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Creating Clean Water Cash Flows

Developing Private Markets for Green Stormwater Infrastructure in Philadelphia

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About the Authors
NatLab is a collaborative effort among Natural Resources Defense Council, The Nature Conservancy, and EKO Asset Management Partners that seeks to create the regulatory, financial, and policy context that will catalyze the investment of additional private capital in green infrastructure, where gray infrastructure has traditionally been deployed. NatLab seeks to stimulate employment, improve quality of life, and generate more resilience in urban communities. Our deliverables include policy recommendations, case studies that allow our work to be replicated, and financing structures that catalyze new commitments to green infrastructure by cities, policy leaders, and private investors.
NatLab's pilot project, implemented from April–September 2012, has been to provide in-depth policy analysis and recommendations for actualizing the market opportunity in green infrastructure in Philadelphia, including a range of policy mechanisms, private sector strategies, and financial structures that can help draw private capital investment in green infrastructure.

About EKO
EKO Asset Management Partners is a specialized investment and advisory firm focused on discovering and monetizing unrealized or unrecognized environmental assets. We invest in projects and companies that create environmental value, as well as advise to companies, investors and governments on natural infrastructure, ecosystem services and environmental markets.

About The Nature Conservancy
The Nature Conservancy is a leading conservation organization working around the world to conserve the lands and waters on which all life depends. The Conservancy and its more than 1 million members have protected nearly 120 million acres worldwide.

About NRDC
NRDC (Natural Resources Defense Council) is a national nonprofit environmental organization with more than 1.3 million members and online activists. Since 1970, our lawyers, scientists, and other environmental specialists have worked to protect the world's natural resources, public health, and the environment. NRDC has offices in New York City, Washington, D.C., Los Angeles, San Francisco, Chicago, Montana, and Beijing. Visit us at www.nrdc.org.

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TABLE OF CONTENTS

EXECUTIVE SUMMARY

When rainwater rushes off Philadelphia's buildings and other impervious structures, it strains the city's combined sewer system, causing approximately 13 billion gallons of untreated sewage mixed with polluted runoff to overflow into city waterways each year. Philadelphia's expansive stormwater runoff problem is no anomaly. It is one of nearly 800 communities nationwide that are required by the Clean Water Act to reduce raw sewage overflows from combined sewer systems, and thousands more have obligations to reduce pollution from separate storm sewer systems. Philadelphia is also one of many cities nationwide that is increasingly turning to green infrastructure solutions as a key part of the stormwater runoff solution. Green infrastructure includes installations such as rain gardens, swales, and green roofs, which capture runoff from impervious cover before it reaches overburdened sewer systems.

Philadelphia has made an unprecedented commitment to using green infrastructure to address its stormwater runoff problems through its ambitious Green City, Clean Waters plan. To achieve compliance with the Clean Water Act, the plan establishes binding targets, over the next 25 years, to transform approximately 10,000 acres (about one-third) of the impervious area in its combined sewershed into "greened acres," on which the first inch of rainfall from any given storm is managed on-site. The city plans to reach its goal through a combination of greened public spaces and regulatory changes intended to induce private investment in green infrastructure development.

A 2012 NRDC paper, *Financing Stormwater Retrofits in Philadelphia and Beyond*, outlined how Philadelphia's new stormwater fee and credit structure could encourage private parcel owners to invest in stormwater retrofits, thereby leveraging private capital to help meet the city's greened acre targets. Building on that paper, this report provides more detailed analysis and action-oriented recommendations to stimulate investment in green infrastructure on the part of municipalities and private investors. Although the analysis and recommendations are directed toward the case of Philadelphia, the aim of the report is much broader: to shed light on strategies that a wide range of cities can use to identify economical green infrastructure retrofit opportunities and, where possible, leverage private capital in efforts to "green" their urban space.

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Although schools represent only 2 percent of impervious cover in the combined sewer area, Philadelphia's Water Department believes the high visibility and educational opportunities associated with schools make them important places to showcase green infrastructure.

Chapters 1 and 2 of the report analyze stormwater retrofit economics and financing challenges that might apply to greening of private parcels in Philadelphia. In addition to identifying existing barriers, the conclusions of Chapter 1 and 2 provide suggestions for how PWD could improve the economic viability of greened acre investments on private parcels through additional policy measures—such as improved regulatory certainty, enhanced transparency in the credit renewal process, creation of an offsite mitigation market, facilitating project aggregation, and direct subsidies for green infrastructure projects on private parcels. Chapters 3 and 4 outline approaches to developing project aggregation and offsite credit trading systems in an effort to enlarge the universe of financially attractive retrofit projects by reducing transaction costs and directing available private capital to the lowest-cost projects. Chapter 5 explores the benefits that private-public-partnership structures could generate by encouraging the development of the most economical greened acres, including retrofits on public or private lands.

Taken together, the chapters suggest that although Philadelphia's parcel-based fee system is a good first step toward drawing private investment to green infrastructure, many economic barriers remain. In the current market environment, the discounted payback periods of most green infrastructure retrofits on private parcels stretch beyond ten years, which is longer than most investors would be willing to accept. However, the report indicates that a range of strategic policy interventions that PWD and other local stakeholders could undertake would substantially expand the market for viable private investment in green infrastructure. Finally, the authors find that implementation of the policy interventions explored in this report are likely to be in PWD's and local tax payer's best economic interest, as the cost to PWD to implement these policies are likely to reduce the City's total costs to meet its green acre goals.

I. HOW TO SPUR INVESTMENT IN GREEN INFRASTRUCTURE RETROFITS ON PRIVATE PARCELS

The City of Philadelphia has already taken a key step towards developing a market for greened acres on private parcels by implementing a stormwater billing system that charges nonresidential customers a monthly stormwater fee based on the impervious area on their parcel. To encourage reductions in runoff through the adoption of infiltrating green infrastructure, Philadelphia offers substantial fee discounts to owners who "green" their parcels by reducing impervious area or otherwise managing runoff onsite. As a result, Philadelphia has created an environment where an investment in green infrastructure retrofits provides ongoing operating savings to nonresidential property owners in the form of reduced stormwater bills.

Utilizing avoided stormwater fees as the sole measure of project payback, the authors estimate that a retrofit project on a given parcel in Philadelphia would need to cost less than \$36,000 per acre (\$0.82 per square foot) in order to achieve full payback within 10 years. Cost estimates for stormwater management practices (SMPs) indicate that sites that are suitable for downspout disconnections or low-cost swales would be the most economically attractive candidates for privately-financed retrofit projects. Under the current market environment, SMPs that are suitable for a wider range of sites, such as porous pavement, rain gardens, green roofs, and flow-through planters, have higher retrofit costs that would not achieve a 10-year payback.

PWD can improve the economic viability of such retrofits on private parcels through policy measures, such as subsidizing retrofits, facilitating project aggregation, and creating an offsite mitigation program. For example, if a subsidy program offering \$3.50/ft2 for green infrastructure retrofits on private parcels were combined with offsite mitigation and aggregation programs, projects totaling up to 73 percent of the city's long-term greened acre targets could become economically viable for private investors. Philadelphia can count these greened acres toward Clean Water Act compliance, and these acres would still come at lower cost than the city would likely be able to achieve through green infrastructure investments in the public right-of-way alone.

Financing Challenges and Enabling Policy Measures

Attractive retrofit economics are a necessary, though not sufficient, lever to attract large-scale investment in stormwater retrofits on private parcels. Current questions surrounding regulatory and revenue certainty will need to be resolved before investors are likely to finance long-term projects where future avoided stormwater fees figure prominently in project payback. For example, PWD has not made available projections of Philadelphia's long-term stormwater fee schedule (and corresponding credit). Making such a projection available would be important, given that changes to the fee structure or credit could have negative impact on an investor's payback period. Similarly, early investors in stormwater retrofit projects may find that risk of regulatory change and project performance risk in general are too high, making financing terms unattractive to property owners. These regulatory and revenue certainty challenges are not insurmountable. Publishing a projected 10-year utility rate schedule and improving information flow about stormwater retrofit credit re-approval are two steps that PWD could take immediately to resolve some of the uncertainty around future parameters of project economics.

In addition to regulatory risk, the very nature of green infrastructure financing presents novel questions for both property owners and project financiers. NRDC's Financing Stormwater Retrofits report identified lack of collateral, high transaction costs in relation to project size, and lack of a track record for stormwater retrofit financing repayment as key project risk elements. Because many nonresidential parcel owners have existing mortgages or other encumbrances on their assets and may be unable to obtain lender consent for additional debt, traditional lending mechanisms may not fit the needs of parcel owners interested in stormwater retrofits. Instead, models similar to those that have been developed in

Figure ES1: Building a Greened Acre Market

	Off-site Mitigation	Aggregation	$0.50/ft² Subsidy	$1.00/ft² Subsidy	$3.00/ft² Subsidy	$3.50/ft² Subsidy
Downspout Disconnection	█████	█████	█████	█████	█████	█████
Swales		█▒▒▒▒	██▒▒▒	█████	█████	█████
Infiltration Trenches			██▒▒▒	█████	█████	█████
Rainwater Harvest & Reuse			█▒▒▒▒	█▒▒▒▒	██▒▒▒	██▒▒▒
Rain Gardens					██▒▒▒	█████
Reducing Impervious (Hard) Surfaces					█▒▒▒▒	█████
Flow-Through Planters					█▒▒▒▒	█▒▒▒▒
Porous Pavements						
Green Roofs						
New Potential Greened Acres	658	215	2,532	2,252	1,015	344
Total Potential Greened Acres	658	873	3,405	5,656	6,671	7,015
Progress to 9,564 Greened Acres Goal	7%	9%	36%	59%	70%	73%

The table above is meant to illustrate the role that specific policy measures can have in increasing the number of economically attractive (<10-year payback) stormwater retrofit projects on private parcels. Distinct policy strategies are listed across the top, and SMPs are listed down the left-hand column. "Off-site mitigation" refers to a program whereby nonresidential property owners could receive stormwater fee credits for investing in retrofits on residential properties. "Aggregation" refers to the use of governmental or quasi-governmental resources to aggregate projects, assuming that such aggregation would substantially reduce transaction costs and would yield economies of scale that reduce capital costs by about 10 percent. "Subsidy" refers to a direct payment by PWD to a property owner to offset a portion of the up-front capital costs of a greened acre retrofit project.

The greened acre bars in each cell illustrate when a specific SMP retrofit type becomes economically viable for private investors, assuming implementation of the policy strategies listed across the top. An "economically viable" project is defined as one that reaches a discounted payback within 10 years, assuming a discount rate of 8 percent. A full acre bar (█████)indicates that a substantial majority of projects—that is, those at or below the 75th percentile cost for a given SMP category—become economically viable when the policy strategy indicated is implemented. For example, all downspout disconnect projects would become economically viable if an off-site mitigation program were created. The quarter-acre bar (█▒▒▒▒) and half-acre bar (██▒▒▒) indicate that only 25 percent or 50 percent of retrofit projects for a given SMP category become economically viable when the policy strategy is implemented. For example, aggregation could make one-quarter of swale projects economically viable.

the energy efficiency finance sector may be well-suited to the green infrastructure space.

Under these financing models borrowed from the energy sector, the retrofit capital provider acts as a project developer, not only providing the financing but also arranging for the design, construction, and ongoing maintenance of the installed projects. In return for the up-front capital and maintenance services, the capital provider/developer enters a long-term service contract with the parcel owner, assuring the developer a portion of the owner's avoided stormwater fees for a fixed period. From the project developer's perspective, the control over the retrofit installation and maintenance provides assurance that the project will receive the optimal stormwater fee reductions, providing a basis for the project developer to be repaid. From the parcel owner's perspective, these financing arrangements are preferable to traditional debt for a number of reasons. In addition to providing most or all of the capital up front, for accounting purposes the long-term service contract with the project developer can be treated as an operating expense, removing the stormwater management practice asset from the owner's balance sheet.

Interviews with members of the investment community revealed that, although technical performance risks for stormwater management practice investments may be acceptable, the limited repayment track record for stormwater retrofits in Philadelphia, coupled with the unsecured nature of the financing, would render most projects unfinanceable at interest rates that would be attractive to parcel owners. Moreover, the investment community suggested that, in the absence of additional financial backstops against potential losses on green infrastructure investments, only a handful of stormwater projects would succeed in securing private financing.

In addition to taking steps to reduce risks associated with stormwater retrofit investment, PWD could create programs that would reduce project risk and therefore improve financing terms for parcel owners seeking capital for a stormwater retrofit. Strategies that have proven effectiveness in enabling energy-efficiency retrofit investments include the creation of a loan loss reserve fund, enabling repayment for retrofits on water bills, and utilizing municipal tax liens to collect repayment. PWD would need to carefully evaluate the potential costs and benefits of each of these programs in turn.

Facilitating Project Aggregation

Even where financing is available on attractive terms to both parcel owners and investors, questions of retrofit economics still loom large in determining how successfully private capital will be drawn into Philadelphia's nascent green infrastructure market. Encouraging private capital to finance stormwater retrofit projects on private parcels will be difficult in part because many projects tend to be small with relatively high fixed costs and transaction costs. Project aggregation, whereby numerous stormwater projects are packaged into an aggregate portfolio, can help overcome many of the barriers to financing smaller projects.

First, aggregation can present opportunities to work through intermediaries that are willing and able to reduce and/or absorb transaction costs. Second, by efficiently managing many projects simultaneously, aggregation can reduce project development costs through economies of scale (for example, with respect to permitting, design, and the acquisition of parts/materials). Third, aggregation may help investors manage risk by diversifying the quantity and character of projects in a stormwater investment portfolio. In essence, aggregation, when done correctly, can help a group of smaller projects operate somewhat like one larger project, which may help to overcome the barriers that usually inhibit private investment in small projects. Potential aggregators include government agencies, special-purpose non-profit organizations, Business Improvement Districts, and for-profit project developers.

Given the benefits of project aggregation, there are several steps that PWD can take to encourage aggregation in the field of stormwater retrofits. These include:

- **Identifying the costs of retrofits.** Develop Philadelphia-specific cost ranges for stormwater retrofits that could be used on educational materials.
- **Informing interested parties of local stormwater opportunities.** Make publicly available information detailing which properties face large stormwater fee increases and which properties show promise as sites for low-cost green infrastructure retrofits.
- **Educating parcel owners.** Include information on billing statements regarding the cost and potential savings of SMP retrofits as well as potential options for retrofit financing. This will provide ratepayers with a clear understanding of project costs and savings, as well as potential financing options.
- **Soliciting interested parcel owners.** Through billing statements, encourage interested ratepayers to sign up for stormwater retrofits. PWD could then pass on lists of these interested customers to appropriate aggregators.
- **Permit streamlining.** In order to reduce project implementation costs and encourage aggregation, explore how permitting rules might be streamlined to simplify the permitting process for aggregated projects.
- **Encouraging nongovernmental organizations to engage in project aggregation.** PWD should explore working with foundations and nonprofits to channel capital (grants, subsidies, etc.) toward potential aggregators that originate, negotiate, and group stormwater retrofit projects.
- **Encouraging Business Improvement Districts (BIDs) to act as aggregators of stormwater management projects.** BIDs have an inherent interest in undertaking the sort of beautifying neighborhood improvements that many stormwater retrofits entail. In addition, they are already connected with relevant landowners; they are set up to conduct outreach to local property owners and, based on the authors' initial discussions, have an interest in serving as greened acre project aggregators.
- **Creating processes that facilitate economies of scale.** PWD could ensure that permitting requirements don't inadvertently discourage aggregation, and/or write rules to permit aggregators to submit retrofit designs across a broad array of small properties. There may also be ways of helping retrofit project developers purchase items and materials in bulk, though it is unclear how governments and others might help in that regard.

Establishing an Offsite Mitigation Program

Under Philadelphia's stormwater fee system, non-residential property owners may reduce their fees only by retrofitting their own property to manage runoff on-site. However, given the economics of stormwater retrofits under Philadelphia's fee and credit structure, only a small portion of non-residential properties are likely to be suitable for retrofits for which the available stormwater fee savings provide an attractive return on investment.

For example, although downspout disconnections are one of the lower-cost retrofit opportunities available, these opportunities exist mainly on residential properties where owners do not receive a discount on their stormwater fees if they implement green infrastructure practices. If non-residential owners could receive credit against their own stormwater fees in exchange for paying to install downspout disconnections on residential properties, it would allow both residential and non-residential owners to reap economic benefits from the lowest-cost retrofit opportunities. The authors estimated that residential downspout disconnections could provide approximately 638 greened acres if property owners could earn credit for investing in them.

In addition to enabling offsite retrofits on residential parcels, an offsite mitigation program could offer credit to two kinds of non-residential retrofits: redevelopment projects or retrofit projects that oversize their stormwater management facilities. Under local regulations, redevelopment projects more than 15,000 square feet must capture one inch of runoff over their entire parcel. For cases of voluntary retrofits on existing developed property, the one-inch capture standard is also used to determine whether a retrofit qualifies for credit against a property owner's stormwater fee. In the case of both redevelopment projects as well as voluntary non-residential retrofit projects, it may be possible to cost-effectively manage more than one inch of on-site runoff or manage additional runoff from the adjacent public right-of-way. The surplus management volume could generate a tradeable credit.

The credits generated, whether by residential owners who install SMPs such as downspout disconnections or non-residential owners or redevelopers, could be sold not only to owners seeking to reduce their own stormwater fees but for whom site conditions on their own parcel would render on-site retrofits too costly.

Adding an off-site mitigation program to the existing stormwater fee structure could deliver several important benefits, including:

- Greater flexibility for constrained property owners by providing a lower-cost option for constrained owners who want to reduce their stormwater fees.
- System-wide cost savings by leveraging the market to find least-cost stormwater management practices.
- An increase in private sector participation by incentivizing property owners not currently covered by the parcel-based stormwater fee structure (i.e., residential properties) to invest in mitigation.
- Maximization of retrofits on commercial properties by incentivizing property owners to retrofit beyond what is required to receive stormwater fee reductions.
- Establishing a market price to reveal low-cost mitigation opportunities, thereby attracting private capital to the most cost-effective retrofits.
- Creation of transparency and a market price for stormwater management practices retrofits.

Establishing an off-site mitigation program would create new administrative burdens for the PWD, such as certifying credits on credit-generating properties, maintaining a public credit registry (along with serial numbers for individual credits), and setting up a system to ensure that credit-generating sites continue to be maintained post-certification. The report offers recommendations on how to design such a program to ensure that it yields greened acres that can be counted toward the PWD's compliance with its Clean Water Act obligations. The report also examines the potential size of the market for tradeable credits; it concludes that demand would likely be high enough to spur a functioning market, but recommends further research to refine initial estimates of the potential supply of credit-generating projects, before a decision is made to launch an off-site mitigation credit program.

II. HOW TO ACHIEVE GREENED ACRES ON A LARGE SCALE ON PUBLIC OR PRIVATE LANDS THROUGH PUBLIC-PRIVATE PARTNERSHIPS

Although there is a significant opportunity to obtain greened acres on private parcels at lower cost than Philadelphia's anticipated costs to green in the public right-of-way, there are likely to also be cost-effective green infrastructure opportunities on a broader set of land types, including school campuses, parks, and vacant lands in the city. With this in mind, the final chapter of this report explores how public-private partnership approaches can be used to finance large-scale green infrastructure that can be applied to a wide range of land types.

In order to meet its Clean Water Act requirements, Philadelphia Water Department will need to finance, design, build, operate, maintain, and monitor compliance for a vast portfolio of greened acres. PWD has budgeted at least $1.67 billion on an inflation-adjusted basis over a 25-year period, to be financed through debt issuance, to green thousands of acres across the city.

As an alternative to a primarily bond-financed approach to achieving its greened acre obligations, the PWD should consider use of a public-private partnership. Such arrangements have been used extensively by governments across the nation and around the world as a means to meet the growing demand for infrastructure construction and maintenance. In an environment of constrained federal and state budgets, these partnerships are seen as a way to engage the private sector more deeply in funding infrastructure projects to meet public service needs. The partnerships can lower the costs of construction and maintenance, accelerate implementation, access new sources of investment capital, preserve balance sheet capacity, and incentivize optimal performance by shifting performance risk to private partners where payments are tied directly to performance.

Although the application of a public-private partnership structure to green infrastructure would be a first if achieved in Philadelphia, the PWD has established a track record of successful partnership projects. Since 1995, the PWD has implemented three public-private partnership structures that are widely thought to be successful projects. Most recently, in 2011, the PWD awarded a contract to finance, install, maintain, and own a new $35 million 5.6 MW cogeneration plant.

The Availability Payment model may be best suited to help the PWD meet its green infrastructure requirements. Under the Availability Payment model, a government entity contracts to make a regular periodic payment to a private sector entity which, is under the terms of the partnership contract, will design, build, and maintain a specified number of greened acres. This framework would require the PWD to make a quarterly or other regular payment for use of the infrastructure in question. The payment can be subject to performance standards that would allow the PWD to reduce the level of its payment amount or eliminate payments altogether in the event that performance is inadequate.

A public-private partnership structure may be able to reduce greened acre costs, as compared to ordinary PWD capital projects, by providing a private partner with opportunities to:

- focus on technical designs and property types where it has a competitive advantage and thus deliver greened acres in a cost-effective manner;
- minimize conflicts between design and maintenance decisions to deliver a portfolio with a lower cost over its lifetime, as compared to a design or practice implemented by one party and then maintained by another;
- achieve economies of scale in the sequencing and organizing a large portfolio of work, rather than small project-specific contracts;
- deploy green infrastructure in a cost-effective manner on property types that PWD would not otherwise have access to, or have access to at reasonable cost.

The private partner contracted to finance and deliver greened acres under the partnership can consider a variety of capital structures that incorporate nontraditional sources of funding, including philanthropic capital, impact-oriented capital held by those interested in achieving environmental objectives alongside financial ones, and traditional institutional capital sources. The authors discussed the concept of a Greened Acre public-private partnership in Philadelphia with a range of professionals involved in infrastructure investing and transaction structuring, corporate sustainability efforts, and corporate foundation grant-making. Those investors suggested a number of considerations on the part of the potential investment base for a Greened Acre partnership project:

- *Performance Risk:* If partnership financing relies on a PWD contractual obligation for repayment, an institution's comfort with the likelihood of performance becomes a critical element of risk assessment. For green stormwater mitigation, there are two types of performance risk: failure to complete construction according to design specifications, and failure to provide ongoing maintenance of infrastructure particularly as related to compliance with environmental regulations and requirements.

  These performance-related risks stand as the largest impediment to a cost-effective pricing of the strategy and will need to be carefully evaluated and structured around in order to satisfy the needs of PWD and potential investors in green infrastructure. Such concerns do not suggest that investors would not have interest in a green stormwater infrastructure partnership. However, if left unmitigated, these concerns would increase the required return associated with financing the structure and project implementation.
- *Scale:* For most investors, the scale required to attract mainstream institutional capital into a single investment entity is likely at least $20 million, and ideally $50 million or more. Mainstream institutional capital is defined here as pension funds, sovereign wealth funds, foundations/endowments, family offices, and private banks. Below the $20 million level, there are certain foundations, family and multifamily offices, and impact-oriented investors who are potential sources of capital. Infrastructure funds would need to make at least a $25 million commitment of resources to any potential partnership product. Around $75 million to $100 million would be an ideal amount of capital to attempt to rise based on local demand for the capital in terms of project need and potential institutional supply of investment capital. These data are encouraging in that they indicate institutional-scale investors could be approached to finance partnership efforts.
- *Pricing:* A partnership structured between the PWD and a private-sector partner would have off-balance-sheet financing. Payments made through a contractual obligation do not imply the same liability to the PWD as an on-balance-sheet loan obligation or bond issuance. Therefore, the return required by investors will necessarily need to incorporate the lower standard of obligation written into the contract. The weaker the PWD contractual obligation, the higher the return required. The stronger the obligation, the lower the return required. At the same time, the contract terms cannot be so strict as to mimic a traditional bond instrument in terms of the PWD's liabilities therein, or the contract will be perceived by PWD's rating agencies to be debt-like, possibly resulting in a highly undesired impact on the PWD's credit rating and debt ceiling.

There is enormous capital capacity to fund infrastructure in the United States and beyond. Public-private partnerships are attractive to investors because they can provide a high level of transparency and generally offer investment premiums in comparison with municipal bonds for similar risks. A partnership arrangement for green infrastructure could allow the PWD to leverage private capital to fund an innovative solution to stormwater mitigation, defer its up-front costs, and provide a compelling opportunity to investors, offering good value to the department on a relative basis.

CHAPTER 1: **ECONOMICS OF STORMWATER RETROFITS ON PRIVATE PARCELS IN PHILADELPHIA**

1.1 BACKGROUND

In urban environments, green infrastructure helps improve local water quality and quantity by reducing stormwater runoff and sewage overflows, providing natural pollutant filtration, and recharging local groundwater supplies. Within our major cities, if landowners could be incentivized to implement green infrastructure practices such as rain gardens, swales, and green roofs, which capture runoff from impervious cover before it reaches overburdened sewer systems, billions of gallons of polluted stormwater runoff could be avoided. These "greened acres" are also of significant value to municipalities that would otherwise need to pay to clean stormwater runoff conveyed through the local storm sewer system.

In order to satisfy Clean Water Act requirements, the City of Philadelphia has made a binding commitment to substantially reduce its annual number of combined sewer overflow (CSO) events over the next 25 years. Adopting an innovative approach to reducing sewer overflows, the City of Philadelphia's Green City, Clean Waters plan relies heavily on green stormwater management practices (SMPs), (i.e., rain gardens, swales, green roofs, etc.) instead of more traditional "gray" infrastructure (i.e., cement piping and storage systems) to achieve its CSO reduction goals. Over the next 25 years, the city aims to transform one-third of the impervious area in the CSO sewershed area (or 9,564 impervious acres) into greened acres. These green acres will be designed to manage on-site the first inch of rainfall from any given storm, effectively treating 80 to 90 percent of stormwater runoff volume produced by a property.[1]

Philadelphia plans to achieve its greened acre commitment through a combination of investments in the greening of public spaces and regulatory changes intended to induce private investment in green infrastructure development. First, the city anticipates that 3,000 greened acres will be achieved through local regulations that will require private redevelopment projects to be built to manage the first inch of rainfall on-site.[2] Second, the Philadelphia Water Department (PWD) has budgeted $1.67 billion in public funds to build additional greened acres as needed to meet the city's commitments.[3] Presently, the intended focus of such public spending is on publicly owned impervious area, such as streets and sidewalks. Third, and most relevant to this report, Philadelphia also has implemented a new stormwater utility fee structure for existing nonresidential property owners, including provisions for fees to be substantially reduced if owners "green" their property to reduce runoff.

The amount of impervious area on a site correlates strongly with the amount of stormwater runoff the parcel generates.[4] In an effort to equitably distribute the financial requirements of stormwater management across its customer base, PWD began phasing in a "parcel-based" fee system in July 2010. Using aerial images of Philadelphia, PWD was able to determine the square footage of impervious area on each nonresidential parcel and apportion the new fee on the basis of each parcel's total impervious and gross area. The new parcel-based fee is scheduled to be phased in over four years, with all nonresidential customers paying a fully parcel-based stormwater fee by July 2013.[5]

The new parcel-based fee structure provides a financial incentive for property owners who either reduce impervious area on their parcels or otherwise manage stormwater on-site. If parcel owners demonstrate that their property can manage the first inch of stormwater that falls on their property, they are eligible for a substantial reduction or credit against their monthly stormwater utility fees.

NRDC's February 2012 report "Financing Stormwater Retrofits in Philadelphia and Beyond" ("Financing Stormwater Retrofits") outlines how Philadelphia's new stormwater fee and credit structure could encourage private parcel owners to invest in stormwater retrofits.[6] The report illustrates the parallels between the challenges and opportunities in the energy retrofit financing market and the green stormwater retrofit market. The report summarizes a handful of financing approaches developed in the energy efficiency retrofit sector (including PACE loan programs, performance contracting, and utility on-bill loans) and explores which of these mechanisms might be most effective in drawing private investment into Philadelphia's stormwater retrofit market.

This chapter provides an update to the financing concepts initially explored in the "Financing Stormwater Retrofits" report. In an effort to better map the financial opportunities and challenges in the nascent Philadelphia stormwater retrofit market, the authors: 1) explored in greater detail the potential market opportunity for each SMP type in the combined sewer service area, and 2) explored issues of opportunity and concern with relevant stakeholders in the public sector, private sector, and nongovernmental groups.

Based on the additional analysis conducted, this chapter addresses the following:

- **Basic stormwater management practice (SMP) costs.** Estimates of the cost ranges for nine basic SMP types were derived using historical cost data from existing literature, available cost data on recent projects in Philadelphia, and desktop analyses of a sample of Philadelphia properties.
- **Break-even analysis.** Given Philadelphia's current parcel-based fee and credit program, a $/ft^2 break-even price for retrofits was calculated based on the available fee reductions as well as an assumed acceptable payback time line of 10 years.

- **Stormwater retrofit cost curve.** A stormwater retrofit cost curve was developed, indicating the relationship between SMP capital cost ($\$/ft^2$), break-even point ($\$/ft^2$), and acreage available for each SMP.
- **Additional policy interventions.** Potential policy interventions are outlined that PWD could implement to improve the basic economics of private investment in stormwater retrofits and strengthen revenue certainty for potential investors (including loan loss structures, on-bill financing, and tax-lien-based structures).

1.2 GREEN INFRASTRUCTURE RETROFITS IN PHILADELPHIA: BASIC ECONOMICS

In "Financing Stormwater Retrofits," the authors provided an initial estimate of Philadelphia's nonresidential stormwater retrofit market. Based on a group of 27 Philadelphia stormwater retrofit case studies for which SMP costs and resulting fee credits were known, the authors provided an initial estimate of the capital required to retrofit two subsets of the city's nonresidential parcels: the "top 100" parcels in terms of highest monthly parcel fees, and all properties with monthly parcel-based stormwater fees in excess of $1,000. The analysis found that it would cost approximately $115 million to retrofit all the top 100 parcels, and $478 million to retrofit the 1,288 parcels with stormwater fees higher than $1,000 per month. The analysis in this chapter seeks to illustrate which stormwater management practices could reach payback within 10 years, using avoided stormwater fees as the sole measure of payback.

1.2.1 Stormwater Fee and Credit

Beginning in fiscal year (FY) 2010, Philadelphia began to phase in the new parcel-based fee system.[7] In July 2013, the new parcel-based fee is scheduled to be fully implemented. At that time, the monthly stormwater fee for Philadelphia's nonresidential properties will consist entirely of a small fixed monthly minimum parcel charge, plus the sum of the parcel's impervious area (IA) charge and a gross area (GA) charge.[8]

(Gross Area Charge)
+
(Impervious Area Charge)
+
(Minimum Parcel Charge)
=
Total Monthly Fee

PWD is currently in the midst of a rate-setting proceeding that will determine its water, sewer, and stormwater rates for FY13–FY15. Assuming PWD's current rate proposal is approved, the stormwater rates for fiscal years 2014 and 2015 will be:[9]

Monthly Parcel-Based Stormwater Fee Rates: Fiscal Years 2014 and 2015

Fiscal Year	Impervious Area Cost per 500 ft²	Gross Area Cost per 500 ft²	Minimum Parcel Charge
2014	$4.50	$0.56	$11.80
2015	$4.75	$0.59	$12.46

Under Philadelphia's parcel-based billing structure, parcel owners can reduce their stormwater fees by retrofitting their parcels with green infrastructure solutions. Fee-reducing credits against the stormwater charge are provided per square foot of parcel area where the first inch of stormwater can be managed on-site. Once a retrofit is approved by PWD, the applicable fee reduction is fixed for a four-year period, subject to maintenance requirements over that period. After four years, the initial credits expire, but they may be renewed. Each credit renewal would be effective for another four-year period, after which owners may again reapply for the credit.[10] More detail on the credit renewal process is provided in the "Revenue Certainty" section in Chapter 2 of this report.

Under PWD's pending rate proposal, the maximum credit that a given parcel could achieve is 80 percent of the parcel's monthly IA and GA charges, provided that the first inch of stormwater is managed over the entire parcel. The dollar value of this maximum potential credit will rise in line with annual stormwater rate increases. For all analyses below, the authors have assumed that rates will increase annually at approximately 6 percent per year following FY15, consistent with the annual average increases in PWD's FY13–FY15 rate proposal as well as PWD's rising revenue needs in order to meet its long-term sewage overflow reduction requirements.

At FY14 rates, the maximum available credit per square foot of greened parcel is approximately $0.10 per square foot per year.[11] In determining whether or not to invest in installing stormwater management practices (SMPs) on a parcel, a commercial property owner will likely assess whether the cost savings derived from the stormwater credit over some period of time justify the up-front capital expense of implementing the measure. This is explored further below.

