**The Livingston County Drain Commissioner Procedures and Design Criteria for Stormwater Management Systems apply only to stormwater management systems within new development projects. The following discussion applies to all aspects of managing land and stormwater.**

## II. Framework for the Design of Stormwater Management Systems

Thoughtful site planning can reduce or eliminate the negative impacts associated with development. Toward this end, communities, regulatory agencies, and designers must begin to evaluate the impact of each individual development project over the long term and on a watershed scale. Such an approach requires the consideration of Best Management Practices (BMPs) that function together as a system to ensure that the volume, rate, timing, and pollutant load of runoff remains similar to that which occurred under natural conditions. This can be achieved through a coordinated network of structural and nonstructural methods, designed to provide both source and site control. In such a system, each BMP by itself may not provide major benefits, but when combined with others becomes very effective.

### Source Controls

Source controls reduce the volume of runoff generated on-site and eliminate initial opportunities for pollutants to enter the drainage system. By working to prevent problems, source controls are the best option for controlling stormwater and include the following key practices:

- Preservation of existing natural features that perform stormwater management functions, such as depressions, wetlands and vegetation along stream banks.
- The minimization of impervious surface area through site planning that makes efficient use of paved, developed areas and maximizes open space. Impervious surfaces are also reduced by encouraging flexible street and parking standards while conforming to Livingston County Road Commission requirements and the use of permeable ground cover materials.
- Direction of stormwater discharges to open, grassed areas such as swales rather than allowing stormwater to run off from impervious areas directly into the stormwater conveyance system. Careful design and installation of erosion control mechanisms and rigorous maintenance throughout the construction period. Effective erosion control measures include minimizing the area and length of time that a site is cleared and graded and the immediate vegetative stabilization of disturbed areas.

### Site Controls

Site controls are the subject of this document. After the implementation of source controls, site controls are then required to convey, pre-treat, and treat (e.g., detain, retain, or infiltrate) the stormwater runoff generated by development. The range of

engineering and design techniques available to achieve these objectives is to some degree dictated by site configuration, soil type, and the receiving waterway. For example, flat or extremely steep topography may preclude the use of grassed swales, which are otherwise preferable to curb and gutter systems, depending on the density of development. Likewise, sites upstream of cold-water fisheries may not be suitable for permanent wet ponds that discharge heated surface waters. But while each site will be unique, some universal guidelines for controlling stormwater quality and quantity can be stated.

**Preferred Hierarchy of Structural Site Controls**

1) In general, the most effective stormwater quality controls are infiltration practices, which reduce both the runoff peak and volume. But to date, structural infiltration devices such as basins and, to a lesser degree, trenches have suffered extremely high failure rates due to clogging. Therefore, an aggressive maintenance program and extensive upstream pre-treatment measures (such as oil/grit separators, sedimentation basins, and grass filter strips) must be incorporated into any stormwater management system that employs these devices. However, the use of oil/grit separators does not replace the need for sedimentation basins. In addition, these practices are only feasible on small sites with suitable soils and no potential for groundwater contamination.

2) The next most effective stormwater site controls reduce the runoff peak and involve storage facilities such as retention and detention ponds. In the selection of an appropriate stormwater pond design, wet ponds are generally preferable to detention ponds since they hold stormwater much longer, allowing more particulate to settle out. In addition, the aquatic plants and algae within wet ponds take up soluble pollutants (nutrients) from the water column. These nutrients are then transformed into plant materials that settle to the pond floor, decay, and are consumed by bacteria. Since this biological process is dependent upon the presence of water, it does not occur in dry ponds. It should be noted that the encouraged use of wet ponds as defined in this manual is not intended to mandate the creation of regulated wetlands as defined by state law.

3) Where site conditions make the use of a wet pond infeasible, ponds should be designed to provide extended detention of stormwater, again to promote as much settling of particulate as possible.

4) Once all possible methods of reducing and treating stormwater on-site have been implemented, excess runoff must be discharged into conveyance systems and carried off-site in a suitable outlet. For this purpose, vegetated swales with check dams are generally preferred to curb and gutter systems and enclosed storm drains. However, we find that suburban homeowners generally do not understand the purpose of swales and roadside ditches. This leads to misuse and modification which prevents proper operation of an open drainage system.

**Pond Design**

***Volume:*** Whereas detention basin design for flood control is concerned with relatively infrequent, severe runoff events such as the 25-, 50- or 100-year storm, design for water quality benefit is concerned with controlling the more frequent storm events (e.g., 1.5-year storm or less). Capturing and detaining the 1.5-year storm effectively avoid the negative impacts of erosive "bankfull" floods.

Also of primary importance to water quality is the capture and treatment of the "first flush," a term used to describe the initial washing action that stormwater has on impervious surfaces. Pollutants that have accumulated on these surfaces are flushed clean by the early stages of runoff, which then carries a shock loading of these pollutants into receiving waterways. By capturing and treating the first 1/2-inch of runoff, up to 90% of all pollutants that are washed off of the land can be removed from stormwater before it enters the drainage system.

Treatment of the "bankfull" flood and "first flush" may be accomplished via the design of "dual detention basins." These basins control stormwater discharge rates for both extreme events to prevent flooding and more frequent runoff events to mitigate water quality impacts and channel erosion.

***Pre-treatment:*** It is strongly recommended that stormwater be pre-treated prior to entering a retention or detention pond by passing first through a sediment forebay. Sediment forebays function to reduce incoming water velocities and to trap and localize incoming sediments, thereby reducing pond maintenance. Sediment forebays also extend the flow path of stormwater, increasing its residence time.