Managing Stormwater in Redevelopment and Greenfield Development Projects Using Green Infrastructure

Economic Factors that Influence Developers' Decisions

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ECONorthwest specializes in economics, planning, and finance. Founded in 1974, we're one of the oldest independent economic consulting firms in the Pacific Northwest. We have extensive experience applying rigorous analytical methods to examine the benefits, costs, and other economic effects of environmental and natural resource topics for a diverse array of public and private clients throughout the United States and across the globe.

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We gratefully acknowledge the assistance of the many individuals who provided us with information and insight in this project. We emphasize, however, that we, alone, are responsible for the report's contents—they do not necessarily represent the opinions of the other individuals involved in this research. We have prepared this report based on our synthesis of the interviews and literature search conducted in the scope of this project, and from our general knowledge of economic principles.

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I. INTRODUCTION AND SUMMARY

Low-impact development and green-infrastructure (LID) are viable strategies for managing stormwater, as reflected by the increasing number of jurisdictions that are either encouraging or requiring their use. As the U.S. EPA develops regulations for controlling non-point-source pollution from stormwater runoff, it is considering requiring local jurisdictions to implement stronger stormwater standards.[1] Among the options it is considering is a volume-based standard that will drive the use of LID more broadly nationwide.

There is currently disagreement as to whether strong stormwater standards uniformly applied across development types would have an impact on where and how development occurs. Some regulators and interest groups have raised concerns that widespread, uniform mandates for stronger stormwater controls, including LID, would undercut efforts to reduce sprawl and to direct future development into already-urbanized areas. These concerns arise from a premise that stronger stormwater controls, and LID in particular, are more expensive to integrate into redevelopment than greenfield development because of site constraints, land costs and other regulatory factors. Facing these increased costs, it is argued, developers may focus their resources on greenfield development and reduce their investment in redevelopment projects. This shift could have unintended, adverse consequences for water quality in the long run by increasing the overall amount of impervious areas in a given watershed.

Other interest groups share concerns about the adverse environmental effects of sprawl, but suggest that the data do not support claims of prohibitive cost and diversion of development to greenfields allegedly caused by strong stormwater requirements. These advocates note that the development process is complex and motivated by a range of factors, many which are highly site-specific, and that no one factor drives decisions on the location and type of development. Further, they argue that, the economic benefits of a stormwater standard—particularly if it requires the use of green infrastructure—will provide economic and livability benefits that will actually encourage the redevelopment of existing communities rather than push development to greenfields.

Smart Growth America (SGA), in collaboration with American Rivers, the Center for Neighborhood Technology, River Network, and the Natural Resources Defense Council, asked us to investigate what impact, if any, strong stormwater regulations that require or encourage LID techniques, uniformly applied to greenfield development and redevelopment, would have on developers' decisions about where and how to build. We approached this project by reviewing relevant literature and interviewing jurisdiction staff and individuals in the development community on these topics:

[1] Throughout this report, we refer to "stronger stormwater standards" to mean water-quality and/or volume standards that require developers to manage the majority of stormwater runoff from impervious surface conversion on-site, ideally using infiltration or retention techniques. The three jurisdictions we focus on in this report recently adopted stronger stormwater standards, relative to what they required previously, and relative to the stormwater controls many jurisdictions in the nation currently require. Each set of requirements is slightly different (see Section II, B for a summary), but in general, they are among the strongest in the nation, and are an indication of the level of stormwater control EPA may consider requiring more broadly as it revises the national stormwater regulations.

- the factors that affect development decisions in greenfield and redevelopment contexts, and the significance of stormwater management in these decision-making processes
- the challenges and benefits of implementing stronger stormwater standards in greenfield and redevelopment contexts
- the range of incentives jurisdictions have implemented or considered to facilitate the adoption of LID in greenfield and redevelopment projects

We focused our inquiry on the developers' decision-making process in three jurisdictions that have recently implemented stronger stormwater standards for retention and/or water-quality treatment, and allow or require consideration of LID or Environmentally Sensitive Design (referred to here as LID): Montgomery County, Maryland; Philadelphia, Pennsylvania; and Olympia, Washington. We first reviewed the literature on the topics above and each jurisdiction's efforts to implement stronger stormwater controls. We then interviewed members of the development community and permitting and planning staff in each jurisdiction to focus on specific issues the existing literature does not sufficiently address.

This report presents the information we have collected on these topics. We organize our findings into seven broad conclusions that inform the primary research question. We summarize them below. We elaborate on each with evidence from the literature and interviews in the following sections. Appendix A presents a bibliography, and Appendix B lists the individuals we interviewed and consulted during this project.

1. Developers are successfully incorporating stronger stormwater controls to meet strict volume-reduction and water-quality standards in both redevelopment and greenfield projects.

Our study found that some developers can and do meet stronger stormwater standards in both redevelopment and greenfield projects. Interviewees who had completed developments that met stronger stormwater standards using LID indicated that doing so required creativity and willingness to experiment with new approaches to projects. They emphasized that pursuing these projects was not without challenge, but they will continue developing in places that require strong stormwater controls and LID. Developers pointed to a variety of reasons for this choice: the markets they participate in respond favorably to the new stormwater designs; meeting regulations with green-infrastructure techniques could be more cost effective than conventional controls; and for some, they simply believed it was the right thing to do for the environment. Some developers we interviewed had not yet implemented projects under the stronger stormwater standards. Some were skeptical, based on their own initial experiences or other developers they'd talked to, that they could make a project pencil out using LID controls. A minority of interviewees held this perspective. Although staff at each jurisdiction had encountered this opinion, none had actually observed that developers were choosing to invest in greenfield projects over redevelopment projects because of the new standards. This is consistent with other findings in the literature (Leistra, Weiss, and Helman 2010).

2. Complying with stormwater regulations is one factor among many that influences a project's costs. It is rarely the driving factor.

Stronger stormwater standards can affect the costs of both greenfield and redevelopment projects. These costs are folded into a *pro forma* analysis that developers and lenders use to assess the viability of a project. Developers we interviewed revealed that their decision-making process incorporates a wide range of economic factors, including various construction costs, current and future market conditions, regulatory incentives and disincentives, and uncertainty and risk. While some developers we interviewed indicated that the costs associated with meeting stronger stormwater standards may change the types of projects they will pursue in the future, many developers described the cost of implementing stormwater controls as minor compared to the other economic factors they considered in deciding whether or not to pursue a project. This is especially true in the context of highly-complex redevelopment projects and green-building infill projects. In general, stronger stormwater standards increase the costs of implementing stormwater controls, a trend that many of the developers we interviewed have experienced since at least the 1980s. Some developers pointed out, however, that using LID controls has helped offset some of the increased cost, compared to using conventional controls.

3. The costs of stormwater controls in general, and LID controls in particular, tend to be more variable and site-specific for redevelopment versus greenfield development.

The developers we interviewed were reluctant to make specific predictions about the extent to which stronger stormwater controls influence the cost of projects. They emphasized that stormwater designs are highly site-specific, and one solution may be feasible and cost-effective at one site, but infeasible or cost-prohibitive at another site. The conceptual framework in Section II outlines the different factors we identified in the literature and through the interviews that influence the cost of implementing stronger stormwater standards. They underscore the site-specific nature of stormwater-control costs, and explain why implementing stronger stormwater controls in redevelopment projects tends to be more expensive than in greenfield projects.

