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The Status of Low-Impact Development (LID) Adoption in Connecticut

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Abstract

The comprehensive plans and land use regulations of 85 of Connecticut's 169 municipalities were reviewed for language related to low-impact development (LID) during the spring and summer of 2016. The assessment, based on a framework developed by the University of Connecticut's Nonpoint Education for Municipal Officials Program, was performed to check progress toward LID adoption prior to the 2017 implementation of new statewide Municipal Separate Storm Sewer System (commonly known as MS4) rules that include a much stronger emphasis on LID than in the past. Follow-up telephone interviews were then conducted with 78 individuals involved in the land use planning process in 74 of these towns to gain insight into specific obstacles and motivations influencing LID adoption. It is clear that LID had established a presence in the state prior to any statewide regulatory requirement. All 85 towns have integrated some form of LID, as broadly defined, into their plans and regulations, although in many cases the practices identified were conservation practices (e.g., tree conservation, open space preservation) not specifically focused on stormwater management. Almost every interviewee (76) noted that at least some support for LID existed in their communities. By far the most common motivation cited for the adoption of LID policies was the work of either staff or land use commission "champions." This was followed by general concern for protecting the environment and addressing stormwater issues. The most common obstacles to implementing LID were the perceived higher costs of LID practices and a lack of educational opportunities. Recommendations from community officials for furthering LID in Connecticut included more learning opportunities, economic incentives, stronger state regulations, and improved local interdepartmental communication.

Background

Connecticut is at least 25 years into an era of water resource protection that recognizes the importance of dealing with stormwater runoff to protect water quality. Low-impact development (LID), also increasingly called green infrastructure or green stormwater infrastructure, is a major strategy to address these issues. The University of Connecticut Center for Land Use Education and Research (CLEAR) has a long history of assisting towns with land use planning and stormwater management, dating back to the advent of the Nonpoint Education for Municipals Official (NEMO) program in 1991 (Arnold et al. 2000). The efforts of NEMO and other programs and organizations, however, have taken place in a setting that offers few regulatory "sticks" and just as few funding "carrots" for towns embarking on the arduous task of overhauling their plans, regulations, and standard practices.

Connecticut has no county government, and land use regulation is done almost entirely at the municipal (town or city) level (Connecticut Department of Energy and Environmental Protection 2009). Decisions are made by volunteer land use boards such as planning, zoning, and inland wetlands commissions, and in many of the smaller towns, these commissions are not supported by even one full-time staff member.

In the case of stormwater, Connecticut had only one community, Stamford, that was included in the rollout of Phase I of the Clean Water Act's Municipal Separate Storm Sewer System (MS4) regulatory program in 1990. A total of 113 towns were subsequently included in the MS4 Phase II General Permit issued in 2004 and reissued in 2009 and 2016 (Connecticut Department of Energy and Environmental Protection 2004b, 2009, 2016). While the 2004 permit requirements called for towns to develop a program to reduce impervious surface and require appropriate infiltration practices, it did not specifically mention or require the use of LID practices or approaches. Towns were given wide discretion to determine how to fulfill those broad requirements.

Similarly, in 2004 the Connecticut Department of Environmental Protection (now the Department of Energy and Environmental Protection) released the Connecticut Stormwater Quality Manual as a planning tool and design guidance for stormwater quality management (Connecticut Department of Energy and Environmental Protection 2004a). While providing some guidance on infiltration practices, it similarly did not mention LID. A subsequent amendment focused on LID was released in 2011, but again was meant merely as guidance and was not tied to the requirements of the MS4 General Permit.

The present study was conducted to assess whether towns in Connecticut were encouraging, requiring, or discouraging LID approaches in their land use regulations and their motivations for doing so. Coincidentally, the study was conducted at a point when this situation was about to undergo a major change. The Connecticut Department of Energy and Environmental Protection had proposed, and has since finalized, a much more targeted MS4 General Permit with a strong focus on establishing LID as the preferred approach to stormwater management. Eight new towns, along with state and federal institutions of a certain size, were added to the program. All permitees are now required to (1) remove any impediments to LID use in their land use regulations, (2) establish LID as the preferred approach to stormwater management where possible, (3) establish a retrofit program to disconnect 1% of impervious cover from the stormwater system per year, and (4) require the on-site retention of a specified amount of runoff for developments and redevelopments or funding to cover a similar amount of runoff reduction elsewhere (Connecticut Department of Energy and Environmental Protection 2016). With these changes forthcoming but not yet in effect in 2016, it was an advantageous time to assess the extent of LID policy implementation in municipalities across the state.

