Article 143

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Stormwater Retrofits: Tools for Watershed Enhancement

Improving aquatic habitat, water quality, and biodiversity within impacted urban streams and rivers are objectives for watershed managers. Stormwater retrofitting is just one available watershed restoration tool. Stormwater retrofits are a series of structural stormwater practices designed to mitigate erosive flows, reduce pollutants in stormwater runoff, and promote conditions for improved aquatic habitat.

Other watershed restoration tools that restore stream habitat and stabilize stream banks are necessary and important for watershed restoration, but without establishing a stable, predictable hydrologic water regime, these tools may not be effective. Erosive conditions and damaging frequent stormwater flows will remain. To successfully improve a stream's overall aquatic health, stormwater retrofitting is a watershed manager's most reliable tool.

Recent efforts in Maryland have identified methods for locating, designing, and constructing retrofits in urban watersheds. Scouting for retrofit sites requires a sound understanding of how, where and which stormwater practices are appropriate for particular situations. This requires an understanding of urban streams, hydrology and stream morphology, and an ability to envision possibilities for enhancement. It is also helpful to have an imaginative approach when attempting to identify appropriate alternatives. Six examples of urban retrofits are identified in Table 1. These retrofits must be adopted to varying site-specific conditions but represent the most common options for urban retrofitting.

Table 1: Retrofit Examples

- Retrofit existing older stormwater management facilities (detention ponds)
- Construct new stormwater practices at upstream end of road culverts
- Construct new stormwater practices at storm drainage pipe outfalls (end of pipe)
- Construct small instream practices in open channels
- Construct "on-site" measures at the edges of large parking areas
- Construct new stormwater practices within highway rights-of-way (cloverleaves)

Stormwater retrofits only emphasize pollutant reduction. It should be recognized that *quantity* frequently creates the most severe urban stream impacts. Watershed managers should look for opportunities to combine quantity and quality controls together in stormwater retrofits.

Stormwater Retrofit Options

1. *Retrofit existing stormwater management facilities*

This option involves converting existing detention facilities (usually dry detention basins) into more functional treatment practices. Older basins are usually modified to become stormwater wetlands or wet ponds. This is perhaps the easiest retrofit option since stormwater is already managed in a distinct location and there is already some resident acceptance and understanding of stormwater management. In addition, modifying existing facilities usually involves minimal impacts to secondary environmental resources (e.g., wetlands, forest cover, migration barriers, etc.)

The retrofit process begins with an analysis of the existing hydraulic characteristics of the facility, reviewing the type of storage originally provided (e.g., two-year, and 10-year storms), and evaluating whether available storage exists for additional water quality treatment. The pond bottom can usually be excavated to create more permanent pool storage (for pond and wetland systems), the embankment can be raised, or the outlet structure modified to obtain additional storage for extended detention.

Another option is to increase the flowpath from inflow point to discharge point by using baffles, earthen berms or pond micro-topography to improve settling conditions. The goal of this type of retrofit is to maintain the original design purpose of the basin as much as possible, while providing additional pollutant treatment. A typical retrofit of an existing detention basin is shown in Figure 1.

2. *Construct new stormwater practices at upstream end of road culverts*

This stormwater retrofit option is installed upstream from existing road culverts by constructing a control structure and excavating a micro-pool. The control structure can consist of a gabion or concrete weir structure or a riser/barrel configuration. The micro-pool