4. Developers respond to benefits that influence their bottom line. In some cases, these may help offset increased costs of complying with stronger stormwater regulations.

While stronger stormwater regulations and LID controls can provide a range of environmental and amenity benefits, developers generally only respond to those benefits that affect their bottom line. Developers we interviewed suggested that LID controls that helped them comply with stronger stormwater regulations at lower cost, increased the sale price or rent of a project, reduced the time to sale, or all three, would affect their decisions to use LID. Specific examples of LID controls providing economic benefits to developers include bioswales and other vegetative stormwater controls that improve the appearance and market appeal of a development while also reducing overall landscaping costs, and greenroofs that reduce energy costs and the long-term cost of roof maintenance. Developers noted, however, that market demand for projects that include LID stormwater controls have not yet expanded beyond niche markets. Factors such as unfamiliarity with the technology and uncertainty about how to address

operations and maintenance of LID controls limit broader use of LID by developers and demand from consumers.

5. Cost-effective responses to stronger stormwater standards require a more collaborative approach to addressing stormwater management.

Interviewees who successfully implement stronger stormwater controls using infiltration and volume-reduction practices in redevelopment projects emphasize the importance of considering stormwater management at the earliest stages of development, and of integrating professionals' expertise throughout the project. These principles are consistent with the conclusions of the broader literature on green building, which emphasize the importance of collaboration among professionals throughout the design process to achieve reductions in overall costs. These principles are especially important in the success of redevelopment projects, because these projects tend to require more complex, site-specific, and creative solutions to effectively manage stormwater.

6. Market adjustments are already reducing costs of implementing stronger stormwater standards, for both redevelopment and greenfield development, a trend that is likely to continue.

Market adjustments include changes on the supply side that result in lower costs to implement stronger stormwater standards and changes in demand that result in increased consumer willingness to pay for projects that incorporate stronger stormwater controls. Market adjustments that have the potential to lower costs include more widespread availability of materials (such as porous pavers), better technologies that reduce the time and/or expense of installation (such as modular greenroof systems), and improved design and engineering expertise. Increased regulatory certainty as more developers become familiar with the permitting process and more permitting officials become comfortable with the new regulatory system also will reduce developers' costs of implementing stronger stormwater controls. Market adjustments also have the potential to increase consumers' willingness to pay for projects that integrate some types of stormwater controls—especially those that add amenities, such as rain gardens, and those that reduce building operating costs, such as greenroofs. Willingness to pay may increase as more consumers recognize and demand the environmental benefits LID provides, as LID techniques become more familiar and main-stream, and as time and increased use demonstrate LID's long-term effectiveness across wider geographic regions and climate conditions.

7. Developers are supportive of incentives that offset costs and ease the transition to stronger stormwater standards. Jurisdictions can use them to increase the level of social benefits derived from LID practices.

All three jurisdictions have or have considered implementing incentives to encourage developers to adopt LID controls as a way of complying with stronger stormwater standards. Jurisdictions themselves have an incentive to offer developers incentives, in part, because many of the benefits LID provides accrue to the jurisdiction or the public at large, but don't register in the developers' private accounting of costs and benefits. Enhancing the private benefits developers can receive from LID by passing through some of the public benefits can create a more economically efficient outcome for society.

Incentives come in a variety of different forms, from direct financial payments and subsidies, to efforts to reduce the costs and risks associated with the permitting and review process. Each jurisdiction we focused on has processes in place to help developers navigate the permitting process more efficiently if they propose to implement LID beyond what current regulations require. Developers generally responded favorably to these efforts and said that they took advantage of them. Among the jurisdictions we looked at, Philadelphia has the most developed financial incentive programs, including a fee offset for managing stormwater onsite and a greenroof tax credit. Developers we interviewed who work in Philadelphia indicated they were aware of these incentives and, in some cases, they had taken advantage of them. Many interviewees expressed their support of stormwater credit and off-site mitigation programs to address the reality that on-site stormwater retention may not be physically possible in every project, and may not be economically feasible in some projects.

II. CONCEPTUAL FRAMEWORK AND METHODOLOGY

We approached this project in two phases: a literature review followed by key-informant interviews. Through the literature review, we developed a conceptual framework to understand the issues developers face with regard to the factors that influence the costs and benefits of implementing increasingly stringent stormwater regulations in redevelopment and greenfield projects. The interviews provided an opportunity to test the framework against developers' practical experiences and collect information not available in the literature.

A. Literature Review

There are many stand-alone studies and reviews of the literature that describe the benefits and costs associated with LID and green infrastructure and compare the costs of LID to conventional development (*see,* e.g., Center for Neighborhood Technology 2010, U.S. EPA 2007, MacMullan and Reich 2007, Gunderson et al. 2011). We drew heavily from our knowledge of these studies to develop our conceptual framework, and cite to them throughout the following section. We did not, however, set out to add another broad literature review of LID economics to the existing body of literature. Instead, we narrowly focused our review of the literature on two specific topics:

1) Studies that describe the differential impact of stronger stormwater regulations on greenfield and redevelopment activities, either quantitatively or qualitatively.

2) Studies that describe the impact of stronger stormwater regulations on developers' decisions to build.

1. Differential Impacts of Stormwater Regulations on Development

Our review found no broad-scale studies that systematically investigated the impacts that stronger stormwater regulations may have on different types of development, specifically greenfield projects and redevelopment projects. The literature contains an ever-growing list of case studies that illustrate developer's experiences integrating LID into different types of projects. Many of these illustrations contain cost information. It is very difficult, however, to draw meaningful conclusions about the relative costs of implementing stormwater controls in greenfield and redevelopment projects from these largely anecdotal illustrations. It is more difficult still to determine potential differential impacts under specific regulatory standards.

We found only one study that directly addressed the differential cost impact between greenfield development and redevelopment (Chesapeake Stormwater Network 2010). This study, which was specific to developments and regulations in the mid-Atlantic region and may have limited applicability in other regions of the country, found that installing LID controls at redevelopment sites with less than 65 percent impervious coverage could be successfully accomplished at little to no extra cost than new development sites. Integrating LID into sites with greater than 65 percent impervious coverage—those in highly urban settings—can be up to 4 times more expensive than new development, however. This conclusion may or may not be relevant beyond the limited cases described in this study. More quantitative research is warranted on this

topic to understand how the cost impacts of stronger stormwater standards may vary across different development types and different markets.

2. Impacts of Stronger Stormwater Regulations on Developers' Decisions

Economists and other researchers have attempted to describe the locational behavior of firms in response to environmental regulation of all types at a regional level for decades. The studies that have emerged illustrate the challenge of finding a definitive answer to this question, given the complexity of the world within which such decisions are made. One analysis summarizes the literature by concluding that the studies have found positive, negative, and no impact, and often produce conflicting, contradictory results (Jeppesen and Folmer 2001). Perhaps because of the methodological and practical challenges inherent in answering such a question, we found no studies that used statistical or quantitative methods to determine how developers have responded to changes in stormwater regulations.

