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DEALING WITH STORM WATER MANAGEMENT

This fact sheet provides information on the guiding principles of storm water management practices, explains the difference between structural and non-structural best management practices (BMPs), and gives examples of different methods of storm water management.

Purpose of Storm Water Management Practices

During development, it is important that a storm water management system is introduced that will mimic the water retention of pre-developed land. As such, the main purpose of storm water management practices is to reduce runoff rates, and thus, peak flows, and to remove pollutants from storm water runoff. To accomplish this, there are two main categories of storm water management practices:

1. Non-structural best management practices
2. Structural best management practices

Non-Structural Best Management Practices (BMPs)

Non-structural BMPs focus on preserving open spaces, protecting natural systems, and incorporating existing landscape features, such as wetlands and stream corridors, into a site plan that manages storm water at its source. Some non-structural BMPs focus on clustering and concentrating development, minimizing disturbed areas, and reducing the size of impervious areas.

Structural Best Management Practices (BMPs)

The term structural BMPs refers to the use of conventional structural features, referred to as "brick and mortar" techniques, used to manage storm water runoff. These include storm water piping systems and man-built holding ponds. Some of the so-called structural BMPs may be based on *natural systems* and may rely on vegetation and soil in order to control storm water.

Both structural and non-structural BMPs should be driven by the following *guiding principles*:

1. Managing storm water as a resource
2. Preserving and utilizing existing natural features and systems
3. Managing storm water as close to the source as possible
4. Sustaining the hydrologic balance of surface and ground water

5. Disconnecting, decentralizing, and distributing sources and discharges
6. Slowing down runoff
7. Preventing potential water quality and quantity problems
8. Mitigating problems that cannot be avoided
9. Integrating storm water management into the initial site design process
10. Inspecting and maintaining all best management practices (BMPs)

Examples of Non-structural BMPs

Open Spaces

Source: http://www.designbuild-network.com

Open spaces are grassed or wooded areas located in developed sites. Their primary function is to increase water quality, but they usually do not serve the function of providing adequate detention for reducing peak discharge.

An open space, located on a gently sloping topography with a moderately or well-drained soil, is capable of reducing the velocity of storm or surface water runoff. This is done by increasing the contact time of runoff water with soil and vegetation. This decreases the flow rate of water and may result in the removal of contaminants as well it can reduce the potential of erosion.

When flow rate is reduced, infiltration, filtration and absorption of storm water runoff can occur on a site. This may result in improved water quality. The increased infiltration that happens in these open spaces can also lead to ground water recharge.

This surface water BMP can be used in *clustered development* (another example of a non-structural BMP) that has adjacent open spaces. In addition, these open spaces can serve as a buffer between wetlands and adjacent developments. Most importantly, open spaces require minimal maintenance once vegetation is established.

Examples of Structural BMPs

Grassed Swales

A grassed swale is a linear vegetated ditch used to reduce the flow velocity of storm water runoff (Storm Water Center). The term also refers to vegetated, open-channel management practices specifically designed to reduce storm water runoff for a specified water volume (ibid). In other words, grassed swales is a flow-rate-based design that is based on the peak flow of stormwater. Grassed channels, dry swales, and wet swales are variations of grassed swales. Although these variations perform the same basic function, their individual design can differ.

Similar to drainage ditches, curbs, and gutter system, swales control water runoff, promote infiltration (i.e. ground water recharge), and can serve as post construction storm water management practice in urban areas. The vegetation in these channels slows down the movement of storm water to enable sedimentation, filtration, and infiltration into underlying soils, and possibly to the ground-water level.

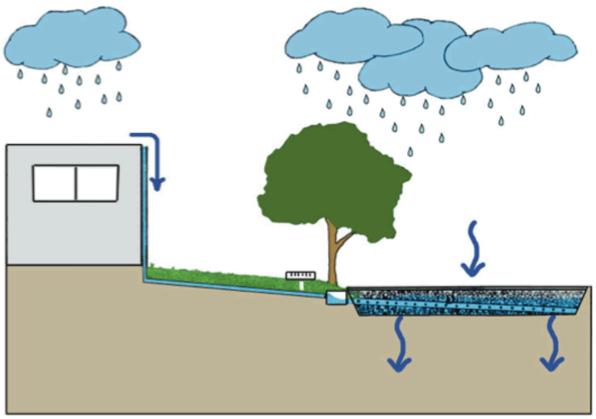

Source: http://www.thomasengineeringpa.com

Due to their linear nature, these channels can be used nearly everywhere including different climatic regions, around residential areas, roadsides, parking lots and highways. For cold and snowy climate, swales may serve a dual purpose of snow storage/treatment as well as storm management practice (Storm Water Center). The disadvantages of using swales include this system not being able to treat very large drainage areas. If improperly designed, swales can also have very little pollutant removal effect and can become breeding grounds for mosquitoes. They also require more maintenance than curb and gutter systems (ibid).

Subsurface Infiltration Beds

Similar to infiltration basin, subsurface infiltration beds provide temporary storage and infiltration of storm water runoff by placing storage media, of varying types, beneath the permeable soil bed.

They generally consist of vegetated, highly pervious soil media underlain by uniformly graded aggregates beds used for temporary storage and infiltration of storm water runoff. They function by collecting storm water runoff from nearby impervious areas, such as roof tops, roads, walkway, parking lots, play fields, lawns etc. The storm water then flows to the subsurface storage media from where it is distributed either naturally or via a network of perforated piping.



