

A Comprehensive Update of the Design and Implementation of Low Impact Development Practices

Researchers, scientists, developers, business owners, graduate students, and a few ambitious undergrads from all over the Southeast U.S. gathered in Asheville, NC on August 13th & 14th to attend the 2012 Low Impact Development Researchers Symposium. The symposium proved an excellent opportunity for those involved in the field of storm water management to share ideas and techniques concerning the reintroduction of storm water runoff from impervious surfaces into the natural water table. Although field techniques varied slightly from person to person, everyone present shared concern for responsible water use. The presenters' goals were to spread cutting edge research in the field of low impact development and to provide the attendees-many of whom own development companies or run environmental engineering firms- with new field techniques that will maximize the efficiency of managing storm water and will minimize the impact development has on the environment. The content focused on five interconnecting areas of study: bio retention, permeable pavement, green roofs, swales, and filter strips.

When a storm event occurs in a natural setting, water meets the earth's surface and begins to infiltrate into the soil. Here, it can flow laterally as shallow soil moisture- where plants can absorb and return this water to the atmosphere through transpiration- or it can move further downward as ground water. As the rain continues to fall, and all pore space in the soil is fully occupied, it can move along the soil surface as runoff. It then moves toward the watershed's depression and collects in the form of a water body (such as a river, stream, or pond.) This is the natural movement of water. Now let's examine a storm event in an urban setting: Water falls from the sky and meets an impenetrable surface such as concrete, asphalt, and the roofs of buildings. We immediately have a problem: the ground water system is denied functionality by the impervious barrier. The water traverses across the surface, picking up pollutants such as sediment, metals, nutrients, and organics along the way. During the warmer months, runoff also absorbs a great deal of heat as it travels across hot pavement. This runoff is then collected in

storm drains where much of the time it is released into natural ecosystems unfiltered, bypassing the natural flow and filtration processes of water. Storm water discharges can lead to detrimental changes in receiving waters, such as erosion, increased flow velocity, higher water temperature, excess sedimentation, and eutrophication. When natural flow and filtration processes are disrupted, water quality and availability is impacted, leading to increased treatment costs, shortages, and water rights disputes in even the most advanced societies. This is precisely why the study of low impact development, though young, is such an important field.

The first topic of discussion, introduced by Dr. Robert Traver of Villanova University, was bioretention. Bioretention is the practice of constructing a water retention area consisting of multiple layers of substrates (such as gravel, sand, and rock) and nutrient absorbing plants. Bioretention cells are useful in areas such as yards or parking lots and are constructed where a depression is located. Storm water enters the cell and is able to permeate slowly through the layers of substrate-, ultimately returning to the water table - but not before the plants absorb nutrients and naturally filter the water. This is in contrast to water from a storm drain dumping directly into a nearby stream. If your municipality treats stormwater, a swap to a bioretention system can save money and energy by treating the water naturally and *for free* (apart from minimal construction costs). Some benefits of installing a bioretention system are the removal of a significant percentage of, phosphorous, nitrogen, sediment, and pathogens.

Understandably, some surfaces can't be covered with nutrient absorbing plants. We need roads to drive on and sidewalks on which to walk our dogs. This is where the concept of permeable pavement comes into play. As Dr. Bill Hunt of North Carolina State University explains- permeable pavement can be used to slowly return stormwater to the water table from the point of impact, rather than by way of stormwater drains. Think of all the pollutants which are intercepted by stormwater on its way to the storm drain. These pollutants never enter your local stream with a permeable pavement system installed. Converting a paved area into a sustainable infiltration zone can be done through two

mediums; porous asphalt or pervious concrete. Construction of these sustainable infiltration zones on a large scale can be pricey, but the maintenance is low and the payoff- by way of chemical free water treatment- is high.

Constructing green roofs is another popular practice that returns stormwater to the natural water cycle without transporting pollutants or disrupting watershed ecosystems. Two types of green roofs were discussed; intensive and extensive. Extensive roofs support a fairly small amount of vegetation (roughly ten to twenty five pounds per square foot) and require little upkeep. Intensive roofs support a heftier vegetative layer (eighty to one hundred and fifty pounds of vegetation per square foot) and require fairly constant maintenance. Green roofs, or “living roofs”, typically consist of four layers; a vegetation layer, a substrate layer, a drainage mat, and an impermeable liner. As pointed out by Dr. Elizabeth Fassman of the University of Auckland, each layer plays an important role in recycling stormwater. Vegetation promotes habitat, reduces absorption of solar radiation, cools the surrounding air, prevents substrate migration, and most importantly intercepts rainfall. Substrate supports plants, stores precipitation, extends the flow path, and provides insulation. The drainage layer comes in handy when the amount of precipitation exceeds the system's storage capacity, in which case water is allowed to drain and exit the system before the plants are negatively affected (Care must be taken in selecting plants that can tolerate extended periods of both wet and dry soil.) A waterproof membrane protects the building from sustaining water damage.

Before the construction of highways, there were many more wetlands and natural water filtering systems. Now that highways cover a fair portion of our terrain, the need to offset their impact on the hydrologic cycle arises. One effective way of doing this is by constructing swale and filter strip systems. The filter strip, consisting of long strips of permeable pavement, acts as a debris collecting buffer between the roadside and the swale. On the non-road side of the filter strip a depression is excavated. This area is then managed as either a wetland swale or a dry swale, depending upon the geographic location and the intentions of the designer. The results from a recent study conducted by Dr.

Bill Hunt conclude that- as far as total nitrogen effluent concentration goes- wetland swales outperform their dry counterparts. Dr. Hunt also postulates that the long term functionality of a swale is dependent upon the amount of maintenance performed on the vegetation within the swale. Dr. Allen Davis of the University of Maryland, recently conducted a study focused on the effectiveness of grass swales. He concluded that complete water volume capture and significant flow reduction occurred during small storm events. Water volume reduction occurred during moderate storm events; however no water volume or flow reduction occurred during large storm events. Concentrations of total suspended solids and all metals were reduced. Dr. Davis stresses the presence of a swale is much more important the presence of a filter strip.

The science of low impact development is an attempt to restore the relationship between natural systems and human needs. All relationships tend to increase in complexity over the passage of time. People meet, and due to various factors, decide to love one another. Only over time do they realize extra considerations must be taken into account to retain a healthy relationship. Humankind's relationship with the Earth is the most complex and arguably the most stressed relationship of all. Unlike relationships between people, this is a relationship we cannot quit. We grow older, and the present becomes history. Again and again we impose synthetic systems on the natural cycles of the earth, striving to cater to our ever increasing economic needs, driven by an increase in population size, hindering nature's ebb and flow which took millennia to perfect itself. Only now, as a whole, are we finally realizing the importance of imitating biological systems in our design of urban infrastructure. By working harmoniously with, rather than in spite of our environment, will we attain a sustainable society. One which will be able to survive the ever increasing complexities we create and therefore are forced to overcome.