2. BMP SELECTION

Selection of appropriate methods for controlling stormwater runoff requires an understanding of how rainfall, surface water hydrology, soils, and vegetation interrelate. This section provides an overview of stormwater runoff – that is the flow of water after rainfall hits the ground – and information about how soils and vegetation affect the flow of water across the ground, and how paved, impervious surfaces affect stormwater runoff. The second part of this section provides a guideline of how BMPs can be selected for a site.

2.1 Factors Affecting Stormwater Management

Stormwater runoff is a natural part of the hydrologic cycle. The volume and speed of runoff depends on the size of the storm, including how much rain falls in a period of time, and the land features of the area. Land features include the size of the catchment area, the slope of the land, the vegetation (or lack of vegetation) covering the land, and the soil present. An area of land where all of the water that falls flows to, from the highest point to the lowest, is called a watershed. Watersheds are comprised of sub-watersheds drained by streams and tributaries within the watershed.

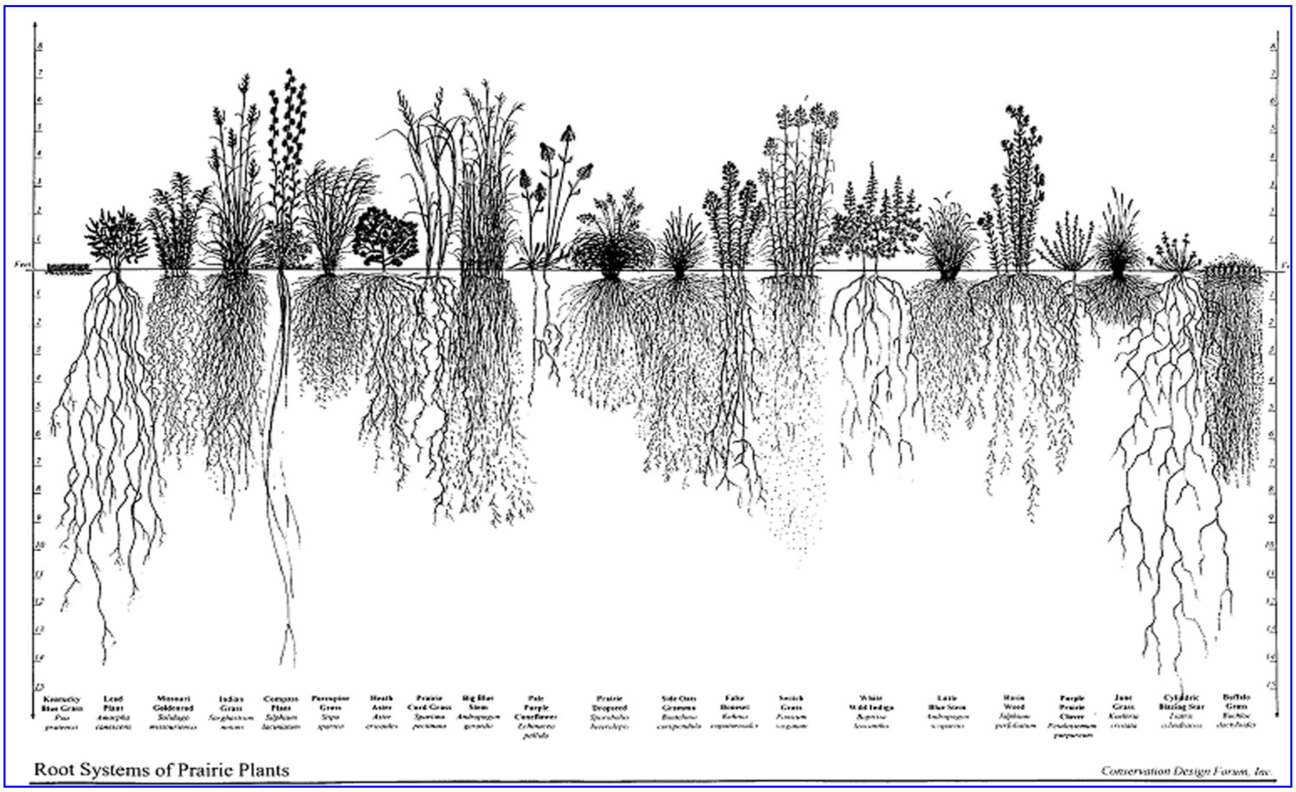
In a natural, undeveloped setting, as rainfall hits the ground it begins percolating into the soil. The amount of rain that will percolate into the soil is controlled by the type of soil and the amount of water hitting it at a given time. Typically, soils with higher amounts of clay, such as many of the soils in and around Lincoln, will rapidly accept water hitting the ground initially, but because water is slow to move through the smaller pores in clayey soils, excess rainfall will runoff. In sandier soils, more water will percolate downward, and less runoff will occur for the same amount of rain.