1.2.2 Stormwater Management Practice Costs

The cost of SMPs can vary widely depending on a given property's features, such as parcel size, slope, soil conditions, and physical constraints. For these reasons, an SMP that is economically advantageous to one property owner may be cost prohibitive to a neighboring property. Generally, SMP unit cost—the cost per square foot of impervious area managed—exhibits an inverse relationship to parcel size; cost typically decreases as the parcel size increases, and vice versa.[12]

Figure 1.1 provides mid-range and quartile (25 percent and 75 percent) cost estimates for a range of SMP retrofits. These estimates include materials, installation, design, and engineering, but not operations and maintenance costs (which can average 2 to 5 percent of total project cost annually).[13]

Figure 1.1: Stormwater Management Practice Retrofits—Estimated Cost Ranges[14]				
Stormwater Management Practice	**SMP COST RANGE $/square foot of impervious area managed**		**SMP COST RANGE $/acre of impervious area managed**	
	Mid-range	**25% and 75% Quartiles**	**Mid-range**	**25% and 75% Quartiles**
Downspout Disconnection (1)	$0.35	$0.33 - $0.38	$15,246	$14,377 - $16,450
Swales (2) (Vegetated Filtration, Retention, and Conveyance Structure)	$1.20	$0.64 - $2.13	$52,272	$27,878 - $92,783
Infiltration Trenches (3)	$1.46	$1.38 - $1.58	$63,598	$59,973 - $68,622
Rainwater Harvest & Reuse (2)	$3.28	$1.28 - $5.33	$142,877	$55,757 - $232,175
Rain Gardens (4)	$4.11	$3.88 - $4.43	$179,032	$168,827 - $193,175
Reducing Impervious (Hard) Surfaces (2)	$4.37	$3.94 - $4.58	$190,357	$171,626 - $199,505
Flow-Through Planters (2)"	$5.90	$3.84 - $7.68	$257,004	$167,270 - $334,541
Porous Pavements (5)	$5.17	$4.88 - $5.58	$225,205	$212,369 - $242,996
Green Roofs (2)	$34.98	$30.70 - $63.97	$1,523,729	$1,337,292 - $2,786,533

The above costs include materials, installation, design, and engineering, but do not include operations and maintenance costs. Cost ranges can vary greatly depending on site constraints. Data Soures:

1. AKRF Cost Estimate. Assumes disconnect is constructed as a do-it-yourself homeowner project.
2. Center for Watershed Protection 2007. *Urban Stormwater Retrofit Practices Manual*. CWP report costs were adjusted to 2012 dollars using a regional construction index. In addition, 20% was added for design and engineering and another 50% for contingency costs.
3. EPA 2004. "The Use of Best Management Practices (BMPs) in Urban Watersheds." EPA report costs were adjusted to 2012 dollars using a regional construction index. In addition, 20% was added for design and engineering and another 50% for contingency costs.
4. AKRF Cost Curve derived from built projects.
5. Urban Design Tools, Permeable Pavers, 2012. Low Impact Development Center, Inc. Urban Design Tools report costs were adjusted to 2012 dollars using a regional construction index. In addition, 20% was added for design and engineering and another 50% for contingency costs. In addition, it was assumed that any porous pavement retrofits would occur on previously paved areas. As a result, the cost of porous pavement installations also includes asphalt removal costs, which are anticipated to be $2.77/ft^2 of impervious area managed. Asphalt removal costs were derived from CWP 2007 Report Appendix E; costs were adjusted to 2012 dollars using a regional construction index. In addition, 20% was added for design and engineering and another 50% for contingency costs.

1.3 MAXIMUM ECONOMICALLY JUSTIFIABLE COST AND POTENTIAL DEMAND FOR SMP PROJECTS

For any given property owner, there are certainly many factors in addition to stormwater fee reductions that are relevant to the decision of whether to invest in an SMP retrofit. For example, the property owner may wish to increase the resale value of the parcel, improve the property's aesthetics, or seek to improve local water quality by reducing stormwater runoff. At the same time, a property owner may have concerns that deter investment in SMP retrofits, such as the concern that retrofit construction, would unduly burden existing tenants, even if the retrofit otherwise makes economic sense in terms of project payback. Ultimately, however, it is the economics of payback on green infrastructure projects based on avoided costs that will likely determine whether SMP investments appeal to a large number of property owners.

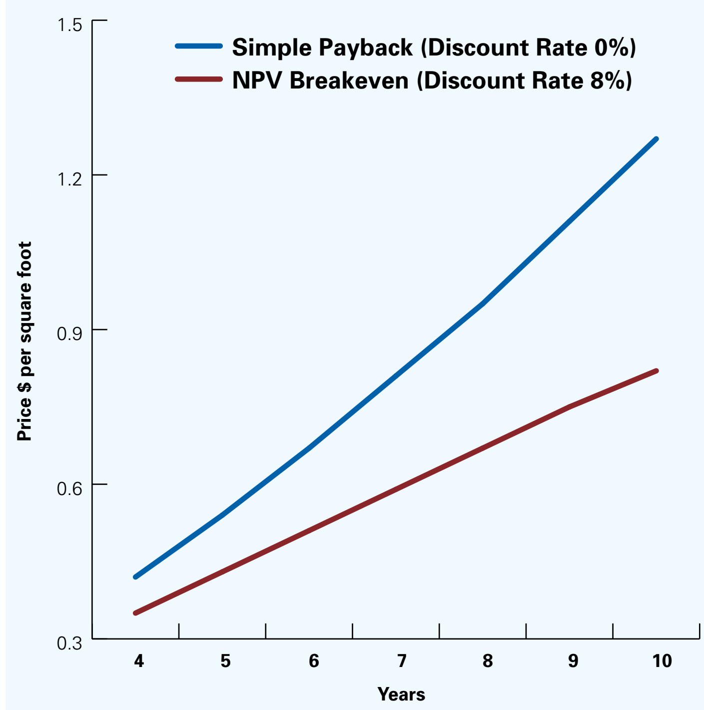
Attractive retrofit economics arise for property owners when the amortized cost of an SMP project is less than the annual stormwater fee reduction generated by the green infrastructure project. . Discussions with property owners and knowledge of how building owners have responded to energy-efficiency retrofit project economics suggest that a property owner who is self-financing a retrofit would likely desire a payback period of no more than three to four years (see "Revenue Certainty" section of Chapter 2). Also drawing from the lessons learned in the energy retrofit market, the authors are using a 10-year payback as a reasonable time horizon for project payback if the project is financed primarily (approximately 80 percent financing) with third-party investor capital.

The break-even analysis in Figure 1.2 presents the maximum economically justifiable cost ("MEJC"), in dollars per square foot, for a retrofit project to achieve payback within a given number of years under the current Philadelphia fee structure. Assuming that a stormwater retrofit project is installed in fiscal year 2014 (FY14) and needs to reach a discounted breakeven on investment in 10 years or less, Figure 1.2 provides guidance as to the MEJC, assuming a discount rate of 8.0 percent, and using the projected 6 percent annual increase in stormwater rates (as noted above). Under these assumptions, the MEJC for an owner installing SMPs in FY14 would be just under $36,000 per acre, or approximately $0.82 per square foot.[15] The MEJC assuming a simple (non-discounted) payback would be $55,000 per acre, or $1.27 per square foot. In other words, a property owner spending $0.82 per square foot could expect to recoup his or her investment in the form of avoided stormwater fees within 10 years, to make the expenditure on green infrastructure as profitable as an alternative investment paying 8 percent annual interest. A building owner spending $1.27 per square foot would recoup his or her investment within 10 years from avoided fees, but with no additional return.

Figure 1.2 illustrates that, at current estimated SMP project costs (presented in Figure 1.1), few private SMP investments appear to meet the MEJC criteria under Philadelphia's current stormwater fee and credit rates. For property owners with payback requirements shorter than 10 years, even fewer SMPs fall under the maximum cost hurdle.

Assuming that private parcel owners will assess whether to implement an SMP retrofit using a discounted payback basis, our analysis suggests that "demand" for project implementation will likely occur for stormwater retrofit projects with up-front capital costs of $36,000–$55,000 per acre ($0.82–1.27/ft^2), depending on the discount rate utilized by the project investor. In future years, as stormwater rates increase, higher-cost retrofit projects will begin to show positive returns on investment due to the higher value of stormwater credits.[16] Until then, however, if Philadelphia property owners are expected to undertake retrofits that cost more than more than $36,000 per acre ($0.82 per square foot), additional financial incentives beyond the existing fee credit will likely need to be offered.

Figure 1.2: Break-even Analysis: Projects Beginning in FY14



1.4 COST CURVE

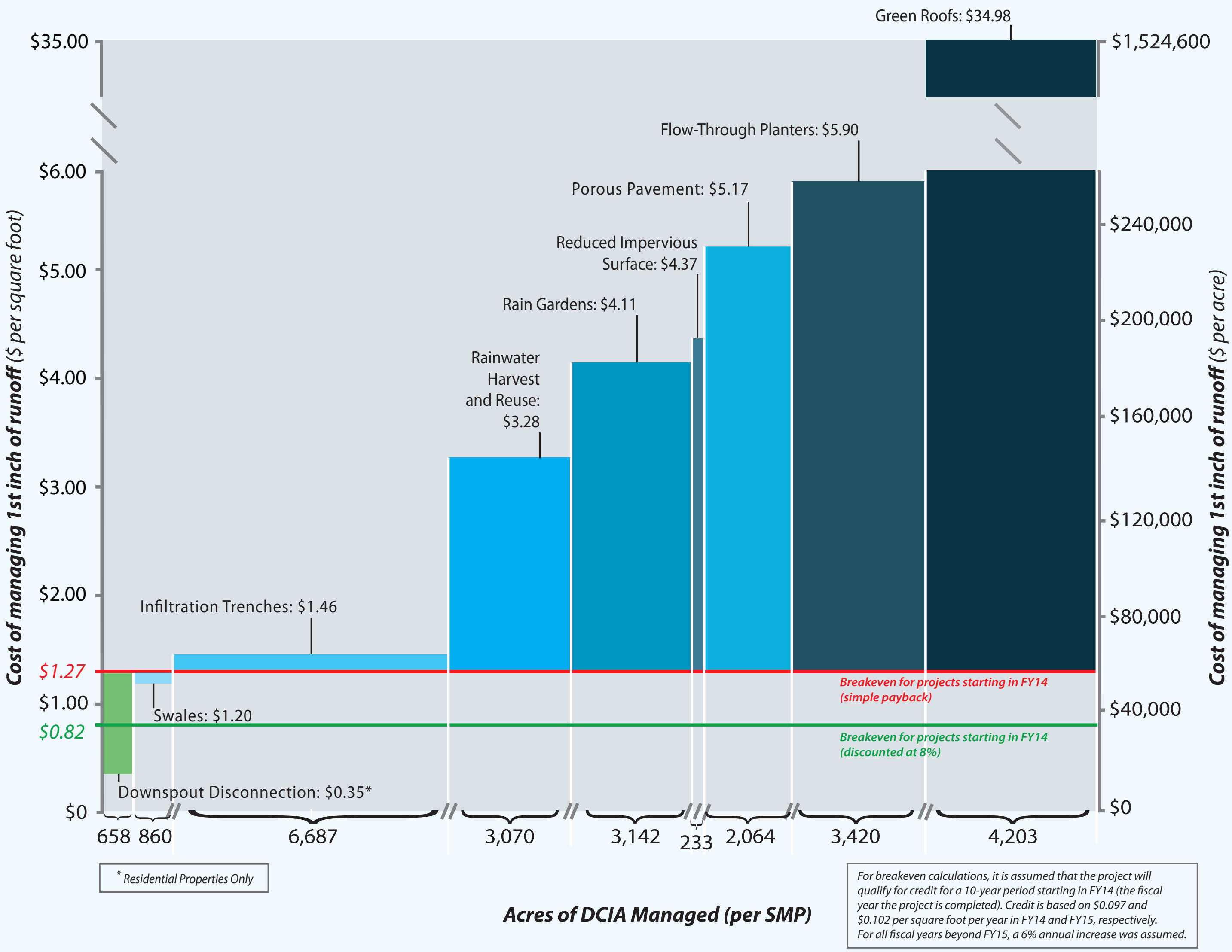
The "cost curve" graph in Figure 1.3, below, illustrates the basic payback of various SMP retrofits on parcels in Philadelphia, assuming that the retrofit is constructed in FY14 and that stormwater rates continue to rise at a rate of 6 percent annually. The cost curve suggests which SMPs are likely to attract private investment at a given rate structure and how many acres of impervious area may be suitable for each SMP.[17]

As described earlier in this chapter, SMP costs can vary widely depending on site-specific conditions. For simplicity, the cost curve presented in Figure 1.3 utilizes the mid-range cost estimates presented in Figure 1.1. The use of mid-range numbers is not intended to account for all properties, but rather to provide insight into the scalability of the universe of owners who will decide to invest in SMP retrofits in a given year and at a given stormwater rate. The cost curve is based on fixed financial assumptions including an 8 percent discount rate, 10-year required payback period, and projected stormwater fee increases of 6 percent (See Cost Curve Legend). For these reasons, the presented cost curve is most useful to broadly compare economics across SMP types rather than as an absolute indication of the economic feasibility of any given project category. Further SMP cost analysis and a case-by-case property assessment would be needed to determine true retrofit costs for any given property owner.

Much like the greenhouse gas reduction cost curve developed by McKinsey in 2007, the SMP Cost Curve presented here is designed to stimulate discussion among policymakers, property owners, private investors, and retrofit contractors about how Philadelphia's new stormwater fee system could promote green infrastructure development throughout the city.[18]

The nine bars represent nine SMPs. Eight of these are PWD-approved measures to manage directly connected impervious area, or DCIA (hereinafter "impervious area") on nonresidential properties;[19] a ninth SMP (downspout disconnections) is best-suited for residential properties, but was included because it represents potentially the lowest-cost type of SMP.[20] The width of each bar indicates the approximate impervious area (in acres) in Philadelphia's combined sewershed for which a given SMP can feasibly manage one inch of stormwater (based on a set of technical assumptions detailed in the appendices to this report).[21] For example, the cost curve shows potential for achievement of 6,687 greened acres through installation of infiltration trenches, and 2,064 acres through installation of porous pavement. When comparing the acreage numbers on the cost curve to Philadelphia's 25-year commitment to greening approximately 9,500 impervious acres, it is important to note that the nonresidential acres represented by each SMP are noncumulative—that is, when summed they will not represent the total nonresidential impervious area in the combined sewershed. This is because the cost curve includes, for any given nonresidential parcel, each type of SMP project that could be used to mitigate that parcel's stormwater runoff.[22]

Figure 1.3: Stormwater Retrofit Cost Curve



Cost Curve Legend

*Most downspout disconnections occur on residential properties. They are included in this chart because they represent the most cost-effective SMP under the current fee and credit structure. While residential properties are not currently subject to a parcel-based fee, Chapter 3 of this report ("Off-site Mitigation") explores using residential property retrofits as part of an off-site tradable stormwater mitigation credit market.

**Supply estimates for each SMP provided in the cost curve represent an estimate of the total available drainage area that could be managed by that SMP. If multiple SMPs were able to feasibly manage a given impervious drainage area, the impervious drainage area was counted toward supply for each feasible SMP type. Therefore, supply estimates are not mutually exclusive among SMP types, and the sum of supply among all SMP categories does not represent the total supply in the combined sewer overflow area.

Acreage calculations for residential and nonresidential properties, per SMP, have a ±22 percent and ±20 percent margin of error, respectively

O+M costs are not included in SMP cost calculations. (Annual maintenance of SMPs amounts to approximately 2 to 5 percent of total project costs. Source: author interview with AKRF staff.)

For all break-even calculations (red and green lines), it is assumed that the project will qualify for credit for a 10-year period starting in FY14 (the fiscal year the project is completed). Credit value is set as 80 percent of the combined IA and GA fee for each square foot of impervious area managed. Specifically, based on PWD's proposed FY14 and FY15 rates, the annual credit values for those two years are $0.097 and $0.102 per square foot, respectively. For all fiscal years beyond FY15, a 6 percent annual increase in the stormwater fee, and in the corresponding credit value, is assumed.

The projected total stormwater fee savings that a ratepayer could earn over the 10-year period spanning FY14–FY23 is $1.27/ft^2 ($56,000/acre) on a simple payback basis, or $0.82 (just under $36,000 per acre) on a discounted basis. These total stormwater savings are represented by the red line (simple payback, 0 percent discount rate) and green line 8 percent discount rate), respectively. Therefore, for any stormwater project beginning in FY14, SMP projects with costs below the critical threshold of $1.27/ft^2 would achieve a straight payback within 10 years, and those with costs below the $0.82/ft^2 threshold would achieve a discounted payback within 10 years.

Given the discounted payback threshold of $0.82/ft2, the mid range and quartile values presented in Fig. 1.1 suggest that only downspout disconnections and lower cost swale projects are likely to acheive a discounted payback over a 10-year time horizon. Together, these two project categories could green 873 acres, moving Philadelphia just over 9 percent of the way toward its goal of 9,564 green acres within the CSO watershed.[23] Given their shorter payback time frame, these 873 acres of potential projects represent the relatively low-hanging fruit for greened acre implementation.

Although downspout disconnections and lower-cost swale projects may be economically attractive under Philadelphia's current stormwater fee structure, estimated costs for a majority of SMP types exceed 10-year payback thresholds.

1.5 IMPACT OF ADDITIONAL POLICY MEASURES ON RETROFIT PROJECT ECONOMICS

Given the estimated project economics outlined in the payback analysis (Figure 1.2) and cost curve (Figure 1.3), PWD will likely need to develop additional policy measures if it aims to encourage parcel owners to invest in stormwater retrofits. This section explores several promising approaches that PWD could take to stimulate the development of lower-cost greened acres on private property.

First, the available data on SMP costs (outlined in Figure 1.1) suggest that downspout disconnection is the least costly practice available to achieve greened acres in Philadelphia.[24] However, most downspout disconnection project opportunities occur on residential properties, and under the current parcel-based stormwater fee system residential owners are not eligible for stormwater fee reductions. Thus, to encourage private financing and implementation of residential downspout disconnections, an off-site mitigation credit and banking program would need to be developed. Such a program would allow nonresidential property owners to use credits derived from financing residential downspout disconnections to lower their stormwater fees. Chapter 4 of this report explores how an off-site credit banking system could be structured and established.

Second, available SMP cost data also suggests that a quarter of swale retrofit projects would be economically viable private investments over a ten year time frame. However, it is important to note that the cost figures presented for all SMPs do not include transaction costs, such as the costs associated with identifying appropriate retrofit sites, lining up contractors, and negotiating contract terms. In the energy efficiency retrofit industry, for example, transaction costs have been found to add 10 to 40 percent to total project costs.[25] Without substantially reducing these transaction costs, even relatively low-cost swale projects would probably be unable to attract private investment.

Aggregation of projects has been proven to substantially reduce transaction costs such as site-specific project identification and contractor search and negotiation. Moreover, project aggregation can reduce capital costs through economies of scale. In contexts such as renewable energy project finance, aggregation of distributed projects has been shown to bring down capital costs by 10 to 15 percent.[26] Similarly, it is anticipated that aggregating stormwater retrofit projects would lead to cost reductions in materials, design, and engineering costs.[27] For example, if a business improvement district aggregated projects across its area of influence, or if a city aggregated projects across CSO neighborhoods, it could expect to realize lower per-square-foot implementation costs. Through the additive benefits of reduced transaction and capital costs, it is anticipated that aggregation could make additional swale retrofit projects economically viable as private investments. Chapter 3 of this report outlines a number of strategies PWD could undertake to facilitate project aggregation.

Finally, although the cost curve analysis suggests that only two types of SMP retrofits (downspout disconnects and a portion of swale projects) may provide a sufficient return to attract widespread private investment in the current market environment, adoption of a subsidy program to cover a portion of the up-front capital costs of SMP installation could lead to a substantial increase in the market for private investment in stormwater retrofits. The impact of distinct subsidy levels on the viability of stormwater projects is explored further below.

Figure 1.4, Building a Greened Acre Market, indicates how a range of policy strategies—including an off-site mitigation program, project aggregation, and direct subsidies—could expand the potential for private investment in greened acre projects.[28] Figure 1.4 illustrates the estimated impact of each policy strategy on the market size of economically viable private investment in greened acre retrofits. As indicated previously, the authors define an "economically viable" green acre project as one that reaches a discounted payback within 10 years, via reduced stormwater fees.

The values in Figure 1.4 suggest additional policy measures could render up to 7,015 acres of stormwater retrofits economically viable and potentially attractive as private investments. These 7,015 acres represent a full 73 percent of PWD's 25-year target of 9,564 greened acres. Implementation of an off-site mitigation program, for example, could create the opportunity for private investment in 658 greened acres through residential downspout disconnections. Similarly, utilizing governmental or quasi-governmental (e.g., business improvement district) resources to aggregate projects could create economically viable private investment opportunities in 215 additional acres of low-cost swale projects, assuming that aggregation would reduce transaction costs and trim SMP capital costs by approximately 10 percent.

The “subsidy” columns in Figure 1.4 illustrate the impact of incremental subsidy amounts on the economic attractiveness of stormwater retrofits. At each subsidy level, from $0.50/ft^2 to $3.50/ft^2, new SMP types become economically viable as private investments, and the total market opportunity of greened acre projects grows considerably. The results of this analysis suggest that if PWD were to implement a capital subsidy program that offered $3.50/ft^2—in combination with off-site mitigation and aggregation programs—PWD could achieve up to 73 percent of Philadelphia’s total greened acre target by successfully inducing private parcel owners to green their parcels. Even at a much lower subsidy rate of $0.50 per square foot, the available cost data suggest that PWD could expand the potential for private investment in greened acre retrofits by more than 2,500 acres, over one-quarter of PWD’s total greened acre target.

A water utility contemplating whether to implement a subsidy program for retrofits on private parcels is likely to weigh the cost of such subsidies against the utility’s cost to achieve mitigation in other ways, such as retrofitting impervious acres on streets, public parking lots, and other public property. Philadelphia is currently incurring costs of approximately $250,000 per acre, or $5.74 per square foot, to construct greened acres in the public right-of-way.[30] By comparison, the cost to PWD of subsidizing a square foot of greened area on a private parcel is roughly equivalent to the up-front subsidy cost (the “Subsidy” column in Figure 1.5, below) plus the forgone stormwater fee (the “Lost Revenue” column). As indicated in Figure 1.5, initial calculations suggest that even at a subsidy of $4.00 per square foot, PWD would be able to realize a new greened acre for $4.82 per square foot—a lower cost than the $5.74 that the city is

Figure 1.4: Building a Greened Acre Market

	Off-site Mitigation	Aggregation	$0.50/ft^2 Subsidy	$1.00/ft^2 Subsidy	$3.00/ft^2 Subsidy	$3.50/ft^2 Subsidy
Downspout Disconnection	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■
Swales		■□□□	■■□□	■■■■	■■■■	■■■■
Infiltration Trenches			■■□□	■■■■	■■■■	■■■■
Rainwater Harvest & Reuse			■□□□	■□□□	■■□□	■■□□
Rain Gardens					■■□□	■■■■
Reducing Impervious (Hard) Surfaces					■□□□	■■■■
Flow-Through Planters					■□□□	■□□□
Porous Pavements						
Green Roofs						
New Potential Greened Acres	658	215	2,532	2,252	1,015	344
Total Potential Greened Acres	658	873	3,405	5,656	6,671	7,015
Progress to 9,564 Greened Acres Goal	7%	9%	36%	59%	70%	73%

Guide to Figure 1.4: Building a Greened Acre Market

Distinct policy strategies are listed across the top, and SMPs are listed down the left-hand column. “Off-site mitigation” refers to a program whereby nonresidential property owners could receive stormwater fee credits for investing in retrofits on residential properties. “Aggregation” refers to the use of governmental or quasi-governmental resources to aggregate projects, assuming that such aggregation would substantially reduce transaction costs and would yield economies of scale that reduce capital costs by about 10 percent.[29] “Subsidy” refers to a direct payment by PWD to a property owner to offset a portion of the up-front capital costs of a greened acre retrofit project.

The greened acre bars in each cell illustrate when a specific SMP retrofit type becomes economically viable for private investors, assuming implementation of the policy strategies listed across the top. An “economically viable” project is defined as one that reaches a discounted payback within 10 years, assuming a discount rate of 8 percent. A full acre bar (■■■■)indicates that a substantial majority of projects—that is, those at or below the 75th percentile cost for a given SMP category—become economically viable when the policy strategy indicated is implemented. For example, all downspout disconnect projects would become economically viable if an off-site mitigation program were created. The quarter-acre bar (■□□□)and half-acre bar (■■□□) indicate that only 25 percent or 50 percent of retrofit projects for a given SMP category become economically viable when the policy strategy is implemented. For example, aggregation could make one-quarter of swale projects economically viable. The subsidy columns assume that aggregation programs have already been implemented, as this is considered a prerequisite to creation of a private investment market in stormwater retrofits.

estimated to be incurring to implement greened acres in the public right-of-way.[31] It is important to note, however, that the calculations in Figure 1.5 assume that property owners maintain these retrofits and continue to receive credit against their stormwater fees for a 10-year period. PWD would likely want to consider, when offering a subsidy for an SMP on a private parcel, additional requirements such as a binding obligation on the property owner's part to maintain the SMP for a period of 10 years or more.

Figure 1.5: 10-Year Projected Cost of Greened Acre Subsidies

Subsidy ($/ ft²)	**Lost Revenue** ($ discounted over 10 years)	**PWD Cost (subsidy + lost revenue)** ($/ ft²)
$0.50	$0.82	$1.32
$1.00	$0.82	$1.82
$2.00	$0.82	$2.82
$3.00	$0.82	$3.82
$4.00	$0.82	$4.82
Current estimated cost to PWD for right-of-way improvements		**$5.74**

Ultimately PWD will need to decide which policy measures will result in the most cost-effective use of public dollars and will make a decision based on a range of factors, many of which are not covered in this chapter. Based on the analysis presented above, it appears that aggregation coupled with a capital subsidy program could help the City of Philadelphia entice private capital into the retrofit market and achieve its greened acre goals at a much lower cost than could otherwise be achieved through publicly-financed retrofits within the public right-of-way.

1.6 CHAPTER CONCLUSIONS AND RECOMMENDATIONS

The break-even analysis and cost curve data in this chapter suggest that, in the near term, Philadelphia's existing stormwater fee and credit system are not likely to generate sufficient return on investment to attract private capital investment in stormwater retrofits among a large number of building owners. The analysis suggests that to strengthen private property owners' interest in investing in retrofits, PWD could consider the following options to improve retrofit project economics for private investors:

- **Gather and share more robust cost data.** PWD should facilitate the discovery of SMP cost data and make general cost data available to parcel owners, retrofit contractors, and other relevant stakeholders. A deeper understanding of installed SMP costs on private parcels in Philadelphia is crucial to making strategic decisions about how distinct incentive programs could impact the size of the retrofit market.
- **Evaluate additional policy measures.** The above analysis suggests that two types of SMP retrofits (downspout disconnects and a portion of swale projects) provide a sufficient return to attract private investment in the current market environment. However, additional policy measures are needed to facilitate actual investment in downspout disconnection and swale retrofit projects. In addition, as illustrated in Figure 1.4, implementation of a subsidy program could potentially stimulate much more private investment into a variety of SMP retrofits and significant movement toward Philadelphia's greened acre goals. PWD should thus consider the following:
  - Create an off-site credit market. The authors' analysis suggests that residential downspout disconnections are the most economically attractive SMPs within Philadelphia's combined sewer area. However, residential properties are currently not eligible for a credit against their stormwater fees. To encourage the greening of these low-cost acres available on residential properties, PWD should explore establishing an off-site credit trading program between nonresidential and residential properties. See Chapter 4 for further discussion of off-site mitigation program considerations.
  - Facilitate project aggregation. In order to reduce transaction costs per project, PWD should take steps to facilitate project aggregation. Chapter 3 of this report contains a detailed discussion of benefits and potential approaches to project aggregation.
  - Develop an SMP retrofit subsidy program. The City of Philadelphia and PWD should consider deploying additional financial incentives for retrofit implementation. This could include offering a direct financial subsidy to install retrofit projects that meet specific parameters, such as cost-per-square-foot thresholds, location in priority combined sewer neighborhoods, project size thresholds, and other community improvement metrics.

    Any direct cash subsidies to cover up-front capital costs of retrofits should be conditioned on a legally binding commitment by the property owner to maintain the SMP for an extended period of years.
- **Raise stormwater fees and/or credits.** PWD could consider raising the stormwater fee or the credit available for a greened parcel. Notably, PWD's flexibility in this regard may be constrained by political and economic feasibility, as well as the need to equitably apportion among all ratepayers (including those who retrofit their own properties) the costs of managing runoff in the public right-of-way.

CHAPTER 2: **STRATEGIES TO FACILITATE FINANCING STORMWATER RETROFITS ON PRIVATE PARCELS**

Presuming that demand among private parcel owners for stormwater retrofits materializes, the vast majority of nonresidential owners would likely seek outside financing for stormwater retrofits, rather than self-finance the entire up-front costs of a retrofit on their parcels. This chapter therefore introduces a third-party financing model that has been developed in the energy retrofit market and builds on the conclusions and recommendations of Chapter 1. The authors explore the specific challenges that could arise as both parcel owners and investors rely on avoided stormwater fees as a measure of payback on their up-front investments in green infrastructure. This chapter then borrows from the energy retrofit sector to suggest a handful of potential programs that the Philadelphia Water Department (PWD) could deploy to mitigate the identified challenges.

2.1 BACKGROUND: THIRD-PARTY "PROJECT DEVELOPER" MODELS

Conversations with property owners and engineering firms, as well as inferences from the energy efficiency finance context, reveal that most nonresidential parcel owners are unlikely to self-finance green infrastructure projects with payback periods longer than three to four years. As indicated in Chapter 1, however, few stormwater retrofits are likely to reach discounted payback within that time frame. As a result, for green infrastructure retrofit projects to be implemented at scale on private parcels, property owners will seek outside financing opportunities for desired projects.

In contrast to a private parcel owner, a third-party capital provider is likely to be more comfortable with a longer payback scenario, particularly when the provider designs, installs, and maintains SMPs, because such a provider will have better knowledge of risks specific to a given project. In addition, whereas a parcel owner is fully exposed to the risk arising from the stormwater retrofit installed on his or her property, a third-party provider will benefit from the ability to spread risk over a portfolio of green infrastructure projects. Drawing from practices in the energy efficiency finance market, where third-party financing of commercial property efficiency projects often extends across a 10-year period, the authors have utilized a 10-year discounted payback as a measure of economic viability for stormwater retrofits underwritten by third-party financing.

Under current market conditions, however, the majority of nonresidential parcel owners are unlikely to be unable to obtain traditional secured debt for stormwater retrofits.[32] Most have existing liens on their assets, including covenants that prevent them from taking on additional (even subordinate) debt backed by the property. Because stormwater retrofit installations would have very low (if any) collateral value if they had to be repossessed, the retrofits themselves are not valuable security in the event of default. The lack of a valuable asset-based security, in combination with the lack of collateral resulting from the retrofit project installation, means that any traditional debt providers would be lending on an unsecured basis, driving interest rates high enough to deter most parcel owners from borrowing, if financing were to be offered at all. It is important to note here that the authors know of no existing loan products tailored to a building owner who will use the proceeds to reduce his or her stormwater fees.

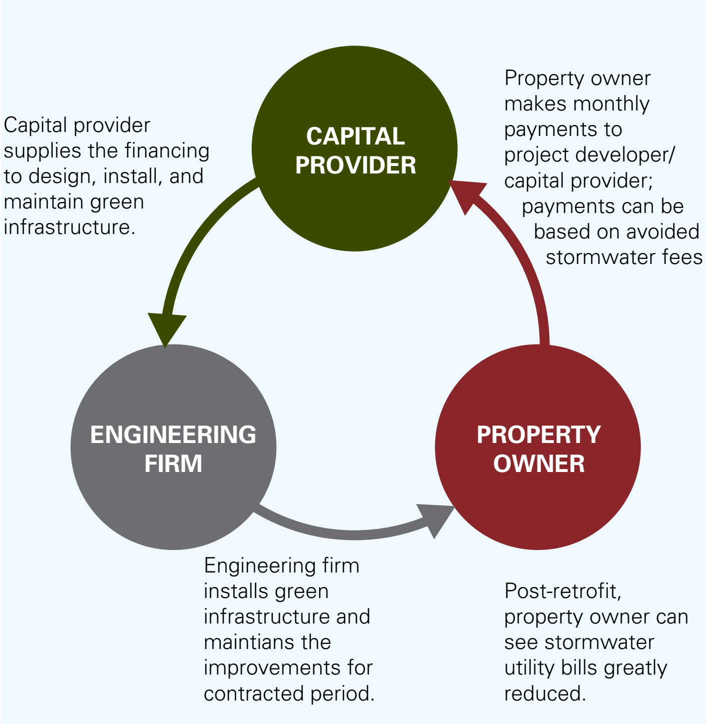
To overcome the challenges of traditional debt financing for stormwater retrofits, the third-party financing models that have arisen in the in the energy retrofit sector may be a good fit for the emerging stormwater retrofit market. Like stormwater retrofits, energy retrofit projects on commercial buildings are also poorly suited to traditional asset-backed debt financing. Therefore, financing models from the energy efficiency sector, often termed "third-party off-balance-sheet" or "project developer" financing structures, are predicated on a private capital investor providing all, or a substantial portion, of the capital needed for a retrofit. Under this structure, the retrofit capital provider acts as a project developer, not only providing the financing but also arranging for the design, construction, and ongoing maintenance of the installed projects. In return for the up-front capital and maintenance services, the capital provider/developer enters a long-term service contract with the parcel owner, assuring the developer a portion of the owner's avoided stormwater fees for a fixed period. From the project developer's perspective, the control over the retrofit installation and maintenance provides assurance that the project will receive the optimal stormwater fee reductions, providing a basis for the project developer to be repaid. From the parcel owner's perspective, these financing arrangements are preferable to traditional debt for a number of reasons. In addition to providing most or all of the capital up front, for accounting purposes the long-term service contract with the project developer can be treated as an operating expense, removing the stormwater management practice (SMP) asset from the owner's balance sheet.

