ASSESSMENT OF STORMWATER MANAGEMENT IN COASTAL SOUTH CAROLINA:

A FOCUS ON STORMWATER PONDS AND LOW IMPACT DEVELOPMENT (LID) PRACTICES

By Lisa Vandiver[1] & Debra Hernandez[2]

[1] University of South Carolina, Arnold School of Public Health, lisa@inlet.geol.sc.edu

[2] Hernandez & Company, LLC, debra@hernandezandcompany.com

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This report provides a summary of the strengths and weaknesses of varied stormwater management strategies (e.g. stormwater ponds and LID practices). Related issues including water quality improvement, the permitting process, design, construction, and maintenance are addressed. Also included are options for improving the weaknesses associated with these stormwater management strategies. This report is based on 19 interviews of stormwater professionals and a workshop with 51 attendants. Stormwater professionals include:

- engineers,
- developers,
- contractors,
- landscape architects,
- regulatory staff, and
- land planners.

The workshop *Stormwater Management in Coastal SC: A Focus on Stormwater Ponds and Low Impact Development (LID) Practices* was held on January 22, 2009. The purpose of this effort is to identify the informational, regulatory, and educational needs of stormwater professionals regarding both traditional and alternative stormwater management technologies. Previous research and the responses provided by stormwater professionals were analyzed for this assessment. This report will assist coastal communities and other stakeholders in making decisions regarding the selection and implementation of stormwater management strategies.

SC STORMWATER MANAGEMENT

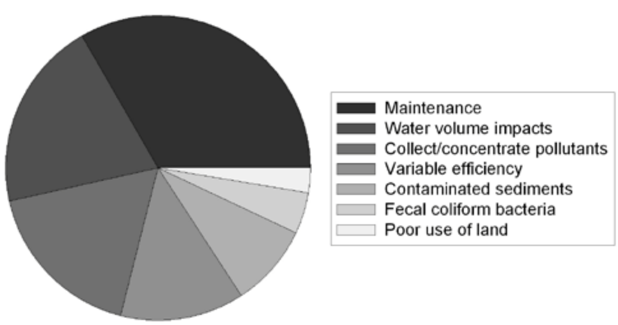
Southeastern coastal regions have adopted and implemented the use of Best Management Practices (BMP) as a means of controlling stormwater quantity and quality. Generally, stormwater regulations in South Carolina require stormwater management systems to retain the first ½ inch of runoff on site or 1 inch of runoff from the built upon area (whichever is greater), maintain pre-development discharge rates, and remove 80 percent of suspended solids during construction (SMSRA, 1991; SCDHEC, 2002; 2003; 2006). The selection and implementation of BMPs in the SC coastal zone must take into consideration regional characteristics such as the flat coastal topography, shallow water tables, and minimal soil storage.

STORMWATER PONDS

Stormwater ponds were initially designed and implemented to manage localized flooding; however, as the impacts of urbanization on adjacent streams and water bodies became better understood, ponds have been required as a mechanism to treat stormwater and protect adjacent water quality (SCDHEC, 2004). Stormwater ponds can be categorized into two general types: 1) detention ponds have a permanent pool of water which is gradually discharged into adjacent water bodies through an overflow structure or 2) retention ponds have a permanent pool of water which is discharged through infiltration and groundwater transport. SC regulations coupled with regional geography and hydrology result in stormwater detention ponds serving as the most commonly used BMPs in the South Carolina coastal zone. In 1999 it was estimated that there were over 8,000 stormwater ponds within the 8 coastal counties of SC alone (Seiwicki et al., 2007). Interviews with engineers of this region suggest that this trend will continue in the future due to the ease of designing, permitting, and constructing stormwater ponds. Ponds also serve a critical role in providing fill material for development within topographically low-lying areas. In addition, ponds can be marketed as an amenity to a development; providing both practical management of stormwater runoff while also serving as open space and oftentimes used for recreational purposes such as fishing, boating, and sometimes even swimming.