Source: http://www.tredyffrin.org

Subsurface infiltration beds are ideally suitable for expansive, flat open spaces located downhill from a nearby impervious layer. They are suitable for managing storm water runoff around residential, commercial, and urban developments. Additionally, they can be used for retrofitting existing storm water management systems.

When properly designed, subsurface infiltration beds can serve as standalone storm water management practice for runoff water volume, rate, and quality control. They maintain aquifer recharge, and help in preserving, creating, and maintaining valuable open spaces and recreational areas. Subsurface infiltration beds can function year round because the infiltration surface is below the frost line. Hence, they are very suitable for snowy regions.

Ponds/Retention Basins

Storm water ponds serve as a mechanism to treat stormwater and protect adjacent water quality. In particular, ponds, also referred to as retention basins**,** are depressions constructed by excavation and embankment procedures in order to temporarily store excess runoff on-site. Storm water basins can also include a permanent pool designed for water quality treatment and may have additional capacity storage, above the permanent pool, for temporal storage of runoff.

Ideally, ponds should be located on a site where the topography allows for the inflow of water into the pond. They should collect water from adjacent drainage areas. The in-flow of water usually goes through the forebay, which is located near the inlet of the pond. Forebays are designed to trap and settle out sediments and heavy pollutants before they reach the main basin. This basin is used for pre-treatment of storm water before it reaches the wet pond.

Source: http://www.mdsg.umd.edu

When water is retained in ponds, pollutant removal results from number of processes including gravity settling of sediments, chemical transformation, and biological uptake of nutrients. Additionally, the infiltration of soluble nutrients in the soil profile also results in increased water quality.

Ponds are very effective in storm water management and quality control even at peak-rate flows. This is because their design incorporates temporal storage of runoff that is beyond the permanent pool of water. Ponds are also very effective in sediments load-reduction before rainwater goes downstream or reaches wetlands. This management practice enables the growth of diverse vegetation and the development of various habitats.

Ponds are suitable for residential, commercial, industrial, and ultra-urban areas; as well as highways, roads, and retrofitting existing storm water management facilities.

Additionally, ponds can be marketed as amenities in development because they provide practical management of storm water runoff, while serving as an open space and recreational facility for bird watching, nature walks, and potentially, boating, and fishing.

The main limitation of storm water ponds is that they require maintenance, and are often left neglected. This "leads to sedimentation, reduction of the storage capacity of the ponds over time, and increased discharge of polluted water to adjacent water bodies" (Messersmith 2007). Further limitations include water volume impacts, collect/concentrate pollutants, variable efficiency, contaminated sediments, fecal coliform bacteria and poor use of land (Vandiver and Hernandez, 2009, p. 2)

Summary of the percentage of stormwater retention and pollutant reduction of various stormwater treatment systems.

Stormwater Treatment System	Reference	Stormwater	TSS	Phosphorus	Nitrogen	Metals	Other
Retention Pond				-16% (Total)	-54% (Total)	93% (Total Zn)	83% (Total HMW PAHs)
Single Detention Pond	Messersmith, 2007	7.5% (volume)	19%		-2.5% (Total)	n/a	14% (Fecal Coliform)
Series of Detention Ponds	Messersmith, 2007	-9% (volume)	88%	71% (Total)	39% (Total)	n/a	55% (Fecal Coliform)
Bioretention Swale	UNH Stormwater Center, 2007	82-85% (peak flow)	97-99%	5% (Total)	29-44% (DIN)	99% (Total Zn)	82-85% (Total HMW PAHs)
	Hunt & Lord, 2006 (tested soil media with varying P levels)	n/a	n/a	-240%-68% (Total)	33-68% (Total)	56-99% (Cu and Zn)	> 90% (Fecal Coliform)
	EPA, 2000	n/a	n/a	85-89% (Total)	3-27% (Nitrate)	32-54% (Cu) & 22-100% (Zn)	n/a
	Dave, 2007; Davis, 2008	49-58% (peak flow)	47%	76% (Total)	83% (Nitrate)	57% (Cu) & 67% (Zn)	n/a
Porous Pavement	UNH Stormwater Center, 2007	68%	99%	38% (Total)	n/a	96% (Zn)	99% (Total HMW PAHs)
Cumulative use of LIDs	EPA, 2000	n/a	91%	3% (Total)	42% (Total Nitrogen)	81% (Cu) & 75% (Zn)	n/a

Source: Vandiver, L. and D. Hernandez (2009)

Conclusion

Each management practice for storm water has its own advantages and disadvantages. It is important that the method of storm water management is chosen based on the context of where it is going to be implemented. This includes considerations such as regional soils, shallow water tables, topography, climate, housing density etc. However, one type of BMP may not be enough to minimize storm water quantity (i.e. reduce storm water peak flows and prevent flooding) *and* improve water quality. Thus, it is suggested that more than one storm water management practice should be integrated into development planning. To enhance performance of storm water management, BMPs can be used in-concert with other BMPs.

Works Cited

Messersmith, M. (2007). College of Charleston Masters Thesis: "Assessing the Hydrology and Pollutant Removal Efficiencies of Wet Detention Ponds in South Carolina."

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