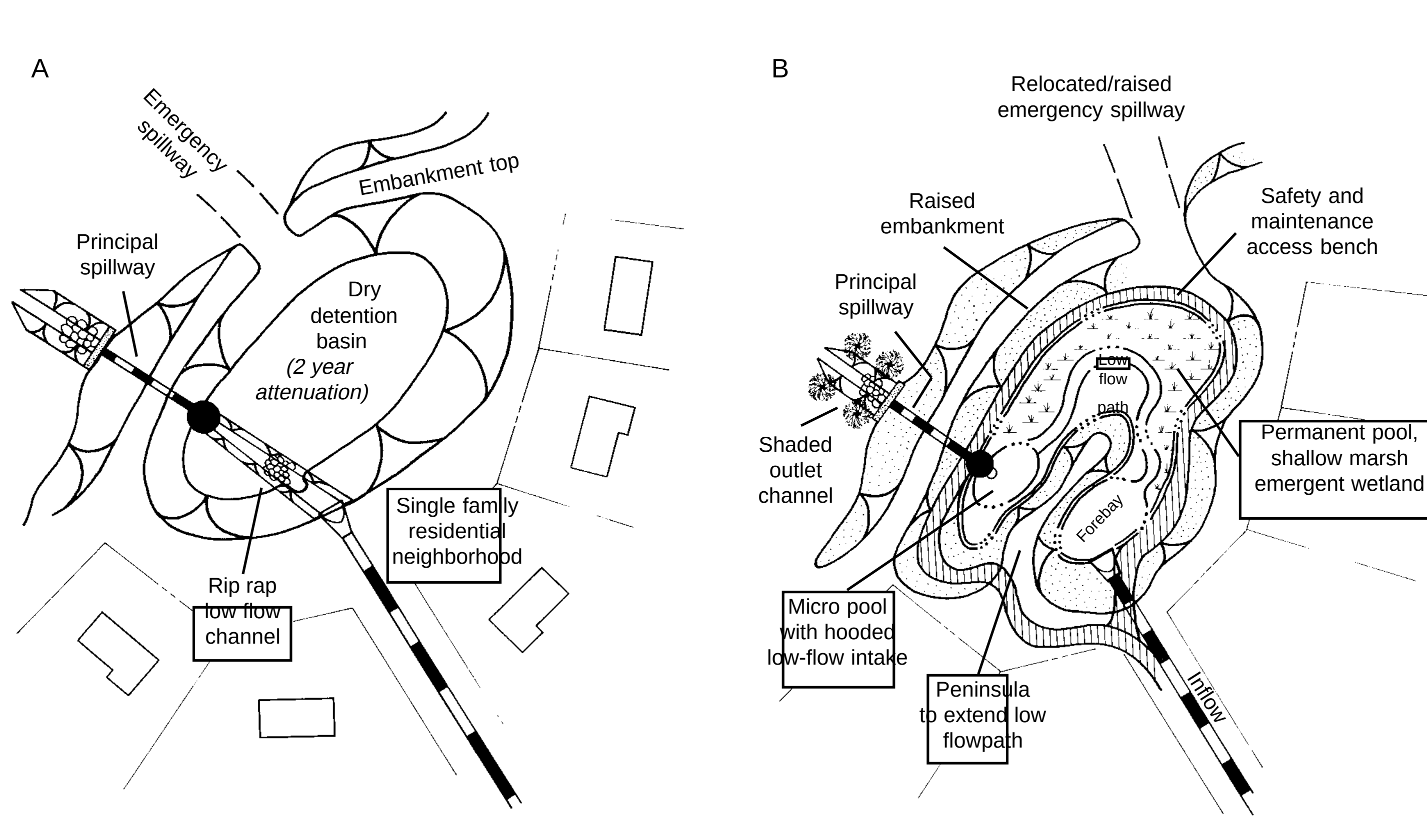

Figure 1: Existing Dry Detention Basin (A) and Shallow Marsh Stormwater Wetland Retrofit (B)

is a small permanent pool with a target volume equivalent to 0.1 watershed inch of storage. This method can be utilized to provide extended detention of runoff with a maximum depth of six feet above the culvert invert. If the upstream area is an open floodplain, it may be possible to construct a wet pond or stormwater wetland retrofit.

Stormwater quality control can usually be accommodated with this type of retrofit. Since roadways are not always constructed as stormwater pond embankment, special measures may be necessary to ensure that these retrofits will meet dam safety specifications for seepage control and passage of the 100-year storm. Secondary impacts also need to be considered with this type of retrofit. Examples of secondary impacts include expansion of the 100-year floodplain, creation of fish migration barriers, modification of upstream wetland hydrology, and potential impacts to existing forests. A typical retrofit utilizing an existing road crossing is shown in Figure 2.