Study Terminology and Overview

LID is an approach to development that promotes absorbing rainwater into the ground (i.e., infiltration) and minimizing runoff using systems integrated with the natural environment. Green stormwater infrastructure is increasingly being used to refer to this approach, at least partly to distinguish these site-level practices from "green infrastructure," a term that includes broader landscape-scale practices (US Environmental Protection Agency 2012). However, in this study and in this article, LID was used as the default terminology because it had by far the longest track record in town documents and broader recognition factor among local officials.

This study was conducted in two phases. The first phase was a review of the plans and regulations of 85 Connecticut towns for references to LID or LID policies and focused on the "what" and "how much" of LID adoption. The second phase, focusing on the "why" of adoption, involved collecting on-the-ground experiences with LID policy adoption via phone interviews involving 74 towns, in an attempt to capture real-world problems and successes with LID implementation.

Methods, Phase One: Status of LID in Municipal Plans and Regulations

The study authors reviewed the plans and regulations of 85 Connecticut towns (Figure 1) through Internet research. The number of towns included was restricted by available CLEAR resources and was not a true random sample, but rather a selected representation. The study began with towns that were known by the NEMO team to have a history of working on or at least considering the use of LID. As additional resources were provided and the scope of the study expanded, the list of towns was expanded to ensure that the overall pool was more representative; additional towns represented all nine regional councils of government in the state, as well as a wide range of population sizes and economic status. Because of the way the towns were

Table 1. Town plans and ordinances were reviewed for consistency with these specific 14 low-impact development practices.

LID Practice	
1. Street Width	Design residential streets for the minimum required pavement width needed to support travel lanes, on-street parking, emergency services and maintenance access. (25 out of 85 towns)
2. Cul-De-Sacs	Minimize the number of residential cul-de-sacs and, where they do exist, incorporate landscaped areas to reduce impervious cover and encourage infiltration of stormwater runoff. (21 out of 85 towns)
3. Road Drainage	Where density, topography, soil and slopes permit, vegetated swales should be used in the street right-of-way to convey and treat stormwater runoff, replacing curb and gutter drainage systems. (34 out of 85 towns)
4. Parking Size	Required parking ratios governing a particular land use or activity should be enforced as both a maximum and a minimum in order to curb excess parking construction. Further, reduce the overall imperviousness associated with parking lots by minimizing stall dimensions and incorporating efficient parking lanes. (44 out of 85 towns)
5. Parking Runoff	Wherever possible, provide stormwater treatment for parking lot runoff using bioretention areas, filter strips and/or other practices that can be integrated into required landscaping areas and traffic islands. (41 out of 85 towns)
6. Conservation/Open Space Subdivision	Encourage development designs that minimize total impervious area, reduce total construction costs, conserve natural areas, and provide community recreational space and promote watershed protection. (76 out of 85 towns)
7. Setbacks and Frontages	Relax side yard setbacks and allow narrower frontages to reduce total road length in the community and overall site imperviousness. Relax front yard setback requirements to minimize driveway lengths and reduce lot imperviousness. (20 out of 85 towns)
8. Sidewalks	Promote more flexible design standards for residential sidewalks on only one side of the street and provide common walkways linking pedestrian areas, use permeable pavement. (44 out of 85 towns)
9. Driveways	Reduce overall lot imperviousness by promoting alternative driveway surfaces and shared driveways that connect two or more homes together. (28 out of 85 towns)
10. Roof Runoff	Direct roof runoff to pervious areas such as yards, open channels, or vegetated areas and avoid routing rooftop runoff to the roadway and the stormwater conveyance system. (20 out of 85 towns)
11. Stormwater Management Plan	As a minimum, a stormwater management plan should be required for sites that have disturbance equal to or greater than one acre, as proposed by the CT Stormwater Quality Manual. The purpose of the plan is to identify potential water quality and quantity impacts of the proposed development, and to propose selected source controls and treatment practices to mitigate against those impacts. (65 out of 85 towns)
12. Riparian Buffers	Riparian Buffers: Create a naturally vegetated buffer along all water resources that also encompasses critical environmental features such as the 100-year floodplain, steep slopes, and wetlands, which should be preserved or restored with native vegetation. (59 out of 85 towns)
13. Clearing and Grading	Clearing and grading of forests and native vegetation at a site should be limited to the minimum amount needed to build lots, allow access, and provide fire protection. (43 out of 85 towns)
14. Tree Conservation	Conserve trees and other vegetation at each development by protecting trees and other vegetation during construction and by planting additional vegetation, clustering tree areas, minimizing native vegetation disturbance, and promoting the use of native plants. (71 out of 85 towns)