In the energy retrofit sector, this type of third-party financing has taken root primarily in the municipal/university/school/hospital sector, where there is often a public credit backstop for project financing. In the purely private sector, only relatively large projects (larger than $500,000) tend to be financed through third-party off-balance-sheet arrangements, and in all cases of successful financing, building owner credit and debt service coverage ratios are strong, and consent for the financing is required from existing lenders.

The third-party off-balance-sheet model is described here to illuminate a financing strategy that could be applied to stormwater retrofits on commercial properties. Although the vast majority of stormwater retrofits within the Philadelphia combined sewer service area will cost less than $500,000 per project, this chapter will detail the important role that project aggregation strategies can play in unlocking stormwater retrofit financing.

The third-party off-balance-sheet model, depicted in Figure 2.1 below, is referred to in the energy efficiency retrofit finance sector as a “third-party off-balance-sheet financing,” “power purchase agreement–style financing” or “energy services agreement financing.”[33]

Figure 2.1: Third-party Off-Balance-Sheet Model



2.2 THE CHALLENGE OF REVENUE CERTAINTY: REGULATORY RISK AND PROJECT RISK

Revenue certainty is a central concern for SMP retrofit investors—both third-party investors and property owners—who are making a substantial capital investment based in part on the promise of future avoided costs to a parcel owner. In the context of Philadelphia’s potential stormwater retrofit market, regulatory risk and project risk are the primary threats to revenue certainty. This section outlines the major regulatory and project risks to stormwater retrofit investors and outlines strategies that PWD and Philadelphia could undertake to improve revenue certainty and improve the attractiveness of the city’s SMP retrofit market.

2.2.1 Regulatory Risk

While property owners who install green infrastructure projects can realize a variety of benefits (such as reduced flooding, increased property value, reduced summer cooling costs), the vast majority of investors will be making investments in green infrastructure based on the promise of reduced stormwater fees. For those investors who will rely on stormwater fee reductions to generate a return on stormwater retrofit investment, perception of the regulatory risk surrounding PWD’s stormwater fee and credit system will dramatically impact their willingness to invest.

In Philadelphia, key revenue uncertainties that could undermine investment potential in stormwater retrofits are 1) potential changes to the current credit and fee policy, and 2) an untested credit renewal process.

These challenges are explored in more detail in the following two subsections.

2.2.1.1 Changes in Credit and Fee Policy

Changes to the broader stormwater fee credit policy and implementation of a proposed Customer Assistance Program are examples of policies that create uncertainty for stormwater retrofit investors.

Changes in Credit and Fee Policy

If a given green infrastructure retrofit is expected to require eight years of avoided stormwater fees to break even, a project investor would require some certainty that the stormwater fee and credit system would remain intact for at least the next eight years. During that eight-year period, *increases* in utility fees (and corresponding credits) would be welcomed, since they would accelerate project payback and the return on the green infrastructure investment. Alternatively, a *decrease* in fees or a change in how owners are credited for green infrastructure could extend the project payback period and reduce the return on investment. In the unlikely case that a regulatory policy shift led to the elimination of the parcel-based fee system altogether, the projected payback on the green infrastructure project would be completely eliminated.

Customer Assistance Program

Under the new fee structure, owners of large parcels with significant impervious surface area are facing substantial increases in their monthly stormwater bills. In response to skyrocketing stormwater fees as the new parcel-based fee is phased in, a cadre of large parcel owners has organized and won concessions from the PWD, including allowances to “highly impacted” owners.

At the urging of these organized parcel owners, PWD implemented the Stormwater Assistance Phase-in Program (SWAPP). SWAPP provides eligible highly impacted owners with the opportunity to limit year-to-year stormwater fee increases to 10 percent.[34]

When initially implemented by PWD, the SWAPP program was scheduled to terminate in FY14, the final year of the parcel-based fee phase-in period. However, earlier this year, at the urging of parcel owners and the City Council, PWD proposed to extend the 10 percent annual increase cap for at least several more years. This continued rate relief program for highly impacted property owners is known as the Customer Assistance Program (CAP). If adopted and maintained over the long term, the CAP would extend the phase-in of the new parcel-based system from four years to as much as 20 to 30 years for the most highly impacted properties.

Implementation of the CAP program would send a signal to the market that Philadelphia's stormwater fee and credit policy are malleable and susceptible to outside political pressure. Moreover, the implementation of a CAP would also negatively impact local investments in green infrastructure projects. Analysis has shown that CAP–eligible properties would realize much lower rates of return on SMP retrofits. In a substantial number of cases, retrofit projects that would be economically desirable to private investors under a full phase-in of the parcel-based fee system would become poor investments under the CAP.[35]

Extension and expansion of the CAP could significantly impact the budding market for SMP retrofit finance. This is due to the likelihood that many of the owners most likely to participate in the CAP are those who would have the most to gain from investing in stormwater retrofits. Currently, 278 parcels are participating in the SWAPP program, representing an aggregate total of 1,933 impervious acres; these would carry over into the CAP, continuing their rate relief and substantially undermining the incentive to invest in retrofits.

For prospective investors in green infrastructure projects, the CAP raises questions regarding the stability of PWD's stormwater fee system, while simultaneously reducing the economic viability of a group of potential large SMP retrofit projects. It is safe to say that the adoption and expansion of the CAP program would further contract the total universe of economically viable retrofit projects—especially if it is repeatedly extended in the future, beyond the next several years.

Instead of repeatedly limiting stormwater fee increases via the CAP program, thereby discouraging potential investment in stormwater retrofits, PWD could create programs to improve the availability of retrofit financing, thereby enabling property owners to "earn" a reduction in their fees by investing in better stormwater management. These ideas are explored further in the sections below.

2.2.1.2 Untested Credit Renewal Process

PWD will be relying on the installation as well as the performance of stormwater retrofits to meet its Clean Water Act compliance obligations. Since many green infrastructure retrofits will cease to function at their designed performance level if not properly maintained, a process to periodically renew stormwater credits is needed. Under current PWD regulations, stormwater fee credits for private parcels expire after a four-year period. To renew the credit, at the end of each four-year period, a professional certification and photographic evidence of SMP functionality must be submitted for reapproval. In addition, the parcel owner must allow PWD access to the property to verify the information provided in the renewal application.[36] Since few potential retrofit projects provide a return on investment in less than four years, the success of most projects would depend on the credit renewal process.

In discussing the stormwater retrofit market with members of the investment community, the authors noted that the limited duration of the initial stormwater credit (four years) and the untested credit renewal process create risk in the form of revenue uncertainty. Because the parcel-based fee and credit system has been in place since July 2010, owners who have obtained reductions in their stormwater fees have not yet had an opportunity to reapply for their credit. As a result, there is some uncertainty regarding how the renewal process will work in practice. While it is hoped that initial renewal applications will bring some sense of certainty to the process, the first renewals will not occur until mid-2014 at the earliest.

In the short term, PWD could take the following steps toward mitigating the perceived regulatory risk and risks associated with credit renewal:

- Publish a long-term fee schedule indicating projected stormwater fees and credits (preferably up to ten years).
- Create a "price floor" whereby investors in stormwater retrofits are guaranteed a minimum credit against their fee for a fixed amount of time, regardless of changes in stormwater fees and credit policy. (Credits would still be subject to periodic renewal, contingent on proper maintenance of the SMP.)
- Provide guidelines explaining what site inspection will entail and explicit examples of projects that will or will not meet renewal requirements.
- Make available an expedited appeal process in cases of credit nonrenewal.
- Consider extending the initial credit beyond four years in recognition of the extended payback period of most SMP projects. In considering such an approach, PWD will need to consider the potential impact that extending the credit period could have on meeting Philadelphia's compliance obligations.

2.2.3 Project Risk

Project risk is a key concern for investors contemplating stormwater retrofits in Philadelphia. These risks include the technical risks of retrofit nonperformance, risk arising from changes in the parcel owner's financial health, or any other scenario that could lead to default in repayment to a third-party retrofit capital provider.

The technical project risks associated with green infrastructure retrofit finance may be not only different but lower-risk, in some cases, than retrofit projects in the energy efficiency sector.[37] For example, in the energy-efficiency space, behavioral factors, such as fluctuations in tenant energy use, can have a notable impact on the avoided costs resulting from a building retrofit. An unexpected decline in energy prices could also reduce future savings, as would a net reduction in building energy use due to tenant vacancy. In addition to behavioral risk, the potential for retrofit performance problems also drives up project risk in the energy efficiency sector. Such risk can include failure of a new chiller or building management system, or unexpected degradation of project performance over time. While green infrastructure retrofits do require ongoing maintenance, such as the raking of a rain garden to ensure that fallen leaves do not block infiltration, the degree of technical risk is substantially lower than for energy-efficiency technologies installed in a high-tech building. Assuming successive credit renewal approvals, revenue risk for stormwater retrofits is therefore tied primarily to the policy resolve of the implementing utility. Therefore, if and when investors gain confidence in the longevity of the stormwater fee system and the character of the credit renewal process, revenue uncertainty can be substantially abated.

NRDC's "Financing Stormwater Retrofits" report identified lack of collateral, high transaction costs in relation to project size, and lack of a track record for stormwater retrofit financing repayment as key project risk elements. Interviews with members of the investment community revealed that, while technical performance risks for SMP investments may be acceptable, the limited repayment track record for stormwater retrofits in Philadelphia, coupled with the unsecured nature of the financing, would lead to project loan interest rates into the double digits. Moreover, the investment community suggested that, in the absence of additional financial backstops against potential losses on green infrastructure investments, only a handful of stormwater projects would succeed in securing private financing.

2.3 PROGRAMMATIC INTERVENTIONS TO MITIGATE PROJECT RISK

To address the revenue challenges outlined in the preceding section, PWD could take a number of immediate actions to mitigate project risk and facilitate investment in green infrastructure. The following section outlines three programmatic options: creation of a loan loss facility to limit revenue risk, development of an on-bill financing program to facilitate project repayment, and development of a tax lien–based financing program to facilitate project repayment.

2.3.1 Loan Loss Facility to Limit Revenue Risk

Creation of a loss reserve facility has proved to be an effective mechanism through which to draw investors into a new and unproven sector by reducing potential financial losses. A loan loss facility, which serves to backstop a larger pool of investment capital, insulates investors from a specified amount of project risk and can thus improve private capital financing terms or enable project financings that otherwise might not have succeeded.

Loan loss reserve facilities have been utilized in a wide range of cases where a public or private entity seeks to stimulate investment in a particular sector. The source of funds for the loan loss reserve could be a public entity (municipal, state, or federal) or a private not-for-profit organization. Over time, the investments that benefit from the initial credit support provided by the loan loss reserve would create a track record of repayment/performance in the supported sector. Future market actors would therefore be better able to assess projects on a more specific, empirical basis.

For purposes of illustration, say a local community development financial institution (CDFI) wishes to help establish a $40 million fund that would be deployed in loans to individual commercial property owners to implement stormwater retrofits. The CDFI could act as project originator and could underwrite each loan on terms mutually agreed upon with other capital providers to the loan fund.

Figure 2.2 depicts a sample capitalization structure for a $40 million loan fund backed by a loan loss reserve. The loan fund could include capital provided by program-related investments (PRI) from a not-for-profit organization and/or funds from a local CDFI or commercial lender. A loan loss reserve to support the CDFI loan fund (depicted in Figure 2.2, below) equaling 10 percent of the total loan fund amount would act as a guarantee against losses incurred by the senior tier(s) of fund capital until the loss reserve is extinguished. (It is important to note that whenever a new loan is extended to the property owner to make improvements, existing lender consent will nearly always be required before any new financing can be undertaken.)

Assuming that a private property owner seeking financing from the fund contributes 20 percent of the retrofit costs for a given retrofit project (thereby seeking 80 percent financing from the fund), and a maximum loan size of $36,000 for each acre (which is the threshold cost under which a project will pay back within ten years, as indicated in Chapter 1), a $40 million loan fund backed by $4 million in loss reserves could support approximately 890 acres on the terms outlined in Figure 2.3.[38]

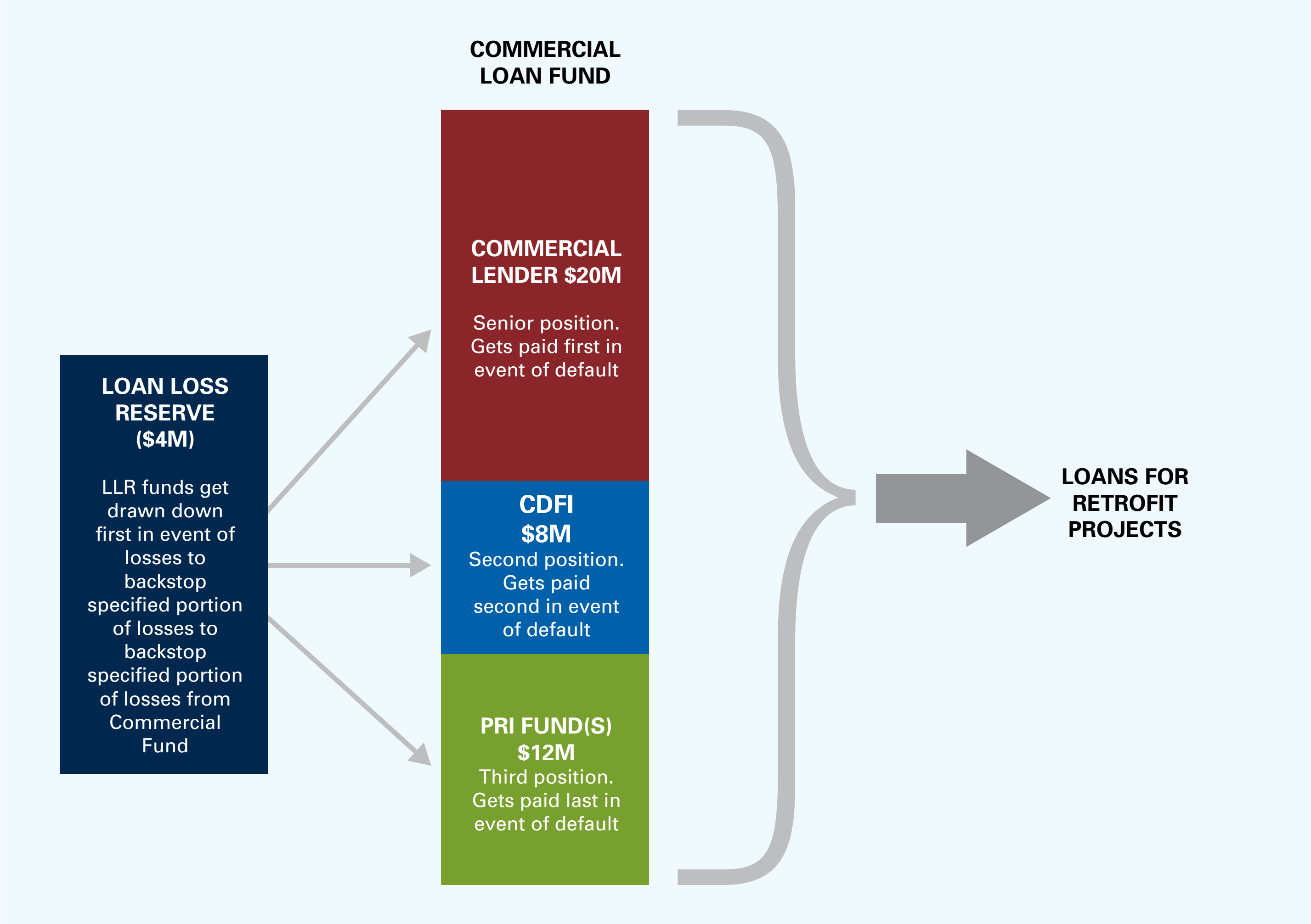
As indicated in Figure 2.3 below, the blended cost of capital for the example loan fund is in the range of 3.9 percent to 5.4 percent. This serves as a minimum interest rate that the fund would charge to borrowers. In order to cover its operating costs, the fund could assess an origination fee to each borrower.

The capital structure in any given fund would need to be agreed upon by the participating capital providers. In order to attract capital providers who would put funds at risk while still keeping the weighted average cost of capital (and therefore the baseline interest rate for borrowers) sufficiently low, the loan fund should be structured to reduce senior lender risk to the maximum extent possible.

There are several approaches the fund could take to reduce risk to the senior lender:

- Require borrowers to provide additional security or guarantee.
- Have second- and third-position capital providers take a longer amortization schedule or even deferred amortization, so that senior tiers of capital could be structured with accelerated amortization and receive early repayments on their principals.

Figure 2.2: Sample Loan Fund Capitalization Structure



- Pledge the full loan loss reserve to the senior lender, such that the senior lender would be willing to lower its cost of capital in line with the lower risk of lost principal. Note that this would increase the risk to the second and third positions, potentially causing them to increase their expected return on investment.

As indicated in the illustrative example in Figure 2.4, following, a number of local institutions could play instrumental roles in augmenting a pool of capital available for stormwater retrofits in Philadelphia.

Although lending could be originated by a local CFDI, a commercial lender or other aggregators could also play origination roles as long as agreed-upon underwriting criteria are met that would minimize repayment risk. Specific underwriting criteria would ultimately be determined by the leadership of the fund and credit enhancement administrator, but could include:

- threshold loan-to-cost ratio with required borrower contributions;
- requirement that borrowers be current on stormwater utility bills and able to demonstrate a track record of timely utility bill payment;
- minimum debt service coverage ratio;
- maximum cost per greened acre; and
- maximum and minimum project cost.

The fund structure presented above represents only one way of addressing credit enhancement through a loan loss reserve fund. Alternatively, concessionary capital from PWD and other institutions could be used in a credit enhancement program to individual lenders.

Figure 2.3: Sample Terms for Participation in Stormwater Retrofit Loan Fund Backed by $4M Loan Loss Reserve						
Capital Tier	**Capital Contribution**	**Loan Fund Subordination Position***	**Lender Project Cost Basis ****	**Effective Lender Project Cost Basis*****	**Term and Amortization**	**Rate**
Commercial Lender Tier	$20M (50%)	Senior Position	0%–40%	0%–34.3%	10 Years 10 Years	6.0%–8.0%
CDFI Tier	$8M (20%)	Second Position	40%–56%	34.3%–48.0%	10 Years 10 Years	3.0%–4.0%
PRI Tier (multiple institutions)	$12M (30%)	Third Position	56%–80%	56%–80%	10 Years 10 Years	1.0%–2.0%
Total fund size: $40M						
Weighted average cost of capital: 3.9%–5.4%						
*Subordination Position refers to the preferential position of each capital tier in cash flow distributions. For example, the senior position receives payments from borrowers first. Once full payment is made to the senior position lender, any excess cash flow is used to pay the second position lender until full payment owed to the second position lender is made. Once full payment is made to the second position lender, any excess cash flow is used to pay the third position lender until full payment is made.						
**Lender Project Cost Basis is the percentage of total project cost associated with underlying loans in the fund's portfolio that is borne by the lender, with the private property owner/borrower assumed to contribute 20 percent of total project costs. Project cost basis is a measure of risk in the project and is often referred to as "loan to cost." The lower the range of exposure, the less risky the lender's position in the capital structure of a given underlying loan in the fund's portfolio.						
***Effective Lender Project Cost Basis represents the maximum percent of a given underlying project's cost that could be lost by the lender, given that the loan loss reserve would be used to guarantee and repay the first portion of any losses incurred by default of the underlying loans in the fund's portfolio.						

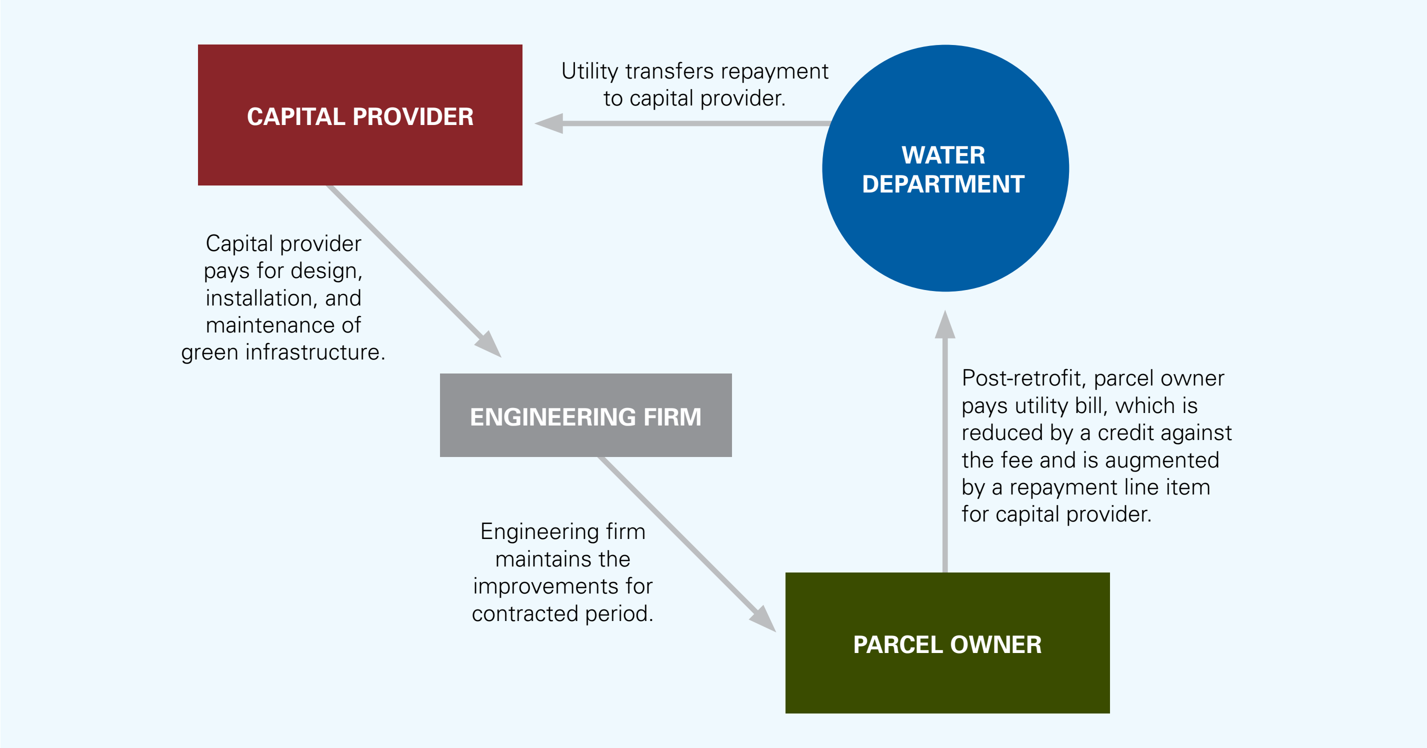
Figure 2.4: Illustrative Example of Institutions Participating in Stormwater Retrofit Loan Fund		
Institution (Examples)	**Participation**	**Motivation**
Philadelphia Water Department	$4M (Loan Loss Reserve)	Meeting CWA requirements by finding lowest-cost acres available within combined sewershed, including those on private parcels
Program-Related Investment(s) From Foundations	$12M	Diverse, such as community investment, green jobs development, and clean water
Community Development Financial Institution (Originator)	$8M	Diverse, such as community investment, green jobs development, and clean water
Commercial Lender (Originator)	$20M	Commercial

2.3.2 On-Bill Financing

A local utility's existing relationship with ratepayers provides a unique opportunity to use known channels for collection of retrofit financing repayment. As indicated by the recent passage of on-bill legislation in New York and California, the structure has gained popularity in recent years in the energy sector, where electric utilities offer on-bill financing and repayment programs in order to facilitate energy efficiency retrofits. As discussed in the NRDC issue brief "On-Bill Financing: Overview and Key Considerations for Program Design," utilities may lend capital to ratepayers to fund energy efficiency retrofit installations and then collect repayment through utility bills. In the energy finance sector, the funds provided for on-bill financing typically come from ratepayer funds or other state or local funds.[39]

In addition to using ratepayer or public funds, a utility that is motivated to help facilitate a particular type of project financing on customers' property can lend its own funds directly to property owners. It can also pare down its role to a purely collection function, allowing third-party capital providers to lend directly, but enabling repayment collection through the existing utility billing system, as depicted in Figure 2.5, below. In this case, the utility would collect the baseline utility rate in addition to the repayment, and would pass the retrofit repayment portion of the bill to the capital provider.

Figure 2.5: Capital Provider Finances Design, Installation, and Monitoring of Retrofits; Utility Collects On-bill Repayment and Transfers Payment to Capital Provider



Where the utility serves as the collection intermediary, a demonstration that a particular owner has a track record of timely utility payment can improve investor confidence that the owner will also submit timely repayment of the SMP line item included as an add-on to the utility fee. In this way, on-bill collection of repayment for project financing can help mitigate project risk for investments, such as stormwater retrofits, where there is no track record of repayment for financed projects.

On-bill financing allows the property owner to view in one statement the aggregate impact of the stormwater credit applied against his or her bill as well as the additional monthly SMP capital repayment. The parcel owner and capital provider could contractually agree on a savings-based repayment schedule that addresses whether and how to divide the fee savings resulting from the retrofit. Only once the final payment to the capital provider has been made will the owner be able to capture the full benefit of the reduced stormwater utility bill.

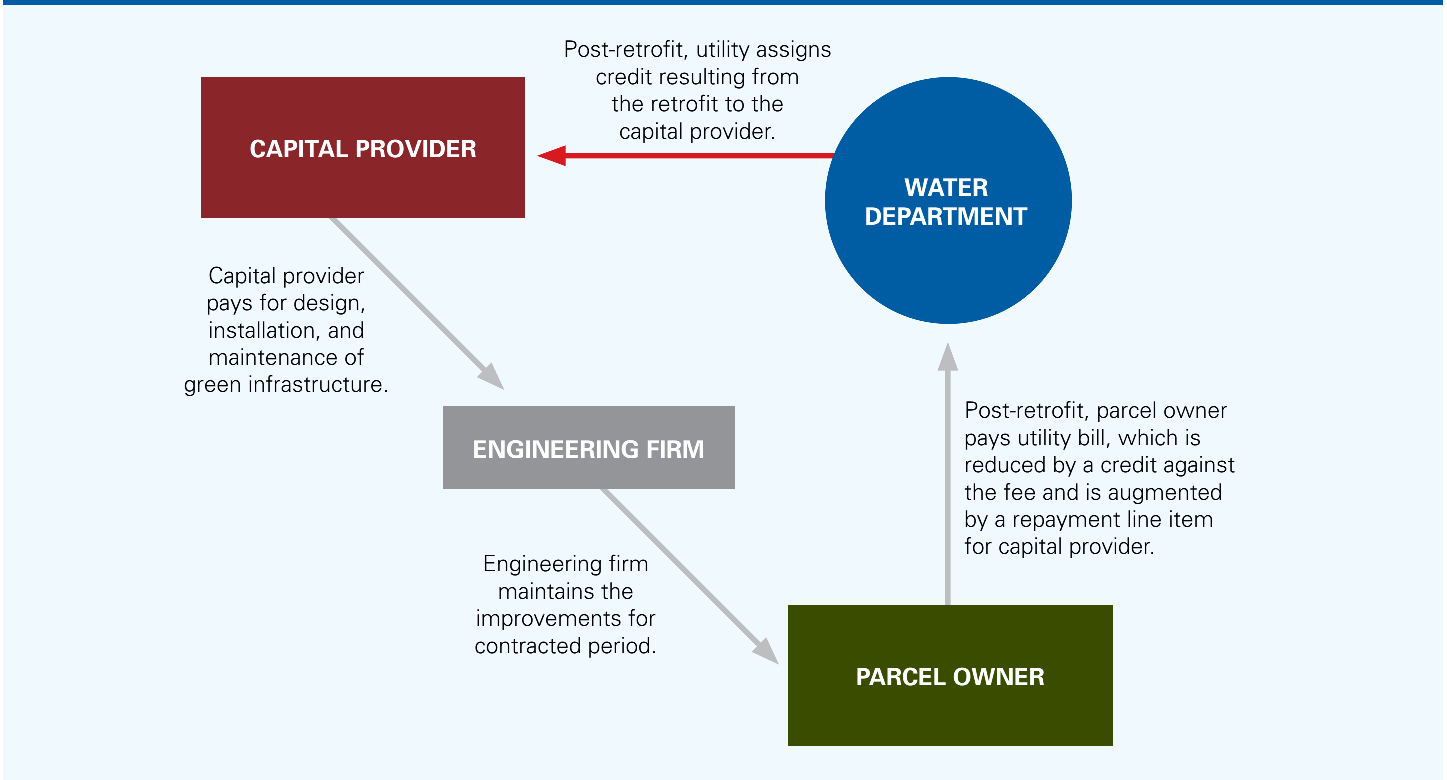
Whereas on-bill collection can facilitate repayment, it does not address the lack of recourse for capital providers: In the event of nonpayment, capital providers are left with only a contractual dispute with a property owner. Although a water or energy utility may technically have the power to shut off service, in practice many utilities may be unwilling to do so in order to compel payment.

In cases such as Philadelphia, however, where the water utility is a municipal entity, on-bill collection of stormwater financing repayment may be able to provide additional security for capital providers in stormwater retrofit projects. If a municipal utility (such as PWD) were both legally able and willing to treat nonpayment of the stormwater financing line item as equivalent to nonpayment of the stormwater bill, failure to repay the stormwater financing line item on a utility bill could result in a tax lien on the property. If the proceeds from the tax lien were assignable to the stormwater retrofit capital provider, this would provide attractive collateral—as well as a strong incentive for the owner to remain current on both utility fees and retrofit repayments.

In Philadelphia, relevant market participants have suggested that municipally backed collection could be sufficient to draw investors to projects they would otherwise be reluctant to finance, even absent another financial backstop such as a loan loss reserve. As of this writing, it remains a question whether PWD has the legal authority to treat nonpayment of a private debt with the same tax lien consequences as nonpayment of a utility bill.

Alternatively, if a utility were willing to assign some or all of the cash value of a stormwater credit directly to the capital provider, rather than provide the full value of the credit directly to the parcel owner, this would improve the attractiveness of an on-bill program to prospective capital providers. While this mechanism has not been implemented by any existing on-bill utility program, it has the power to provide additional repayment assurance and reduced risk to the capital provider. This structure, illustrated in Figure 2.6, below, would appeal to capital providers because instead of underwriting the parcel owner, they would be underwriting the utility. This structure would also provide benefits to the parcel owner, as financing terms for PWD-insured projects should be better than those for individual parcel owners.

Figure 2.6: Utility Assigns Credit Resulting From Retrofit Directly to Capital Provider



2.3.3 Tax Lien–Based Security Mechanisms: PACE and Springing Liens

Given the role that tax lien-based security can have in attracting project investors, two variations on the tax lien theme are also instructive. The best-known example of tax-lien financing, developed in the energy efficiency/renewable energy context is Property Assessed Clean Energy (PACE), where repayment for constructed clean energy projects is secured through a line item on the property tax bill. Another variation on the tax lien financing theme is a "springing lien" structure, which will be discussed below. Although in both cases the municipality utilizes its tax lien authority to ensure payment, project underwriting standards would still be need to be met (e.g., credit rating, debt service coverage ratios, timely property tax payments) in order for properties to qualify for program participation.

2.3.3.1 Property Assessed Clean Energy (PACE)

PACE is a finance program that was developed to help residential and commercial building owners afford renewable energy, energy efficiency, and water efficiency improvements. Currently, 27 states and the District of Columbia have passed legislation providing municipalities with legal authority to implement local PACE programs.[40]

In a typical PACE model, a municipality issues special revenue bonds, the proceeds of which are disbursed to participating property owners to finance parcel-level energy or water efficiency improvements. Property owners who receive PACE financing for such retrofits agree to repay the project costs via assessment fees on their property taxes for up to 20 years.

As discussed in "Financing Stormwater Retrofits," PACE could be used to finance stormwater retrofits in municipalities where those improvements result in cash savings to the property owner.[41] That being said, no municipality currently utilizes a PACE financing structure for stormwater-related improvements. Moreover, it is anticipated that modifications to existing PACE legislation would need to be made if a municipality wanted to expand the mechanism to cover green infrastructure projects. With respect to Philadelphia, it is important to note that Pennsylvania does not currently authorize PACE programs.

2.3.3.2 Springing Liens

An alternative to PACE is a "springing lien" financing structure. In this model, similar to PACE, investors extend capital to parcel owners for property improvement and are repaid through municipal tax collection. However, under the springing lien approach, a tax lien on the property is triggered *only* when property owners default on project repayment. In this regard it differs from the PACE approach, which is premised on municipal collection from the start.