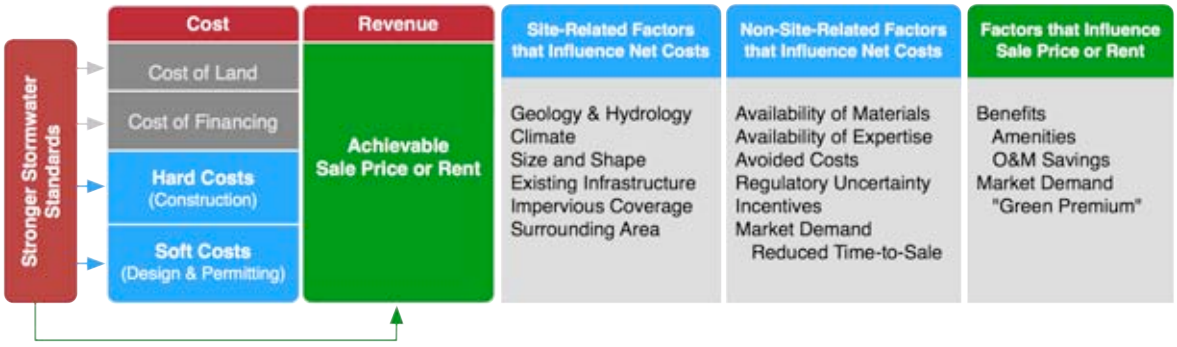
We did, however, find one recent study that used interviews of local permitting officials to inform how stronger stormwater regulations in the District of Columbia might affect developers' decisions about where to build (Leistra, Weiss, and Helman 2010). As part of the study, the researchers attempted to describe how developers responded to similar stormwater regulations in four other jurisdictions: Philadelphia, Chicago, Portland, and Seattle. Through interviews with municipal officials, the study's authors found that the new stormwater requirements have not had, or are not expected to have, discernible effects on development. In Philadelphia, which we also focus on in this study, the study's authors found that, while some developers threatened to pull projects when the regulations went into effect, municipal officials did not actually observe that this occurred. Officials attributed this to other factors influencing developers' decisions more than stormwater costs, and the City's expedited approval process, incentives, and customer service.

B. Conceptual Framework

The results of our focused literature review suggest that few researchers have set out to answer the question we were asked to investigate. There are many ways one might attempt to answer this question. Limited resources, time, and data required us to take a qualitative approach. We focus broadly on describing the economic drivers of developers' decisions, and how stronger stormwater standards may interact with these decisions. Our study does not attempt to quantify the costs developers incur from complying with particular stormwater regulations, to estimate the benefits of stronger stormwater regulations, or to predict the specific effects stronger stormwater regulations will have on particular developments or regional development patterns.

Many factors influence developers' decisions on where and how to build. We developed a conceptual framework to guide our inquiry into developers' decision-making processes and provide insight into this question: *How will stronger stormwater regulations influence how and where developers decide to build, and what impact, if any, are they likely to have on overall development patterns and trends*? Figure 1 illustrates our conceptual framework.

Figure 1. Conceptual Framework



Source: ECONorthwest

When developers embark on a project, they usually develop a financial model, called a *pro forma*, that estimates the project's anticipated financial return. The *pro forma* typically includes four major categories of costs: land, financing, hard costs (e.g., construction), soft costs (e.g., design and permitting) (Nachem 2007). A *pro forma* assumes that all these costs are financed upfront into a stream of debt service that, when compared to achievable sale price or rent, generates a reasonable return on investment. What a developer considers "reasonable" varies depending on their personal preferences and a project's risk and complexity.

The cost categories are shown in the left side of the diagram in Figure 1, the revenue on the right. Stronger stormwater regulations primarily affect two categories of cost most directly: hard costs and soft costs, shown in blue. To a lesser extent, stormwater regulations may also influence the cost of land and financing costs, identified in gray in Figure 1. Depending on how a developer implements stormwater controls, stronger stormwater standards also may affect the achievable sale price or rent, shown in the diagram in green.

The first two subsections, below, describe how stronger stormwater standards might affect the cost and revenue sides of a development *pro forma*. The third and fourth subsections unpack these relationships, and describe how variations in site and non-site related factors might affect the extent to which stronger stormwater standards influence cost and revenue, and ultimately, the developers' decision-making process.

1. Cost-Related Factors in the Developers' Decision-Making Process

Stronger stormwater standards have the potential to influence the costs in the *pro forma* analysis and affect how a project pencils out. The most direct effects are on hard and soft costs, identified in blue in Figure 1. The extent to which stronger stormwater standards affect these costs will depend, in part, on the existing level of stormwater management controls developers are accustomed to factoring into their projects. The effect on cost could be very different if regulations impose a new requirement where none existed before, versus incrementally strengthening retention or water-quality standards or requiring the use of certain best management practices (BMPs), such as LID, over more conventional controls. In the first instance, the direction of the effect likely will be more predictable (positive) and uniform in magnitude across development projects. In the

second instance, depending on the degree of regulatory change and how different developers are already approaching stormwater management, the direction and magnitude of the effect will likely vary considerably, and the overall effect from project to project may be less clear.

Hard Costs. Both conventional and LID stormwater controls have hard costs—in the short-run to install, and in the long-run to maintain. Stormwater controls represent a portion of the total construction costs, and the ratio of stormwater-control costs to other hard costs can vary considerably from project to project. An extensive and growing body of literature exists on the construction cost of conventional stormwater controls (*see,* e.g., Brown and Schueler 1997, Heaney, Sample, and Wright 2002, Narayan and Pitt 2006). There is also a growing body of information on the construction costs of various LID controls (Schueler et al. 2007, WERF 2009), although the costs of LID controls are still less-well understood and documented (Stephenson and Beamer 2008). In general, the costs of LID controls are more dependent on site characteristics than conventional controls, and the variation in costs across LID BMPs for different development types, geographic regions, and climates is not well documented through systematic research (although the body of anecdotal case studies is growing).

Stronger stormwater management regulations (those that require LID and those that do not) may affect hard costs by requiring more extensive stormwater infrastructure to treat higher volumes or greater levels of contamination. The effect of stronger regulations, however, may not always be straightforward: by using LID techniques that provide higher levels of treatment, many developers have been able to minimize conventional infrastructure and actually reduce the overall hard costs associated with stormwater management (U.S. EPA 2007, MacMullan and Reich 2007). In general, the infrastructure to address stormwater (LID or conventional controls) on more constrained sites with higher levels of impervious coverage—typical of redevelopment and retrofit projects—will cost more than unconstrained sites with large amounts of land (Schueler et al. 2007, Chesapeake Stormwater Network 2011). Schueler et al. (2007), for example, found that the cost of implementing stormwater controls in redevelopment projects with high ratios of impervious surface can be 1.5 to 4 times the cost of constructing stormwater controls at new development sites. This research was conducted in the mid-Atlantic region and may not be applicable to other regions, with different climate, hydrology, and geology. Ultimately, it is critical to acknowledge that the effect of stronger stormwater regulations on hard costs depends on a variety of site-specific factors described in more detail in subsection three, below.

