2)
	Multiple Pond System	●	●	(2)
Stormwater Wetland BMPs	Subsurface Gravel Wetland	●	●	(2)
	Shallow Wetland	●	●	(2)
	Extended Detention Shallow Wetland	●	●	(2)
	Pond/Wetland System	●	●	(2)

BMP Category	BMP Type	Site Ground Slope (1)		
		Less than 2%	2% - 6%	6% - 10%
Water Quality Conveyance BMPs	Dry Water Quality Swale	💧	Check dams required	
	Wet Water Quality Swale	💧	Check dams required	
Stormwater Reuse BMPs	Rain Barrel	Not Applicable		
	Cistern	Not Applicable		
Proprietary BMPs	Manufactured Treatment System	Not Applicable		
Other BMPs and BMP Accessories	Green Roof	Ground Slope Not Applicable (max 20% roof slope)		
	Dry Extended Detention Basin	💧	💧	(2)
	Underground Detention (no infiltration)	💧	💧	💧

Notes:

(1) Refers to post-construction slope at the BMP site.

(2) More difficult and costly installation for site slopes of greater than 6% due to the need for a potentially large embankment and other design modifications. Limited to 9.4% resultant slope. Embankment slope may be 2-33% with a level spreader and 2-15% without.

Legend	💧	Suitable
	(See notes)	Suitable under certain conditions or with design restrictions as noted
		Generally not suitable

Table 8-4. Physical Feasibility – Soil Infiltration Capacity (Hydrologic Soil Group)

BMP Category	BMP Type	Hydrologic Soil Group (HSG)			
		A	B	C	D
Infiltration BMPs	Infiltration Trench	💧	💧	(4)(5)	
	Underground Infiltration System	💧	💧	(4)(5)	
	Infiltration Basin	💧	💧	(4)(5)	
	Dry Well	💧	💧	(4)(5)	
	Infiltrating Catch Basin	💧	💧	(4)(5)	
	Porous Asphalt	💧	💧	(4)(5)	
	Pervious Concrete	💧	💧	(4)(5)	
	Permeable Concrete Interlocking Pavers	💧	💧	(4)(5)	
Filtering BMPs	Bioretention	💧	💧	(4)(5)	(4)(5)
	Sand Filter	💧	💧	(4)(5)	(4)(5)
	Tree Filter	💧	💧	(4)(5)	(4)(5)
Stormwater Pond BMPs	Wet Pond	(1)	(1)	(1)	💧
	Micropool Extended Detention Pond	(1)	(1)	(1)	💧
	Wet Extended Detention Pond	(1)	(1)	(1)	💧
	Multiple Pond System	(1)	(1)	(1)	💧
Stormwater Wetland BMPs	Subsurface Gravel Wetland	(2)	(2)	(2)	💧
	Shallow Wetland	(1)	(1)	(1)	💧
	Extended Detention Shallow Wetland	(1)	(1)	(1)	💧
	Pond/Wetland System	(1)	(1)	(1)	💧

BMP Category	BMP Type	Hydrologic Soil Group (HSG)			
		A	B	C	D
Water Quality Conveyance BMPs	Dry Water Quality Swale	♦	♦	(4)(5)	(4)(5)
	Wet Water Quality Swale	(3)	(3)	♦	♦
Stormwater Reuse BMPs	Rain Barrel	Not Applicable			
	Cistern	Not Applicable			
Proprietary BMPs	Manufactured Treatment System	Not Applicable			
Other BMPs and BMP Accessories	Green Roof	Not Applicable			
	Dry Extended Detention Basin	♦	♦	Liner recommended to prevent groundwater inflow	
	Underground Detention (no infiltration)	♦	♦	♦	♦

Notes:

NRCS Hydrologic Soil Group (HSG) as determined from field-verified soil textural class of the soil (refer to Chapter 10 - General Design Guidance for Stormwater Infiltration Systems for soil evaluation methods).