The springing lien structure was suggested to the authors of this report by a Philadelphia-based commercial banker. Although the idea appears to be viable if a municipality is willing (and legally authorized) to implement it, there are no current known examples of this structure's actually being used, in the energy project finance context or elsewhere.

The springing lien model was suggested to PWD, but the agency indicated that under current law, the City of Philadelphia lacked statutory authority to levy tax liens in the event of property owner default on private debts. However, in cities where municipalities are authorized to use their tax lien authority to enforce a private contract when the purpose is public in nature (such as alleviating the need for the city to pay for expansion to public storm sewer systems), a springing lien financing structure could be a viable way to provide additional security to investors in green infrastructure retrofits. As of this writing, however, it remains a question whether other cities may have such legal authority.

2.4 CHAPTER CONCLUSIONS AND RECOMMENDATIONS

Conversations with property owners suggest that, even in a market environment where the economics of stormwater retrofits are favorable, property owners would still be reluctant to tie up capital in an on-site SMP project. Therefore, in addition to the policies and programs outlined in Chapter 1, the Philadelphia Water District would need to consider further measures to encourage the development of a thriving third-party financing market for private parcels. In considering the development of third-party financing mechanisms, it is clear that issues surrounding regulatory and revenue certainty will impact the development of private financing markets for greened acres. Based on the authors' findings, PWD should consider the following recommendations to strengthen regulatory and revenue certainty:

Recommendations to Increase Regulatory Certainty

- **Establish a long-term stormwater fee schedule.** Increased certainty of long-term stormwater fee policies and credit renewal procedures would 1) help parcel owners and third-party investors evaluate the desirability of the stormwater retrofit market, and 2) reduce risk of revenue volatility. For example, any actions PWD could take to make available a 10-year projected fee schedule could help alleviate long-term fee and credit policy uncertainty.
- **Restrict the Customer Assistance Program.** The CAP substantially reduces the viability of private investment in stormwater retrofits on the largest impervious properties. If PWD's goal is to optimize private sector investment in green acre development, it should consider greatly reducing the scope of the CAP; at a minimum, the program should not be extended beyond the three additional years PWD is currently proposing.
- **Create a credit price floor.** PWD could establish a "price floor" whereby investors in stormwater retrofits are guaranteed a minimum credit against their fee for a fixed amount of time, regardless of changes in stormwater fees and credit policy. (Credits would still be subject to periodic renewal, contingent on proper maintenance of the SMP.)
- **Reduce stormwater credit renewal uncertainty.** To reduce uncertainty and risk regarding the credit renewal process, PWD should consider the following:
  - Provide guidelines for the fee credit renewal process, including what site inspection will entail and examples of projects that would or would not meet renewal requirements.
  - Provide an expedited appeal process, in case of credit nonrenewal.
  - Consider expanding the credit time period, given that very few projects will reach simple payback in less than four years.

Recommendations to Increase Revenue Certainty

- **Continue to research the viability of on-bill financing and collection**, with efforts including but not limited to:
  - exploring the legal viability of on-bill financing in Philadelphia;
  - determining whether default on a stormwater retrofit repayment could be treated in the same way as default on a stormwater bill;
  - determining the legality and political will to assign liens on property to ensure retrofit repayment; and
  - determining the cost to administer an on-bill financing program.
- **Explore development of a loan loss reserve fund.** PWD should continue investigating the impact, viability, and structure of a loan loss reserve facility that would serve as a financial backstop for a commercial loan fund, with efforts including but not limited to:
  - researching viable sources for a loan loss facility, including but not limited to public sources such as clean water state revolving funds or private funds such as corporate or philanthropic sources;
  - determining how a commercial loan fund backed by a PWD-provided loan loss reserve could impact parcel owners differently from existing financial assistance programs offered by PWD, such as grants available through the Stormwater Management Incentives Program (SMIP);
  - exploring how a PWD-funded loan loss facility might impact PWD's financial bottom line differently from existing financial assistance programs, such as SMIP;
  - working with relevant stakeholders to evaluate the potential impact of a loan fund in proving out specific retrofit financing models and creating an attractive market for project developers/aggregators;
  - in partnership with relevant stakeholders, gauging the volume of interest in a commercial loan fund from potential capital contributors and potential demand for financing from parcel owners.

CHAPTER 3: **THE ROLE OF AGGREGATION**

3.1. BACKGROUND

Encouraging private capital to finance stormwater retrofit projects can be difficult, in part because many of the projects tend to be small with relatively high fixed costs and transaction costs. These challenges are not unique to stormwater finance; indeed, they also impact other resource efficiency projects like energy finance. In the energy finance world, large projects tend to be more financially attractive than small projects because they achieve the scale and efficiencies to overcome fixed costs and transaction costs. In other words, the cost of, for example, legal fees can be a small percentage of total overall costs for a large project, while the same fees can be a considerable percentage (or even an insurmountable one) for a smaller project.

It is important to note that fixed costs and transaction costs are related concepts. Fixed costs are costs that are not dependent on the amount of goods or services produced.[42] In other words, they will remain relatively stable regardless of the size of a project. For example, in the case of stormwater retrofits in Philadelphia, a fixed cost would be the application fee required when pursuing stormwater fee credits. In contrast, transaction costs relate to the time and money needed to "get a project done." These involve identifying a project, drafting contracts, conducting due diligence, etc. The challenge with investments in small projects is that the fixed costs and transaction costs can overwhelm the projects' expected revenues and returns, making these projects financially unattractive.

Project aggregation can help overcome many of the barriers to financing smaller projects. The packaging of numerous stormwater projects into an aggregate portfolio could help increase the financial attractiveness of stormwater retrofit projects in a number of ways. First, aggregation can present opportunities to work through intermediaries that are willing and able to reduce and/or absorb transaction costs. Second, by efficiently managing many projects simultaneously, aggregation can reduce project development costs through economies of scale. Third, aggregation may help investors manage risk by diversifying the quantity and character of projects in a stormwater investment portfolio. In essence, aggregation, when done correctly, can help a group of smaller projects operate somewhat like one larger project, which may help to overcome the barriers that usually inhibit private investment in small projects.

This chapter will look at how aggregation can be used as a way of encouraging private capital to invest in stormwater project finance. Transaction costs will be reviewed from the point of view of an investor, fixed costs will be reviewed from the point of view of project developers, and the role of aggregation in minimizing these costs will be explored. This chapter will also survey the universe of organizations that could play an instrumental role in stormwater project aggregation, including discussion of why some of these entities might be willing to shoulder stormwater retrofit transaction costs. The chapter will conclude with a look at how governments, NGOs, and other interested parties can help encourage the aggregation of stormwater management projects as a way of attracting private capital to this space.

3.2. REDUCING TRANSACTION COSTS THROUGH AGGREGATION

The study of transaction costs is a fundamental component of modern economic theory. Although the use of the term goes back to the 1930s and has a number of specific meanings in the field of economics, for the purposes of this report, transaction cost is defined as "any expenditure that is not directly involved in the production of goods or services but is essential for realizing the transaction."[43]

In order to implement a successful retrofit project, an investor would likely have to bear transaction costs for project identification, contracting, monitoring, and collection. Each of these represents some expenditure of money, time, or resources in order for an investment to take place. These investment transaction costs can be summarized as follows:

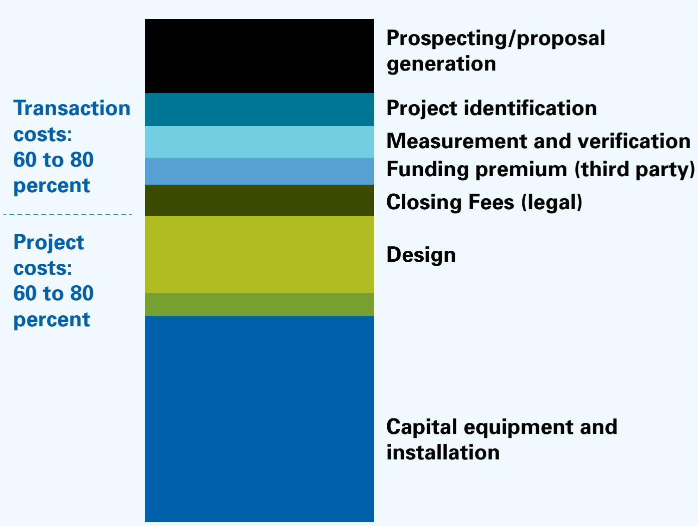
Figure 3.1: Transaction Costs Associated With Stormwater Project Investment

Project Phase	Transaction Costs
IDENTIFICATION	• Identification of potential projects • Collection of information on project characteristics • Project assessment and due diligence (modeling expenses and revenues, assessing risks) • Legal fees • Evaluation of a project and deciding whether to invest
ACQUISITION	• Negotiation with project owners (and/or landowners) • Preparation of contracts • Procurement
MONITORING	• Establishing mechanisms to monitor projects and ensure they are delivering the promised returns • Ensuring that counterparties fulfill their obligations • Reaction to problems that threaten returns
COLLECTION/EXIT	• Billing, collecting returns • Enforcement of contracted terms • Activities associated with exiting a project

For an investor, these transaction costs are essentially fixed: They do not change significantly with the size of the project or the amount of money being invested. These fixed transaction costs therefore incentivize investors to finance bigger projects—projects that have the potential to generate revenues that are much larger relative to the size of the associated transaction costs.

How significant are these transaction costs in the field of stormwater retrofit finance? It is difficult to say. Since private financing for stormwater retrofits is not yet commonplace, there is limited empirical evidence to estimate the average range of transaction costs for a typical stormwater retrofit investment. In addition, it is challenging to accurately track transaction costs because many of these costs are not directly visible, but instead take the form of employee time and effort. As a proxy for transaction costs in the context of stormwater retrofits, it may be illustrative to consider the transaction costs incurred in the energy efficiency and carbon finance industries. Much like the stormwater management practice (SMP) market, both the carbon and energy efficiency markets are characterized by small projects that require significant transaction cost in search, contracting, monitoring, etc. In the energy efficiency field, transaction costs have been found to account for 10 to 40 percent of total project costs.[44] The chart below, which is based on interviews with energy service companies (ESCOs) in the U.S., highlights the fact that a significant amount of overall project costs are transaction costs, particularly those related to the identification and sourcing (also known as the origination) of projects.

Figure 3.2: Transaction Costs as a share of ESCO Project Costs



Source: Easton Consultants, S.F.M.C: Energy Service Companies. *A Market Research Study, Prepared for Energy Center of Wisconsin*: 64, 1999. Available from http://www.ecw.org/ecwresults/181-1.pdf.

Again, since many transaction costs are fixed, one way to overcome the economic challenges of project transaction costs is to increase project size so the transaction costs are smaller relative to the project's expected total revenue. Unfortunately, in many cities (including Philadelphia), there are few opportunities to finance large stormwater retrofit projects, owing to the spatial constraints of small urban parcels. Instead of making individual projects larger, another way of addressing the transaction cost problem is to have intermediaries aggregate projects so that the origination, acquisition, and collection costs of multiple projects function more like those of a single project. Aggregation of this type does not eliminate transaction costs, but rather reduces them or transfers them to entities that are more willing to shoulder the costs. In some cases, the transfer of transaction costs makes sense because other organizations are in a better position to find and originate stormwater management projects. In essence, aggregation serves to "outsource" transaction costs to improve the desirability of projects to outside project developers and investors.

An intermediary might be willing to absorb some transaction costs for one of several reasons, including these:

1. ***The intermediary has specific policy goals to address stormwater pollution.*** For example, governments might subsidize the process of project origination and aggregation on private property in order to achieve clean water goals at lower cost. Likewise, an existing NGO or a specially created stormwater entity could be interested in serving as a project aggregator to meet a given organization's conservation or community development goals. In both of these scenarios, third-party nonprofit entities can help subsidize transaction costs in an effort to encourage additional private capital into financing stormwater retrofit projects.

2. ***The intermediary has a financial interest in financing and developing stormwater management projects.*** For instance, businesses whose products or services are utilized to construct stormwater retrofit projects have a financial interest in seeing the market for SMP projects flourish. By aggregating smaller projects, they are creating new markets for their products or services. Examples here include engineering service firms that sell "green infrastructure" solutions, and vendors of green roofs. Such a dynamic has already been seen in the field of energy efficiency finance, where the makers of energy efficiency products (such as high-efficiency HVAC systems) have created ESCOs (see box 3.3, below) that serve as project aggregators. Some of these ESCOs have been able to attract large amounts of private capital.

3. ***The intermediary represents stakeholders who stand to benefit from stormwater projects and is situated in a position to aggregate.*** For example, business improvement districts (BIDs) could be used by property owners to share in the benefits of stormwater fee reductions and the co-benefits of green infrastructure such as site beautification and public space improvements. BIDs are particularly attractive as aggregators because they have existing

relationships with property owners, who might consider participating in an aggregated project portfolio with fellow members and neighbors. In such a scenario, the transaction costs (particularly those related to origination) could be cut significantly because relationships with project beneficiaries already exist. Moreover, a BID may be willing to serve as an aggregator because BID-wide stormwater improvements can be consistent with the organization's mission, which often includes making physical improvements within the district, and would add relatively little cost to its ordinary business operations.

3.3 REDUCING PROJECT DEVELOPMENT COSTS THROUGH AGGREGATION

In addition to helping reduce transaction costs, project aggregation of stormwater retrofits could lead to project cost savings through economies of scale. In this section we will look at how project aggregation could help lower specific SMP implementation costs.

Figure 3.3 presents a general list of cost line items involved with production of a stormwater retrofit. Those activities denoted with an asterisk are areas where opportunities exist for cost savings through project aggregation (e.g., where material or services can be acquired in bulk).

Figure 3.3: Indicative List of Stormwater Retrofit Costs

1.Design
- a. Survey of site
- b. Proposal of stormwater management practices to be used
- c. Collection of site data
    - i. Mapping of location of subsurface utility structures
    - ii. Infiltration testing
- d. Modeling of facilities to be installed
- e. Creation of installation specifications for facilities used on project*
- f. Creation of construction plans
- g. PWD preapproval and construction permitting*

2.Project Bidding and Contracting
- a. Construction
- b. Mobilization of equipment and materials to site area*
- c. Purchase of materials*
- d. Purchase or rental of equipment*
- e. Labor
- f. Transportation
- g. Survey and documentation of completed installation
- h. Closeout*

4.Approval by PWD
- a. Submission of documents to PWD and completion of PWD site visit

5.Operation and Maintenance
- a. Monitoring*
- b. Erosion control
- c. Vegetation upkeep
- d. Damage repair

Opportunities to realize economies of scale by conducting development activities on an aggregated level rather than on a project-by-project basis may be found in the steps of design, project bidding and contracting, procurement of construction materials and equipment, PWD preapproval and permitting, and operation and maintenance.

In the design stage, there may be opportunities to develop one set of specifications that could apply to many different retrofit projects. Construction specifications detail how a particular feature of a construction should be built. On each project site, specific dimensions will need to be planned for each feature, but one set of SMP retrofit specifications could be developed and applied (with minor modifications) to all similar SMP retrofits being developed.

If multiple projects are being developed simultaneously, the project developer will be able to purchase materials in larger quantities and secure equipment for longer periods. Such bulk purchasing should enable project developers to secure materials and equipment at lower unit costs. Similarly, when working with contractors, the aggregation of multiple projects will provide leverage for the negotiation of better rates for each individual project.

There may also be opportunities to reduce costs by coordinating activities across multiple projects simultaneously. If the development of multiple projects can be carried out in parallel and staged appropriately, equipment and personnel can be deployed more effectively. For example, if a construction company can mobilize equipment, workers, and materials to work on 10 sites in close proximity simultaneously, it can allocate its resources more efficiently than it could if it were working to mobilize resources for a singular retrofit project.

Opportunities to reduce time spent and costs incurred exist not only in project development but also in project documentation. For example, the retrofit preapproval process could be streamlined if documentation for multiple retrofits were prepared, submitted, and evaluated at the same time. Similarly, if multiple projects conclude within a narrow window of time, all can be closed out at once, which may be more efficient than closing out many projects separately.

3.4 POSSIBLE AGGREGATORS

3.4.1 Government Agencies as Facilitators of Aggregation

There are various motivations for governments, at both the state and municipal level, to serve as aggregators for stormwater retrofit projects on private lands. First, governments may see this form of aggregation as a cheaper, easier way of achieving their stormwater management goals. If governments can attract additional private capital through project aggregation, they can more effectively leverage their scarce resources to spur stormwater retrofits and a reduction in stormwater runoff events. Alternatively, governments can facilitate or endorse other NGOs or private companies to serve as project aggregators.

Which role a government assumes may be location specific. Governments may find that there are no existing nonprofit or private sector firms willing to take on the role of local project aggregator. In this case, a government may decide that it makes sense to serve as an aggregator until another entity emerges to take on that role. Chances are, however, that most governments will find that they gain more leverage by simply encouraging aggregation via appropriate policy changes.

One way in which local governments can facilitate SMP project aggregation is through the provision of information that helps connect property owners, project developers, and investors. For example, PWD has access to information regarding properties that have large impervious areas, high scheduled fee increases, and favorable property characteristics for SMP retrofits. If this information could be aggregated and provided to project developers and investors in an appropriate way, it could help developers/investors efficiently identify potential projects that have favorable characteristics and economics for an SMP retrofit. Alternatively, to help property owners better understand their financing options, PWD could distribute materials informing parcel owners about emerging financing options and terms. Finally, it could set up an exchange whereby interested property owners and aggregators can contact one another.

Beyond assistance with project aggregation, governments could encourage investment by helping reduce the risk of SMP project investment. On-bill and tax lien financing (as discussed in Chapter 2) could serve to catalyze aggregation mechanisms by which individual retrofit projects could join other projects that are subject to similar participation requirements. Under a financing mechanism similar to the PACE programs in the energy efficiency industry, stormwater retrofit providers could use the government's ability to collect property taxes as a way of guaranteeing repayment of investments. For more details on the PACE system, see Chapter 2 of this report.

3.4.2 Government Agencies as Project Aggregators

If a government agency were appropriately positioned, it could undertake aggregation itself. Chapter 4, section 4.3.3., contemplates how a government agency could aggregate projects on public land in order to generate credits that could be purchased by private property owners who are covered by parcel-based stormwater fee. A concern here is that, by serving as an aggregator of projects on public land, the government could be competing with potential private sector aggregators. In addition, it could be possible for a government agency to set up a third-party organization, either a nonprofit or a public-private partnership, responsible for aggregating projects on public or private land. An example of such a partnership in the energy efficiency space can be found in the discussion of the New York City Energy Efficiency Corporation, below.

Alternatively, for a municipality to issue bonds, backed by property owner payments via utility bill or tax assessments, on the capital markets. The municipality would then make the funding available to property owners along with an approved list of project implementers and project types. Such a structure would significantly reduce transaction costs associated with project search and identification, information search, and project provider search. It would also help facilitate repayment of private capital that is channeled into this space. A variation on that idea might be to use the bond proceeds to guarantee or insure a private capital investment in the retrofit space. These ideas are discussed in detail in Chapter 2.

The cost of originating projects is one of the most important transaction costs in many areas of investment (e.g., energy efficiency finance and carbon project investments). Beyond the identification of projects, other important transaction costs relate to monitoring projects and collecting/obtaining repayment. In all of these areas,

Box 3.1: Government Facilitating Aggregation: The Case of SMEDs in Philadelphia

One particularly interesting example of a government agency using its unique position to facilitate aggregation is the creation of what PWD refers to as Stormwater Management Enhancement Districts (or SMEDs). A SMED is an area that the water department has identified as having potential for large, coordinated green infrastructure projects. In essence, the city is trying to encourage the development of economies of scale by creating new geographic units where stormwater management is most effective when developed across many properties simultaneously.

PWD has a two-step process that it uses to identify SMEDs. First, PWD identifies large, multiproperty areas in which green infrastructure retrofits are technically, economically, and practically attractive (lowering one set of transaction costs for retrofit projects, those related to project identification). As PWD identifies SMEDs, it then contracts with an engineering specialist to evaluate potential projects and prepare a Stormwater Improvement Plan. Once this plan is finished, it will be clear whether a retrofit project is financially attractive, and a specific project implementation strategy will be made available to an eventual project developer. In essence, the government here is helping lower the costs of project assessment and analysis.

In the case of SMEDs, PWD helps to reduce the transaction costs of the deal by taking the initiative to identify projects, conduct a feasibility study, and begin retrofit planning. Once a SMED evaluation and stormwater improvement plan has been created, the identification step of a transaction may be largely completed, which could reduce transaction costs significantly.

Once PWD identifies a promising project through the SMED process and has estimated the amount of investment needed to make the retrofit, there are various ways in which private investment could be used to fund the project. Under one potential scenario, it may be necessary to identify an organization that could serve as a project developer, perhaps a nonprofit with community development goals that would benefit from a completed stormwater improvement plan created by PWD. This organization would coordinate the negotiation of terms with the constituent property owners within the SMED, and then serve as a representative of the project to potential investors (effectively serving as an aggregator). It would also work with property owners to implement the plan, therefore helping to address the transaction costs related to negotiation and contracting.

governments could help private investors overcome some of these costs. In terms of project identification, governments can connect investors with project developers needing money; in terms of monitoring, governments can use their existing infrastructure to facilitate the monitoring of retrofit projects; and in terms of collection/repayment, governments can tap into on-bill finance or tax-collection infrastructure as ways to facilitate repayment.

There are a number of potential concerns that might be associated with government serving as an aggregator (or even facilitating aggregation) in this space. These include:

1. ***Claims that government might be unduly subsidizing private capital gains.*** It is true that any government spending that facilitates investment by private companies could be seen as a subsidy. But it could also be seen as a way for government to prime the pump of private investment, leveraging its scarce dollars to stimulate private investment and achieving results much greater than what the public sector would be able to achieve on its own. This is no different from governments' leveraging private capital for traditional infrastructure investments.
2. ***Concern that additional costs would be placed on government agencies as they shoulder the burden of transaction costs.*** This concern is warranted, but it can be overcome if governments are very clear on the cost-benefit analysis surrounding their investments. It is likely that any transaction costs absorbed by government (in the form of staff time, for instance) would, if they lead to more retrofits, be a good use of government dollars since such expenditures might achieve greater stormwater benefits than other uses of that money.
3. ***Concern that the cheapest, most profitable, and lowest-hanging fruit might be handed over to private investors, while government is left with the most expensive retrofits.*** This concern would be valid if the private sector retrofits were being undertaken on public property. If, however, the projects are on private properties, then these are stormwater improvements that would otherwise be difficult for government to access. Even on public properties, allowing private actors to undertake the "cheapest" or "easiest" retrofits may make sense if the private sector can undertake them more efficiently and less expensively than government (see Chapter 5 for additional details on proposed partnership structures).

In short, the response to these arguments is that by facilitating aggregation (or, in rare instances, serving as an aggregator), government can leverage its scarce resources to use private capital for projects that create public value—projects that would not otherwise occur without government facilitation.

3.4.2.1 NGOs as Aggregators

Some municipalities create nonprofits to help facilitate private investment in public policy outcomes. The New York City Investment Fund (NYCIF) and the New York City Energy Efficiency Corporation (NYCEEC) are two examples of nonprofit aggregators. NYCIF was founded by business leaders working through the Partnership for New York City, an economic development organization, to catalyze job creation and economic development through innovative financing for entrepreneurship.[45] NYCEEC was founded by the City of New York to support the city's energy and climate action goals by catalyzing an energy efficiency retrofit financing market for private building owners.[46] NYCIF is funded by business leaders while NYCEEC receives a mix of public and philanthropic funding, including from NRDC and the Rockefeller Foundation.

NGOs like NYCIF and NYCEEC can serve as project aggregators by absorbing the transaction costs associated with project origination, information gathering, and due diligence. Their functions can include:

- **Project facilitation/matchmaking.** An NGO can serve as a single point of contact for parcel owners and investors in a region, thereby limiting the search process for both interested property owners and investors.
- **Project vetting.** Similar to a government aggregator, an NGO can pre-approve a list of project developers and project types, reducing transaction costs.
- **Provision of lower-cost capital.** NGOs can provide lower-cost capital, helping to make smaller projects more economical. Lower-cost capital, which can be used to leverage returns for traditional capital partners, can come from foundations through program-related investments (PRIs), philanthropic donations, or loan guarantees (see Chapter 2 for an illustration of how NGO capital could be deployed in a stormwater retrofit fund.

3.4.2.2 NGOs as Aggregators

Business Improvement Districts (BIDs)

To help realize economies of scale, local organizations with existing relationships with property owners could leverage those existing relationships to aggregate viable stormwater retrofit projects.

BIDs are a particularly attractive potential partner in Philadelphia and nationwide. Their aims can vary, but BIDs serve generally to facilitate cooperation among local businesses to develop neighborhood economic development and beautification projects. Established by local ordinance, BIDs collect fees from local businesses to fund improvements that benefit the overall business atmosphere of the neighborhood. BIDs can provide services such as cleaning, security, landscaping, and marketing of the business district to neighborhood consumers.

As BIDs are already aimed at improving the aesthetic and economic vitality of a neighborhood marketplace, there may be a strong mission fit to serve as an SMP project aggregator. By actively managing stormwater retrofits, BIDs could reduce the operating costs of local businesses as well as improve and differentiate the appearance of the local marketplace.

BIDs could also serve as effective managers of SMP projects because they are established to coordinate with numerous property owners to manage landscaping and small-scale construction projects. Transaction costs such as outreach and project identification should be significantly cheaper when working with a BID, since the organization already has a relationship with property owners. Moreover, a BID could ease negotiations with potential investors by serving as a single counterparty for contract negotiations.

3.4.2.3 BID Project Aggregation Process

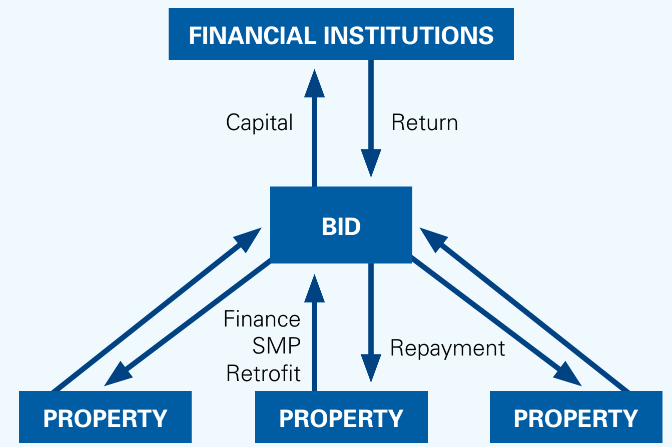
While there are many ways in which a BID could facilitate SMP project aggregation, here we present one potential example of how such a process might work.

A BID manager could begin the process by finding suitable projects for financing. A BID could search for projects by conducting a feasibility study, preparing documentation on costs and expected fee savings, and initiating conversations with property owners regarding the commitments that would be required to embark on a project. Once a BID identified a promising set of projects, it could present the aggregate project to an investor and serve as the single point of negotiation between the investor and the underlying property owners. This would enable the investor to analyze the project as one large investment with one counterparty, which would be more efficient than analyzing many projects and negotiating with many smaller counterparties.

A BID could facilitate the process of negotiation by setting up contracts between the retrofit project manager (which may be the BID manager or another organization) and the property owners. This would allow investors to enter into one contract with the BID. Under such a scenario, the investor could disperse funds to the BID manager, which would then be responsible for fund dispersal to specific projects. After SMP construction, property owners would realize stormwater fee savings, which the BID manager could collect from member businesses to repay the loan/investment amount. Throughout the life of the project (even after loan repayment), the BID manager would oversee maintenance of the green infrastructure project to ensure adequate performance.

Under the structure outlined above , the BID would be serving as a stormwater project aggregator and manager, absorbing ongoing transaction costs that private capital might not be willing or able to provide. The BID would thus help capture economies of scale and reduce risk by bundling various small-scale projects into a larger portfolio of SMP projects.

Figure 3.4: Structure of Financing Aggregated BID Project



3.4.3 Service Providers as Aggregators

Under the third party "project developer" financing model described in "Financing Stormwater Retrofits" and in Chapter 2 of this report, property owners would transfer a portion of their stormwater fee reductions over a set number of years to the project developer in exchange for the up-front capital financing required to build the retrofit. This offers property owners the opportunity to benefit from lower stormwater fees over the life of the project without being required to make the initial capital investment in the SMP retrofit. Moreover, structuring a deal on a pay-for-performance basis has tax benefits for the client (i.e., the building owner). It allows the owner to treat the work as a services contract for tax purposes, which means it can be written off. (In contrast, if the project were treated as an operating expense, the owner would have to amortize the costs over an extended period.)

Project developer models achieve economies of scale by focusing on large projects—universities, hospitals, and other large institutions (See Section 2.1). Some administrative work would be required to create an aggregation mechanism via project developers: marketing the opportunity to property owners, synthesizing projects according to type or geography. However, firms would benefit from such work by generating additional revenues from projects made more economical by aggregation. In addition, a partnership among project developers and PWD could help facilitate this process.

Box 3.2: BID Case Study: The Aramingo Shopping District

The Aramingo Shopping District is a Philadelphia BID composed of 73 individual properties, which include businesses such as Lowe's Home Improvement, Walmart, and Chick-fil-A. The Aramingo BID has communicated an interest in managing stormwater retrofit installations, in large part because the green infrastructure enhancement would beautify the area, increasing the attractiveness of the constituent properties.

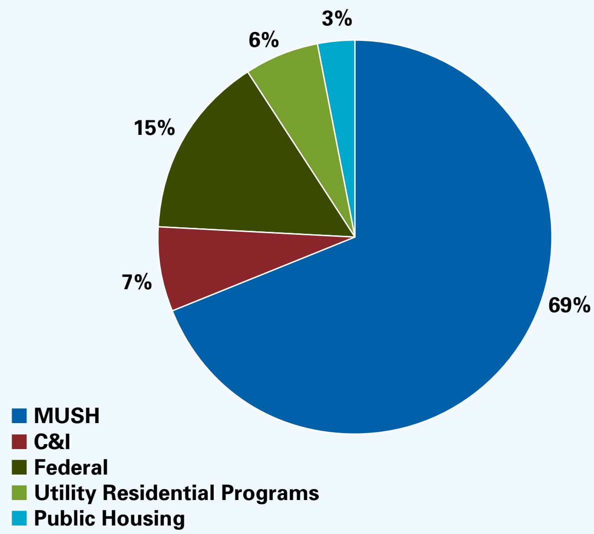
The affairs of the Aramingo BID are managed by Impact Services, a nonprofit community development corporation. Impact Services has obtained funding from PWD to conduct a feasibility analysis to identify potential stormwater retrofit projects within its district. Once projects are identified through the feasibility analysis, Impact Services may be in a position to aggregate the retrofit projects that would generate the greatest stormwater fee savings at the lowest cost, and could present this aggregated investment opportunity to a financial institution.

Box 3.3: ESCOs and the Possibility of a "Stormwater ESCO"

In trying to understand how stormwater projects might be aggregated, it is useful to look at how aggregation works in the energy efficiency sector. The energy efficiency field faces some of the same challenges as stormwater retrofits: Projects are small, transaction costs are high, and there is a desire to leverage private investment. In response to these challenges, energy services companies (ESCOs) have emerged to serve as aggregators of smaller energy efficiency projects. By understanding how ESCOs work, we can better understand how similar structures might also serve as aggregators in the stormwater space.

Many ESCOs stem from companies that manufacture energy efficiency equipment and install energy efficiency retrofits. In the 1970s, during the height of the oil crisis, these companies realized that they could generate more business and attract outside financing if they turned themselves into "virtual utilities," capitalizing the installation of turnkey energy efficiency retrofits and then taking a share of the energy savings. This approach allowed them to aggregate smaller projects and also to overcome customer skepticism—that the promised energy savings would never materialize.

ESCO Revenues in 2008



ESCOs work by undertaking all of the necessary energy efficiency retrofits for buildings or businesses (including conducting feasibility studies, designing the systems, developing proposals, and installing the retrofits) at little or no risk to the property owners. Rather than pay for the retrofit up front, customers pay the ESCOs a share of the energy savings realized as a result of the retrofit. In order to finance this work, ESCOs obtain loan financing, other private financing, or are part of large component manufacturers (e.g., GE, Honeywell) or energy companies (e.g., Chevron). By aggregating smaller projects and taking on the risk of the promised energy savings, ESCOs minimize transaction costs and help achieve economies of scale in the energy efficiency business. A similar mechanism might provide similar benefits in the stormwater management sector.

According to a survey conducted by the Energy Analysis Department at Lawrence Berkeley National Laboratory, ESCOs as a sector generated $4.1 billion dollars in revenues in 2008, with the majority of that revenue coming from large energy efficiency projects in what is informally known as the "MUSH" sector (municipal and state governments, schools, and hospitals). Residential projects accounted for only around 6 percent of ESCO business.

One way to encourage the development of aggregating project developers might be for governments to contract with retrofit providers to undertake the work in return for a portion of the fee rebates. For instance, the Philadelphia Water Department could work with engineering firms to deliver third party project-developer services for stormwater retrofits within some of its newly created SMEDs.