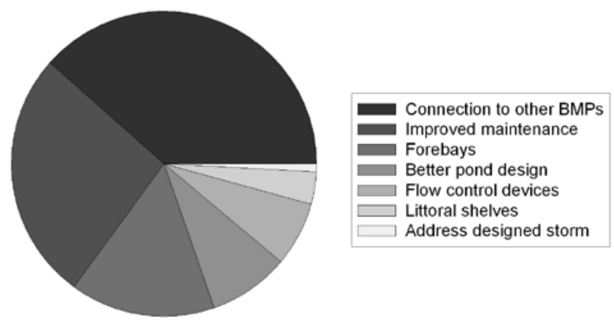
Although national research suggests that these ponds are effective in reducing stormwater peak flows and retaining pollutants (Table 1), recent regional research suggests that the efficiency of these ponds may be less than nationally reported (Messersmith, 2007). It is important to note that BMP efficiency is dependent upon several factors including: storm characteristics (rain volume, intensity, frequency), pond age, pond size, and pond design (length:width, placement of inlet and outlet) (SCDHEC-OCRM, 2007). In addition to the broad question of regional efficiency of stormwater ponds, other more specific concerns suggest a need to re-evaluate the impact of stormwater ponds on water quality. Since ponds are designed to retain stormwater, they receive high loadings of nutrients, pesticides, chemicals, and fecal coliform (SCDHEC-OCRM, 2007). As a result, the surface waters and sediments of these ponds become compromised and can lead to problems such as harmful algal blooms (HABs) or fish kills within the ponds. These conditions can be expected (given the purpose of the pond) and may not necessarily be problematic, however, these ponds attract humans and wildlife, and there is often exchange between the pond and adjacent tidal creeks. These conditions can create a health hazard for those exposed to the pollutants (e.g., toxins and pathogens). In addition, these ponds are oftentimes neglected and not regularly maintained, which leads to sedimentation, reducing the storage capacity of the ponds over time and the discharge of polluted water to adjacent water bodies (Messersmith, 2007).

LIMITATIONS OF STORMWATER PONDS



Attendants of the workshop felt that maintenance was the biggest disadvantage to stormwater ponds (33%). It was noted that pond failure is not apparent and ponds are generally maintained for aesthetics, as opposed to LID practices where lack of maintenance may lead to flooding; therefore, the maintenance of ponds can be easily overlooked. Oftentimes the costs associated with pond maintenance can serve as a disincentive to Homeowners Associations (HOAs); therefore there is an educational need to inform the homeowners on the importance of maintaining their ponds. Most notably, there is a lack of monitoring and enforcement of pond maintenance which must be addressed through education and the development of maintenance guidelines for local municipalities. Additional disadvantages that were noted included: water volume impacts of ponds (20%) (e.g., conveying stormwater to one location rather than promoting natural infiltration and groundwater recharge throughout a site), the collection and concentration of pollutants (18%), and variable efficiency of ponds (13%). The attendants were also concerned about sediment contamination (9%), fecal coliform bacteria (4%), and the fact that ponds are a poor solution to small sites and can be seen as a waste of developable land (3%).

OPTIONS TO ADDRESS LIMITATIONS OF STORMWATER PONDS



Generally speaking the attendants felt that there was a need to address concerns associated with ponds either through providing an alternative to ponds or retrofitting a pond through the use of other BMPs, stringent pond design guidelines, or addressing maintenance educational needs. The majority of responses suggested that ponds should be used in concert with other BMPs (38%) to minimize the quantity and improve the quality of stormwater leaving a site. One engineer noted that a pond in the Lowcountry was not capable of achieving the regulatory standards of discharging stormwater over 24 hours due to the low relief and shallow water tables of this area. Therefore, by incorporating ponds as one component of a stormwater management plan one can benefit from the advantages of ponds while also improving the performance of a stormwater treatment system of a site. Respondents also felt that the issues related to ponds are primarily due to a lack of maintenance, which if addressed could improve the

performance of ponds (27%). Specifically there is a need for better enforcement of maintenance plans and education of the homeowners. Additional options for improving the performance of ponds were suggested including: forebays (15%), better pond design (9%), flow control devices (7%), littoral shelves (3%), and addressing the design criteria (e.g, design storm event) of ponds (1%).