Soft Costs. Stormwater systems require engineering expertise to design, and jurisdictions typically require developers to demonstrate a stormwater control plan before they issue a building permit. The literature suggests the design and permitting costs, for LID and conventional controls, range depending on the BMP, but are typically around 25 to 40 percent of a BMP's construction costs (Schueler et al. 2007, Brown and Schueler 1997).

Stronger stormwater management regulations can increase the design and permitting costs by requiring more studies and documentation to obtain permits and more specialized engineering expertise to design new types of controls. Increased uncertainty about how to meet new regulations or how jurisdictions implement new regulations can

increase the time and costs of navigating the regulatory process, which also increases project costs (Braconi 1996, Randolph et al. 2007). More complicated or constrained sites may require more intensive and expensive stormwater design and permitting efforts, which would suggest that soft costs associated with LID or conventional stormwater controls could be higher for redevelopment projects than greenfield projects.

Cost of Land. The value of land is a function of the allowable uses on the property (entitlements), achievable pricing (rents), costs (hard costs like building materials and plumbers, and soft costs like planning and financing), and expected returns (profit). Developers see the market price of the finished project and hard and soft costs as being largely outside of their control. Thus, the developer focuses on the cost he or she can influence most strongly: the cost of property acquisition. In other words, a developer will solve backwards to determine what he or she is willing to pay for property based on the other costs to complete the project. Shifts in variables, such as hard costs, will directly affect the ability to pay for land. Stronger stormwater controls that increase the hard or soft costs of stormwater management may limit or lower what the developer can pay for land. In some cases, developers already own the land. In that situation, the cost of land factors into a developers' decision as an opportunity cost (what the developer could sell the land for if he or she did not want to redevelop it), and the effect of stronger stormwater standards in this calculation is more complicated.

Financing Costs. Lenders provide developers with working capital. They are risk limiters, not profit maximizers. Lending is a low-margin, high-volume business that generally receives fixed returns in the form of upfront fees and interest. These fees and interest factor into the developers' *pro forma.* Financial institutions make credit decisions based on a project's cash flow that will be available to pay debt service. Some lenders are important partners in community development efforts, and will accept a higher risk project without a corresponding increase in interest rates, but in general, riskier projects will cost a developer more as lenders seek to cover the risk in their portfolio. Stronger stormwater management regulations that increase a project's overall cost have the potential to reduce the margin of certainty that a project will pencil out, which would increase the risk from the lender's perspective and lead to higher financing rates.

2. Revenue-Related Factors in the Developers' Decision-Making Process

Developers' decisions are affected not only by factors that influence costs, but also by factors that influence the achievable sale price or rent (the revenue, identified in green in Figure 1)—the benefits to developers. LID stormwater controls can have **market and non-market benefits** that conventional stormwater controls do not (Center for Neighborhood Technology and American Rivers 2010). When considering developers' decision-making processes, however, it is very important to identify when these benefits materialize and to whom. While stormwater controls may produce water-quality benefits in the local watershed, for example, these benefits are unlikely to translate directly into an economic benefit a developer can capitalize into the sale price or rent of the development.[2]

[2] Some studies show that water-quality improvements can positively affect the values of adjacent property (Kirshner and Moore 1989, Leggett and Bockstael 2000).

Other benefits more directly accrue to the building owner or resident and may affect property value. Some consider the amenities that LID controls provide to be visually appealing, and would be willing to pay more to live or work in the environment they create. This demand may positively influence property values (Ward, MacMullan, and Reich 2008). Recent research is demonstrating that neighborhoods built around green streets provide more opportunities for neighbors to interact with each other, providing a positive community environment that many people may be willing to pay more to enjoy this benefit (Dill et al. 2010). Other features associated with LID BMPs, particularly green roofs, can generate benefits for building owners and occupants by reducing heating and cooling costs, and reducing maintenance costs by increasing the lifespan of the roof (David Evans and Associates and ECONorthwest 2008).

In the end, **market demand** and consumer willingness to pay determine the rent or sales price that developers earn on a project. If people aren't willing to pay for the features that LID stormwater controls provide, or don't recognize a difference between LID and conventional stormwater practices, the benefits of stronger stormwater standards that require LID may have little influence over developers' decisions. In some cases, if regulations produce features that consumers perceive as negative, they may actually lower the achievable sales price or rent. In general, however, the demand for green buildings and sustainable stormwater practices has been increasing in response to the rapid growth in the global green building industry, which is the fastest growing sector of the building industry (Jackson et al., 2010). This trend likely means that these factors will play an increasingly important role in developers' decisions.

3. Site-Related Factors that Influence Costs and Benefits

The costs and benefits associated with implementing stormwater management controls are highly site-specific. This is especially true when stronger stormwater management controls require on-site retention and treatment using LID controls. Site characteristics largely determine which types of LID controls may be used, and the wide range of costs across different LID controls may lead to widely-divergent control costs from project to project. Different LID controls also result in different levels of benefits and interactions with market demand. Local differences in public and private experience adapting LID to local conditions can also affect costs and the way benefits are perceived at the site level.

A site's **geology and hydrology** determine how effectively different infiltration techniques will address stormwater management (Langdon 2007). Level sites that infiltrate well may support infiltration techniques with little additional soil amendment or earth movement. Sites that do not infiltrate well or are sloped may require extensive modification to implement infiltration practices effectively, increasing costs, in some cases substantially. Some sites may not support any infiltration, and techniques that don't rely on infiltration, such as collection systems (rain barrels and cisterns) or vegetative systems (greenroofs and tree planters) must be used instead, often (though not always) at increased cost (Schueler et al. 2007 and U.S. Army Corps of Engineers 2009).

A site's **regional and micro-climate** can influence the way both infiltration and retention techniques are designed, with various implications on cost and achievable benefits (*see,* e.g., U.S. EPA 2010). Places with prolonged drought or freeze periods will have the

greatest influence on design considerations. In some cases, cold-weather climates may limit the range of BMPs, or their effectiveness (Roseen et al. 2009). Total precipitation and variation in precipitation throughout the year may influence the design and utility of other BMPs, such as rainwater capture systems and greenroofs (Schroll et al. 2011, Sands 2003).

The overall **size and shape of the site** is important, as sites with large amounts of land—again, more typical of new development projects than redevelopment projects—may benefit from economies of scale (Langdon 2007). The literature suggests that construction costs decrease on a per-unit basis as the overall size of the stormwater control increases (Lampe et al. 2005).

Existing infrastructure and **impervious surface coverage** also affect the costs of implementing stormwater controls (Chesapeake Stormwater Network 2011 and Lukes and Kloss 2008). Existing built infrastructure reduces the land available for stormwater control, and reduces the flexibility to implement a wide range of stormwater-control designs.

4. Non-Site-Related Factors that Influence Costs and Benefits

The site-related factors described above have the potential to directly influence the costs and benefits associated with implementing stronger stormwater standards. There are several other factors unrelated to a given development site that may influence developers' decisions about whether to pursue a project that requires LID stormwater controls. Some of these factors affect the cost side of a developers' equation, while others influence the revenue side and lower a development's net costs.