3.5. CHAPTER CONCLUSIONS AND RECOMMENDATIONS

Aggregation can play a key role in attracting private capital into stormwater retrofit finance. Through reducing transaction costs, increasing economies of scale, and spreading risk across multiple projects, aggregation can simultaneously help increase returns and reduce the risk of SMP retrofit projects. Given these benefits, there are several steps that PWD can take to encourage aggregation in the field of stormwater retrofits. These include:

- **Address the transaction costs of finding and originating smaller projects.** Experience in the energy efficiency retrofit industry illustrate that one of the highest transaction costs impeding project implementation is project origination. Therefore, anything that can be done to facilitate project origination would go a long way toward attracting additional private finance to the stormwater market. In an effort to encourage project aggregation, PWD should:

- **Identify the costs of retrofits.** Develop Philadelphia-specific cost ranges for stormwater retrofits that could be used on educational materials to prospective nonresidential property owners.
- **Inform interested parties of local stormwater opportunities.** Make publicly available information detailing which properties face large stormwater fee increases and which properties show promise as sites for low-cost green infrastructure retrofits.
- **Educate parcel owners.** Include information on billing statements regarding the cost and potential savings of SMP retrofits as well as potential options for retrofit financing. This will provide ratepayers with a clear understanding of project costs and savings, as well as potential financing options.
- **Solicit interested parcel owners.** Through billing statements, encourage interested ratepayers to sign up for stormwater retrofits. PWD could then pass on lists of these interested customers to appropriate aggregators.
- **Permit streamlining.** In order to reduce project implementation costs and encourage aggregation, explore how permitting rules might be streamlined to simplify the permitting process for aggregated projects.

- **Encourage nongovernmental organizations to engage in project aggregation.** PWD should explore working with foundations and NGOs to channel capital (grants, subsidies, etc.) toward potential aggregators that originate, negotiate, and group stormwater retrofit projects.
- **Encourage BIDs to act as aggregators of stormwater management projects.** BIDs are natural aggregators of stormwater management projects. BIDs have an inherent interest in undertaking the sort of beautifying neighborhood improvements that many stormwater retrofits entail. In addition, they are already connected with relevant landowners; they are set up to conduct outreach to local property owners, and based on the authors initial discussions have an interest in serving as green acre project aggregators. In order to encourage BIDs to take on this role, PWD should:
  - Conduct outreach sessions with BIDs to determine their interest in taking an active role in stormwater project aggregation.
  - Put interested BIDs in touch with potential sources of private capital interested in investing in this space, to help match investors to available projects.
  - Subsidize feasibility studies for BIDs to become stormwater aggregators, as it has already done with the Aramingo BID.
  - Capitalize on the case study of the Aramingo BID. The Aramingo BID has already demonstrated interest in serving as an aggregator of stormwater management projects. PWD might help the organization accomplish this and then use it as an illustrative case study for other BIDs.
- **Clarify how project aggregators could work within the SMED process to develop projects.** SMEDs provide a ready-made construct to facilitate the aggregation of stormwater management projects. Already, PWD is working with engineering services firms and others in select SMEDs to undertake stormwater management projects. In addition to what it is already doing, PWD should:
  - Help encourage (or even create) NGOs or other entities in specific SMEDs that might serve as relevant aggregators for the stormwater management projects outlined in the SMED's stormwater improvement plan.
  - Link the relevant organizations in each SMED with sources of private capital interested in this space.
  - Design a process by which an aggregator can benefit from the conclusions of the SMED process and can gain access to the property owners within the management district.
- **Create processes that facilitate economies of scale.** Preliminary research indicates that permitting, design, and the acquisition of parts/materials are among the aspects of stormwater retrofit projects that are most amenable to achieving economies of scale. Therefore, any actions that help potential aggregators take full advantage of these are likely to lead to increased aggregation. To facilitate project cost reduction through economies of scale, PWD could ensure that permitting requirements don't inadvertently discourage aggregation, and/or write rules to permit aggregators to submit retrofit designs across a broad array of small properties. There may also be ways of helping retrofit project developers purchase items and materials in bulk, though it is unclear how governments and others might help in that regard.

Beyond activities that could facilitate aggregation, it is important to note that different types of aggregators might be best suited for different types of projects. For instance, BIDs and SMEDs might be better suited to aggregate larger commercial properties, while NGOs and government agencies might be more adept at aggregating smaller, residential-type properties. In theory, service providers should be willing to aggregate both commercial and residential properties, but in practice they are likely to seek out the larger projects. Economies of scale will likely mean that the larger projects have the highest returns, so private capital will almost certainly focus on larger projects at the outset. In terms of achieving low-cost stormwater management retrofits, this should not pose a problem, since these are also the retrofits that will likely deliver the biggest bang for the buck. However, if there is interest in ensuring that smaller projects get done, then additional subsidies may be required to cover the much higher transaction costs that smaller projects entail.

CHAPTER 4: **OFF-SITE MITIGATION**

4.1 INTRODUCTION

Philadelphia's parcel-based stormwater fee and credit program (hereinafter "stormwater management service charge" or SMSC) allows nonresidential customers to reduce their stormwater fee through the construction of approved stormwater management practices (SMPs). However, many property owners may lack cost-effective on-site options for mitigation given the constraints of their property. One potential alternative to provide flexibility for these property owners could be an off-site stormwater mitigation crediting program, whereby constrained property owners could purchase credits instead of building on-site SMPs or paying the stormwater fee. This chapter examines the feasibility and structure of an off-site program and explores the potential for supply under such a program. An off-site mitigation program would allow property owners to benefit from retrofits even when those retrofits do not generate credits for *their own* stormwater fees. For instance, residential owners who are not eligible for credits against their stormwater fee, and commercial owners who oversize their retrofits to manage more than an inch of runoff, could install retrofits and earn stormwater credits that could be sold to other property owners who lack financially attractive options for on-site investment.

Adding an off-site mitigation program to the existing stormwater fee structure could deliver several important benefits, including:

- Greater flexibility for constrained property owners by providing a lower-cost SMP retrofit option than may be available on their own parcels.
- System-wide cost savings by leveraging the market to find least-cost SMPs.
- An increase in private sector participation by incentivizing property owners not currently covered by the parcel-based stormwater fee structure (i.e., residential properties) to invest in mitigation.
- Maximization of retrofits on commercial properties by incentivizing property owners to retrofit beyond what is required to receive stormwater fee reductions.
- Establishing a market price to reveal low-cost mitigation opportunities, thereby attracting private capital to the most cost-effective retrofits.
- Creation of transparency and a market price for SMP retrofits.

Establishing an off-site mitigation program would also create new administrative burdens for PWD, such as certifying credits on credit-generating properties, maintaining a public credit registry (along with serial numbers for individual credits), and setting up a system to ensure that credit-generating sites continue to be maintained post-certification. And such a program would have to be carefully designed to ensure that it yields greened acres that can be counted toward PWD's compliance with its Clean Water Act obligations. These issues are also explored below.

4.2 SUPPLY AND DEMAND

To analyze the potential off-site mitigation market, the dynamics of credit supply and demand must be examined. By definition, an off-site retrofit would have to capture runoff in a location, or in an amount, that would not earn credit against the stormwater fee of the property where the retrofit is installed. We have identified three distinct types of properties that have the potential to meet this criterion:

i. residential properties,
ii. development and redevelopment projects, and
iii. non-site-constrained commercial properties.

Each of these properties has unique characteristics and regulatory requirements that allow them to be sources of supply. Residential properties are not currently eligible for credit under PWD's parcel-based stormwater fee structure; therefore, any stormwater mitigation they perform is additive and should receive credit. Development and redevelopment projects (which are required to manage the first inch of runoff) and already-developed commercial properties that voluntarily undertake retrofits to reduce their own fees could elect to manage more than one inch of on-site runoff or to manage additional runoff from an adjacent public right-of-way. The surplus management volume could generate an off-site stormwater mitigation credit.

Demand for off-site mitigation credits would come from property owners under the stormwater fee structure who, because of site constraints, could not retrofit their own properties. Authors' analysis suggests that there may be relatively few off-site credit and on-site mitigation opportunities. Therefore, authors assume that there would be sufficient demand for mitigation credits as long as the cost of these credits is less than the cost of the stormwater fee.

Box 4.1: Potential for an Off-site Mitigation Program within PWDs Regulatory Authority

PWD maintains authority to implement a market for parcel-based stormwater fee credits under 351 Pa. Code § 5.5-801, which allows the Department to "fix and regulate rates and charges for supplying water...and for supplying sewage disposal services." PWD currently operates a stormwater management services credit system under section 304.5 of the Philadelphia Water Department Regulations. However, substantial opportunity exists to establish an expanded credit system for the parcel-based stormwater fee program that would allow for creation of off-site stormwater mitigation credits through implementation of green-infrastructure-based SMPs. Such a program could greatly increase the use of green infrastructure in the Philadelphia area, resulting in reductions in stormwater runoff, stormwater pollutant load, and CSO events.

4.3 MARKET STRUCTURE: OFF-SITE MITIGATION TRADING

To understand how an off-site mitigation program could work, this section explores three possible models for off-site mitigation trading: bilateral, citywide, and public aggregation. Each of these frameworks has advantages, but it is important to note that these models are not mutually exclusive and, indeed, could coexist and support one another.

4.3.1 Bilateral Trading

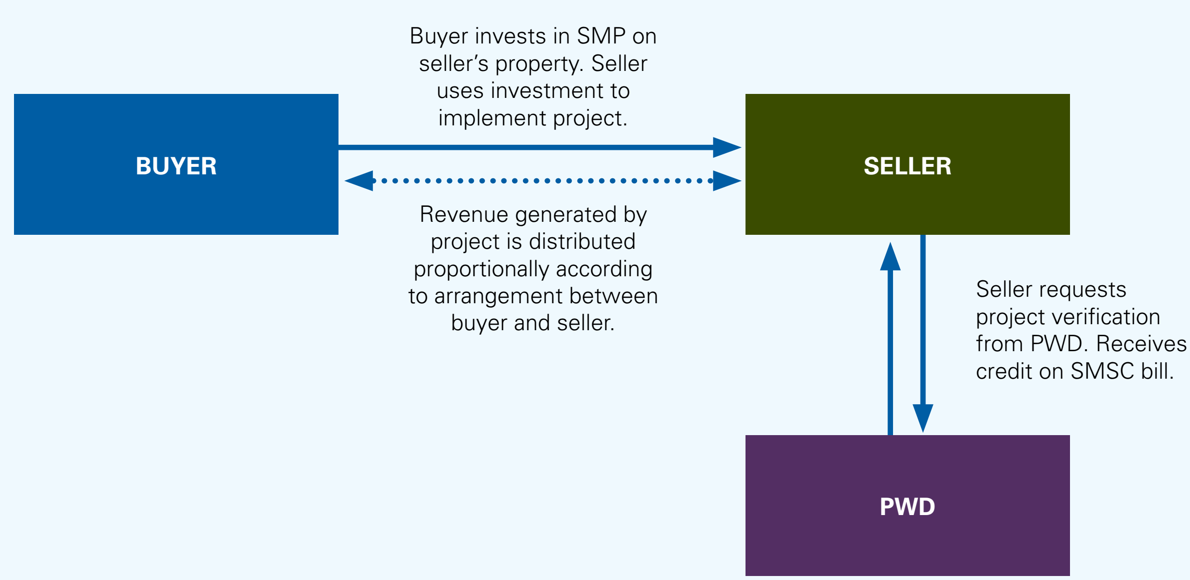
The most basic off-site mitigation trade entails a bilateral transaction between a buyer and a seller. In this scenario, property owner #1 (the buyer) enters into an agreement with property owner #2 (the seller) to invest in an SMP on the seller's property. In exchange for this investment, the buyer receives the associated benefits (i.e., cost savings) related to the stormwater fee reduction, which the buyer can then use to offset his own stormwater fee.

Of course, the off-site benefits transferred via the bilateral transaction would need to be recognized by PWD in order for the buyer to use the credit against his stormwater fee. PWD could simply recognize the SMP and credit the buyer's account, or preferably PWD could issue a tradable instrument, an off-site credit. In this latter scenario, the seller would register the retrofit with PWD for approval. Once it was approved, PWD would issue a credit to the seller, who would then transfer the credit to the buyer. The buyer would then be able to use this credit to offset his stormwater fee. This concept of a tradable instrument or credit is relevant in each of these models and would facilitate the operations of an off-site mitigation program.

In a bilateral trading scenario there are several ways a buyer and seller could interact, depending on the requirements of each party. If the seller is capital constrained or requires technical assistance, the buyer and seller could work together at all stages of SMP development. In this instance the buyer could provide the investment capital as well as design and engineering assistance. Alternatively, if the seller has sufficient capital and access to design expertise, the buyer and seller could operate independently. The seller, or a third party working with the seller, could develop the project independently and then sell the final credits to the buyer.

Typically, a bilateral agreement between a buyer and seller would be negotiated for a fixed term and a fixed fee, meaning that a fixed supply of credits would be transferred to the buyer. All transaction and credit costs would be

Figure 4.1: Bilateral trading (shared savings)



directly negotiated between the two parties; however, as in many markets, standardized contracts can be created. As the market matures, third-party project developers could emerge who would work with potential sellers to finance and develop projects, as well as brokers who would facilitate transparency and connection between buyers and sellers.

For off-site mitigation and bilateral trading to work, the seller must be able to provide mitigation on a per-unit basis for less than the stormwater fee. Further, the buyer must be able to use the credits generated from the SMP to reduce his stormwater fee. Therefore, PWD must provide a clear pathway for the certification and registration of SMP credits so they can be used against the stormwater fee. One possibility would be to use PWD's existing process for registering and validating on-site fee credits.[47]

There are some benefits to a bilateral transaction, primarily in its potential for simplicity and ease of deployment. From PWD's perspective, a bilateral transaction may require minimum intervention and investment in market infrastructure since it simply requires the recognition by PWD of the credits generated by the seller for use against the stormwater fee. Further, a seller may be able to use a bilateral agreement as a basis from which to seek financing for SMP construction.

While there are benefits, there are also significant drawbacks when compared with a program that allows broader, citywide trading. The price and other details of a bilateral trade are typically kept confidential and therefore fail to develop a transparent market price that other property owners could use to guide their retrofit decision-making process. Additionally, a bilateral trading program does not take full advantage of the market mechanism to find efficiencies and least-cost mitigation. Rather than a robust market with a transparent value for credits and bids and offers, in a bilateral program buyers and sellers will have to seek each other out on a one-on-one basis. If a relationship is not already established between the two parties, there is little to no infrastructure available to facilitate a new relationship based on trading. In addition, buyers and sellers will have to invest in advertising their needs. This implies a cost and inefficiency.

As a point of comparison, renewable energy credit (REC) markets use bilateral trading. REC markets are predicated on the creation of a renewable portfolio standard (RPS), which mandates that utilities purchase a certain percentage of their power from renewable sources. Under this scenario, a utility may choose to enter into a long-term, bilateral contract with an energy supplier to meet its RPS requirements (or purchase RECs on the spot market, if one exists). Often, the renewable energy supplier will use the bilateral agreement as a means to finance development off-site that will ultimately supply RECs to the utility. Exchanges do exist in REC markets but are not widespread, given the disaggregated nature of REC markets.

4.3.2 Citywide Trading

To improve the efficiency of an off-site mitigation program, PWD should consider allowing broader participation incorporating citywide trading or sewershed-specific trading of mitigation credits. (See Section 4.11 for guidance on sewershed-specific trading.) As in bilateral trading, in a citywide trading program a developer of an off-site mitigation project would seek certification from PWD, or a third party

Figure 4.2: Citywide Trading

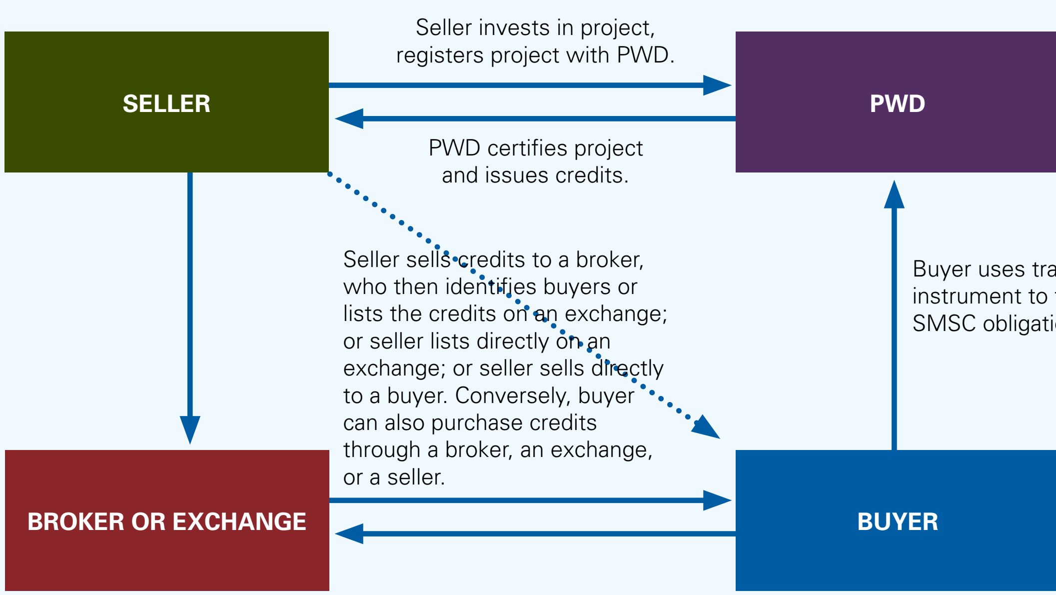
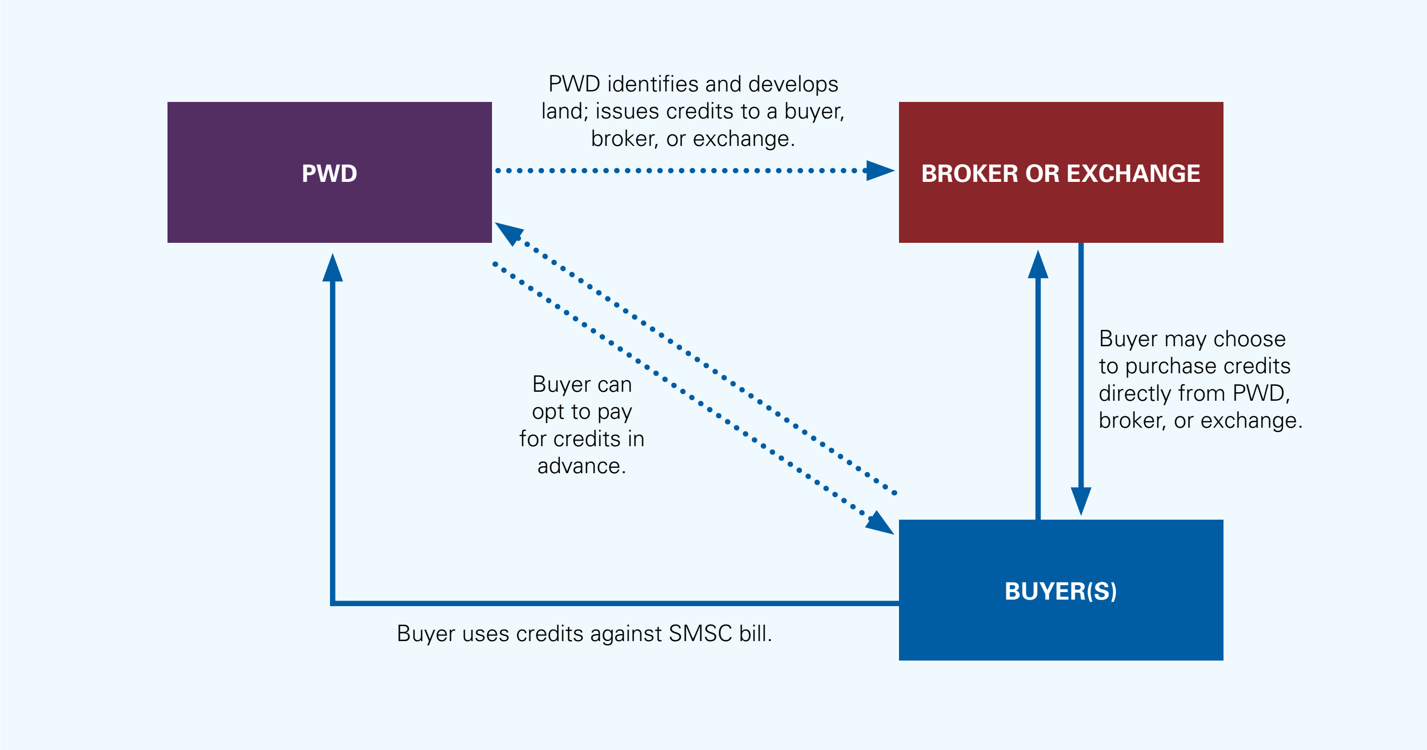


Figure 4.3: Public Aggregation: Option #1



designated by PWD, and upon successful certification would be issued a tradable instrument that could be held or sold. However, unlike bilateral trading, the seller could sell all or part of the credits he receives to any other party—either citywide or within his geographic boundary. That party, in turn, could choose to use those credits against his own stormwater fee or resell the credits to another buyer. The fact that the credit is now separated from the original seller is a key distinction between bilateral and citywide trading. Critical for this approach to work is the integrity of the certification program (refer to Section 4.8 for more details).

A citywide trading program would best harness the power of the market to incentivize property owners to invest in SMP retrofits, at or above the baseline. Benefits of a citywide approach include:

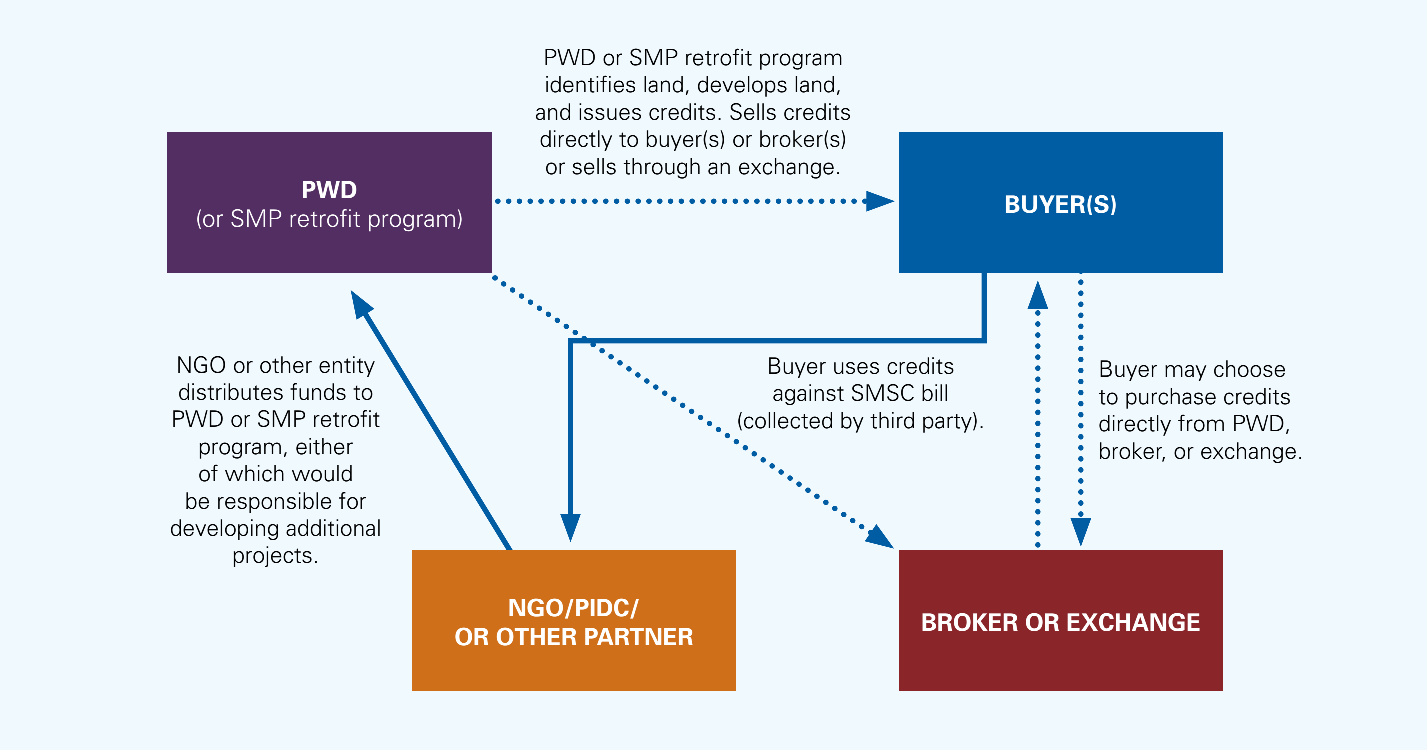
- Increased liquidity, with more buyers and sellers;
- Greater flexibility, with more options for constrained property owners and more potential buyers for off-site mitigation projects; and
- Increased likelihood of an open market with transparency on credit prices. A transparent market price for a unit of SWM mitigation would allow property owners to make informed investment decisions and would make it more likely that least-cost SMPs are being put into practice.

While these benefits are compelling, a broader program may require a larger administrative burden for PWD to establish the appropriate rules, processes, and market infrastructure to support such a program. This would include PWD regulation, the procedure to certify credits (this will likely be required for a bilateral trading program as well), and the possible establishment of a marketplace or exchange through which credits can be bought and sold. (See Section 4:14 for further discussion.)

4.3.2.1 Public Aggregation

While the two market structures described in the previous section rely on transactions between two private entities, another structure to consider is public aggregation. Under this scenario the city, or an entity designated by the city, would act as an aggregator to develop mitigation projects on private and possibly public land that could be offered in the form of stormwater fee credits to constrained property owners. A constrained property owner would be able to purchase credits from the city once they were created, or pay up-front into a fund that the city would use to develop stormwater retrofit projects. Either way, public aggregation would provide significant flexibility and a single contact for constrained property owners to participate in off-site mitigation. Moreover, purchasers would have the assurance that credits generated by the city would continue to function and not become invalidated, thereby reducing risk to the purchaser. The city in turn would be able to leverage economies of scale by aggregating demand from several property owners and investing in stormwater management interventions at a larger scale and on property that might otherwise not be available to a private developer, such as vacant lands.

Figure 4.4: Public Aggregation: Option #2



It is worth noting that the city might also choose to designate an entity to act on its behalf. For example, PWD could designate an NGO, the Philadelphia Industrial Development Corporation, the Philadelphia Municipal Authority, or another entity to collect on its behalf and then distribute the money directly into a program that facilitates SMP retrofits. This program could be implemented by PWD, by this same entity, or by a private contractor administered by either of the former options.

Revenue generated through public aggregation would result in fewer dollars received by PWD through the stormwater fee. In order to be a viable alternative for constrained property owners, their payments into the fund would have to be less than their SMSC (as would be the case in all off-site credit trading schemes). In this scenario, PWD would receive lower net revenue than would have been generated through the traditional stormwater fee. However, public aggregation may have benefits that could justify its implementation, even when considering reduced revenue. For example, revenue from the sale of city-generated stormwater credits could be allocated to a capital budget rather than an operating budget, which is where stormwater fees reside. This type of budget flexibility could be attractive to PWD, as the transition to parcel-based billing is relatively new and its effect on long-term capital budget expenditures is not yet fully understood. Another advantage is temporal, as revenue from credit sales may be received in a lump sum rather than in monthly installments, as is the case with the stormwater fee. This faster revenue stream may be attractive to PWD because it can use the money—along with its enhanced budget flexibility—to continue its own mitigation efforts. Finally, giving additional flexibility to constrained property owners may help mollify potential opposition to parcel-based billing.

One important consideration is to avoid competition between the public and private sectors for credits where the public aggregating mechanism would underbid the private developers. Therefore PWD should consider limiting the deployment of public aggregation to constrained property owners and consider placing a limited term on the aggregation mechanism that would serve to jump-start the program and offer flexibility to constrained property owners early. If unsuccessful, or if the program reduces PWD revenue beyond an acceptable level, the program could phase out while bilateral or citywide trading continued unabated.

Under any market structure, it is expected that PWD would bear some additional regulatory burden to set up a stormwater retention credit (SRC) market, enact policy, and incrementally improve the marketplace, as necessary. However, if a private marketplace were to evolve out of effective policy and the ability to establish a sufficient credit supply—as would be the aim with a public aggregation strategy—PWD's regulatory burden should lessen over time. Again, these structures are not mutually exclusive and indeed could be designed to work together. For example, bilateral trades could take place within the framework of a citywide trading program, as could a public aggregation option.

4.3.3 Recommendations

Philadelphia should consider implementing a citywide trading program that introduces a tradable instrument that can be bought, held, or sold through an exchange. Introducing a tradable instrument increases the liquidity of the off-site market because it would attract more buyers and sellers to the marketplace. Further, a transparent market price for a unit of SWM mitigation would allow property owners to make informed investment decisions—making it more likely that least-cost SMPs would be put into practice.

4.4 MARKET MECHANICS

Once the fundamental structure of the off-site credit market has been selected, several issues pertaining to the mechanics of the market must also be considered in order to ensure that the market is robust, transparent, and efficient. PWD must decide on a denomination, or unit, for off-site credits, as well as a life span for those credits. A credit exchange, or other infrastructure to facilitate the buyer-seller relationship, must be established in order for parties to come together and transact. PWD must set eligibility criteria for credit-generating projects, which may require determining whether geographical restrictions should be set for those projects vis-à-vis the sites purchasing the credits. PWD must determine requirements for project maintenance, inspection, and verification. Finally, public participation and transparency should be emphasized through a public comment process and an openly accessible online trading registry.

CASE STUDY: Washington, D.C.

In August 2012, the Washington, D.C., District Department of the Environment (DDOE) proposed new stormwater regulations for the city, pursuant to its recently renewed municipal separate storm sewer system (MS4) permit. These regulations require new development and redevelopment sites to retain on-site the volume of runoff generated by a 1.2-inch storm (the 90th percentile rainfall event in Washington, D.C.).

However, the regulations offer developers the option of retaining some of that volume off-site, as long as they demonstrate that a minimum of 50 percent of the retention requirement is met on-site. When a site selects the off-site compliance option, it may achieve its "off-site retention volume" by purchasing stormwater retention credits (SRCs), each of which corresponds to one gallon of retention for one year, by paying DDOE's in-lieu fee, or by a combination of the two. The site owner may use SRCs that it has earned elsewhere in the District or purchase them on a private market. Regulated site owners are responsible for their off-site retention volume on an ongoing basis.

Sites may generate SRCs by installing management practices that achieve retention in excess of regulatory requirements, either by achieving any amount of retention on a site that is not subject to the regulations, or by achieving retention above and beyond what is required of that site by the regulations (up to a ceiling of the volume generated by a 1.7-inch, or 95th percentile, storm). After approving an application to certify SRCs for eligible retention capacity, DDOE will certify up to three years' worth of SRCs for that capacity. After that three-year period, the owner of the retention capacity may apply for more SRCs.

These regulations are still in draft proposal form, and the program is subject to change until the regulations are finalized by DDOE in 2013. While the authors of this paper do not necessarily endorse all aspects of the proposal, it provides one useful illustration of how a tradable permit system could be structured.

CASE STUDY: Charlotte, NC

In 2008, the city of Charlotte, North Carolina, instituted an off-site mitigation program to provide flexibility for site-constrained property owners conducting development or redevelopment efforts downtown and in other targeted areas. The program was designed to reduce cost barriers for redevelopment that supported growth of Charlotte's light rail system—a priority of elected officials, who are principally concerned with economic revitalization—while protecting the city's water assets from impairment. In the fall of 2011, the program was expanded to incentivize redevelopment citywide, including suburban areas. The program is administered under Charlotte's post-construction control ordinance—its permitting system for new development and redevelopment areas.

The ordinance allows property developers to pay a one-time fee if cost or site constraints prevent them from meeting their stormwater retention mandates (85 percent retention of total suspended solids from the first inch of a rainfall event). The city charges the developer $60,000 per impervious acre ($90,000 in the suburbs) so it can perform its own mitigation off-site on city-controlled lands, primarily through easements on private or public property. The fee is based largely on land costs (to the city), construction costs, and 20 years of operations and maintenance. One key drawback of this structure is that after 20 years, the cost of operations and maintenance shifts to the ratepayer, as opposed to the developer. The city, in turn, is able to achieve large economies of scale using this regional approach, and it is now building off-site SMPs for less than $30,000 per acre. A 2010 study from the Nicholas Institute for Environmental Policy Solutions quoted a comment by Daryl Hammock, Charlotte's stormwater manager, on the cost difference between on-site and off-site mitigation: "On one three-acre urban site, the costs for underground stormwater treatment were estimated to be about $700,000. By allowing [developers] to pay a fee, in this case, $180,000, everyone was happy. The city is able to take $180,000 and treat a much larger area—approximately 18 acres—for the same cost."

Since July 2008, this program has collected $3,238,405 over 33 projects for an average cost per project (to the developer) of just over $98,000. The money generated is invested in regional pond retrofits that remove total suspended solids and increase stormwater detention. Because the city views the program as a success, and based on interest from local project developers, Charlotte is now exploring the potential for private developments to generate stormwater retention credits (SRCs).