How fast water runs off the soil is also dependent on the vegetation covering the soil. If thick, dense vegetation is covering the soil, the flow of water across the ground surface is slowed. When slowed in this manner, water has more opportunity to infiltrate into the ground. The more vegetative canopy that there is - the leaves of grass and the branches and leaves of trees and shrubs - the more rain is intercepted and slowed in its descent to the ground, again, allowing more rainfall to either infiltrate into the ground, or to evaporate after the rainfall has stopped.

Dense growth of prairie grasses allows rainfall to infiltrate into the ground.

While the amount of vegetation above the ground affects how much rain can runoff across the ground surface, the amount of vegetative matter below the ground – the roots – also significantly affect how much rain will infiltrate into the soil, or how much may runoff. As roots grow into the soil, they create channels in which rainwater will flow down into the ground. In addition, as the roots grow and die from season to season, the organic matter in the soil retains those macro-pores, creating a much more open, permeable soil. As larger roots die and decay, they leave larger macropores, and other biological activity, such as the work of earthworms and insects that thrive in the root-rich soil, create even more macropores for rain to flow into. Even clay soils, with a high amount of organic matter, can be porous enough to allow substantial amounts of rainfall to infiltrate.

In the Midwest and Plains States, prairie vegetation created deep, organically-rich soils. Rainfall readily infiltrated into the soil where it continued to flow through the subsurface to slowly fill streams and rivers. Native prairie grasses and forbs – flowering plants and shrubs – sent their roots deep into the soil, in some cases in excess of eight feet below the soil surface. This benefits the plants in two ways: first, the deep roots had more access to life-sustaining water so they could withstand the dry periods. Second, the roots provided firm anchors for the plants that allowed them to stay firmly in place and outcompete other, non-native plants, and withstand strong flows of water when extreme storm events did occur. In contrast, non-native plants, such as many turf grasses and exotic flowers, have shallow root systems that don't facilitate movement of rain into the soil, nor are these plants well-sustained during dry periods. Because of their shallow roots, rainfall infiltration is limited, and more water will be lost as runoff.



Native plants send their roots deep into the round, contrasted by the roots of turfgrass (left side). The deeper roots open pores into the soil, providing more storage of rain where it falls.

With the growth and development of Lincoln, increasing amounts of the once-permeable soil have become paved or planted to turf grasses. With the increased amounts of pavement, the amount of rainfall runoff from the ground surface increases dramatically, flowing quickly, almost un-impeded, to storm drains and their eventual outflow into the streams. Consider that for every acre of paved surface, nearly all of the rain that falls will flow to streams that nature did not design to carry in such quantities or at such velocities.