chosen, the statistics generated by the study should not be extrapolated to the entire state. Despite this limitation, the results can be considered to be robust and informative, with slightly more than 50% of Connecticut's 169 municipalities surveyed.

To examine town plans and regulations, the authors compiled relevant documents through "manual" searching of municipal websites and made use of general search engines. Documents analyzed included plans of conservation and development (comprehensive plan), zoning regulations, subdivision regulations, wetland and watercourse regulations, road standards, and any stormwater- or LID-specific documents (such as guides, checklists, or design manuals) that were discovered. Findings were recorded in a spreadsheet, along with a source note indicating the exact location of each policy.

The documents were searched for key words and phrases related to LID policies. First, each town's documents were reviewed for any general references to "reducing impervious surfaces" or "LID." This was to give a very general feel for whether the issue of LID was addressed at all in town documents. Second, the researchers looked for specific policies related to LID. Although the state has published the Connecticut Stormwater Quality Manual (Connecticut Department of Energy and Environmental Protection 2004), which includes an LID appendix added in 2011, no statewide guidance provides draft language or an overarching LID policy that towns can easily adopt. Although some towns refer developers to their own in-house LID design guidelines, the more common approach is to integrate LID into the many relevant plans and regulations comprising the town's land use policies. *Developing a Sustainable Community: A Guide to Help Connecticut Communities Craft Plans and Regulations That Protect Water Quality*, a guide prepared by the NEMO program, outlines many of these strategies (Rozum 2009). The guide is organized around two general LID and 14 specific policies that are divided into three general land use planning topics: residential streets and parking, lot development practices, and conservation of natural areas. As a result, the project team decided to use these 16 policies as the basis for evaluating town comprehensive plans, regulations, or ordinances for LID adoption and comparing the results among towns (Table 1).

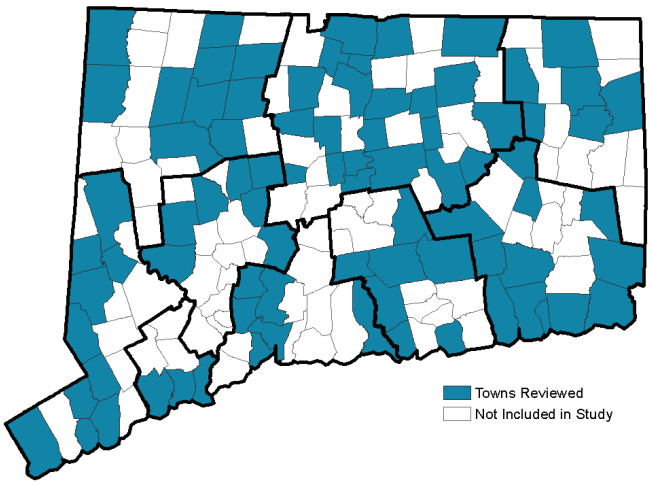

Figure 1. Plans and ordinances were reviewed for the towns highlighted in blue.