While not a direct analogue to the city aggregation market structure discussed earlier in this report (Charlotte's off-site program involves a fee in lieu of on-site compliance), its success proves that a city can, in some cases, take on the project developer role more cheaply than private parcel owners.

4.5 CREDIT DENOMINATION

In order for a credit to be traded, it must first have a clearly defined unit of denomination. By analogy, within the carbon offset market a unit is defined as the right to emit 1 metric ton of carbon dioxide (CO_2) or another greenhouse gas set to an equivalent basis (CO_2e). Once a unit is established, it is then packaged into a credit using an offset ratio. The compliance authority under which a credit will be applied determines the offset ratio, which we can think of as units avoided to units emitted. The ratio can be 1:1, 2:1, or something else. Another way to think about this would be to consider how many units an emitter would have to purchase for every metric ton of CO_2e it emits.

Within the stormwater trading context, a parcel owner would purchase a stormwater retention credit (SRC) to offset his stormwater management fee. SRCs are similar in that they need to be set on a standard, unitized basis, with a defined offset ratio. This basis can be one or more of the following: temporal, meaning the length of time an SMP measure will remain a viable mitigation tool (discussed in more detail in Section 4.9, below); spatial, meaning the amount of area needed to manage runoff; or volumetric, meaning the volume of water the measure is able to manage. We recommend using all three parameters and discuss a number of options below.

4.6 SRC OFFSET RATIO

The simplest approach would be to use a 1:1 offset ratio. This means that the retention capacity needed for an on-site retrofit to receive a fee reduction (1 inch of stormwater) can be replaced on a one-to-one basis with an off-site credit purchased by the parcel owner. For example, Washington, D.C.'s proposed SRC regulations call for a 1:1 offset ratio.

While this is appealing for its simplicity, there are at least two scenarios in which an offset ratio other than 1:1 is likely to be necessary, and a third scenario in which such a higher ratio is worthy of consideration. First, if credit is provided for retrofits that manage more than 1 inch of runoff on-site (see discussion below), a different offset ratio is likely necessary. As noted below, there are diminishing environmental returns on greater levels of stormwater capture; therefore, capturing an extra half-inch of runoff beyond the first inch should not generate a full one-half of the value of a 1-inch credit.

Second, if credit is given for retrofits that manage less than 1 inch of runoff, a different offset ratio may be necessary. The value to PWD of capturing only a fraction of an inch on a site is not necessarily directly proportional to the value of capturing a full inch of runoff. As noted below, PWD would need to quantify the value to develop an appropriate offset ratio.

Third, an offset ratio of greater than 1:1 can be a useful way of hedging against the possibility that an SMP will not be well maintained to achieve peak performance at the credit-generating site. This risk also exists, of course, for on-site projects. However, this risk may be substantially increased when a credit purchaser combines credits from many small off-site projects (as opposed to a single on-site project). The risk may also be increased for certain types of projects; this could include SMPs installed on residential properties, which may be more likely to be inadvertently damaged by the actions of homeowners. For these reasons, PWD should consider an offset ratio of greater than 1:1 for any categories of off-site retrofits that are deemed to have a higher risk of failure than typical on-site projects.

4.7 OPTIONS FOR SRC UNIT DENOMINATION

Before presenting options for unit denomination, it is important to distinguish who is eligible to generate credits. If the credit is being generated by a site not subject to the parcel-specific fee (e.g., a residential property, then any retention capacity installed is additive and therefore should generate a credit. On the other hand, credit-eligible sites (e.g., commercial and condominium properties) would need to add retention capacity beyond what would be required to simply reduce their fee (more than 1 inch) (see Option 3, below).

Option 1

1 credit = 1 inch of stormwater managed per square foot

Placing credits on per-square-foot basis reduces land area restrictions that could preclude smaller properties' participation in the SRC market. (See Section 4:17 for more detail.) It is worth lowering barriers to entry for smaller projects, especially for residential property owners, by providing credit for smaller interventions (such as downspout disconnects). In addition, PWD regulations enable property owners subject to the parcel-based fee to apply for a partial impervious-area credit. This credit is based on 1 inch of stormwater managed by an on-site SMP, where the square footage of the impervious-area credit approved is equivalent to the square footage of IA that is managed.[51] Because there is no minimum square-foot limit under current on-site credit regulations, it may be unwise to have an off-site minimum square-foot limit for SRCs (as is the case in Option 2). In addition, buyers will likely want to trade in quantities specific to their needs. Placing SRCs on a per-square-foot basis would allow buyers to buy no more and no less than what their parcel size requires.

The disadvantage of this approach is that it increases the amount of individual credits needed for commercial parcel owners to fully reduce their stormwater fee, as they may have far larger areas to offset than a residential property or other small property could generate in credits. A potential result is an increased administrative burden and cost to commercial parcel owners—under a bilateral agreement, or agreements, the buyer might have to find multiple sellers to meet his total compliance needs, transact more credit purchases, and possibly pay a fee per transaction. Transaction fees may come in the form of a fee to PWD for minting/certifying the credit, which could be either absorbed by the seller or assumed by the buyer. Another possibility would be for the buyer to use a broker or exchange, which could aggregate credits generated from multiple sellers and bundle those credits into a single transaction for the buyer. The transaction fee in this case would likely be a fixed sum paid to the broker or exchange for transacting the deal.

Option 2

1 credit = 1 inch of stormwater managed per 500 square feet (spatial basis for IA parcel fee)

This option would set a minimum spatial requirement (500 square feet) for off-site credit generation. Because 500 square feet is the minimum threshold for commercial properties under Philadelphia's parcel-based fee, this requirement should not restrict options on the buy side. In addition, similar transaction costs as discussed above may come into play. On the bilateral side, limiting SRCs to a larger area would limit the amount of sellers a buyer would need to transact with, and thereby limit his potential administrative costs.

However, from the authors' initial analysis of potential, relatively inexpensive stormwater credit supply, it appears that the largest source of economically viable credits in the city is small residential projects (less than 500 square feet). Using this credit denomination would severely limit the number of credits in the market unless there were a mechanism to combine or aggregate smaller, partial credits.

Option 3

Properties not subject to the SMSC: Partial credits of ¼, ½, and ¾ inch

Properties subject to the SMSC: ½ inch credit for properties mitigating beyond the first inch

This option may be used in conjunction with one of the two options listed above. It is meant to provide financial incentive for parcel owners not subject to the SMSC to voluntarily install any level of retention capacity feasible (both in terms of cost and space). It would also reward SMSC-eligible parcel owners who opt to mitigate beyond their 1" requirement, allowing them to sell off the additional mitigation as an SRC.

As mentioned at the beginning of this section, encouraging properties not subject to the SMSC to mitigate their runoff would add to retrofit incentives currently in place. Capturing a full inch of runoff from impervious areas on a residential property is clearly of value to PWD. PWD should also consider whether it could quantify the value—in terms of reducing sewage overflows—of managing less than a full inch of runoff from such sites. If PWD can quantify that value relative to projects that manage a full inch of runoff, then it could potentially expand the supply of retrofit projects by awarding credits for projects that manage less than an inch of runoff and assigning an appropriate offset ratio.

Second, for properties subject to the parcel-based fee, the option of awarding credit for managing runoff in excess of 1 inch also warrants further study. The majority (roughly 80 to 90 percent) of runoff in Philadelphia is generated by storms of 1 inch of rainfall or less, suggesting diminishing marginal benefits (in terms of reduced sewage overflows) from managing additional increments of runoff beyond 1 inch.[52] Yet, once quantified, the environmental benefits of mitigating beyond 1" may be worthy of inclusion in the credit-trading scheme (with an appropriate offset ratio). For the purposes of our supply analysis, we assume that stormwater-credit-eligible properties that can mitigate beyond 1 inch of runoff would be able to sell off their surplus as credits (see Section 4:17, following).

Because a near-term supply of credits is crucial to ensuring that a credit trading system is utilized to its fullest extent, we do not recommend placing any undue barriers on credit generation. Therefore, we recommend using a combination of options 1 and 3 (pending further analysis by PWD of appropriate offset ratios for option 3), in order to allow the maximum number of residential and nonresidential property owners the opportunity to generate credits and participate in the trading scheme.

4.8 CREDIT CERTIFICATION

Before buyers and sellers can begin to trade credits, PWD must make key decisions about the features of those credits. Specifically, PWD must determine how those credits will be certified in order to become sellable, what the life span of the credits will be, and when the clock begins to tick on that life span.

Before credits are to be exchanged for a reduction in a ratepayer's stormwater fee, PWD must certify that the installed retrofit SMP is functional and will actually retain the volume that corresponds to the fee reduction.

As for the entity that will perform the credit certification, PWD has two options: It can certify the credits itself (using its existing on-site requirements as the basis for certification), or it can delegate a third party with granted authority to certify credits. As part of the current Stormwater Credits Program for on-site retrofits, PWD performs all certification itself. The benefit of taking full responsibility for this task, as PWD has likely determined, is that the department can exercise complete oversight and quality control over the credit certification process. However, taking full control can also mean a significant expenditure of resources and staff time. This will particularly be the case if PWD greatly expands the number of properties that are eligible to participate as credit generators in an off-site mitigation program. While the expense to PWD could be partially offset by a user fee similar to the application fee that PWD already charges on-site credit generators, the certification process may nonetheless become unwieldy if the number of program participants increases significantly.

PWD could conserve resources by delegating certification authority to an independent third party, but doing so would require answering questions such as: What are the necessary qualifications for this third party? What benefit will the third party gain from the arrangement—will it receive a cut of the stormwater fee discount, be paid a flat fee by PWD on a contractual basis, or be compensated in some other way? How much oversight will PWD exercise—for example, will it perform occasional audits to ensure that credits are being properly certified? Will the third party be licensed by PWD?

Will it bear any liability if the credit seller's retrofit SMP fails to perform the necessary retention? In carbon markets, it is standard practice for the party developing the credit to pay the costs of an accredited third-party verifier.

If PWD can devise a cost-effective arrangement that ensures adequate oversight of the certification process while relieving some of the administrative burden on the department, it may want to delegate this process to a third party. If PWD chooses such an arrangement, the third party should be required to document all credit certifications to PWD, with data about each individual project. This documentation must entail sufficient quality assurance and quality control for PWD to be able to vouch for all certified projects in its reporting to Pennsylvania Department of Environmental Protection (PADEP) and the Environmental Protection Agency (EPA) about how many greened acres have been achieved through the off-site mitigation program. As a result, if PWD intends to use a third party for credit certification purposes, the department should secure advance approval of that arrangement from PADEP and EPA. By contrast, the proposed credit program in Washington, D.C., authorizes only the District Department of the Environment (DDOE) to certify credits.[53] This arrangement ensures that DDOE will have complete control over the certification and tracking of every credit.

PWD must also address details of the credit certification process. PWD's current process for certifying on-site credits through its Stormwater Credits Program is generally appropriate for certification of off-site projects as well. As with PWD's on-site credit process, PWD should require off-site credit applicants to complete an application form and provide required documentation, including a stormwater management plan and photos of the SMP and surrounding drainage area. As discussed below, maintenance plans are also critical and should be submitted with the application. For example, similar to PWD's current requirements for on-site credits, Washington, D.C.'s proposed program would require applications for credit certification to include a completed application form, documentation of the right to the credit (typically proof of ownership of the property where the SMP is located), a copy of a stormwater management plan that meets DDOE specifications or the SMP and area draining into it, an executed maintenance contract, and any other documentation that DDOE believes is necessary.[54]

PWD also needs to determine whether it will charge a fee for credit certification, and if so, the amount of the fee. Charging the current rate (for on-site credits) of $150 for the initial application and $50 for a renewal application would provide administrative consistency as long as this rate continues to cover PWD's (or a designated third party's) certification costs. By contrast, DDOE proposes to charge a significantly greater fee of $700 to $1,050 (depending on project size) for department approval of a stormwater management plan.[55]

PWD could continue to allow certification if the applicant submits photo documentation of the project; this is generally what it does for on-site credit applicants, with physical inspections occurring only at the department's discretion. This arrangement is in line with the proposed Washington, D.C., regulations, which state that DDOE "may" conduct inspections of SMPs before certifying credits, at the department's discretion.[56] Although routine site visits for each credit applicant are more resource-intensive, they are also more reliable, and consequently we recommend them as an audit system to guard against improper SMP installation (and resulting worse-than-expected retention benefits).[57]

4.9 CREDIT LIFE SPAN

In a perfect world, the life span of a stormwater retention credit would be exactly equal to the life span of the SMP that generated it; this way, the fee discount earned from the credit would last exactly as long as the corresponding volume retention was achieved. However, in reality, this is not a practical goal as the life span (and consistent performance) of an SMP is not easily predicted. Moreover, assigning a different life span to each retention credit would prove an administrative challenge. Thus the designers of a credit trading program must decide upon a standard life span for retention credits.

Problems can arise if stormwater retention credits last indefinitely or a very long time. For example, if a property subject to the stormwater fee buys credits from another parcel owner to retain stormwater on its behalf and the obligation ends there, there will be a risk that the retention practice will fail or be removed at some point in the future. In such a scenario, the rate-paying property would be receiving a stormwater fee discount even though no stormwater reductions were being realized. In addition, the idea of maintaining an SMP indefinitely may be so daunting to potential credit sellers that they will decline to enter the program, thus reducing the supply of off-site credits.

Because of these factors, it may be desirable for an off-site mitigation program to use credits that have a defined and relatively short life span. If credits have limited life spans, the rate-paying property (the credit buyer) will periodically need to repurchase credits—or "cash in" its credits with PWD—in order to continue receiving a discount on its stormwater fee. Under such a scenario, credits could have a life span on the order of four years, which is the span PWD already uses for its on-site Stormwater Credits Program.

Limited-lifetime credits would reduce the risk of administering unearned credits, while also making the program less daunting for potential credit generators/sellers. This arrangement could also prove more flexible for credit purchasers, in that they could periodically reassess their credit portfolios. For example, a buyer could periodically determine if it was more cost effective to pay more or less of their stormwater fee or purchase more or fewer credits.

Washington, D.C.'s response to this problem is instructive. The District's first, unofficial trading program proposal required credits to have a very long life span—about 30 or 40 years, which is the average life span for a development in the District. However, DDOE identified three weaknesses with this plan: the two already described (potential SMP failure and daunting responsibility for credit sellers), along with the problem of market participants facing a high-stakes, one-time opportunity to set the right price for the credit.[58] Subsequently, the District revised its proposal so that a credit purchaser is subject to a permanent net retention requirement (because this program implements mandatory stormwater retention regulations) for the life of the development, but the credits themselves have a life span of only one year. Each year, a regulated site must prove to DDOE that it has fulfilled its retention obligation by using retention credits corresponding to its volume obligations for the upcoming year (or by paying an in-lieu fee).[59]

On the other side of the transaction, for credit generators and sellers, DDOE will certify up to three years' worth of credits for any given retrofit SMP.[60] The credit-generating site is then required to maintain the SMP for that authorized three-year period. At the end of that period, the owner of the credit-generating SMP may apply for another three years' worth of credits, which DDOE will certify after verifying that the project is still eligible. (By way of example, an SMP with 1,000 gallons of retention capacity per year can be certified for 3,000 credits at a time.) With the exception of the fact that DDOE allows credits to be banked indefinitely, as discussed in the next section, this arrangement is a reasonable one because it ensures that credits represent volume retention by an SMP that has been recently inspected.

4.10 CREDIT TIMING AND BANKING

Once an SMP retrofit is constructed, the life cycle of an off-site mitigation credit is marked by at least four defining events: 1) certification of the credit by PWD, 2) issuance of a tradable credit to the seller, 3) transfer of ownership from seller to buyer, and 4) use (or "retirement") of the credit by the buyer to receive a benefit (in Philadelphia, a discount on the stormwater management service charge (SMSC)). It is important to note that credits should be usable only after the SMP is fully functioning and retaining the intended volume of stormwater runoff, but not before.[61] Additionally, a credit should expire if it has not been retired within the determined life span. The life span of the credit would likely start at credit certification in order to parallel the existence of the actual SMP, and end when the SMP needs recertification.

The temporal gap between certification of credits and their use (or retirement) is commonly referred to as credit banking. Credit banking offers several benefits both to market participants and to the program administrator. For property owners considering a retrofit, credit banking provides incentives to take early action and reduces risk by providing certainty that they will be able to sell credits in later years. For potential buyers, credit banking allows for increased flexibility in planning and risk management by allowing them to invest early and hold credits until they most need them. Banking may also eliminate certain complications for program administrators by avoiding the need to cancel or invalidate expired credits. For example, Washington, D.C., has proposed to allow indefinite credit banking as part of its trading program: A credit may be banked indefinitely, and the one-year life span of the credit does not begin until the date the credit is used to fulfill a site's compliance obligations.[62]

While credit banking provides some clear benefits, it also creates a problem of non-contemporaneousness. In other words, the on-the-ground reductions in stormwater runoff and the benefits being gained by the credit purchaser may not be occurring at the same time. In fact, by the time a credit is used for a fee discount (or, in cities like D.C., for regulatory compliance), the corresponding SMP may no longer exist anymore. This arrangement is potentially problematic because the environmental benefit of retaining stormwater at time A may not be the same as it is at time B.

By way of example, imagine that a credit purchaser buys 10,000 credits at once and then uses 1,000 credits each year to earn a stormwater fee discount for 10 years. In this situation, 10,000 credits' worth of retention has been achieved in the first year (contributing to CSO reduction), but none in the following nine years (not contributing anything to CSO reduction). This situation would be particularly problematic in Philadelphia due to the need for PWD to show under its consent decree that it has achieved greened acres. PWD must have a certain target number of greened acres actually in place at any point in time. Consequently, allowing credit banking would mean that ratepayers would be allowed to receive discounts on their stormwater fee at a point in time when PWD is unable to get credit toward its own regulatory obligations for the underlying greened acre.

To avoid situations where credits are being used for fee discounts at a time far removed from when the corresponding SMPs have ceased to have any benefit, it is necessary to require that credits be used within a certain period of time. For the purposes of this program we recommend that the clock start ticking on a credit at the point of certification (step 1) and last for the entire four-year certification term. Credit purchasers should not be allowed to bank credits beyond the four-year certification period. However, additional consideration is needed to determine whether it should be permissible to bank credits *within* the certification period—that is, whether a credit generated by the existence of an SMP in year 1 could be applied to reduce a parcel owner's charge in year 4.

4.11 GEOGRAPHIC SCOPE OF OFF-SITE PROJECTS

A central concern for any proposed off-site mitigation credit program will be the geographic scope or extent of potential credits—in effect, whether a limit will be placed on off-site project location selection, and if so, how that limit will be defined. This aspect of the off-site mitigation program involves physical characteristics of the city's watersheds (boundaries defined at the sub-watershed or watershed level, or left open to any location within the city's jurisdiction), and the differences between areas of the city served by combined sewer systems (CSS) versus those serviced by separate storm sewer systems (MS4).

The goal in establishing a geographic limitation on where off-site mitigation projects could be implemented would help ensure that all program goals for water quality are met. Limiting the geographic scope of credit trading would provide oversight of the distribution of stormwater runoff reduction benefits. Such control and oversight would ensure that sites performing off-site mitigation, or sites purchasing credits, do not cluster in a way that reduces the water quality (and other) benefits desired by PWD. However, when determining the allowable geographic scope of off-site projects, it is important to recognize that the potential supply of mitigation sites, and thus the cost of buyer participation in the credit market, is likely to increase in line with the size of the allowable area.

While potential geographic scoping options are addressed below, a final determination on how to draw geographic boundaries may need to wait until further analysis is undertaken on the number and location of off-site mitigation projects. Ultimately, any program should consider these factors and be designed to achieve the objective of increasing use of green infrastructure within CSO areas.

4.11.1 The Art of Drawing Geographic Boundaries

The PWD jurisdiction has seven main watershed units (or areas of land in which precipitation drains to a particular body of water). They are: Cobbs Creek/Darby Creek (often referred to as the Darby-Cobbs watershed), Schuylkill River, Wissahickon Creek, Pennypack Creek, Poquessing Creek, Tookany-Tacony/Frankford Creek, and Delaware Direct watersheds.[63] (These may be further divided by CSO/MS4 boundaries, as discussed in Section 4.12, below.) Historically, natural watersheds were used to "facilitate drainage," and surface waterways in Philadelphia formed a framework in which to plan a network of conveyance pipes.[64]

There are multiple ways, both within the watersheds and through combining watersheds, to structure an off-site mitigation credit-trading program. The most likely potential boundaries would be:

- **Entire PWD/city jurisdiction.** This is the least restrictive option, with the least potential control over water quality outcomes.
- **Watershed-level boundary.** This is a moderately restrictive option, with at least partial potential control over water quality outcomes.
- **Sub-watershed or sewershed boundary.** Adopting a geographic boundary limit smaller than the individual watershed scale is the most restrictive potential delineation but also offers the greatest potential control over water quality outcomes and the siting of greened acres.

4.11.1.1 Entire PWD/City Jurisdiction

Opening the entire city to a unified trading program would likely increase potential program participation, including potentially maximizing green infrastructure investments with otherwise-planned capital projects in the public right-of-way or on public lands throughout the city. However, this option would not ensure that each waterbody would benefit from the pollutant load reductions necessary under the EPA CSO Control Policy. The policy requires compliance individually for each of the three distinct combined sewer systems (CSSs) associated with PWD's three sewage treatment plants. This option would allow sites electing to purchase stormwater runoff credits to become clustered such that certain areas would receive substantially less actual runoff reduction benefit under the program, an undesirable outcome. (A similar concern can be raised for separate storm sewer areas in that city-wide trading would result in certain areas' purchasing credits rather than using green projects to reduce runoff volume associated pollutant loading.) As a result, this degree of flexibility appears too great to ensure maximum overall benefit from the program.

4.11.1.2 Watershed Boundary

Using watershed boundaries as the geographic scope for each trading program area may provide enough flexibility to ensure adequate participation and adequate opportunity for PWD to maximize green infrastructure investments, while simultaneously assuring that each major creek or surface water within the city sees a substantial enough overall reduction in runoff to result in improved water quality and reduced flooding or to comply with CSO consent decree requirements.

Selection of watershed boundaries for program purposes may raise issues including whether each watershed can be treated similarly. For example, is a transfer of benefits from the lower Schuylkill River watershed to the upper Schuylkill watershed equivalent to a transfer within a smaller watershed? While this approach has its limitations in terms of providing hyper-localized water quality improvements, from a compliance standpoint it is highly preferable to the unrestricted option of selecting the entire PWD jurisdiction for trading.

4.11.1.3 Sub-Watershed or Sewershed Boundary

Utilizing sub-watersheds (subset drainage areas of a designated watershed) or sewersheds (areas draining to a particular outfall of set of outfalls), consisting of total areas smaller than the entire watershed, provides the greatest control and limits the opportunity for project clustering. However, it is expected that this approach would restrict project and market development by narrowing the supply of potential low-cost projects. Private investors might also be deterred by sub-watershed-level restrictions because they would create a market with less demand, less trading, and thus less liquidity.

4.11.2 Project Safety Net: Philadelphia Water Department

It is important to note that incentivizing private retrofits is not the only strategy PWD will pursue to meet its greened acre development objectives. To fulfill its CSO consent order obligations, the department will also invest directly in retrofits, especially in the public right-of-way or on other publicly owned property. Therefore, the agency will have some ability to offset the negative impacts of project clustering by directing public investment to those areas that receive fewer privately financed retrofits. In light of this PWD "safety net," if a relatively restrictive geographic scope were found to hinder participation in private retrofit development, it could be desirable to increase project location flexibility and backfill with government-sponsored projects.

4.12 DISTINGUISHING BETWEEN CSO AND MS4

Distinction between CSO and MS4 areas, or (as mentioned above) subdivisions within each combined sewershed, must be considered as part of any trading scheme. While there are important water quality benefits associated with implementing green infrastructure projects in MS4 areas, they will not help Philadelphia meet its consent order obligations to reduce pollution from its combined sewers.

If PWD so desired, it could provide a reduced-value credit for projects within MS4 areas that were purchased by property owners located within a combined sewershed. However, given PWD's current priority objective of reducing CSO pollution, we suggest that PWD prohibit trading of credits between buyers in the combined sewershed and sellers in MS4 areas.

4.13 PUBLIC PARTICIPATION AND TRANSPARENCY

Public participation and program transparency will be key features of any off-site mitigation and trading program. If the city awards property owners a discount on their stormwater fees based on SRC credits, the public will want to know that such discounts are warranted.

Therefore, PWD should commit to developing a publicly transparent program that takes into account the views of the public and program participants. PWD should allow public input on the proposed structure of the program pursuant to its usual notice-and-comment procedures for proposed regulations. The department should then maintain a publicly accessible online database and credit registry where the details of off-site mitigation transactions can be viewed. To supplement this process, PWD could assign serial numbers to each credit, such that the use of the credit can be traced back to the SMP from which it was derived. Providing information and serial numbers on all credits generated, bought, and sold within the trading system will give buyers, sellers, regulatory agencies, and the public real-time insight into the state of the marketplace.

As the EPA has noted, "[t]ransparency and the free flow of information creates stable expectations and outcomes for market participants. With fewer lurking 'unknowns,' participants will feel less vulnerable in the marketplace and their required risk discount may shrink."[65] Consistent with the public disclosure recommendations EPA's *Water Quality Trading Toolkit*, PWD should "clearly articulate the uncertainties associated with [SMPs], their implementation, maintenance and operation, and how these uncertainties will be addressed.... EPA's Trading Policy encourages states and tribes to make electronically available to the public information on the trading partners, the quantity of credits generated and used, market prices where available, and delineations of watershed or trading boundaries."[66]

In connection with these public transparency measures, PWD must decide who will be responsible for the cost of setting up the registry, and who will be responsible for maintenance of the technology and the information. Will it be PWD or a third party? When considering whether to internalize responsibility for managing the registry, PWD will need to weigh its interests in maintaining control over what information is released, and how, against the cost and resource savings that could be realized through outsourcing the service.

4.14 ROLE OF A CREDIT EXCHANGE

Exchanges play an important role in financial and environmental markets. A credit exchange, which can be owned and operated either publicly or privately, is a marketplace where buyers and sellers can come together to transact credits. It serves several important roles including providing transparency, price discovery, liquidity, and governance for the market.

An exchange can serve several purposes, which can range from simply listing projects to providing a fully functional trading platform that allows buyers and sellers to transact. In addition to providing liquidity and transparency, an exchange can also provide a transaction clearing function. Clearing is the process by which an intermediary assumes the role of buyer and seller for a transaction in order to reconcile orders between transacting parties. This clearing function reduces counterparty risk and facilitates smooth market operations.[67]

4.15 OPERATIONS AND MAINTENANCE

There are two fundamentally different approaches to SMP operations and maintenance (O &M) requirements in voluntary credit programs.

1. **Contractual obligation.** O &M could be structured as a requirement that is binding on the credit generator throughout the life span of the credit. In such a scenario, a credit generator would have to guarantee maintenance as part of the certification process. PWD could then force the credit generator to continue maintaining the SMP throughout the credit term.
2. **Misuse it, lose it.** Alternatively, O &M obligations could merely be a condition for redeeming a stormwater retention credit, such that a credit generator is free at any time to stop maintaining an SMP, with the only consequence being that the credit is no longer redeemable.

PWD should consider adopting the contractual obligation option, as PWD has a vested interest in being able to certify that greened acres are being delivered and maintained in line with the city's consent decree targets. While allowing credit generators to stop maintaining SMPs and terminate credits in the middle of a credit term might be more attractive to market participants, this factor is outweighed by PWD's obligation to deliver functioning green acres.

As an initial matter, an O&M plan should be submitted and approved as part of credit certification and origination. PWD must decide if O&M plans for off-site SMPs will be standardized, and if so, whether PWD or a third party will create the standardized form or guidance document.

In addition to an O&M plan, a legal mechanism is needed by which PWD can enforce the maintenance obligation in the case of operator default. This legal mechanism could mimic the structure of the city's mandatory stormwater management requirements for new development and redevelopment projects. Under existing regulations, construction on regulated developments may not commence until PWD has approved an O&M plan for the project.[68] The O&M plan must include a signed agreement between the owner and the city to maintain SMPs in accordance with the plan, and both the plan and signed agreement must be recorded with the Philadelphia Department of Records, which makes the agreement enforceable against all current and future property owners.[69]

4.15.1 Current O&M Obligations and Moving Forward

In contrast, PWD currently does not require any maintenance agreements to be signed for its voluntary on-site Stormwater Credits Program. An applicant for stormwater credits must simply submit a management plan for the credit-generating SMP(s) along with its application, and when a credit generator applies for credit renewal, it must merely provide evidence (inspection records) to show that maintenance has been performed on the SMP(s). As a result, PWD lacks any sort of enforceable mechanism to ensure that SMPs generating credits are properly maintained.

The option PWD has selected for compliance with its mandatory program is one of the most enforceable mechanisms available. While maximum enforceability makes it more likely that SMPs will be maintained, enforceable legal mechanisms are also more daunting to property owners and may discourage participation in a voluntary program, reducing the supply of off-site credits. On the other hand, the lack of any maintenance agreement for PWD's current Stormwater Credits Program means that the department has no way of ensuring that SMPs are maintained for the duration of the credit term. Consequently, PWD should consider some intermediate form of maintenance arrangement for its voluntary credit programs—something less daunting than the recorded agreement used for regulatory compliance, but more enforceable than the total lack of agreement currently used for on-site retrofits.

In this section the authors describe and evaluate a number of options that PWD could select for its off-site mitigation program. These options vary in terms of both enforceability and administrative burden—that is, how easy or difficult it is for PWD to negotiate the particular form of the agreement, and how much of the maintenance burden is placed on PWD.

Option 1: Regulatory Maintenance Requirement

Under the most straightforward option, PWD's regulations would require credit generators to maintain their SMPs, with attendant punitive consequences (such as fines or fees) should a PWD inspection reveal maintenance violations. The site owner would not be required to sign or file any document agreeing or committing to this obligation. While the regulations would be fully enforceable, this option presents a higher risk of maintenance failure because—this being just an ongoing regulatory requirement—the property owner is not necessarily made conscious or reminded of his obligation. The property owner who initially installs the SMP may become aware of the obligation during the project application and credit certification process, but if the property changes hands, the next owner may not be made aware of it. This option is not recommended (and authors are not aware of any stormwater programs that use this option).

Option 2: Unenforceable Pledge to Maintain SMPs

This option would require credit generators to sign unenforceable pledges to maintain SMPs. This mechanism was used in the recent stormwater retrofit rebate program signed into law in Prince George's County, Maryland. This legislation authorizes the county's Department of Environmental Resources to require residential rebate applicants to sign a pledge to maintain the SMP.[70]

This option is the least burdensome for project generators because it is unenforceable. Residential property owners in particular—who are typically less sophisticated regarding stormwater management technologies—will be more likely to participate in such a program if they are not afraid enforcement action will be taken against them if they fail to maintain their SMP. However, because this option produces elevated project risk for PWD, it is not recommended.

Option 3: Enforceable but Unrecorded Maintenance Agreement

This option would require property owners to sign contractual agreements to maintain SMPs located on their properties. Contracts like these are legally enforceable against those who sign but are not recorded against the title to a property and, therefore, would not be enforceable against future owners if the property is sold.

The agreement could contain a provision requiring the owner to notify PWD in the case of property ownership transfer, so a new agreement could be negotiated with the new owner. If the initial owner failed to notify PWD, he would remain liable for maintenance costs even after the property changed hands.[71] If notification was made but the new owner opted not to maintain the SMP or to allow a third party to maintain it, the credit would be terminated. As extra insurance against SMP failure, the maintenance agreements could be structured such that if a property owner failed to maintain the project, PWD could enter the property, perform the maintenance itself, and then levy and collect a special assessment or fee.

Examples of jurisdictions that use enforceable but unrecorded maintenance agreements in connection with on-site SMPs installed to satisfy a property owner's regulatory obligations for development projects include Suffolk, Virginia, and Mentor, Ohio.[72] This is also the option proposed in Washington, D.C.'s trading program for credit-generating sites. Under that program, retention capacity will be eligible for credit certification if the site owner has submitted an executed maintenance contract or signed a promise to follow a maintenance plan for the period of time during which the certification of credits is requested, in compliance with a District-approved stormwater management plan.[73] If a property owner violates this contractual obligation, it will be subject to a number of potential consequences. The District will not certify additional credits in the future for the unmaintained SMP; and the District will require the owner of the retention capacity to compensate for the capacity that was not maintained during a given time period by (a) forfeiting the corresponding number of credits, (b) purchasing replacement credits that the District will retire, or (c) paying an in-lieu fee to the District.[74]

This option strikes a reasonable balance between enforceability and maximization of participation (as the property's title remains unburdened; see below). This option is our preferred option for off-site credit generators if maintenance agreements contain provisions governing property transfer and right of entry for local government, as described above. In addition, if the credit life spans are indeed three to five years, the commitment on the part of the off-site credit generator is limited, which makes administration and enforcement simpler to manage.