3. *Construct new stormwater practices at storm drainage pipe outfalls*

This retrofit often consists of constructing new stormwater treatment practices at the immediate terminus of storm drainage systems. These retrofits are often designed as off-line stormwater practices. Flow splitters can be utilized to convey the water quality treatment volumes to a stormwater practice while allowing larger storms to bypass the retrofit. Examples of stormwater practices that are often applied in this retrofit option include sand filters, peat-sand filters, bioretention areas (article 110), off-line wetlands and wet ponds (refer to article 150 for more information on parallel pipe systems and flow splitter design). Consideration must be given to regulatory restrictions when constructing stormwater practices in a floodplain. Figure 3 shows a schematic plan for this method of retrofitting.

4. *Construct small instream practices in channels*

Previously channelized streams are potential sites for small instream detention structures in some small subwatersheds. These retrofits consist of small weir walls or check dams placed across the channel. A small ponding area is provided upstream of the retrofit for establishing wetland vegetation. This type of retrofit is usually very easy to install and can provide some moderate pollutant removal benefits, but can have potentially adverse impacts on the floodplain. Existing floodplain levels must be carefully compared to those created by the retrofit. Often these channelized streams have been designed to convey a certain frequency storm event with a given cross-section. Modification of this geometry may affect adjacent properties and downstream structures.