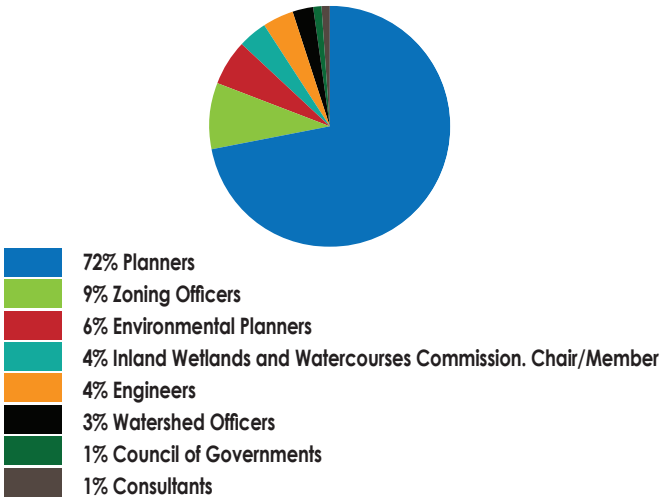

Figure 2. Composition of town staff interviewed as part of this study.

Methods, Phase Two: The View from Practitioners

To gain a better understanding of the on-the-ground realities behind the inclusion of LID in town plans and regulations, 78 confidential telephone interviews involving 74 of the 85 reviewed towns were conducted (Figure 1). All of the towns reviewed as part of Phase One were invited to participate in the interviews but not all were able or willing to do so.

The pool of interviewees included town planners, zoning officers, wetlands officers, Inlands Wetlands and Watercourse Commission members, environmental planners, engineers, council of government staff members, and consultant planners. Although the study included a wide array of community perspectives, town planners were the chief target

and contributed a majority (72%) of the responses (Figure 2). Information collected in the interviews was limited to opinions of the individual and did not necessarily reflect the views of the majority of officials in any particular town.

Each telephone interview used a semi-structured interview approach (Cohen and Crabtree 2006) and ranged from approximately 10 to 30 minutes. Interviews were loosely structured conversations focused on three main questions (Table 2), along with impromptu follow-up questions based on the responses and findings from the Phase 1 regulation review. Verbal responses were categorized by question, and the results were recorded using a Google Form so that all interviews were recorded into a common database, which was reviewed for commonalities between responses to the three main questions. Similar responses were then grouped into broader categories based on similar ideas, driving forces, and/or obstacles.

Table 2. Semi-structured interview questions.

Main Interview Questions
1) Does your community encourage/require the use of low impact development or green infrastructure to deal with stormwater? And if so, in what ways?
2) What would you say are the factors driving your community to encourage (or not encourage) LID?
3) What are the biggest obstacles to implementing LID regulations or practices in your town?

Results: Phase One

The majority of town regulations and plans reviewed indicate a broad awareness of LID approaches and an interest in reducing impervious surfaces. Of the 85 towns reviewed, 65 (76%) mentioned reducing impervious surfaces and 54 (64%) specifically mentioned LID in their plans or regulations. This suggests a fairly widespread understanding of the effects of impervious surface runoff on water quality. However, the picture changed slightly as the focus shifted to examining specific policies aimed at translating that general awareness and interest into practice.

Overall, of the 14 policy approaches, the three most common were conservation or open space subdivisions, tree conservation, and the requirement of stormwater management plans that address stormwater quantity and quality impacts for developments of a certain size (Table 3). More than 85% of towns included in the review implemented one or more of these strategies. Although these three share the broader goals of reducing imperviousness and addressing stormwater, they are not specifically focused on LID practices or the disconnection of impervious surfaces from the stormwater system.

Table 3. Type and number of specific LID practices found in town regulations.

LID Practices by Number of Towns Adopted		
1. Conservation/Open Space Subdivision	(76 out of 85 towns)	89%
2. Tree Conservation	(71 out of 85 towns)	84%
3. Stormwater Management Plan	(65 out of 85 towns)	76%
4. Riparian Buffers	(59 out of 85 towns)	69%
5. Parking Area	(44 out of 85 towns)	52%
6. Sidewalks	(44 out of 85 towns)	52%
7. Clearing and Grading	(43 out of 85 towns)	51%
8. Parking Runoff	(41 out of 85 towns)	48%
9. Road Drainage	(34 out of 85 towns)	40%
10. Driveways	(28 out of 85 towns)	33%
11. Street Width	(25 out of 85 towns)	29%
12. Cul-De-Sacs	(21 out of 85 towns)	25%
13. Roof Runoff	(21 out of 85 towns)	25%
14. Setbacks	(21 out of 85 towns)	25%

By contrast, for instance, the highest adoption rate among specific site-level policies or practices was for reduced sidewalk and parking requirements, adopted by approximately 52% of municipalities. Other LID practices specifically addressing impervious surfaces—such as minimizing parking runoff, promoting shared driveways, narrowing street widths, and altering cul-de-sac design to allow for infiltration—were codified in less than half of the towns. The two least common LID applications were regulations to reduce roof runoff and regulations to relax setback and frontage requirements. These appeared in the plans or policies of approximately one out of every four towns in the study.