Option 4: Recorded Maintenance Agreements

This option, which is currently used by PWD for properties complying with mandatory stormwater regulations, uses property law mechanisms to place a binding obligation on a property where an SMP is located. Real property law provides a number of ways to require certain actions by property owners; these mechanisms vary from state to state. One of the most common is a covenant, a signed agreement that is recorded against the title of the property and can, therefore, be enforced against subsequent owners

The chief advantage of property law mechanisms, from PWD's perspective, is that they ensure that the SMP will be maintained even if the property is sold. However, property owners are frequently reluctant to burden their properties with these instruments, primarily because they make it more difficult to sell the property.[75] As a result, imposing a requirement to record a maintenance agreement might discourage participation in a voluntary credit trading program. (Since maintenance obligations apply only during the time-limited period for which a credit is certified, however, an easement would not be permanent, but rather linked to the lifetime of the credit. This would reduce the encumbrance placed on a property by the easement; a property owner would be free not to seek renewal of a credit, letting the easement expire along with the credit.)

One city that uses these mechanisms in its off-site programs is Charlotte, North Carolina. In Charlotte, the O&M agreement for an off-site SMP must be recorded against the title at the deed recorder's office so that it is binding against all subsequent purchasers and will appear in the chain of title under generally accepted title-searching principles.[76] Washington, D.C.'s draft stormwater regulations also provide that the *on-site* (regulated) property must file a covenant to maintain the site's SMPs; this covenant includes both the on-site and off-site responsibilities of the regulated site.[77] This means that the regulated property owner is liable for violating its regulatory obligations if the off-site SMP(s) are not properly maintained. The covenant is binding on all subsequent owners and must provide for inspection of and access to the SMP at reasonable times by the District or its representative. Credit-generating sites, on the other hand, are not required to file a covenant, as discussed above.

Because this option may discourage participation in a voluntary program, and because having an obligation that runs with the land may not be critical if credit life span is relatively short, PWD may want to consider adopting a different approach for credit-generating sites.

Option 5: Escrow Accounts

Finally, PWD could require property owners to pay some amount (for example, a percentage of SMP construction cost) into an escrow account that is set aside to fund future maintenance of SMPs for the duration of the credit life span. The property owner would be required to replenish the escrow account as funds were withdrawn. The account would act as a guarantee that funds would be available for necessary maintenance activities. Several municipalities in North Carolina require escrow accounts for all structural SMPs constructed within the jurisdiction.[78]

Under this option, the maintenance could be actually performed by either the property owner or PWD. The latter scenario would be more attractive to property owners, especially those who lack engineering expertise, but it would significantly increase PWD's administrative burden. Under any circumstances, a forced payment into an escrow account would increase the cost of credits to the buyer.

Escrow accounts are not necessarily a separate and distinct option; they can be required in conjunction with any one of the legal mechanisms described earlier in this section. They may discourage participation in voluntary programs, however. If PWD does not opt to require escrow accounts, it might want to require some other financial verification to ensure that an off-site property is equipped financially as well as technically for proper maintenance.

4.15.2 Recommendation

In order to ensure that SMPs are maintained for the duration of the credit period, we recommend the combination of Option 3 (enforceable but unrecorded maintenance agreements) and some financial obligation, either in the form of an escrow account or another type of financial verification.

4.16 INSPECTION AND VERIFICATION OF OFF-SITE SMPS

The credit program will be required to develop a protocol for SMP inspection to ensure adequate performance during the lifetime of the credit. PWD will have to determine whether inspections are to be self-reported, conducted by PWD, or handed by a designated third party.

- The inspection programs will implicate, at a minimum, the following considerations:
- Inventory of type and extent of each SMP/facility;
- Creation of an inspection checklist for each facility, based on the maintenance needs for that particular facility type;
- Recordkeeping protocols;
- Identification of inspection personnel—what training or experience is necessary for a given inspection?
- Frequency of inspection—may vary according to SMP type and volume/flow rate of runoff;
- Reporting protocols—are records kept on-site, or collected and reviewed by a central authority?
- Protocol for addressing violations of inspection requirements or failure to conduct inspections for self-reporting programs, or for addressing failure of project proponent to properly maintain SMPs.

As mentioned above, the final choice of inspection program elements may be influenced by the selection of legal mechanism for SMP maintenance enforcement.

4.17 THEORETICAL SUPPLY AND DEMAND FOR OFF-SITE MITIGATION

The viability of an off-site stormwater mitigation credit program will depend strongly on demonstrating sufficient supply and demand for off-site stormwater mitigation credits. On the demand side, property owners who have seen a dramatic increase in fees due to the switch to parcel-based billing (parking lots, industrial sites, big box retailers, etc.) will seek any way possible to reduce their fee exposure at the lowest cost. However, for many property owners, on-site constraints will preclude the lowest-cost stormwater retrofit options (such as rain gardens). Payback periods for more expensive technologies that work in constrained settings (such as green roofs and subsurface infiltration systems) are often too long—sometimes well in excess of 20 years—to warrant investment. Therefore, assuming SRC purchase prices reflect the lowest-cost option to these property owners, it is likely that the demand for off-site stormwater mitigation credits will be high, and therefore not the limiting factor in establishing a viable off-site stormwater credit market. Of course, this assumption could be undermined if the administrative hurdles of buying and selling credits are too burdensome, or costly, to undertake.

The current stormwater fee for nonresidential customers is approximately $0.10 per square foot of directly connected impervious area (DCIA) per year, with an expected 6 percent increase annually. Using a 10-year payback period, discounted at 8 percent, authors estimate that viable off-site stormwater mitigation credit projects will initially need to have a maximum cost structure of $0.82 per square foot of DCIA.[79] As the SMSC changes over time, the financial viability of retrofit projects will also change. However, if the initial cost to generate off-site stormwater mitigation credits is significantly higher than $0.82 per square foot of DCIA, credit producers are unlikely to find willing buyers and the market will fail to develop. See the break-even analysis of Figure 1.2 for a more detailed look at the financial viability of various SMPs relative to different fee structures.

4.18 THEORETICAL SUPPLY: TYPES OF RETROFITS/INTERVENTIONS

Below is a detailed supply analysis for three potential sources of SRCs: residential properties, redevelopment sites, and retrofits of existing nonresidential development. The analysis was conducted by AKRF, an environmental, planning, and engineering consultancy. For a detailed explanation of methodology, please refer to Appendix V.

4.18.1 Residential Properties

The approximately 364,700 residential parcels located in the Combined Sewer Overflow (CSO) boundary of the Philadelphia account for 43 percent of all impervious area within the 432,900 total parcels within the CSO boundary. Under the current stormwater credit regulations, residential properties are not eligible for stormwater credit. Still, managing the impervious area on these properties could generate salable credit "supply" (i.e., credit that would not be used for on-site fee reduction) for nonresidential property owners who lack financially attractive on-site retrofit options. This type of program could provide a means to extend stormwater credit benefits to residential customers.

It is worth noting that PWD recently implemented a program called Rain Check, which offers certain residential property owners partial reimbursement for installing on-site SMPs. The program is currently in a pilot stage, and the selection of eligible properties is in process. If successful, PWD plans to launch the initiative citywide.[80] How the Rain Check program would relate to an off-site stormwater fee credit program requires further consideration.

To estimate the stormwater credit supply associated with residential property retrofits, a random sample of 20 residential parcels within the CSO boundary was selected for analysis, with the results extrapolated to the full universe residential parcels within the CSO boundary.

Among the 20 sampled properties, the authors estimate that approximately 9 percent of the total impervious area could be treated using downspout disconnection (Figure 4.5). The assumed cost for a downspout disconnect project of up to 500 square feet is approximately $50.[81] The average drainage area size for each sample disconnection was approximately 143 square feet. Scaled to all residential parcels within the CSO boundary, approximately 658 acres of impervious area credit could be generated using downspout disconnection, a total cost of approximately $10,033,952, or $0.35 per square foot impervious area managed.[82] Given the expected 22 percent margin of error, the total impervious area credited is expected to range from 513 acres to 803 acres, and the total runoff volume managed is expected to fall between 1,863,448 and 2,914,624 cubic feet.

Also, the authors estimated that among the 20 sample properties an additional 23 percent of the impervious area could be managed using rain gardens (Figure 4.5). The average drainage area for each sample rain garden was approximately 442 square feet. Scaled to the broader universe of residential parcels within the CSO boundary, authors estimate that approximately 1,682 acres of impervious area credit could be generated using rain gardens, at a total cost of $301,114,132, or approximately $4.11 per square foot. Given our expected 22 percent margin of error, the total impervious area credited is expected to range from 1,312 acres to 2,052 acres, and the total runoff volume managed is expected to fall between 4,762,560 and 7,448,760 cubic feet.

Figure 4.5: Credit Supply for Stormwater Management Practices on Residential Properties

Sample sites		Universe (residential CSO, 1-97% IA)
Total DCIA (sf)	25,607	318,538,170
Downspout Disconnection only		
Total treated DCIA (sf)	2,293	28,668,435
Annual credit:	$231	$2,868,449
% treated:	9.0	9.0
Avg. cost/sf treated	$0.35	$0.35
Total cost	$800	$10,033,952
Rain gardens only		
Total treated DCIA (sf)	5,843	73,263,779
Annual credit:	$583	$7,266,737
% treated:	22.8%	22.8%
Avg cost/sf treated	$4.11	$4.11
Total cost	$24,015	$301,114,132

Given the unit costs derived for this study, on average, most residential rain gardens are unlikely to provide a viable source of stormwater credit for an off-site mitigation program without additional subsidy. In rare cases where the homeowner would be able to design, build, and certify the credit without the use of professional design or construction contractors, the cost associated with rain garden construction could be significantly lower than reported here. In contrast with rain gardens, the average cost of downspout disconnections is likely low enough that tradable off-site stormwater fee credits, if available from PWD, would provide a sufficient return on investment to a property owner. Homeowners could relatively easily retrofit their existing downspouts to discharge to existing pervious areas using household tools and materials available from home improvement stores. Downspout disconnection kits and how-to guidance could be developed to assist residential homeowners in implementing disconnections. An on-line self-registration system could be developed to help homeowners easily obtain credit for their disconnections. Because the annual credit associated with disconnections would be on the order of only $50 (for a 500-square-foot roof area[83]) under current crediting levels, the credit registration process could be a significant barrier to widespread adoption, even if design and construction costs can be kept low. From the PWD perspective, a random system of spot inspections could be useful in ensuring long-term performance while minimizing administrative costs.

It is worth noting that the $50 installation cost assumes the homeowners have installed the measure themselves. However, PWD's requirements for SMP certification (e.g., appropriate gradient and size of pervious area into which the downspout is redirected) may be a cumbersome barrier for most homeowners wishing to receive credit. Engineering costs to ensure compliance can run upwards of $1,500. If the homeowner needs to bear this expense, this measure may be cost-prohibitive. However, there may be several possible ways to overcome this barrier. For instance, a project developer with sufficient engineering expertise could aggregate multiple retrofits into one project, assuming all costs. In this case, the developer would be the owner of the subsequent credits and would presumably pay the homeowner a portion of the proceeds. Alternatively, PWD could embark on an educational program and/or partner with local hardware stores to develop a parts kit, so the homeowner would be equipped with the requisite knowledge and tools to perform downspout disconnections to PWD standards without the help of an engineering firm. The authors do not necessarily endorse a self-installation approach; ultimately, PWD will need to ensure that downspout disconnections are never performed in a way that causes flooding, and that any SMP installation for which it grants credit meets the relevant technical requirements to be counted toward PWD's own greened acre obligations under its consent order.

4.18.2 Redevelopment

Redevelopment projects offer a potential source of off-site stormwater mitigation credits. Redevelopment projects in Philadelphia are subject to a variety of stormwater management requirements. The specific requirements that will apply to a given project depend on a number of factors including 1) whether the project is a redevelopment or new development, 2) whether the project directly drains to the Schuylkill River or Delaware River, and 3) the total earth disturbance associated with the project. However, most projects are required to comply with the water quality requirement, which mandates the on-site management of the first inch of runoff from DCIA using an approved SMP. If developers elect to provide on-site water quality management for more than the first inch of runoff from DCIA, up to 1.5 inches (or another agreed-upon cutoff), or are able to manage runoff from DCIA in the adjacent public right-of-way, the surplus management volume could generate a source of off-site stormwater mitigation credit. However, the availability of this source of off-site stormwater mitigation credit depends on property owners' ability to manage the surplus water volume at a cost low enough to justify their additional investment.

Unlike stand-alone retrofit projects, redevelopment projects offer the potential to absorb some of the one-time costs associated with retrofit construction (e.g., survey, mobilization, and closeout). Therefore, opportunities to cost-effectively manage excess runoff may be found in large redevelopment projects (on sizable industrial properties, for instance) where stormwater runoff can be managed via relatively large vegetated surface practices. For smaller projects (e.g., small commercial office buildings) where the redevelopment design calls for the use of structural stormwater management practices like subsurface infiltration systems to meet water quality requirements, the marginal cost associated with managing more than the first inch of runoff from DCIA may be a cost-effective alternative to vegetated surface practices. Overall, redevelopment projects may offer significant cost-effective off-site SMSC mitigation credits.

The authors estimate that approximately 104 acres of DCIA within the CSO boundary is redeveloped each year. For the present analysis, it was assumed that most redevelopment projects would opt to manage stormwater using subsurface infiltration in order to maximize the property's usable area, and that it would generally be feasible to oversize such subsurface facilities. By oversizing SMPs on these redevelopment properties to capture 1.5 inches of runoff, an annual surplus runoff volume of approximately 189,300 cubic feet could be managed using subsurface infiltration. By managing this surplus volume, redevelopers could generate approximately 52.2 acres of off-site stormwater mitigation credit. The off-site stormwater mitigation credit would provide approximately $227,000 in new stormwater fee credits per year, if the surplus stormwater retention capacity were credited at a 1:1 ratio with the first inch of runoff. (However, as discussed in Section 4.6, PWD should actually establish an offset ratio at a lower value for retention capacity greater than 1 inch; the appropriate ratio is not presently known.)

Based on data from recent redevelopment projects in Philadelphia, the average unit cost was estimated to be $1.13 per square foot of off-site stormwater mitigation credit. At this rate, the total annual cost associated with generating off-site stormwater mitigation credit from redevelopment sites is estimated to be $2,555,550. It should be noted, however, that as of FY14 rates, a $1.13 square foot credit would likely not be sufficient to induce private investment (see Chapter 1). This could change over time as the rate increases or if project costs decline.

4.18.3 Nonresidential Properties—Retrofits of Existing Development

The approximately 68,200 nonresidential parcels subject to the parcel-based stormwater fee located within the CSO boundary account for 57 percent of all impervious area on the 432,900 total parcels within the CSO boundary (approximately 10,400 impervious nonresidential acres of the total 18,200 impervious acres). Because nonresidential customers who invest in on-site retrofits to manage the first inch of runoff would likely apply the credits generated toward reducing their own stormwater charges, we assumed that management of more than 1 inch of on-site runoff would be required to generate off-site credit. In effect, nonresidential customers could oversize their treatment facilities to manage more than 1 inch and thus earn supplemental credit that could then be sold to other nonresidential customers. Alternatively, nonresidential customers could earn supplemental, tradable credits by oversizing their retrofits to manage runoff from the adjacent public right-of-way.

Figure 4.6. Credit Supply and Costs for Off-site Mitigation On Sample Nonresidential Properties

Address	Surplus 0.5" On-site Volume (cf)	Equivalent Credit Area, Surplus 0.5" On-site Volume (sf)	Adjacent Public 1" Volume (cf)	Equivalent Credit Area, Adjacent Public 1" Volume (sf)	Cost to Manage Surplus 0.5" Volume On-site ($)	Cost to Manage Surplus 0.5" Volume On-site ($/sf)	Cost to Manage Adjacent Public 1" Volume ($)	Cost to Manage Adjacent Public 1" Volume ($/sf)
5801 Tabor Ave.	19,000	228,000	N/A	N/A	$153,000	$0.67	N/A	N/A
5801 Tabor Ave.	14,000	168,000	N/A	N/A	$121,000	$0.72	N/A	N/A
2414 Weccacoe Ave.	16,000	192,000	7,600	91,200	$135,000	$0.70	$65,000	$0.71
6901 Elmwood Ave.	26,000	312,000	2,700	32,400	$191,000	$0.61	$21,000	$0.65
5400 Langdon St.	60,000	720,000	1,700	20,400	$356,000	$0.49	$11,000	$0.54

For retrofits of existing development, it was assumed that large sites, using SMPs that rely on vegetated surface practices, would account for virtually all opportunities to manage more than 1 inch of runoff from on-site impervious area, or to manage 1 inch of runoff from the adjacent public right-of-way, at a cost low enough to attract private investment under present circumstances. Applying criteria based on this assumption to identify potential projects, we estimate that stormwater retrofits could manage 147,000 cubic feet of surplus runoff volume (including 0.5 inch of on-site surplus runoff and/or up to 1 inch of runoff from the adjacent public right-of-way). This volume would be sufficient to provide 41 acres off-site stormwater mitigation credit at a unit cost of approximately $26,000 per acre of credit—if the surplus stormwater retention capacity is credited at a 1:1 ratio with the first inch of runoff. (However, as discussed in Section 4.6, PWD should actually establish an offset ratio at a lower value for retention capacity greater than 1 inch.)

This supply is associated with design and construction of five SMPs on four large properties at an average cost of $0.60 per square foot of off-site stormwater mitigation credit (including both on-site surplus runoff and runoff from adjacent right-of-way) (Figure 4.6). These were the only sites identified as viable, using the criteria above. If circumstances change such that higher-cost SMPs produce an attractive return on investment, the potential supply would increase significantly.

4.19 CHAPTER CONCLUSIONS AND RECOMMENDATIONS

Off-site mitigation could play a role in helping PWD meet its stormwater mitigation goals. For some property owners with physically constrained sites, there may be no retrofit options that are financially attractive at present. By allowing such owners to reduce their stormwater fees by investing in off-site project credits, PWD could spur green infrastructure development. However, until more information is gathered on the actual costs of SMPs, it is impossible to accurately estimate the potential market for tradable credits. Additional research on SMPs is necessary to determine a source of supply of off-site projects for which the available stormwater fee credits would provide a sufficient return on investment, and it should be conducted before a decision is made to launch an off-site mitigation credit program. Presented below are a set of recommendations for such research and for the core principles that should be included in a successful, enforceable off-site mitigation program.

- **Conduct further research and analysis to determine more accurately the likely supply of off-site projects.** Determine if the market size is large enough to justify creating an off-site mitigation program.
  - There is significant uncertainty concerning SMP project costs (see Chapter 1). Further research on costs should include a focus on the specific types of projects as potential sources of credit supply.
  - Given current cost projections, downspout disconnection—a retrofit specific to residential properties—is the only retrofit measure with a positive net present value over 10 years at current SMSC rates (see Chapter 1). A key assumption underlying the low cost of downspout disconnections ($0.35/ft^2) is that homeowners could implement them in a do-it-yourself manner, without the need for professional services for project implementation and certification. A research priority should be to determine the minimum level and cost of professional services that may be needed to ensure the proper design and installation of residential projects.
- **Consider granting residential properties off-site credits.** Based on analysis to date, downspout disconnections are the most promising source of low-cost credit supply. In order to unlock the potential supply from these SMP retrofits and to incentivize residential property owners to participate in green infrastructure retrofits, PWD should:

- If the cost of engineering or other professional services referenced in recommendation #1 are reasonable, PWD should develop a program directed to residential properties to help jump-start this market. This program could include education and technical assistance and could be facilitated through local hardware stores, to emphasize the do-it-yourself nature of this SMP.
- Consider assuming the responsibility for providing any necessary technical assistance to homeowners, free of charge. PWD would make its own assessment as to whether this additional cost is worthwhile.
- Combine the potential off-site credit trading program with PWD's new Rain Check program (which provides a direct subsidy to homeowners for retrofits).

- **Utilize a tradable crediting instrument.** Introducing a tradable instrument that can be bought, held, or sold, increases the liquidity of the off-site market, as it would attract more buyers and sellers to the marketplace. Further, a transparent market price for stormwater retention capacity (SRC) based on a tradable instrument would allow property owners to make informed investment decisions.
- **Consider allowing credit generation for less than 1 inch on properties not subject to the SMSC.** Encouraging properties not subject to the parcel fee and credit to mitigate their runoff would add to retrofit incentives currently created by the credit structure. Capturing a full inch of runoff from impervious area on a residential property is clearly of value to PWD. PWD should also consider whether it could quantify the value—in terms of reducing sewage overflows—of managing less than a full inch of runoff from such sites. If PWD can quantify that value relative to projects that manage a full inch of runoff, then it could potentially expand the supply of retrofit projects by awarding credits for projects that manage less than 1 inch of runoff and assigning an appropriate offset ratio.[84] To follow this approach, PWD would need to ensure it has a valid methodology, acceptable to its regulators, according to which these projects could be counted towards PWD's consent order targets.
- **Consider allowing credit generation for mitigation above 1 inch on all properties.** The environmental benefits of mitigating beyond 1 inch may be worthy of inclusion in the credit-trading system. However, PWD should analyze the environmental benefits of managing an additional half-inch or more, and determine whether these benefits are marginal or substantial. PWD would also need to determine whether these credits should be included on a 1:1 basis or discounted.
- **Trading of credits within a citywide trading program should be limited geographically in a way that serves PWD's priorities for stormwater management.** The geographic scope of credit trading should be designed to ensure that PWD priorities, such as reducing the number of CSO events, are well served. This would include, at a minimum, prohibiting trades between CSO and non-CSO areas, or reducing the credit value of such trades.
- **All tradable credits should be certified by PWD, or a designated third party, before they can be redeemed for a discount from a ratepayer's stormwater fee.** To conserve resources, PWD can contract with a third party to perform credit certifications, as long as the third party is required to document all certifications to PWD with enough information for PWD to determine how many greened acres have been achieved. The credit certification process may include a site visit to inspect and verify the SMP(s).
  - Following certification, PWD should ensure that a legal mechanism exists that allows access to a given property for inspection of SMPs. If PWD determines that self-report inspections are sufficient, PWD should penalize failure to self-report. In all cases, PWD must establish criteria and protocols for inspections, reporting, and recordkeeping.
- **Credits should have a defined life span, with limited banking.** A credit life span, possibly equal to the four-year certification period, is needed to reduce the risk of retention failure and to minimize barriers to entering the credit market. Credit purchasers should not be allowed to bank credits beyond the four-year certification period, since fee reductions should not be awarded after the obligation to maintain the underlying SMP has ended. Additional consideration is needed to determine whether it should be permissible to bank credits within the certification period (that is, whether a credit generated by the existence of an SMP in year 1 could be applied to reduce a parcel owner's charge in year 4).
- **Maintenance requirements for off-site SMPs should be defined and enforced.** PWD should view SMP maintenance as a binding obligation that lasts for the duration of the of the credit term so it can reliably count the number of greened acres implemented and track progress toward compliance with its consent order. To enforce this obligation, PWD should require credit generators to sign a binding maintenance agreement. Such agreements should contain provisions governing transfer of the property and right of entry for PWD.

CHAPTER 5: OPPORTUNITIES FOR PAY-FOR-PERFORMANCE STRUCTURES TO ACHIEVE GREENED ACRES

The authors propose that the Philadelphia Water Department consider the use of a pay-for-performance structure to finance, construct, operate, maintain, and monitor projects undertaken to meet its greened acres obligations. The structure would take the form of a public-private partnership (PPP), which at its core is a contractual agreement between a public agency and a private-sector entity that delivers infrastructure projects and services.

Public-private partnerships have been used extensively by governments across the nation and around the world as a means to meet the growing demand for infrastructure construction and maintenance. In an environment of constrained federal and state budgets, PPPs are seen as a way to engage the private sector more deeply in funding infrastructure projects to meet public service needs. PPPs are in theory a means to reduce project costs, accelerate implementation, access new sources of higher risk/reward-seeking capital, and shift risk of performance from the public sector to the private sector.

There is enormous capital capacity to fund infrastructure in the U.S. and beyond. More than $31 billion in 2010 and $17 billion in 2011 was raised for funds targeting infrastructure investments. Some 224 transactions were executed in the most recent full calendar year. PPPs are attractive to investors because they can provide a high level of transparency and generally offer investment premiums in comparison with municipal bonds for similar risks. A PPP arrangement for green infrastructure could allow PWD to leverage private capital to fund an innovative solution to stormwater mitigation, defer its up-front costs, and provide a compelling opportunity to investors, offering good value to the department on a relative basis.

5.1. THE GLOBAL AND U.S. PUBLIC-PRIVATE-PARTNERSHIP INFRASTRUCTURE MARKETS

PPP structures vary significantly from sector to sector and from country to country, depending on the nature of the infrastructure projects in question and differences in the respective legislative frameworks that govern the contracting processes. While some PPPs engage private-sector partners to implement individual operations such as design, paving, or metering, others involve the private ownership and operation of infrastructure facilities providing services to municipalities and states that are subject to specific regulatory standards and constraints.

PPPs are used as a means of achieving the optimal distribution of risks and value between the public and private sector.[85] PPPs have the potential to deliver an array of benefits to public agencies, including lower construction and maintenance costs for infrastructure projects, access to new sources of funding, and shifting of performance risk away from taxpayers and toward private investors and companies.

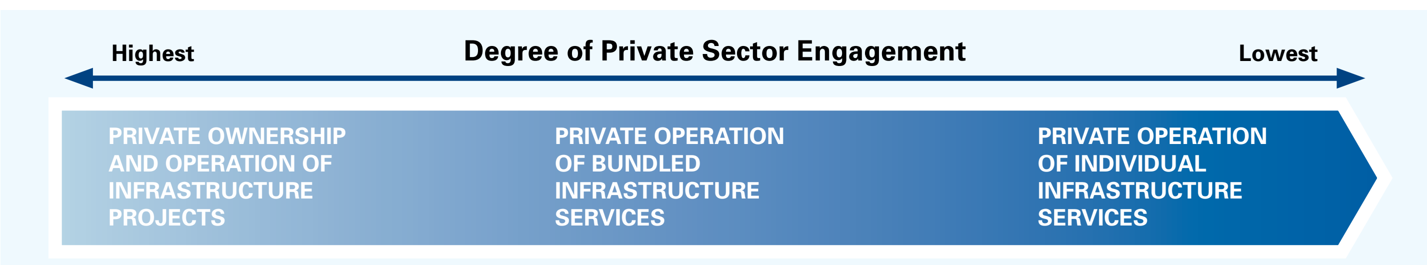
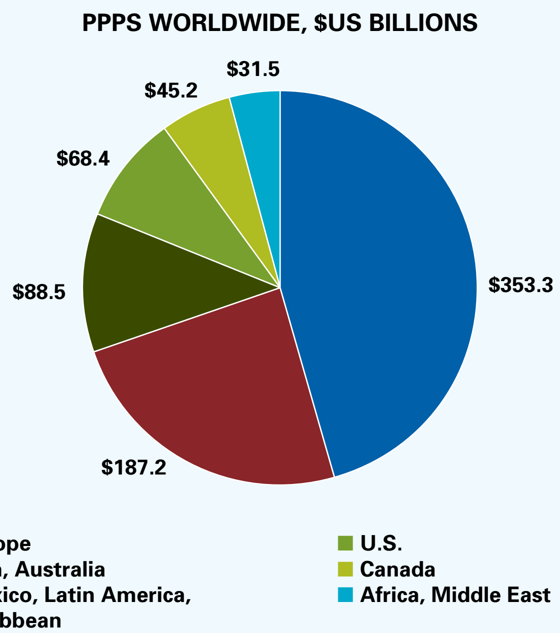


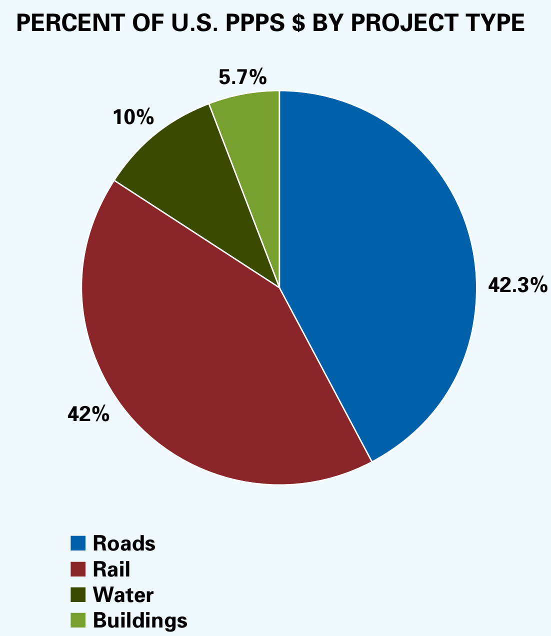
Figure 5.1: Benefits of PPPs

Potential Benefit	Description
Lower Construction and Maintenance Costs	Private-sector entities may be able to deliver lower-cost projects through more efficient implementation and operation. Where projects are constructed and maintained by the same private-sector entity, there is greater incentive at the point of construction to take steps to lower future operations and maintenance costs. Efficiencies may also be gained through economies of scale by contracting for multiple projects and services bound together in a single procurement at a single point in time, rather than individual procurements over time.
Access to New Sources of Funding	PPPs can be financed using off-balance-sheet funding mechanisms that can reduce the impacts on a public agency's balance sheet, depending on the type of liabilities embedded in the PPP contract. In addition, PPPs' higher financing risk has a ready demand from investors willing to absorb the risk in exchange for investment premiums relative to typical municipal bond spreads.
Shifting of Performance Risk to Private Investors and Companies	PPP contracts can be structured with a range of features to reduce risks to the public agency involved, including caps on payment for construction, payment only upon completion of projects according to specifications and time lines, payments over time only upon ongoing performance, and compliance of the project with specific standards and other metrics.

Figure 5.2: Utilization of PPPs Worldwide and in U.S.



Source: Public Works Financing 2011.



Source: Works Financing Int'l Major Projects Database 2010.

The U.S. has been slower than Europe and Asia to pursue PPPs. Between 1985 and 2011, there were 377 PPP infrastructure projects funded in the U.S, or 9 percent of total PPP projects worldwide. Europe leads the infrastructure PPP market, with 45 percent of nominal value of all PPPs,[86] and increased PPP funding sixfold between 1990 and 2005/6.[87] More complex versions of PPPs in which the private-sector partner designs, builds, finances, operates, and maintains the project accounted for 12 percent of the projects implemented in the U.S. and 24 percent of contracted dollars. Seven of the 12 complex PPP projects were implemented between 2008 and 2010.[88] PPPs globally have been utilized for projects in defense, environmental protection, government buildings, hospitals, information technology, municipal services, prisons, recreation, schools, solid waste, transport, tourism, and water. PPPs have been implemented in the U.S. across an array of project types, most significantly in the transportation sector.

While some public agencies or municipalities, such as Philadelphia, are able to implement PPP structures without enabling legislation at the state level, high-quality PPP legislation can mitigate many of the challenges of PPP execution. Twenty-two states have PPP legislation to allow eligible public authorities to engage with the private sector on infrastructure projects. Fifteen states provide PPP authority for lower-level public entities.[89] Key features of enabling legislation include:

- Permission for unsolicited proposals;
- Combination of government funds with private funds;
- Wider array of procurements allowed for project delivery;
- Long-term franchisee leases or concessions;
- Ability for public-sector agency to hire its own technical consultants; and
- Public-sector outsourcing for O&M and other asset management duties.

To date, no PPP has been implemented with a focus on green infrastructure. While PPPs have not been used extensively for water-related infrastructure more broadly, it may be helpful to provide an overview of two PPPs utilized for CSO-related gray infrastructure, in Indianapolis in 2008 and in Holyoke, Massachusetts, in 2010. The figure below provides context for the terms of those PPPs as a benchmark for designing a PPP structure to fund and manage green stormwater infrastructure in Philadelphia.

PWD or its advisers could contact municipal authorities utilizing PPPs for water-related infrastructure to explore best practices with respect to contract terms and performance standards, and to identify potential process pitfalls.