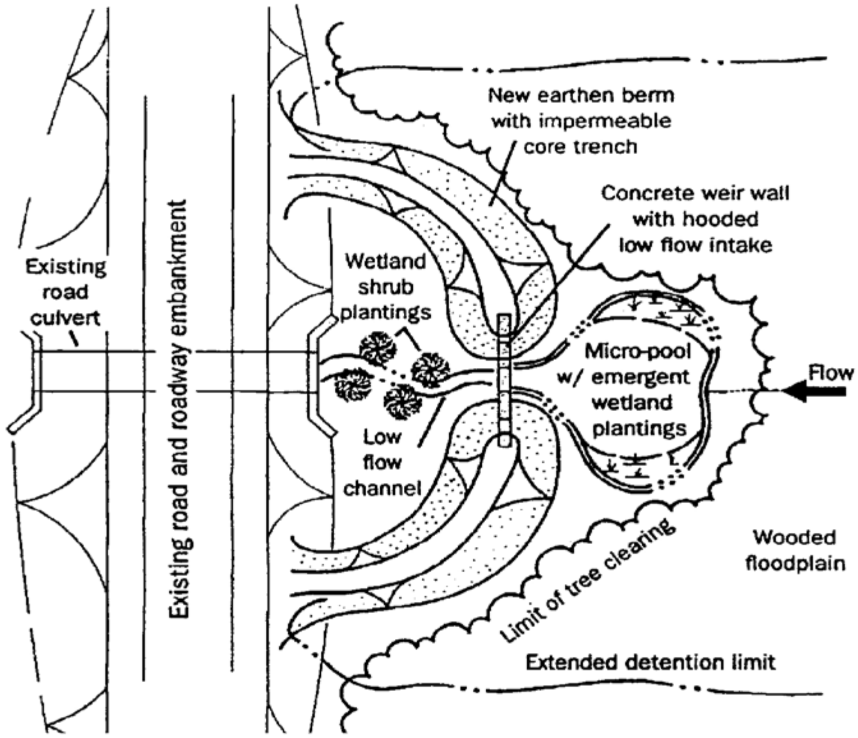

Figure 2: New Stormwater Practice at Upstream End of Road Culvert

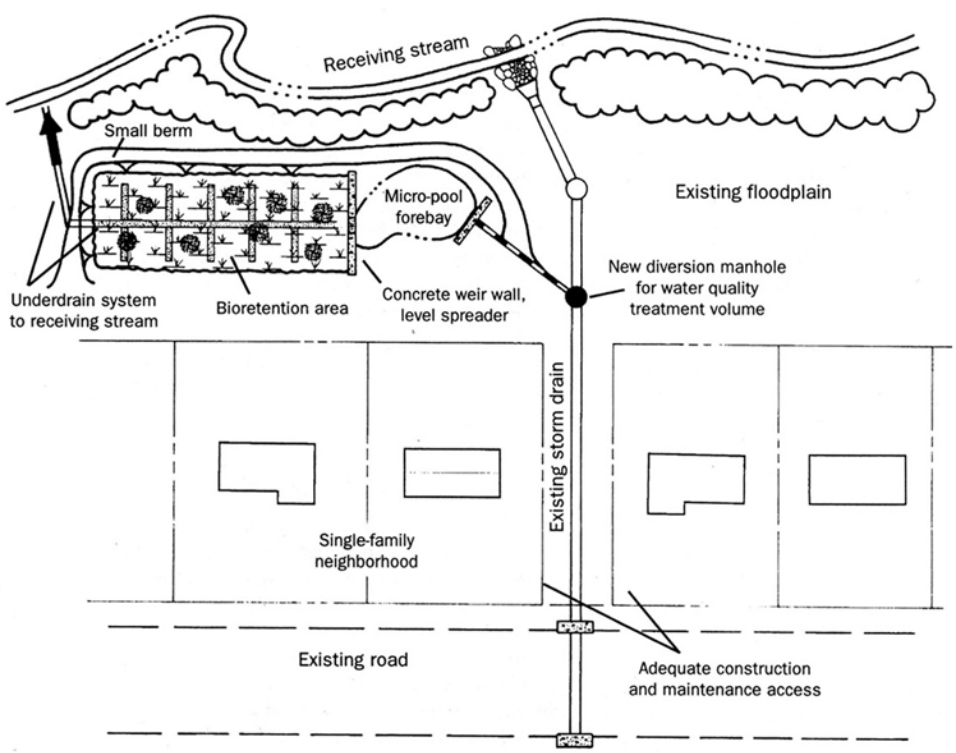

Figure 3: New Stormwater Practice at Existing Storm Drain Outfall (Off-Line Bioretention)

Table 2: Elements to Consider in Stormwater Retrofitting	
Element	**Consideration**
Construction/ maintenance access	Ensure that retrofit site has adequate construction and maintenance access and sufficient construction staging area
Utilities	Verify existing utility locations, assess likelihood for conflicts, avoidance or relocation potential
Wetlands, forests, and sensitive streams	Identify existing natural resources and estimate sensitivity, avoid and minimize impacts where possible, assess likelihood for conflicts and permit acquisition complications
Conflicting land uses	Identify adjacent land uses, select stormwater practices that will be compatible with nearby properties
Complementary restoration projects	Look for opportunities to combine projects, such as combining stream stabilization and habitat restoration with retrofitting in a complementary manner
Permits and approvals	Assess the difficulty of obtaining permits and identify necessary agencies to contact
Retrofit purpose	Define project purpose (i.e., is the retrofit intended to help stabilize the hydrologic regime in terms of quantity controls or is the retrofit more directed at pollutant removal in terms of quality controls?)
Cost	Retrofits can vary in cost from a few thousand to several hundred thousand dollars. A preliminary cost assessment should be conducted as part of a stormwater practice selection and implementation process

5. *Construct on-site measures at the edge of large parking areas*

Large parking lots are often ideal candidates for the installation of new stormwater retrofits. Some recent techniques, such as bioretention, improved porous pavement and sand filters may be appropriate for these retrofits. Infiltration practices, underground vaults, or other quantity practices may also be appropriate in some situations. Refer to articles 105 and 110 for detailed information on these stormwater practices.

6. *Construct new stormwater practices in highway rights-of-way*

Existing highway systems often have significant open spaces to install various stormwater retrofits. In particular, cloverleaf open space can be an ideal location for stormwater wetlands and pond systems if drainage areas/patterns allow. Care must be taken to not create a safety hazard for traffic, and maintenance access should be an integral part of the design.

Conclusion

Table 2 provides some key elements to consider in the selection and design of stormwater retrofits. Designers and watershed managers must consider a wide variety of issues when selecting retrofit options.

In summary, retrofitting is a useful tool for watershed enhancement and stream quality improvement. Several techniques are available to help establish a stable hydrologic condition and reduce stormwater runoff pollutants to receiving waters. Retrofitting requires a variety of skills for successful identification, design, and implementation. When combined with other watershed restoration efforts such as stream bank stabilization and habitat improvements, retrofitting can contribute to better urban waters which sustain a diverse and healthy aquatic ecosystem.

—RAC