The number of LID practices adopted per town varied widely. Nearly half of the towns (41) have adopted a majority

(9 or more) of the 16 policies identified in NEMO's guide on developing a sustainable community. Of those 41 "heavy adopters," 12 towns (14%) have adopted the vast majority (13 or more) of the identified LID policies. Conversely, 44 of the reviewed towns have adopted 8 or fewer of the recommended policies, with 11 adopting 4 or fewer (Figure 3).

These results were reviewed in relation to population size and median home price values for each town to determined whether there were any connections between a town's size or wealth and either high or low likelihood of LID policy adoption. Although a complete correlation analysis was not conducted, no obvious connection was found. Wealthy or more populous towns were not significantly more or less likely to have adopted the 16 LID policies than less wealthy or less populous towns.

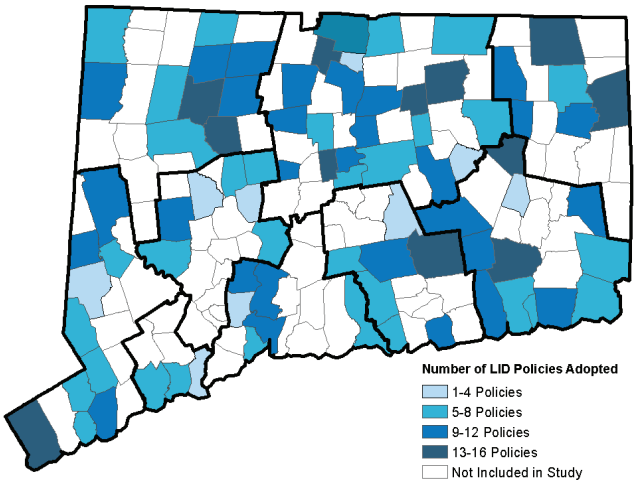

Figure 3. Number of LID-friendly policies/regulations adapted by towns investigated in the study.

Results: Phase Two—Decision-Maker Interviews

Interviewees were asked: What are the factors driving your community to encourage (or not encourage) green infrastructure/LID? Their answers were then categorized and compiled based on the type of response.

The five most common answers are shown in Figure 4. Interviewees repeatedly named staff and/or commission "champions" as reasons for implementing LID. Two-thirds of the towns (49 of 74) said that these individuals played a particularly strong role in promoting LID adoption, whether through pressing the topic with developers in commission meetings or advocating for its integration in town regulations. This finding is consistent with NEMO's first-hand experience after more than 25 years of working with towns on these issues: the towns most likely to embrace LID are those with a knowledgeable LID champion(s) consistently advocating for its inclusion in plans, regulations, and specific development projects. Similarly, studies of regulations in other states have found that one of the barriers to LID adoption is a lack of political will (i.e. a lack of local champions) (Roseen et al. 2011).

Environmental motives and stormwater concerns were also named as major reasons for acceptance of LID.

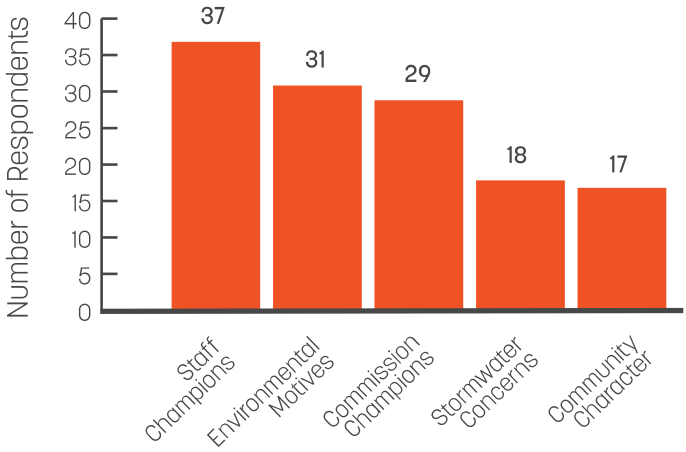

Figure 4. Factors driving adoption or inclusion LID practices in local plans and regulations as identified in this study.