(1) An impermeable liner is required if the bottom of the system does not intercept groundwater.
(2) The system should be lined with an impermeable liner to prevent groundwater exchange with runoff in the subsurface gravel bed.
(3) Feasible if constructed with an impermeable liner but wet water quality swales are generally impractical in HSG A and B soils
(4) Underdrain Recommended
(5) Dispersed/Sheet flow

Legend	♦	Suitable
	(See notes)	Suitable under certain conditions or with design restrictions as noted
		Generally not suitable or very limited suitability

Table 8-5. Physical Feasibility – Depth to Seasonal High Groundwater Table and Bedrock

BMP Category	BMP Type	Depth to Seasonal High Groundwater Table (1)				Depth to Bedrock		
		< 1 ft	1 – 2 ft	2 – 3 ft	> 3 ft	< 2 ft	2 – 3 ft	> 3 ft
Infiltration BMPs	Infiltration Trench			(2)	💧		(2)	💧
	Underground Infiltration System			(2)	💧		(2)	💧
	Infiltration Basin			(2)	💧		(2)	💧
	Dry Well			(2)	💧		(2)	💧
	Infiltrating Catch Basin			(2)	💧		(2)	💧
	Porous Asphalt			(2)	💧		(2)	💧
	Pervious Concrete			(2)	💧		(2)	💧
	Permeable Concrete Interlocking Pavers			(2)	💧		(2)	💧
Filtering BMPs	Bioretention		(3)	(2)	💧	(3)	(2)	💧
	Sand Filter		(3)	(2)	💧	(3)	(2)	💧
	Tree Filter		(3)	(2)	💧	(3)	(2)	💧
Stormwater Pond BMPs	Wet Pond	💧	💧	(4)		💧	💧	💧
	Micropool Extended Detention Pond	💧	💧	(4)		💧	💧	💧
	Wet Extended Detention Pond	💧	💧	(4)		💧	💧	💧
	Multiple Pond System	💧	💧	(4)		💧	💧	💧
Stormwater Wetland BMPs	Subsurface Gravel Wetland	💧	💧	(4)		💧	💧	💧
	Shallow Wetland	💧	💧	(4)		💧	💧	💧
	Extended Detention Shallow Wetland	💧	💧	(4)		💧	💧	💧
	Pond/Wetland System	💧	💧	(4)		💧	💧	💧

BMP Category	BMP Type	Depth to Seasonal High Groundwater Table (1)				Depth to Bedrock		
		< 1 ft	1 – 2 ft	2 – 3 ft	> 3 ft	< 2 ft	2 – 3 ft	> 3 ft
Water Quality Conveyance BMPs	Dry Water Quality Swale			(2)	💧		(2)	💧
	Wet Water Quality Swale	💧	💧	(4)		💧	💧	💧
Stormwater Reuse BMPs	Rain Barrel	Not Applicable				Not Applicable		
	Cistern	Not Applicable				Not Applicable		
Proprietary BMPs	Manufactured Treatment System	Not Applicable				Not Applicable		
Other BMPs and BMP Accessories	Green Roof	Not Applicable				Not Applicable		
	Dry Extended Detention Basin	(6)	💧	💧	💧	(5)	💧	💧
	Underground Detention (no infiltration)	💧	💧	💧	💧	💧	💧	💧

Notes:

Depth from bottom of infiltration systems or top of filtering systems to seasonal high groundwater table and bedrock or other impermeable material or subsurface layer as determined from test pits or soil borings (refer to Chapter 10 - General Design Guidance for Stormwater Infiltration Systems for soil evaluation methods).

(1) Stormwater BMPs designed with an underdrain system and impermeable liner may be used in areas where the required vertical separation to SHGT and bedrock cannot be met. Such systems are suitable for providing treatment but do not provide retention credit.

(2) Strictly residential uses or for stormwater retrofits where the minimum 3-foot separation cannot be met due to existing site constraints and there is little risk to groundwater quality, or where groundwater is already impacted (classified as GB) and there is little risk to groundwater quality from the infiltrated stormwater.

(3) For unlined filtering systems, the bottom of the filtering system should be at least 1 foot above SHGT and bedrock.

(4) Liner required in permeable soils.

(5) At least 1 foot of separation required.

(6) Liner recommended.

Legend	💧	💧	Suitable
	(See notes)	(See notes)	Suitable under certain conditions or with design restrictions as noted
			Generally not suitable