For comparison, consider the engineering term often used in stormwater design, the runoff coefficient. For impervious, paved areas, such as streets, sidewalks, and parking lots, the runoff coefficient is typically a value from 0.7 to 0.95, meaning that from 70 to 95 percent of rainwater will run off the site. For vegetated areas, the runoff coefficient will typically have a value from 0.05 to 0.5, depending on the type of soil and the type of vegetation covering the site. As a result, one acre of parking lot can produce 16 times more stormwater runoff than one acre of meadow each year (Maryland Dept. of Environment, 1998). The dramatic increases in stormwater runoff have profound impacts on stream stability and quality, quickly producing flooding, damages to stream banks, and erosion and damage to property.

The goal of alternative stormwater BMPs is to restore some of the capacity of natural systems within developed areas and treat stormwater where it falls, allowing it to infiltrate into the soil, to slow its movement to streams and channels, improve water quality, and to reduce peak flows and floods. The types of BMPs selected to achieve these goals depends on the characteristics of each area as described above. A BMP selection matrix can help determine which BMPs are appropriate for small urban sites (Minneapolis Metropolitan Council Environmental Services, 2001). A summary of the BMP selection matrix is presented on the following pages as an example of an approach Lincoln can use to implement BMPs in our city.

2.2 Stormwater Treatment BMP Selection Matrix

A BMP Selection Matrix that was previously developed is attached to guide the user through three steps that progressively screen:

- BMP suitability and maintainability for treating stormwater,
- Physical feasibility of implementing the BMP(s), and
- Community and environmental factors.

Step 1 assesses the suitability and maintainability of the BMP for treating stormwater with the following question: Can the BMP meet the stormwater rate, volume, and water quality treatment requirements recommended or potentially mandated in the future by local regulations, or are a number of BMPs needed? The designer uses the matrix to determine if a particular BMP can meet the rate, volume, and water quality requirements identified in the site characterization. If a particular BMP cannot meet the rate control or volume reduction criteria, it does not mean the BMP should be eliminated from consideration, but that other BMPs may be necessary to achieve these goals.

This step also assesses the potential of the BMP to improve water quality by evaluating four criteria: Total Suspended Solids (TSS), phosphorus and nitrogen, metals, and fecal coliform.

The ability of the BMP to provide “benefits” in regard to each criteria are ranked as “primary,” indicating that the BMP has a primary effect of controlling the pollutant; “secondary,” indicating that there may be some benefit, and “minor,” indicating that the BMP has little or no benefit in controlling the pollutant.

Step 2 asks: Are there any physical constraints at the site that may restrict or preclude the use of a particular BMP? In this step, the designer uses the matrix to determine if the soils, water table, drainage area, slope or hydraulic head conditions present at the site might limit the use of particular BMPs. This step evaluates BMPs by six primary factors:

- **Soils**: Information based on data from USDA-NRCS soil surveys for the site.
- **Water Table**: Indicates the minimum recommended depth to the seasonally-high water table from the floor of the BMP.
- **Drainage Area**: Indicates if the BMP is suitable for small sites.
- **Head**: Provides an estimate of the elevation difference needed at a site to allow for gravity operation within the BMP.
- **Area Requirements**: Examines the typical space or area requirements for a BMP.
- **Ability to Accept Hotspot Runoff**: This examines the ability of the BMP to accept and treat runoff from an exceptionally contaminated hot spot. This last criteria may or may not be relevant to the BMP selection for a particular site.

Step 3 asks: Do the remaining BMPs have any important community or environmental benefits or drawbacks that might influence the selection? The designer uses the matrix to compare BMP options with regard to:

- **Maintenance**: This criteria assesses the relative maintenance effort for the BMP relative to frequency of inspection, scheduled maintenance, chronic maintenance problems, and accessibility to necessary equipment.
- **Community Acceptance**: This criteria assesses the Community acceptance as measured by market and/or preference surveys, potential or reported nuisance problems, and visual orientation (prominence or attractiveness).
- **Construction Cost**: BMPs are ranked according to their relative construction costs per impervious acre treated.
- **Wildlife and/or Natural Habitat**: BMPs are evaluated for their ability to provide wildlife or wetland habitat.

The full version of the BMP selection matrix is provided in Attachment A.