The **availability of materials and expertise** to implement new or unfamiliar stormwater controls or **regulatory uncertainty** regarding these controls can affect a developers' costs. Developers operating where few engineers with experience implementing LID-type controls are working, for example, may pay more to obtain that expertise. Similarly, some LID techniques require specialized materials that may need to be shipped from other parts of the country, increasing costs beyond what they would be if they were available locally. Regulatory uncertainty is often cited as a big factor affecting the overall cost of implementing stronger stormwater standards. Sites that require more complex stormwater-control strategies may take more time to navigate regulatory reviews. Some LID controls may not be clearly defined or allowed, reducing the range of options engineers have to manage stormwater and potentially increasing costs.

Using LID controls can help **avoid other development costs**, and some jurisdictions offer **regulatory or monitory incentives**, all of which can financially benefit developers. Some LID stormwater controls may cost more than traditional controls, but can help developers avoid other costs that the traditional approaches cannot. The literature provides many examples of avoided costs when LID controls are integrated into a project, including less conveyance infrastructure and fewer curbs and gutters (U.S. EPA 2007). Sometimes jurisdictions offer financial and other **incentives**, such as fee reductions or fast-track permitting that help offset overall project costs and provide a reason for developers to pursue certain stormwater-management techniques even if they add hard costs up front.

C. Interview Site Selection and Methodology

We conducted key-informant interviews with public officials and individuals involved in development. We designed these interviews to better-understand the gaps in the literature about the range of economic factors that influence developers' decisions when faced with complying with stronger stormwater standards.

In conjunction with SGA and its partner organizations, we selected three jurisdictions that have implemented stronger stormwater controls. We used these screening criteria to guide our selection process:

1. The jurisdiction has adopted a strong stormwater regulation (e.g., volume-based, water-quality-based, or explicit LID requirement).
2. Jurisdiction boundaries should include a mix of potential redevelopment and new development opportunities.
3. Regulation should apply similarly to redevelopment and new development.
4. Set of jurisdictions should reflect a diversity of geography.
5. Preference for jurisdictions that haven't received a lot of research attention already.

Our selection process was challenged by the fact that few jurisdictions in the country have actually implemented mandatory LID requirements or stormwater regulations that require significant retention or water-quality treatment on-site. Those that have, have done so only recently. We selected these communities:

Montgomery County, Maryland. Montgomery County enacted its first stormwater management standards nearly forty years ago, and has strengthened them several times to address declining water-quality in the region. In 2010, the County passed a revised stormwater ordinance that maintained the existing volume standards, which require both new development and redevelopment projects to protect water quality for the first inch of stormwater and control volume for the first 2.6 inches of stormwater. The new regulations require greenfield developments to use environmental site design (ESD, which is equivalent to LID) to meet these standards for the first inch of stormwater, and require ESD to the "maximum extent practicable" for redevelopment. County staff is in the process of clarifying what "maximum extent practicable," means for redevelopment projects, and are adjusting local ordinances to remove barriers to implementing LID (Montgomery County Department of Environmental Protection 2011, Biohabitats 2010). After considerable concern from the development community that the proposed regulations would have a significant impact on the cost of projects and discourage redevelopment, the regulations incorporated a provision to allow the County to grant administrative waivers for projects that received approval before the regulations were passed (Montgomery County Department of Permitting Services 2011).

Olympia, Washington. Olympia's stormwater program is one of the oldest in western Washington, and continues to be one of the most stringent. It adopted its most recent regulations in 2009, which apply to both new development and redevelopment (City of Olympia, Washington 2009). The regulations are modeled on the Western Washington Stormwater Manual (Washington Department of Ecology

2005), but go beyond the state-level standards, especially for water-quality treatment. Developments meeting certain minimum size and disturbance criteria must match stormwater discharges to pre-development rates from 50-percent of the 2-year peak flow to the full 50-year peak flow. Water-quality standards also apply, and must be managed using approved on-site treatment BMPs, including LID controls. Although the regulations apply to both new development and redevelopment, in its 2009 revision to the regulations, Olympia added a financial cap for mitigating existing impervious surfaces at redevelopment projects, at 30-percent of the total project costs. The state of Washington is currently considering more broadly requiring LID controls in its next regions of the Western Washington Stormwater Manual, due out in 2012 (Washington Department of Ecology 2010).

Philadelphia, Pennsylvania. Philadelphia adopted revised stormwater regulations in 2006 that apply to both new development and redevelopment. All development projects (new and redevelopment) must control stormwater quality for the first one-inch of runoff from connected impervious surfaces. This provision was adopted to 1) recharge groundwater and increase stream base flows, 2) restore more natural site hydrology, 3) improve water quality, and 4) reduce combined sewer overflows (CSOs) from the city's CSO system. This requirement must be met using infiltration techniques. If infiltration is demonstrated to be infeasible, a waiver may be considered. Philadelphia also has adopted channel protection and flood control standards, which require slow release of the 1-year, 24-hour storm event and require developers to prevent the occurrence of flooding in downstream areas. Redevelopment projects may apply for exemptions from the channel protection and flood control requirements by reducing land disturbance by 20 percent from predevelopment and post-development conditions (Philadelphia Water Department 2011).

Within each jurisdiction, we identified and interviewed the key municipal officials with experience designing and implementing the new stormwater regulations. These interviews helped us clarify the regulatory context within which developers were making decisions. They also helped us understand how the development community, as a whole, is responding to the new regulations.

To capture the range of perspectives from the development community, we interviewed builders, engineers, landscape designers, and architects in each jurisdiction. We identified potential interviewees by contacting trade organizations (e.g., the U.S. Green Building Council, Master Builders Associations), reviewing public documents, searching web-based directories, and soliciting recommendations from the public officials and other interviewees in each jurisdiction.

Appendix B contains a complete list of the individuals we interviewed for this project.

III. FINDINGS AND CONCLUSIONS

Our review of the literature, described in the previous section, and the interviews we conducted revealed many insights into how developers in different parts of the country respond to stronger stormwater standards. In this section we present the results of our interviews in each jurisdiction together, rather than as three separate case studies, because the themes that emerged were strikingly similar across the jurisdictions. Where interesting differences across jurisdictions stand out, we highlight them. We organize the results of the interviews, with insights from the literature, into seven broad findings.

As we attempted to understand how developers responded to the most recent regulatory changes, we were faced with the reality that economic conditions since 2007 have had an unprecedented effect on all types of development. The three jurisdictions we focused on all adopted stronger stormwater standards between 2006 and 2010—although each had stronger-than-average regulations prior to this. In many places, very little development activity has occurred at all since stronger stormwater regulations were implemented. Many of the projects that have gone forward were grandfathered under previous stormwater regulations. Because of this, the responses we collected in our interviews were often—but not always—based on conjecture or theoretical understanding, rather than actual experience or observation. In all jurisdictions we studied, the market has yet to fully respond to the new regulatory environment. Repeating this study in 2 to 3 years likely would yield an interesting comparison to our results.