LID PRACTICES

Low Impact Development (LID) strategies integrate the use of site planning (e.g., clustering, reducing impervious cover, preservation of open space) and alternative stormwater management strategies (e.g., bioretention swales, pervious pavement, rain water harvesting) to promote the infiltration and retention of stormwater runoff at the source to foster maintenance of a sites' pre-

Table 1: 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	UNH Stormwater Center, 2007	81% (peak flow)	72%	16% (Total)	54% (DIN)	93% (Total Zn)	83% (Total HMW PAHs)
Single Detention Pond	Messersmith, 2007	7.5% (volume)	19%	-6% (Total)	-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 & White, 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
	Davis, 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
	Dietz & Clausen, 2008	No change in volume from 0 to 21% impervious cover	n/a	No change in TP export from 0 to 21% impervious cover	No change in TN export from 0 to 21% impervious cover	n/a	n/a

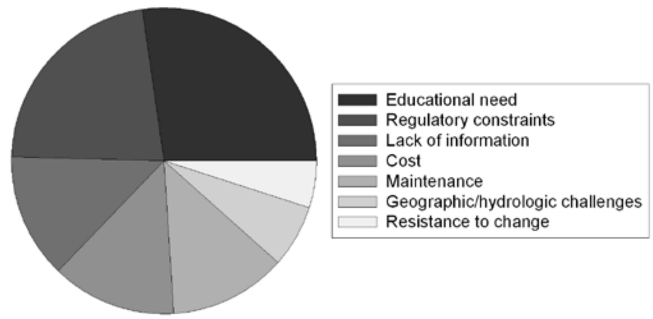
development hydrologic condition (Prince George's County DER, 1999). For the purposes of this report, subsequent use of the term LID practices will refer to the stormwater management technologies utilized to minimize the impact of development on a site.

LID practices were first implemented in Prince George's County, Maryland in the 1990s. Since then, there have been a handful of research projects to evaluate the efficiency of these LID practices in reducing stormwater runoff and maintaining pre-development discharge rates. These projects have found that bioretention swales, pervious pavement, surface sand filters, vegetated roof tops, and gravel wetlands are effective at reducing runoff rates and removing selected pollutants (e.g., total suspended sediments (TSS), nutrients, metals, polyaromatic hydrocarbons) from stormwater runoff (EPA, 2000; Hsieh and Davis, 2005; Hunt and White, 2006; Roseen et al., 2006; UNH Stormwater Center, 2007; Dietz and Clausen, 2008). LID practices can generally reduce stormwater peak flows and pollutant loads to levels similar to traditional stormwater management techniques (e.g., detention ponds), suggesting they may be a reasonable alternative to ponds (Table 1) (EPA, 2000, UNH Stormwater Center, 2007; Dietz and Clausen, 2008).

Although there have been several studies that suggest LID practices may be a useful alternative to traditional stormwater management, these studies were conducted in areas outside of the Southeast coastal region and may not apply to regional soils and shallow water tables. Subsequently, scientists, developers, managers, and engineers alike are uncertain whether LID systems will be efficient at retaining stormwater volume and pollutants along the Southeastern coast where soil storage is generally minimal and rain events are flashy and oftentimes intense. The regional geographic and hydrologic limitations of the Southeast coast have also resulted in a suite of perceived and real concerns among the professional stormwater community regarding the use of LIDs. Consequently the prevalence of LID practices is limited along the Southeast coast.

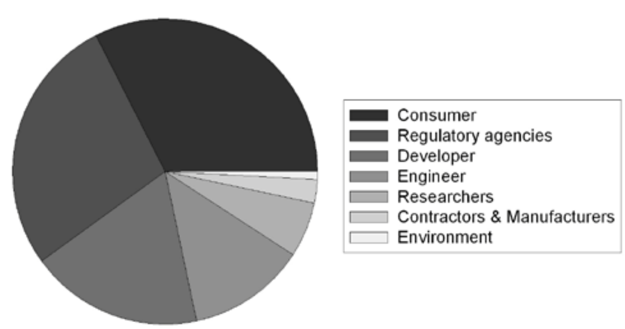
When questioned about the obstacles that may inhibit the regional implementation of LID practices, workshop participants indicated that the educational needs of stakeholders (27%) and the regulatory process (22%) were the primary obstacles. Participants suggested that there is a need for education across all sectors including consumers, developers, engineers,

OBSTACLES TO UTILIZING LID PRACTICES



and local elected and municipal officials. Most notably there is a need for marketing of LID to promote their implementation. From the regulatory side, the lack of collaboration between SC Department of Health and Environmental Control (SCDHEC), local municipalities, and intra-governmental departments of those municipalities (e.g., fire, building codes, zoning, planning) creates initial obstacles when attempting to implement something new and unfamiliar, such as LID practices. The creation of guidelines for the design, permitting, and maintenance of LID practices would assist in the intergovernmental struggles between the state and local municipalities. Participants also suggested a need for flexibility in federal and state regulations to accommodate regional needs and provide "regulations based on science," rather than their current prescriptive basis. Additional identified obstacles included a need for information (e.g., standard models and guidelines), the costs associated with LID, maintenance issues, regional geographic and hydrologic challenges, and a general resistance to change.

