Storm Water Low Impact Development (LID) Part 1 – LID Concepts

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LID Concepts

Introduction

Low Impact Development (LID) is a relatively new concept for storm water management that can provide numerous benefits to a community that is different than the benefits provided by conventional storm water management approaches. Storm water runoff is a major source of water pollution in urban areas. When rain falls onto the hard surfaces in an urban landscape, the water cannot infiltrate into the soils in the same way that it does in a rural landscape, so the runoff volume and peak flows are significantly increased. Most LID techniques are designed to reduce and treat storm water near its source. Use of LID (also called green infrastructure in some areas) can help to mitigate the impacts of urbanization.

In an attempt to mitigate the impacts of urbanization, LID techniques promote substantially more infiltration into the soils than normal storm water management techniques. There are many different LID techniques, but from an engineering standpoint, they can all be broken down into the simple hydraulic functions.

Rainfall analysis for LID analysis is also much different than for other storm water projects. Typical rainfall analysis for a storm water project involves determining return period values, such as a 2-year, 10-year, or 100-year event. For most of the United States, these values can be easily obtained from the National Weather Service's NOAA Atlas 14. These values are inappropriate for analysis of a LID feature, however. The rainfall data used for the analysis of a LID feature uses some of the same data as that used for return period analyses, but the analysis is much different.

Basic Impacts Of Urbanization

As a rural area develops, natural watersheds are eliminated and replaced with urban watersheds. These urban watersheds include a variety of hard surfaces, including streets, parking lots, sidewalks, buildings, and driveways. When even a small amount of rain falls on these hard surfaces, water accumulates and runs off, rather than infiltrating into the soils. Therefore, these hard surfaces are commonly called impervious surfaces. Table 1 shows some typical values that highlight how a change in the percent of impervious surfaces impacts how a watershed responds to rainfall. Runoff increases significantly as the percentage of impervious surface increases, while infiltration decreases significantly.

Table 1 - Composition of Hydrologic Flow

Watershed	Evapotranspiration	Shallow infiltration	Deep infiltration	Runoff
Forested	40%	25%	25%	10%
10%-20% impervious	38%	21%	21%	20%
35%-50% impervious	35%	20%	15%	30%
75%-100% impervious	30%	10%	5%	55%

The increases in impervious surface and the resultant decrease in infiltration results not only in increased peak flows but also increases in total runoff volume. It also results in substantial increases in storm water pollutants, which are then conveyed to receiving streams or require installation of expensive treatment systems. Because more water runs off, the groundwater recharge is reduced, which can impact future drinking water availability in areas that rely on wells for water supply.

Historical Approach To Urban Drainage

The historical approach to urban drainage was to collect the surface runoff as fast as possible and convey the water to a receiving water body – a lake, the ocean, a stream or river, or a natural drainage channel. This approach requires large pipes and a large financial investment. It can create significant impacts downstream due to increases in flows and in total volume. It also quickly washes pollutants from the urban drainage to the receiving waters. The large peak flows make it uneconomical to treat these pollutants.

The conventional approach to urban drainage has changed only slightly from the historical approach. The conventional approach is to construct detention ponds, either local or regional ponds, to reduce post-development peak flows to pre-development levels. The piping systems are somewhat less costly than those required in the historical approach because the detention ponds reduce peak flows downstream. However, the piping system upstream of the detention ponds is essentially the same. This conventional approach still requires substantial financial investments in a drainage facility. It does reduce peak flows and the associated impacts but does not decrease the total volume of the runoff and does very little to promote additional infiltration. Most pollutants are still washed to receiving water bodies because a typical detention pond provides very limited water quality improvements.

LID Concepts

The basic concept behind the use of LID techniques is to attempt to match the pre-development hydrology more closely. The desire is to match the initial abstraction volume as much as possible and mimic the water balance. The primary way this is accomplished is to attempt to reduce the impacts of impervious surfaces on the amount of water that infiltrates into the ground.

In a typical storm water control system, the control is accomplished by the use of a very small number of large controls, such as regional detention ponds. Implementation of LID on a watershed involves the installation of a large number of small-scale controls. The small-scale controls are uniformly distributed throughout the entire developed drainage basin. The cumulative impacts of this large number of small controls result in additional filtering, detention, retention, recharge, and evaporation, all of which work to more closely resemble the hydrology of the undeveloped watershed.

The advantages of LID design include:

- Promotes more sustainable land development patterns
- Storm water is viewed as a resource to be conserved or used rather than a waste product to be disposed of.
- Promotes infiltration, which results in significantly lower total runoff volumes and potentially lower peak flows.
- The piping system could be potentially smaller than those for a conventional system, provided detention ponds are still used.
- The size of the detention ponds can be reduced from those for a conventional system because the volume of runoff is reduced.
- The volume of pollutants that runs off a site into the detention pond is substantially reduced.

LID design takes a much different approach to storm water management, starting at the source of the runoff, rather than simply dealing with the runoff after the development design is completed. The basic LID principles include conserving natural areas, minimizing development impacts, and using integrated management practices. Benefits of the use of LID features include a reduced volume of runoff and a reduction in urban heat island impacts (excess heat caused by large amounts of impervious surface, especially in downtown areas). They also provide urban habitat for a variety of birds and smaller animals and are generally aesthetically pleasing.

There are a wide variety of practices that are considered to be LID features. However, these practices can be combined into a small number of different types. The most common type of LID feature incorporates a vegetated surface combined with a small amount of surface storage (usually less than 6 to 12 inches), a carefully selected growing medium, and native, uncompacted soils below. These features store runoff for short time periods and promote additional infiltration. The following features fall into this category:

- Bioretention Cells (see Figure 1)
- Rain Gardens
- Vegetated Swales
- Tree and Shrub Depressions
- Landscape Island Storage (see Figure 2)

Figure 1 shows a bioretention cell adjacent to a parking lot. This bioretention cell collects runoff from the adjacent parking lot and stores it until it infiltrates into the soil or evaporates. The water is conveyed into the bioretention cell simply by grading the parking lot to drain to the bioretention cell and using curb stops for vehicles. The curb stops allow for water to easily go around the concrete and enter the cell at many locations, rather than using curb and gutter and directing the water into the cell in a single location. Note that this bioretention cell has a variety of plant types and sizes (grasses, bushes, and small trees). This diversity improves the aesthetic value of the cell and also increases the ability of the bioretention cell to use the water.

Figure 1 – Bioretention Cell adjacent to a parking lot

Figure 2 – Landscape Island