1. Developers are successfully incorporating stronger stormwater controls to meet strict volume-reduction and water-quality standards in both greenfield and redevelopment projects.

Our study found that some developers can and do meet stronger stormwater standards in both redevelopment and greenfield projects. Interviewees who had completed developments that met stronger stormwater standards using LID indicated that doing so required creativity and willingness to experiment with new approaches to projects. They emphasized that pursuing these projects was not without challenge, but they will continue developing in places that require strong stormwater controls and LID for a variety of reasons: the markets they participate in respond favorably to the new stormwater designs; meeting regulations with green-infrastructure techniques could be more cost effective than conventional controls; and for some, they simply believed it was the right thing to do for the environment. Some developers we interviewed had not yet implemented projects under the stronger stormwater standards. Some were skeptical, based on their own initial experiences or other developers they'd talked to, that they could make a project pencil out using LID controls. A minority of interviewees held this perspective. Although staff at each jurisdiction had encountered this opinion, none had actually observed that developers were choosing to invest in greenfield projects over redevelopment projects because of the new standards. This is consistent with other findings in the literature (Leistra, Weiss, and Helman 2010).

Several important distinctions about the way developers approached compliance with stronger stormwater standards in redevelopment projects stand out:

- Redevelopment applications of stormwater controls, including LID techniques, are usually more site-specific and custom than greenfield applications, although this depends on the nature of the redevelopment. Redevelopment sites that are taken down to bare soil can often be treated more like greenfield sites. Redevelopment sites with considerable existing impervious cover, or sites that are surrounded by or incorporate existing infrastructure are generally more challenging to accommodate stormwater management than greenfield or less-dense redevelopment sites.

- The three jurisdictions in our study have strong stormwater regulations that govern greenfield and redevelopment projects. Each jurisdiction also has "off-ramps" that permit developers to avoid full compliance with the new regulations if they can demonstrate engineering, site-condition, or financial reasons why they cannot implement the new controls. Off-ramps can include payment in lieu, off-site mitigation, on-site trading, alternative treatment practices, and reduced performance criteria. Staff in Montgomery County are currently developing clear and consistent guidelines for applying off-ramp provisions, such as using LID to the "maximum extent practicable," that may relax standards for some redevelopment projects. In Olympia, permitting officials described taking a pragmatic approach to permitting stormwater controls for some redevelopment projects that contend with complex existing infrastructure (both on-site and off-site) and connections to existing systems. In Philadelphia, permitting officials allow on-site trading for difficult sites, where one part of a site may not meet the standards, but another part exceeds the standards. There are currently no explicit requirements in any of the jurisdictions that mandate the use of specific BMPs, such as green roofs, on redevelopment sites to fully meet infiltration or water-quality targets.

2. Complying with stormwater regulations is one factor among many that influences a project's costs. It is rarely the driving factor.

Stronger stormwater standards can affect the costs of both greenfield and redevelopment projects. These costs are folded into a *pro forma* analysis that developers and lenders use to assess the viability of a project. Our interviews revealed that developers' decision-making process incorporates a wide range of economic factors, including various construction costs, current and future market conditions, regulatory incentives and disincentives, and uncertainty and risk. While some developers we interviewed indicated that the costs associated with meeting stronger stormwater standards may change the types of projects they will pursue in the future, many developers described the cost of implementing stormwater controls as minor compared to the other economic factors they considered in deciding whether or not to pursue a project, especially in the context of highly-complex redevelopment projects and green-building infill projects.

- In general, stronger stormwater standards have increased the costs to implement stormwater controls, a trend that many of the developers we interviewed have experienced since at least the 1980s. Some developers pointed out, however, that using LID controls has helped offset some of the increased cost, compared to using conventional controls.

- Among the interviewees we spoke to, the majority agreed that complying with stormwater regulations has become a larger component of both greenfield and redevelopment projects, in terms of complexity and cost.
- Complying with stormwater regulations is considered a cost of doing business, and most members of the development community we spoke with did not view the cost of managing stormwater as a major deciding factor in whether or not they pursued a particular project.
- Interviewees cited zoning regulations (and related provisions, such as density limitations and height restrictions) and non-stormwater environmental regulations, such as wetlands and critical habitat areas, as the primary regulatory factors guiding a site's development potential and a project's viability. These are usually larger factors in greenfield development than redevelopment.
- Several interviewees in Philadelphia said that labor costs, which they claimed were driven higher by union wages, made many redevelopment projects in the city unviable. Interviewees in Olympia or Montgomery County did not identify labor costs as a major factor.
- Consumer demand and market conditions matter to developers above all other factors. Developers emphasized that they build where the market demands development. If the market is strong for redevelopment projects in urban areas, interviewees said they would continue to meet that demand. Likewise, if people continue to demand the type of housing that new greenfield sites accommodate, developers maintained that they would continue to pursue these projects.
- In deciding between sites that would accommodate similar types of development, developers indicated that the potential stormwater management costs associated with a site could be among the deciding factors. In general, however, developers noted that market demand trumps the costs of stormwater controls. All things being equal, however, where there are substitute sites, higher stormwater costs could dictate project location.
- Redevelopment projects generally fall into one of two categories: those that are more financially risky because they are being built in a market with soft demand and many potential substitutes with fewer site constraints, and those that are less financially risky because they are being driven by high demand and are higher-end, and sometimes green-branded, projects. For the former group, any factor that influences costs—including stricter stormwater regulations—may affect the project's viability. For the latter group, stricter stormwater controls have not been an issue, and may actually be integrated as an amenity or help the project achieve green ratings.

3. The costs of stormwater controls in general, and LID controls in particular, tend to be more variable and site-specific for redevelopment versus greenfield development.

The developers we interviewed were reluctant to make broad generalizations about the extent to which stronger stormwater controls influence the cost of projects. They emphasized that stormwater designs are highly site-specific, and one solution may be feasible and cost-effective at one site, but infeasible or cost-prohibitive at another site.

The diagram presented in Section II outlines the different factors we identified in the literature and through the interviews that influence the cost of implementing stronger stormwater standards. They underscore the site-specific nature of stormwater-control costs, and explain why implementing stronger stormwater controls in redevelopment projects tends to be more expensive than in greenfield projects. This discussion of costs, however, cannot be separated from the discussion of other factors that influence developers' decisions: avoided costs and market and non-market benefits may help offset increases in direct costs, and market demand and other regulatory and non-regulatory factors may support increases in net project costs.

- Developers incorporate stormwater-management costs into *pro forma* analyses of all development projects. The proportion of total development costs attributable to stormwater controls is highly variable, especially in redevelopment projects. Developers we interviewed were unable or unwilling to provide specific "rules of thumb" for either the proportional costs of stormwater relative to overall development costs or the difference in costs to implement stormwater controls between redevelopment and greenfield projects.
- Many developers we interviewed noted that it is not difficult to incorporate LID for equal or less cost than conventional stormwater controls in a greenfield development. When asked the same question about redevelopment or infill development, developers were very reluctant to make broad generalizations. They were quick to note that the additional costs could be insignificant or major, depending on site conditions.
- Implementing stronger stormwater standards are often, though not always, more expensive in redevelopment projects than greenfield projects. Developers identified several reasons for this:

  Soil characteristics: poor, compacted soils require more amendment to support infiltration. Infiltration may not be allowed at all on sites with contaminated soils. Redevelopment sites are more likely to display these challenging soil conditions.