STAKEHOLDERS THAT HAVE THE BIGGEST INFLUENCE ON LID IMPLEMENTATION

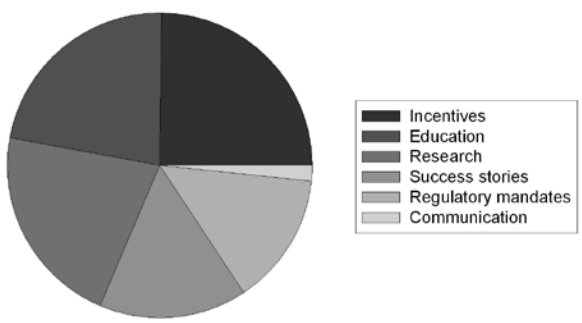


When questioned about which stakeholders would have the potential to influence the implementation of LID practices, participants suggested that both consumers (33%) and regulatory agencies (28%) would have the biggest impact. It is necessary for the consumers to have initial buy-in to LID practices then

regulatory backing of those stormwater features would assist in the selection of LID over more traditional stormwater features and improve the permitting process. Given the support of the consumer and the regulatory agencies, developers and engineers would make the choice to select, design, and implement the use of LID practices within their development.

Participants suggested that the creation of incentives (e.g., bonus density, tax incentive, expedited review, flexibility in enforcement while LIDs are new, lower impact fee, stormwater comprising a greater component of LEED certification) would offer an opportunity to increase the prevalence of LID practices

OPTIONS FOR INCREASING LID USE



in the region (25%). Specifically, it was suggested that linking LIDs with LEED certification could serve as a marketing tool for LID practices among developers, engineers, and contractors/suppliers. Since the consumer must initially buy-in to LID practices, it was also suggested that there may be a need for incentives for the consumer (e.g., reduced stormwater utility bill for treating stormwater on site). Due to the lack of knowledge and information regarding the regional use of LID practices, education (22%), research (21%), and success stories (16%) are needed to provide the information and knowledge dissemination necessary to promote the use of LID practices. This information should be disseminated at all levels and through forums such as: Urban Land Institute, American Society of Civil Engineers, American Society of Landscape Architects, American Planning Association, Carolina Clear, and Lowcountry Earth Force. Participants also felt that regulatory mandates (14%) would assist in the regional implementation of LID practices, but there is a need for regionally relevant information to support such mandates. It was also noted that the internal politics of municipalities can serve as an obstacle to implementing LIDs; therefore, increased communication between municipal departments would assist in their implementation (2%). Until then, Planned Unit Developments (PUDs) can serve as an amendment to local zoning and a means for implementing LID practices within larger developments.

CONCLUSION

Input at the workshop from stormwater professionals and regulatory officials demonstrated agreement that ponds will continue to be a feature of future stormwater treatment systems; however, there is a need to address the current limitations of ponds. Specifically there is a need to address pond maintenance through homeowner education and regulatory enforcement. In addition, ponds should be coupled with additional BMPs (e.g., created wetlands, LID practices, grassy swales) to enhance the retention and removal of stormwater and its associated pollutants leaving a site. Overall, participants agreed that stormwater management cannot be addressed through a "one-size-fits all" prescriptive approach. Instead there needs to be flexibility in state and local regulations to allow for site scale management of stormwater based on the needs of a particular location (e.g., stormwater quantity or quality control) and the hydrologic conditions of the site (e.g., water table depth, soil storage capacity, soil infiltration rates, proximity to adjacent water bodies).

Participants agreed that LID practices may be a reasonable addition to ponds; however, such alternatives to ponds should not be mandated at this time because there are still too many questions and uncertainties related to their performance, construction, and maintenance. Instead there needs to be more research, success stories, education of all stakeholders, and incentives to promote the implementation of LID practices.

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