Environmental rationale for LID included stewardship of local water sources (either specific local waterbodies, such as Long Island Sound, or water resources more generally) and an overall desire to protect the environment. In contrast, stormwater concerns centered more on specific issues, such as flooding, erosion, and sedimentation control. Finally, the list of top five drivers includes a desire to protect overall community values and community character.

After the discussion on motives, interviewees were asked: What are the biggest obstacles to implementing LID regulations or practices in your town? The top five barriers are listed in Figure 5.

Two barriers dominated the responses. First, interviewees listed the higher cost of LID as a major barrier. The term "higher costs" in this context has several meanings. Some individuals cited higher cost as a fact, while most mentioned the *perception* of higher cost among developers and commission members as a barrier. The difference between fact and perception speaks directly to the second most commonly cited barrier: the lack of educational opportunities. Thirty-eight percent of respondents mentioned the need for more learning opportunities for a variety of audiences if LID adoption was to continue. In particular, several interviewees indicated that that many engineers and public works employees are wary of LID because they are unsure of how to install and maintain the practices and/or feel these practices are still unproven. Town planners also indicated a need for more education on LID for themselves and a resulting unease in whole-heartedly recommending or championing LID. The need for education for the general public was also mentioned.

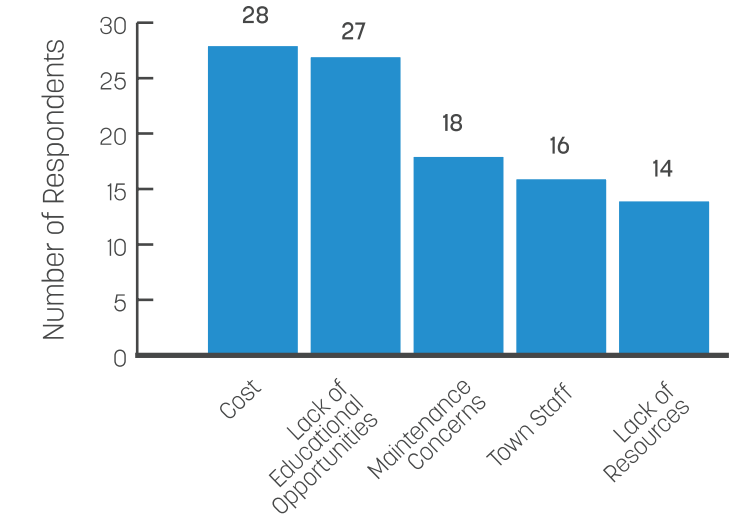

Figure 5. Top 5 barriers to LID adoption as identified in this study.

Maintenance concerns were also a recurrent theme. Interviewees explained that often times it is unclear where the responsibility lies for the long-term care of LID sites, especially in residential settings when properties change hands, and how to ensure that maintenance is carried out such that LID installations continue to function. Furthermore, respondents mentioned a disparity in comfort level between town maintenance of conventional stormwater systems and the maintenance required by LID practices.

Other obstacles included individual town-staff resistance, lack of resources, lack of economic incentives, the need for clearer/stronger state guidance, and the difficulty of collaboration, whether between departments within one town or across town lines. All of these obstacles are largely consistent with what has been found in other states (Clean Water America Alliance 2011; Roseen et al. 2011; Vail and Meyer, 2012).

Discussion

Phase One of this study attempted to identify the status of LID in town plans and regulations in Connecticut. With data collected on 85 of the state's 169 municipalities, the results demonstrate that LID and the idea that impervious cover is connected to water quality have established a presence in the plans, regulations, and practices of many towns. A majority of the towns examined specifically mention LID and/or reducing impervious cover in their land use documents. Further, Phase Two interviews revealed that only 2 of 78 respondents from the 74 towns included said that they have not encouraged LID in any form and have no future plans for incorporating the practice into their regulations.