  Impervious coverage: infiltration techniques are cheaper to construct on large sites with extensive pervious area. Redevelopment sites tend to have higher densities than new development, with less land available for infiltration BMPs. In general, the higher the impervious coverage, the more expensive managing stormwater is likely to be.

  Existing infrastructure: redevelopment sites tend to have existing infrastructure that must be considered in designing stormwater controls. In some cases, this may reduce the flexibility engineers have to design cost-effective solutions for managing stormwater, increasing costs.

- Driving the cost differential, in large part, is the more limited range of BMPs available to manage stormwater on constrained, largely impervious sites. Developers indicated that for many urban redevelopment projects, BMPs on the lower end of the cost curve (e.g., rain gardens and managed wetlands) are not possible. Instead, they must rely on BMPs that are perceived as being on the higher end of the cost curve in many cases, such as greenroofs, micro-swales,

water capture and reuse, stormwater planters, and permeable pavement materials (either pavers or pavement).

- Regulatory uncertainty can increase a developers' costs in the planning and design stages of a project. While regulatory uncertainty is not unique to stronger stormwater regulations, the site-specific nature of using green infrastructure to comply with regulations is inherently more varied than conventional approaches to managing stormwater. It is more difficult for regulators to provide black-and-white guidance for complying with the regulations across all potential circumstances. Moreover, the application of regulatory guidance for stormwater management in redevelopment projects may be more uncertain than in greenfield sites because of the greater variability across and unique characteristics of each redevelopment site. This may, in part, contribute to the perception that it costs more to integrate stronger stormwater controls into redevelopment projects. The developers we interviewed identified these ways in which regulatory uncertainty increased their costs, especially for redevelopment projects:

  Multiple plan reviews: All three jurisdictions require stormwater designs to be incorporated into early plan review, before other permits are issued. If changes to the stormwater design are required later—a common situation, especially in redevelopment projects—plans often must be re-reviewed, adding time and cost to the review process. It is important to note that some developers indicated that early plan review requirements actually helped reduce uncertainty and costs in many cases, because they were forced to address and resolve potential stormwater-related issues while there was still flexibility in the design process.

  Inconsistent application of standards and guidance: Inconsistency in how both developers and permitting officials interpret stormwater standards can cause considerable uncertainty that may lead to increased costs. Developers identified two issues that have increased their uncertainty under the stronger stormwater regulations: 1) receiving different signals from officials within the same jurisdiction about how applications of stormwater controls on a given site may be approved and 2) stormwater design applications that are approved for one site may not be approved for a site with similar characteristics at a different location or future time. Without clear, predictable, and consistent guidance, developers spend more time, and thus cost, navigating the permit-review process.

  Overbuilding: Engineers and developers may hedge against a plan rejection by overdesigning or building multiple levels of stormwater controls, which adds unnecessary costs to the project (but, in theory, reduces the costs associated with regulatory review.)

4. Developers respond to benefits that influence their bottom line. In some cases, these may help offset increased costs of complying with stronger stormwater regulations.

While stronger stormwater regulations and LID controls can provide a range of environmental and amenity benefits, developers generally only respond to those

benefits that affect their bottom line. Developers we interviewed suggested that LID controls that helped them comply with stronger stormwater regulations at lower cost, increased the sale price or rent of a project, reduced the time to sale, or all three, would affect their decisions to use LID. Specific examples of LID controls providing economic benefits to developers include bioswales and other vegetative stormwater controls that improved the appearance and market appeal of a development while also reducing overall landscaping costs, and greenroofs that reduced energy costs and long-term cost of roof maintenance for their customers. Developers noted, however, that market demand for projects that include LID stormwater controls have not yet expanded beyond niche markets. Factors such as unfamiliarity with the technology and uncertainty how to address operations and maintenance of LID controls limit broader use of LID by developers and demand from consumers.

- Developers in each jurisdiction recognized that many of their customers respond positively to the landscape amenities LID BMPs provide. Few developers said that the landscape amenities translated directly into increased property values or higher rents, however.
- Developers who observed that LID could increase property values focused narrowly on the green sector of the market, and incorporated many green-building techniques into their residential infill properties. LID is one of the multiple green attributes of these developments, and the relative importance of LID compared to the other green attributes (e.g., high-efficiency windows, low-VOC building materials, etc.) is difficult for developers to identify.
- Several developers, particularly in Montgomery County, MD and Olympia, Washington, said that some of their customers still expect to see the traditional curb-and-gutter, sidewalk design that characterizes conventional stormwater management techniques. They do not respond as favorably to the LID designs characterized by rain gardens, bioswales, narrow streets, and fewer sidewalks.
- Several developers commented that some customers are wary of LID designs that require maintenance, and that bioswales and rain gardens may actually deter some potential customers from buying a property.

5. Cost-effective responses to stronger stormwater standards require a more collaborative approach to addressing stormwater management.

Engineers and developers who successfully implement stronger stormwater controls using infiltration and retention practices emphasize the importance of considering stormwater management at the earliest stages of development, and of integrating professionals' expertise throughout the project. These principles are consistent with the conclusions of the broader literature on green building, which emphasize the importance of integrating professionals throughout the design process to achieve reductions in capital costs (*see,* e.g., Kibert 2008).

- Some professionals and jurisdictions recognize that thinking about stormwater management early in a project's design is critical to successfully and cost-effectively implementing stronger stormwater controls. Jurisdictions encourage this approach by requiring stormwater management plans, or encouraging consultation with permitting officials early in a project's evolution. Considering

stormwater first allows engineers and developers the flexibility to extract cost savings, maximize site efficiencies, and work around more complex features of a site that could lead to increased costs later.

- Interviewees who successfully and cost-effectively implement LID emphasize the value of collaboration among professionals involved in site design, including the engineer, architect, and builder. This approach treats stormwater management as an integral part of project and site design, rather than as an isolated engineering exercise.
- Engineers often lead the design process that includes implementing stormwater controls. Yet, many engineers have not yet acquired the necessary skills and experience to implement LID controls efficiently and cost-effectively. This lack of experience increases the cost of responding to stronger stormwater standards. Developers raised these issues about the lack of skilled engineering expertise:

  Scarcity of expertise. Those engineers that have LID expertise often charge a premium for it, which increases the overall cost of implementing LID, compared to conventional controls.

  Lack of appropriate tools. Many engineers rely on engineering software or other tools that do not easily accommodate LID designs or collaboration with other professionals, e.g., architects, designers, builders, etc.

  Need for education. Some engineering higher-education programs now include LID training as part of their curriculum. As more engineering students learn LID techniques and apply them in their professional careers, the costs associated with these issues will decrease.

6. Market adjustments are already reducing costs of implementing stronger stormwater standards, for both redevelopment and greenfield development, a trend that is likely to continue.

Market adjustments include changes on the supply side that result in lower costs to implement stronger stormwater standards and changes in demand that result in increased consumer willingness to pay for projects that incorporate stronger stormwater controls. Market adjustments that have the potential to lower costs include more widespread availability of materials (such as porous pavers), better technologies that reduce the time and/or expense of installation (such as modular greenroof systems), and improved design and engineering expertise. Increased regulatory certainty as more developers become familiar with the permitting process and as more permitting officials become comfortable with the new regulatory system also will reduce the developers' cost of implementing stronger stormwater controls. Market adjustments also have the potential to increase consumers' willingness to pay for projects that integrate some types of stormwater controls—especially those that add amenities, such as rain gardens and reduce building operating costs, such as greenroofs. Willingness to pay may increase as more consumers recognize and demand the environmental benefits LID provides, as LID techniques become more familiar and main-stream, and as time and increased use demonstrate LID's long-term effectiveness across wider geographic regions and climate conditions.

- Developers and engineers we interviewed reported that new LID materials and technologies are becoming more available, less costly, and more reliable. They indicated that they expect this trend will further reduce costs.
- Some developers in Montgomery County reported that finding engineers and designers who specialize in LID practices and are comfortable with navigating the permit review process is difficult, because this expertise is limited and in high demand. They reported that the professionals with this expertise can charge a premium to work on projects, which developers must factor into their overall costs. This was not identified as a major issue in Olympia or Philadelphia, which suggests that the market may have already responded to the higher demand for those types of services.
- LID is still perceived as a new technology, and consumers don't always fully understand or value the services it provides. As information on LID spreads, demand may increase for developments that incorporate LID—especially those BMPs with enhanced amenities, such as landscaped bioswales, greenroofs, and rainwater catchment. This could lead to higher rents, higher property values, and less time on the market. These demand-side factors can help offset the increased costs that may occur when integrating LID into a project. Anecdotal evidence in Portland and Seattle, where LID techniques have been implemented for over a decade, suggests that property values are enhanced where these techniques are used (Leistra, Weiss, and Helman 2010, Ward, MacMullan, and Reich 2008).
- Demand for the benefits that LID provides can influence whether developers are willing to take on more risk or higher costs to implement LID. Most developers we interviewed reported that demand for the benefits LID provides is limited, and these benefits don't influence their decisions on how to implement stormwater management. With the exception of a developer in Olympia, Washington that specializes in infill residential construction of green homes, the developers we interviewed did not perceive that LID currently offers significant benefits in terms of increased property values or other amenity values. Many recognize, however, that with future market changes, these benefits could become a larger factor in the future.

7. Developers are supportive of incentives that offset costs and ease the transition to stronger stormwater standards. Jurisdictions can use them to increase the level of social benefits derived from LID practices.

All three jurisdictions have or have considered implementing incentives to encourage developers to adopt LID controls as a way of complying with stronger stormwater standards. Jurisdictions themselves have an incentive to offer developers incentives, in part, because many of the benefits LID provides accrue to the jurisdiction or the public at large, but don't register in the developers' private accounting of costs and benefits. Enhancing the private benefits developers can receive from LID by passing through some of the public benefits can create a more economically efficient outcome for society. Incentives come in a variety of different forms, from direct financial payments and subsidies, to efforts to reduce the costs and risks associated with the permitting and review process. Each jurisdiction we focused on has processes in place to help developers navigate the permitting process more efficiently if they propose to

implement LID beyond what current regulations require. Developers generally responded favorably to these efforts and said that they took advantage of them.

- Developers responded favorably to incentives that reduce the uncertainty associated with the permitting, to the extent that these incentives reduce the time (and associated costs) of getting approval to implement LID. Developers identified these techniques that help with the permitting process: streamlined or fast-track permitting, guaranteed permit review times, and access to permitting staff for collaborative problem solving early in the process. All three jurisdictions have fast-track review processes for green development concepts in place. Philadelphia guarantees plan review for redevelopment projects that disconnect 95 percent of impervious area and don't increase the burden on public infrastructure within 5 business days. Developers expressed mixed opinions about how well these fast-track processes actually work in practice.

- Reduced stormwater fees provided many developers with strong incentives to incorporate LID into redevelopment projects. Fees pegged to impervious area coverage tipped the economic equation for at least one developer considering integrating pervious pavement, one of the more common BMPs used in redevelopment. Developers and engineers in Philadelphia indicated that the City's fee reduction program was becoming a useful tool to get buy-in from customers on including BMPs that would quality for the credit.

- Direct subsidies for LID BMPs on the higher end of the cost scale, such as greenroofs and rainwater catchment systems, can encourage developers to integrate LID into redevelopment projects where other BMPs are not technically feasible. These types of incentives are useful transition tools, helping to build a market for materials and expertise that eventually drives costs down and makes these techniques more broadly affordable in the long run.

- Many developers mentioned that a fee-in-lieu or credit-offset program for stormwater would be an effective way for dealing with exceptionally difficult sites where LID is physically impossible or too costly. Such programs may serve a useful role in a LID regulatory scheme, but they would have to be designed carefully to maximize the environmental benefits that are achievable on-site and collect a payment that is sufficient to actually implement controls off-site that can address the remaining stormwater-related effects.

- Philadelphia has a fee-in-lieu program. Permitting officials said that it is rarely used, because the fee is set such that it is usually cheaper for developers to implement stormwater controls on-site. Permitting officials suggested that this fee-in-lieu program is designed as a useful way to force developers to take a harder look at their site when considering the feasibility of implementing stormwater controls.

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APPENDIX B: LIST OF INTERVIEWEES

Montgomery County, Maryland

Rick Brush, Manager, Montgomery County Department of Permitting Services, Water Resource Plan Review

Steve Shofar, Chief, Montgomery County Division of Watershed Management

David Borchardt, P.E., LEED-AP, Tower Companies

Chris Earley, LEED-AP, Greening Urban

Kenneth Michael, NAI Michael Companies, Inc.

Ken Wallace, McCarthy and Associates

Paul Woodburn, Ben Dyer Associates, Inc.

Mike Novy, P.E., Ben Dyer Associates, Inc.

Guy Semmes, Hopkins & Porter Construction, Inc.

Olympia, Washington

Andy Haub, Planning and Engineering Manager, City of Olympia Public Works Department

Tom Hill, Permit and Inspections Manager, City of Olympia Community Planning and Development

Art Castle, Interim Vice President, Building Industry Association of Washington

Sean Comfort, P.E., AHBL

Scott Bergford, Scott Homes

Damon DeRosa, P.E., LeRoy Surveyors & Engineers

Bill Creveling, P.G., LeRoy Surveyors & Engineers

Philadelphia, Pennsylvania

Chris Crockett, Director of Planning and Research, City of Philadelphia Water Department

Christine Marjoram, Stormwater Plan Review Program Manager, City of Philadelphia Water Department

Howard Steinberg, Onion Flats/Plumbob

Michele Adams P.E., Meliora Environmental Design

Bob Rosenthal, Hovnanaian Homes

Thomas May, P.E., LEED-AP, Urban Engineers

Angelo Waters, P.E., LEED-AP, Urban Engineers