While the overall message about the connection between land use and water quality appears to have taken hold, specific requirements to use LID practices are less common. The most common strategies that Connecticut municipalities have used to promote LID in their town documents are more broad-based conservation practices, such as tree conservation and conservation subdivision regulations. Less frequently, towns employ practices that are more recognizable site-level LID features, such as porous pavement, shared driveways, and cul-de-sacs that allow for infiltration. Still, almost half of the towns sampled had a majority of the LID practices tracked in this study (9 or more out of 16) codified in their plans and regulations.

Phase Two of this study revealed that a wide range of motives affect the incorporation of LID considerations into town documents, as well as the actual implementation of LID in the field. Town champions, whether at the staff or commission level, appear by far to be the strongest driver behind LID adoption and integration. Overall concern for the environment and stormwater management also appears to be a strong motive. Phase Two also illustrated that towns

also face significant barriers to LID implementation. The top barriers cited were the perception that LID is more costly than conventional systems and the lack of educational resources targeted at specific audiences.

An important observation is that there appears to be a disconnect between what is "on the books" in plans and regulations and what is practiced "on the ground." In other words, the level of commitment to LID in plans and regulations did not necessarily correspond to the level of LID adoption occurring in actual practice. Interviews revealed that some towns that rated high in the Phase One research did not appear to have many actual installations of LID, while other towns with a low Phase One rating had implemented quite a few LID practices, apparently facilitated via "informal" procedures rather than codified regulations. This serves to emphasize the "champion factor" identified in the interviews as a motivator. However, it also highlights the danger of relying on champions. Once those champions are gone, if the practices are not supported by town plans and regulations, will they be continued?

This study itself has now become a part of the ongoing LID education in Connecticut, as the state transitions to the new regimen ushered in by the revised MS4. The LID regulation examples have been compiled into an online storymap at http://s.uconn.edu/stateofLID. Towns can use the storymap to search for regulatory language from other towns that they can then incorporate into their own LID regulations, thereby meeting their obligations under the new General Permit.

Conclusions

As noted, the results of this survey cannot be assumed to characterize the complete LID story in Connecticut. However, approximately half of the state's towns were included, and the major findings represent strong themes that were consistently and widely expressed.

The state of LID in Connecticut is at an interesting point. More than 25 years have passed since these concepts were first introduced (although somewhat less than that since "early adopter" towns experimented in their on-the-ground implementation). As this research shows, LID practices as codified through town documents are often still restricted to methods that have their genesis in broader conservation efforts. This is not a bad thing by any means. However, there is a slower adoption rate for the more stormwater-specific practices that most have come to equate with the terms LID or green stormwater infrastructure.

These interview results indicate that for the most part, the LID concept is familiar at the local level, and the interest is present. Where adoption has occurred, it has most often been the work of local staff or commissioners (or others) that champion the LID cause and maintain the pressure and/or momentum for change. This confirms the convictions of the CLEAR/NEMO team based on more than 25 years of experience working with communities on land use issues. Where adoption is slow or nonexistent, the prime barriers are cost and education. In some cases the higher cost may be quite real, but in others it is a perception that could be managed by addressing the other prominent barrier, lack of education. Many other barriers—such as maintenance concerns and "push-back" by town staff, developers, or the public—are also issues that can be addressed through education and technical assistance.

It is also instructive that the carrot approach of educating towns, professionals, and others about LID and encouraging its use has been more effective in getting those concepts broadly integrated into plans and regulations, but less so in codifying a change in the default approach by which stormwater is managed. Perhaps this is where the barriers of cost and lack of education for various stakeholders in the land use planning process have had more sway. Much of that will likely change now that Connecticut's new MS4 General Permit compels towns to more specifically require the use of LID to address stormwater runoff.

However, even with these permit requirements, continued education is necessary. For towns to fully implement this new standard, the same educational challenges must still be addressed, with not only town staff provided the necessary education, but also developers, engineers, and contractors. If not integrated into land use regulations properly, properly installed, or properly maintained, the systems will fail, potentially creating the misconception that "LID doesn't work here". If these challenges are met, Connecticut appears to be poised at a "tipping point" in which LID could soon become the norm rather than the exception.

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