Figure 5.3: Existing Transportation PPP Authority by State

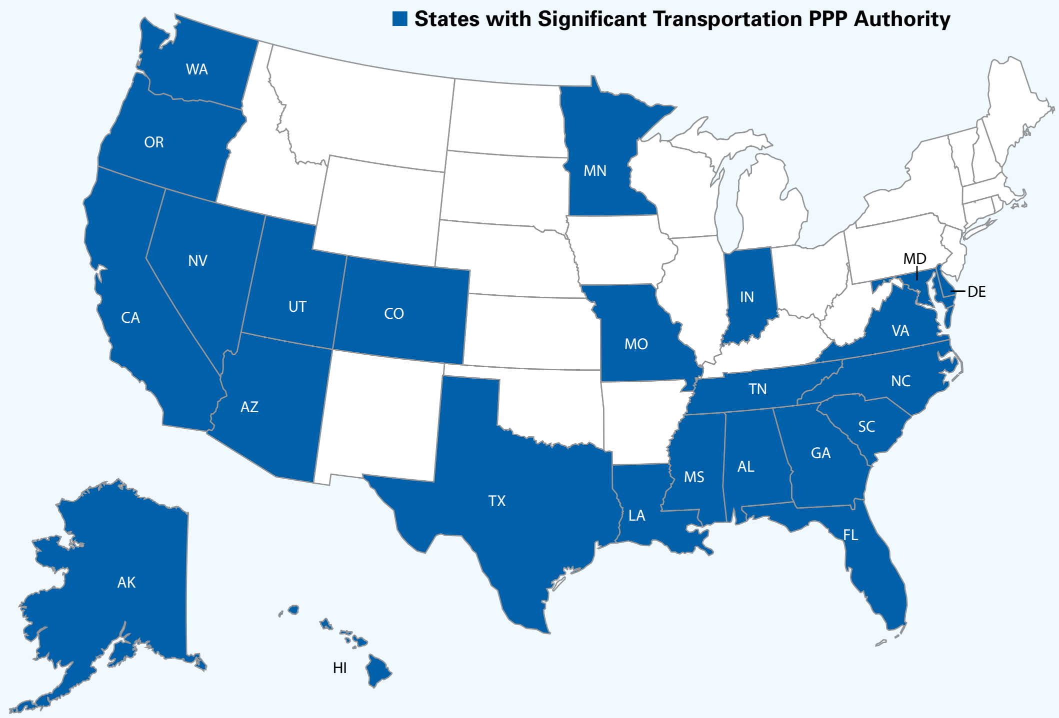


Figure 5.4: PPP Case Studies[90]

Key Features	Holyoke, MA	Indianapolis, IN
Public-Sector Partner	City of Holyoke, MA	City of Indianapolis, IN
Private-Sector Partner	United Water	United Water
Project Summary	Under an EPA consent order, Holyoke was required to reduce untreated overflows into the Connecticut River. Holyoke issued an RFP for a company to design and build a CSO facility and upgrade others for 20 years.	Extension of contract executed in 1994 for operation, maintenance, and long-term planning for city's water and wastewater treatment systems.
Implementation Environment	MA general laws provide a framework conducive to implementing public-private partnerships.	Indiana state statute allows public entities to contract with private entities for the development, financing, and operation of projects through PPP entities.
Benefits	$10 million in cost savings (relative to projected public management costs). Completed 1 year ahead of schedule.	PPP is believed to have saved Indianapolis $189 million in first 15 years of contract term (relative to public management costs).
Contract Provisions	20-year contract for design, construction, and operation of 103-million-gallon-per-day wastewater treatment facility and for upgrading and operating the current wastewater infrastructure.	10 year-contract extension; fixed payment plus CPI adjustment factor.
Implementation Metrics	92 percent reduction in untreated discharges.	Unknown at time of publication.

5.2. PHILADELPHIA'S EXPERIENCE WITH PPPs

Pennsylvania has not historically had PPP-enabling legislation in place. In 2008, then-Governor Ed Rendell failed in a controversial attempt to pass legislation enabling a PPP structure to be used to lease the Pennsylvania Turnpike. However, in June 2012, Pennsylvania lawmakers approved a public-private partnership measure to give state and local governments more flexibility in using firms to design, build, finance, and manage roads throughout the state. Projects must be approved by a seven-member state panel, and a 20-day period is provided in which the legislature can in turn overrule a project. Though the measure is limited to road infrastructure, its passage may set an important precedent and holds promise for the use of PPPs with other types of public infrastructure.

Figure 5.5: Example PPPs in Philadelphia

	Biogas Cogeneration Facility	**Biosolids Recycling Center**	**Automatic Metering Reading Services Contract**
Public Counterparty	Philadelphia Municipal Authority (PMA)	Philadelphia Municipal Authority (PMA)	Philadelphia Municipal Authority (PMA)
Private Partner(s)	Ameresco for design and construction of a cogeneration facility; Bal Green Biogas, which finances and owns the facility and leases the use of the facility to PWD/PMA	Philadelphia Biosolids Services, LLC, a joint venture of Synagro Technologies, McKissock & McKissock, and Len Parker and Associates	Itron, Inc.
Date of Contract	2011	2006-2007	1997
Total Term	16 years commencing after completion of construction	Interim period with maximum of 5 years, plus a Class-A period with a 20-year term, with one 5-year renewal option	18 years with two 1-year extension options
Scope	Develop and operate $35 million facility to cogenerate electricity and heat using biogas from the city's Water Pollution Control Plant.	Design, finance, build, own, operate, and maintain certain new facilities for the processing of the city's biosolids (solid waste removed from sewage during treatment)	Deliver and install ERT meters and maintain them over time; collect and deliver meter data to PWD
Ownership of Assets	Private partner owns and leases the facility to the city	PWD and PMA retain ownership of the existing BRC facility and the new facilities site with a buy-out option on the other assets; private partner owns improvements to existing BRC facility and the new facilities	Upon installation, PMA becomes owner of all meter equipment and has the right to purchase any additional equipment upon termination of contract with Itron.
Terms of Compensation	• Lease payments commence upon completion of construction and receipt of certifications • Lease payment consists of a basic rent subject to various adjustments including preservation of a net return to the lessor that provides for basic rent increases to cover certain cost escalations	Payments for service as follows: • Service fee in FY 2007 of approximately $20 million • Subsequent years adjusted by CPI and a transportation cost index • Class-A period with estimated fee of $19 million plus $5 million in energy costs	• Fixed payments made upon completion of installations with incentives for timely performance; fixed payments per month according to data delivery completion
Potential Penalties for Performance Failures	• Penalties of 10K/day and a $2 million flat fee for late completion of construction • Penalties of liquidated damages on a $300–$600 per kW-e and BTU/kW-e basis	• No payment required in the event the private partner fails to perform • PWD/PMA can earn nonperformance credits for performance that does not hit specified targets	• Financial penalties for failure to meet performance standards; ban from future contract awards; contract termination paired with default payments to PMA
PPP Financing	Unknown at time of publication	• $65 million to fund new facilities construction financed through the PA Economic Development Financing Agency	• RFP for the project contemplated use of PWD's tax-exempt financing status

Even without enabling PPP legislation in place in the past, as illustrated in Figure 5.5, PWD has implemented three such structures since 1995 that are widely thought to be successful projects. Most recently, in 2011, PWD awarded a contract to finance, install, maintain, and own a new $35 million 5.6 MW cogeneration plant. The plant will be powered by biogas derived from waste sludge at the city's wastewater treatment facility. When completed, the biogas plant is expected to provide virtually all of the electricity and heat needed to operate the wastewater facility. It is expected to save the city $4 million in energy expenses and provide some 250 jobs to local residents.

Previously, PWD and the Philadelphia Municipal Authority (PMA) executed contracts with a consortium of private partners to design, finance, build, own, operate, and maintain new facilities for processing the city's biosolids and to operate the city's existing Biosolids Recycling Center.[91] PWD utilized the PPP structure in this case because it did not believe it could provide biosolids services in as efficient a manner as could be done through the PPP contract. The PPP contract is estimated to have saved the city approximately $5 million per year (20 percent of its projected operating costs absent the partnership), placed the risk of performance on PWD's/PMA's subcontractors, and helped conserve PWD capital funds for other needed infrastructure improvements.

In 1997, PWD executed an 18-year contract with Itron, Inc., to collect and deliver water-metering data from more than 450,000 households, which required the installation of water meters and data management systems. The contract reflects PWD's belief that the utilization of a third party to manage a large portfolio of metering assets offered an array of benefits to the city.

These three examples can be seen as constructive and successful precedents demonstrating the basic viability of the PPP structure in PWD's experience across an array of infrastructure types, including the use of long-term contracts and performance-based compensation.

5.3 A GREEN STORMWATER INFRASTRUCTURE PPP

5.3.1 Concept Overview

The authors propose that PWD consider use of a PPP structure to finance, design, build, operate, maintain, and monitor compliance for a portfolio of greened acres to assist PWD in meeting its requirements under the EPA-mandated consent order. While the PPP structure has been used extensively internationally and domestically for traditional gray infrastructure, the use of a public-private partnership for green stormwater infrastructure would be groundbreaking, yet it would borrow from related precedents and thereby lower execution risk. The form of PPP most relevant for the purposes of funding green stormwater mitigation in Philadelphia and other municipalities is the so-called availability payment model, whereby a government entity contracts to make a regular, periodic payment to a private-sector entity that delivers and manages greened acres. An availability payment framework is often used for infrastructure where the private partner is not generating revenues directly from consumer usage of the infrastructure; simply stated, such a framework would require PWD to make a quarterly or other regular payment for use of the infrastructure in question. The payment can be subject to performance standards that would allow PWD to reduce its payment amount or eliminate payments altogether in the event that performance is inadequate. PWD would stipulate the performance standards in its request for proposals (RFPs) and contract terms.

Figure 5.6: Sample Elements of a PPP Agreement

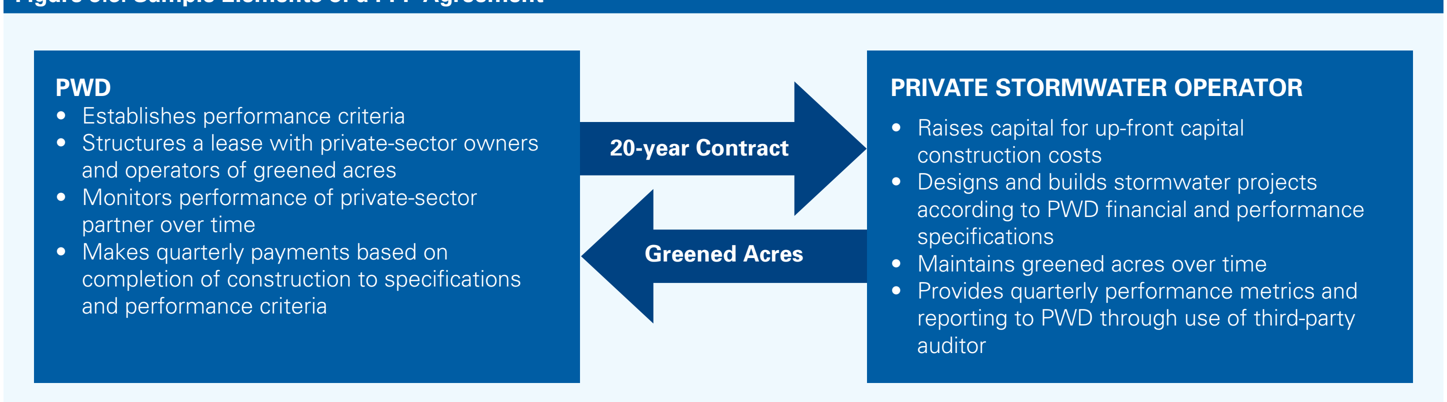


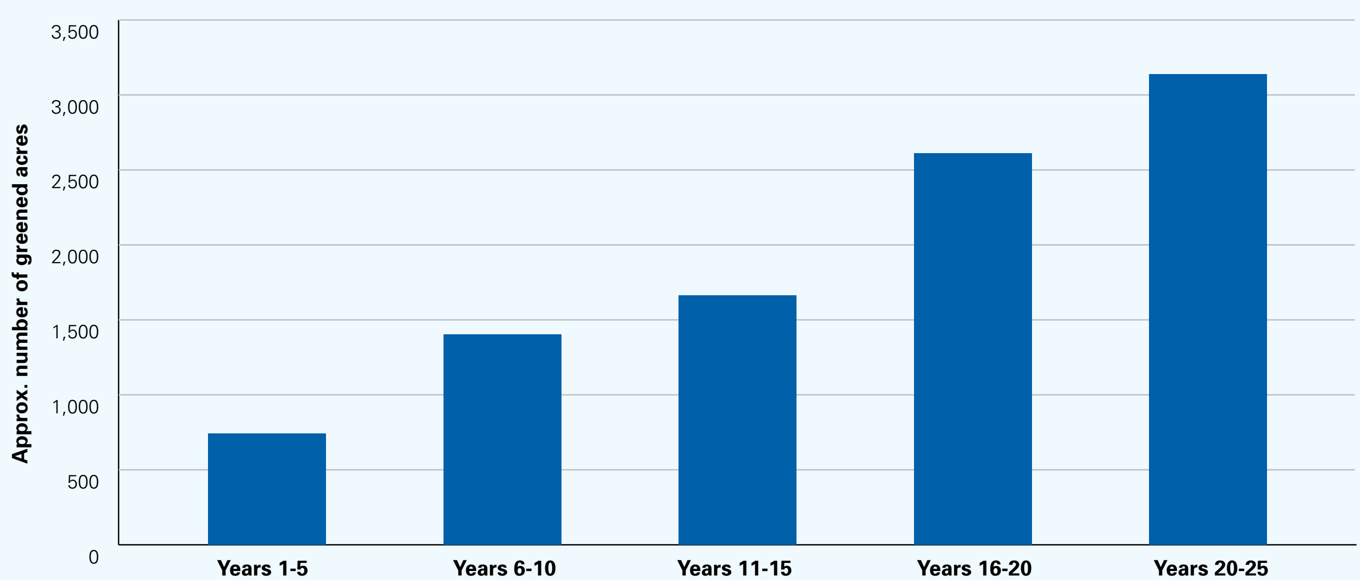
Figure 5.7 below highlights sample PPP terms:

Figure 5.7: Sample PPP Contract Terms	
Public-Sector Partner	Philadelphia Water Department/Philadelphia Municipal Authority
Number of Greened Acres Targeted	300–400 greened acres in a single portfolio
Annual Payment Amounts	Predetermined payment schedule with built in CPI inflators Bonus payments based on quality of performance, timeliness of delivery, etc. Premised on maximum construction cost per greened acre Maximum initial annual payment of ___________ Maximum annual cost escalation of ___________
Contract Term	Master contract: 20 years plus two 5-year extensions Underlying property-access contracts: 10 years with renewal options requiring renewal 2 years in advance of end of contract term
Performance Metrics	Construction design completed and audited to specifications set forth by PWD in the PPP contract Annual or biannual SMP auditing based on specific performance risks associated with the SMP type
Termination Provisions	In the event that the private-sector partner fails to meet its obligations under the contract, PWD may not terminate the contract itself, but may substitute the private partner engaged to provide the services set forth in the contract and assign ownership of any equipment deployed for use with the greened acres. (Such terms protect the financial sponsors of the project.)
Other Issues	Contract must not in any way impair PWD's credit rating or negatively impact its debt ceiling

5.3.2 Benefits and Risks for PWD

PWD has allocated at least $1.67 billion[92] on an inflation-adjusted basis, over a 25-year period, to green at least 9,564 acres across the city, pursuant to a consent order with the Pennsylvania Department of Environmental Protection. PWD's compliance strategy relies on achieving the required number of greened acres through a combination of direct investment in capital projects and the application of local regulatory requirements to redevelopment projects, which require such projects to retain runoff on-site. In a bond offering last year, PWD projected that redevelopment projects would yield 3,000 greened acres over 25 years.[93] This suggests PWD is planning for its $1.67 billion budget to cover the remaining 6,564 acres—an estimated $250,000 of funding per greened acre on an undiscounted basis. PWD expects to finance its greened acre program primarily through debt issuance. Although PWD has not published a long-term budget for absorption of the allocated capital over time, the PWD Consent Order and Agreement sets forth the required number of greened acres in five-year increments over the 25 year period, as indicated in Figure 5.8 below:

Figure 5.8: PWD's Greened Acre Requirements



The authors believe that the PPP structure may offer a compelling alternative to PWD's current greened acre plans, with clear benefits to PWD in meeting its clean water obligations. Potential benefits are discussed in the three sections that follow.

5.3.2.1 Lower-Cost Construction and Operations

The authors understand that PWD is currently delivering greened acres with an estimated up-front cost of $250,000 per greened acre, primarily implemented in the public right-of-way, and that PWD expects the cost of greened acres to diminish over time. If PWD were to undertake a PPP to deliver a greened acre portfolio, it might consider establishing a maximum acceptable construction cost per greened acre in any RFP it would issue for a PPP structure. The maximum acceptable construction cost per acre would set a cost ceiling on acceptable acres in a given portfolio, and would be set with the objective of reducing construction costs relative to PWD's expectations of what it could implement on its own.

It has not been within the scope of this study to complete the technical survey that would be necessary to determine the viability of a private sector party's ability to deliver greened acres at a lower cost than what PWD could achieve on its own. Nevertheless, there are reasons to expect that a lower-cost portfolio could be delivered:

- A private partner contracted by PWD can focus on technical designs and property types where it has a competitive advantage and thus deliver greened acres in a cost-effective manner.
- A single partner engaged for the full range of design, construction, and maintenance of greened acres can construct a portfolio so that it delivers the lowest cost over its lifetime, as conflicts between design and maintenance decisions can be optimized and rationalized (as opposed to a design or practice implemented by one party and then maintained by another, where inherent inefficiencies will be embedded in the cost structure).
- An up-front commitment to a partner able to deliver a sizable portfolio of greened acres will enable the partner to achieve economies of scale in the sequencing and organizing of its work, economies not available to greened acres implemented in small increments over the 25-year period currently contemplated under the consent order and agreement.
- A private-sector partner may be able to deploy green infrastructure in a cost-effective manner on property types that PWD would not otherwise have access to, or have access to at reasonable cost.

In order to determine whether a PPP can offer more cost-efficient greened acres to PWD, the authors recommend that a "value for money" analysis be completed whereby the total up-front and ongoing costs of a publicly managed portfolio of greened acres on both public and private properties is compared with the total up-front and ongoing costs of a privately managed portfolio of greened acres. If this analysis suggests clear cost savings in some areas but not in others, PWD can decide not to pursue the PPP, or it can set forth the scope of services to be delivered by the private partner accordingly. For example, if PWD determines that operations and maintenance for a project can be handled most cost-effectively by the department itself, it can engage the private partner to focus only on the design, construction, and financing aspects of a greened acres program.

The consulting firm AKRF was engaged to provide an estimate of costs and the potential supply of greened acres on residential and commercial properties. Notwithstanding the limitations of the cost curve analysis described in Chapter 1, the cost curve suggests that there are numerous opportunities to green acres for less than the $250,000 per acre that PWD is currently estimated to be spending to green acres.[94] As indicated in Chapter 1, the cost curve should not be read as indicting the total supply available, given that simple summing of the AKRF analysis double-counts properties where multiple types of SMPs could be implemented, but rather as an estimate of the total number of SMPs possible within each SMP category type. The figures below summarize the estimated number of potential greened acres and capital requirements for each category of SMP.

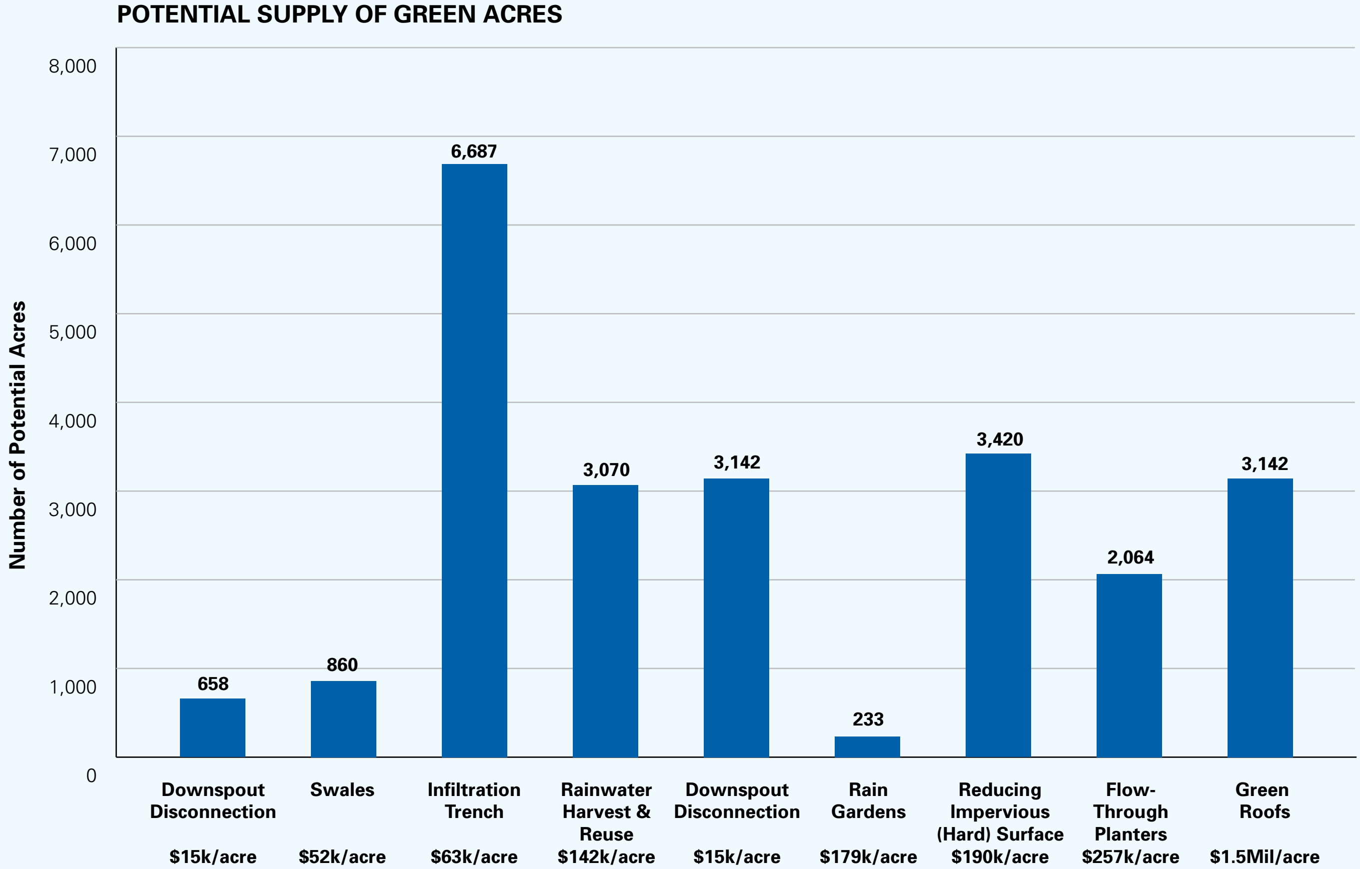
A PPP could be structured to invite private partners to submit proposals to green acres on any combination of residential, commercial, and public properties such as schools and hospitals. Utilizing a PPP structure to deliver downspout disconnections might prove challenging, as it assumes implementation of the SMP on over 360,000 residential properties. Significant work would need to be undertaken to evaluate the cost of administering a downspout disconnection program over such a large portfolio of properties. PWD in that case might be better off utilizing a strategy such as the one implemented by the city of Portland, Oregon, which distributed downspout disconnection kits free of charge to residents to self-install in a program that was oversubscribed and deemed highly successful.

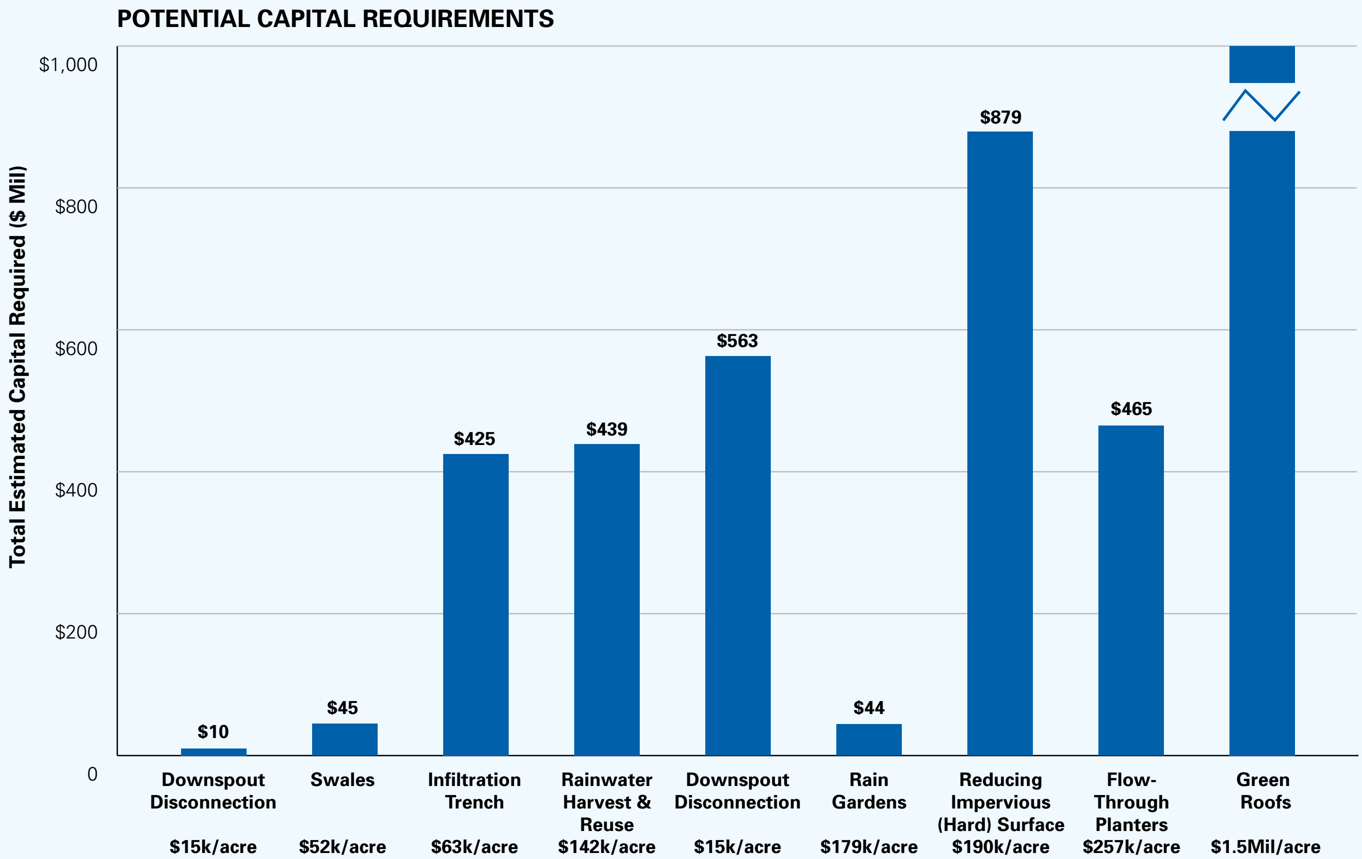
A PPP structure might be better suited to engage a private partner to deliver a portfolio of greened acres utilizing swales, porous pavement, rainwater harvest and reuse, and rain garden SMPs. Alternatively, PWD could design the PPP to engage a private partner to focus specifically on a property type such as schools, parking facilities, university campuses, or vacant lots. The scope of projects targeted by PWD in a PPP structure should, in any case, offer opportunities for private partners to deliver acres in the most cost-effective manner possible.

5.3.2.2 Access to New Sources of Funding

Because PPP financings tend to price higher than government issued bonds, given their off-balance-sheet structure, they have the ability to attract a different class of investors. For example, many large private-equity infrastructure funds have return hurdles in the range of 10 to 12 percent or higher on a leveraged basis. PWD's tax-exempt bonds trade in the 4 percent range. A PPP capital structure that offers higher-risk and higher-reward opportunities for equity investors can dramatically increase the capital

Figure 5.9: Estimated Potential Supply of Greened Acres and Capital Requirements by SMP





available for funding greened acres construction and operations.

The private partner contracted to finance and deliver greened acres to PWD can consider a variety of capital structures that incorporate nontraditional sources of funding, including philanthropic capital, impact-oriented capital held by those interested in achieving environmental objectives alongside financial ones, and traditional institutional capital sources. Use of creative financing structures could blunt the likely premium required to complete the financing and thereby enable PWD to benefit from the other features of the structure. See Section 5.5, below, for a discussion of investor feedback and factors affecting required returns.

5.3.2.3 Shifting of Performance Risk to Private Companies and Investors

Use of a PPP structure gives PWD the opportunity to shift both performance risk and cost management risk to a private-sector partner. Cost management risk is mitigated for PWD in a PPP structure because payments to the private partner would be dependent on achievement of established performance goals. Should the partner fail to achieve the performance goals, PWD would not be obligated to make payment. As a result, the financial risk associated with the PPP strategy is minimal. However, the performance risk cannot be shifted entirely to the private partner.

Unlike other infrastructure expenditures such as transportation projects, PWD will in any case be required to comply with its obligations under the EPA consent order and its Long Term Control Plan. Should PWD rely on a private partner to fulfill a portion of the required number of greened acres and that private partner should fail to perform, PWD will need to identify alternative means of compliance at a potentially higher cost and with insufficient time to enable substitution of acres to take place. Therefore, PWD will need to pinpoint the key drivers of performance risk and manage them accordingly. Figure 5.10 below maps out the life cycle of project implementation and can be used to analyze the specific risk drivers that could impair delivery and performance of a PPP greened acre portfolio. We have grouped those risks in three categories including the pre-construction risk, the construction risk, and the operations and maintenance risks.

Given the heightened sensitivity PWD will have to performance risk, it is important to manage the risks present throughout the life cycle of project implementation. PWD is experienced in assessing and managing construction and operations and maintenance risks, but preconstruction risks could be impactful. In particular, private partners may be unable to provide appropriate performance guarantees to PWD on delivery of greened acres because they may be unable to secure access rights to some properties for project implementation. However, PWD should not engage a private partner without receiving guarantees on delivery of greened acres over the term of a contract that relies on property access.

This risk may be mitigated through the use of a two-stage selection process in which PWD offers a contingent contract to a private partner, subject to that partner's securing access to properties in a limited time period. For example, private partners could be invited to submit a preliminary proposal that would identify a specific portfolio of greened acres for delivery. PWD could provide the "winner" with a modest budget and a six-month time frame in which to secure access rights to the properties included in the stage-one proposal. At the point of selection of the winner of the first stage, PWD could enter into a contingent contract where the final contract execution is subject to certification of the portfolio assembled by the private partner against specific performance standards during the six-month period. In the event the partner cannot assemble the access rights to the properties, PWD's contingent commitment would expire at low cost to PWD and with time for the department to implement its own program or identify an alternative partner. In such an arrangement, the private partner can better justify its time investment and opportunity cost of use of resources to solidify the availability of greened acres, while PWD reduces its exposure to the key preconstruction risk in the life cycle of the project.

Figure 5.10: Lifecycle of PPP Project Implementation

PRECONSTRUCTION

1. Identify specific acres to include in portfolio, including properties and likely SMPs
2. Assemble portfolio by securing access rights to properties for project implementation
3. Conduct all design work to refine precise costs and funding required
4. Raise capital

CONSTRUCTION

1. Prep property sites
2. Construct projects

OPERATIONS AND MAINTENANCE

1. Conduct ongoing maintenance activities
2. Periodically evaluate technical performance of project
3. Provide ongoing reporting to PWD
4. Implement necessary capex improvements over time

PWD can mitigate the other, more typical risks in a PPP structure by including in the contract termination provisions such that nonperformance would be addressed by financial guarantees. These would provide capital to PWD to redeploy on alternative projects directly, or allow PWD to substitute the existing partner with a new one, to which any property access rights could be assigned.

5.3.3 Procurement Process

The implementation of a PPP structure usually involves three stages, including project appraisal and structuring, contract design, and contract management, as described in the figure below. In particular, PWD can first identify an appropriate cost benchmark and then to establish whether it is possible to deliver a cost-effective portfolio of greened acres, set forth in a value -for-money analysis comparing the costs and benefits of the public versus private-sector options. If the analysis is promising, PWD can consider designing a scope of work and draft contract to issue as part of an RFP process soliciting competitive bids for delivery of a greened acres portfolio.

Use of a PPP structure would likely require PWD to utilize the Philadelphia Municipal Authority, a special-purpose procurement entity that is permitted to engage in long-term contracts. Use of the PMA requires approval by the Philadelphia City Council. The diagram below sets forth the contract structure that PWD could use to engage a private partner.

Given PWD's success with the prior PPPs implemented since 1995, the authors are optimistic that the City Council would support a green stormwater PPP. Opposition to PPP structures in the U.S. more generally has centered on several key issues. First, in an effort to achieve cost savings, some private partners develop financial models that intend to use nonunion labor for the construction and operation of the project. Where union jobs are at stake, union opposition can form. Second, some constituents are suspicious of private-sector partners more broadly and consider the use of PPP structures as a privatization of public assets for private-sector profit at the expense of taxpayers. For example, numerous toll road PPPs have been opposed due to private-partner plans to significantly increase toll rates over time, earning profits by passing on higher costs to citizens, which can act like a regressive taxation program. In the case of a green stormwater PPP, these concerns are not particularly relevant. To ensure that union jobs are not lost in the construction and maintenance of greened acres, PWD could require that union labor be used through the contracting process. As for the rate increase issue, this structure does not presume direct ratepayer compensation to the private partner, and PWD could in theory set in place a fixed payment schedule in advance, with agreed-upon escalations to compensate for inflation, and so on. The authors are optimistic that typical risks related to PPP procurement are minimal or easily mitigated through contract design.

Figure 5.11: Stages of a PPP Procurement Process

APPRAISAL AND STRUCTURING

- Establish appraisal criteria including feasibility and economic viability of the project, commercial viability of the project, value for money of the PPP, and fiscal resposibility
- Identify, assess, prioritize, and allocate the risks of the PPP among the various entities expected to be part of the structure

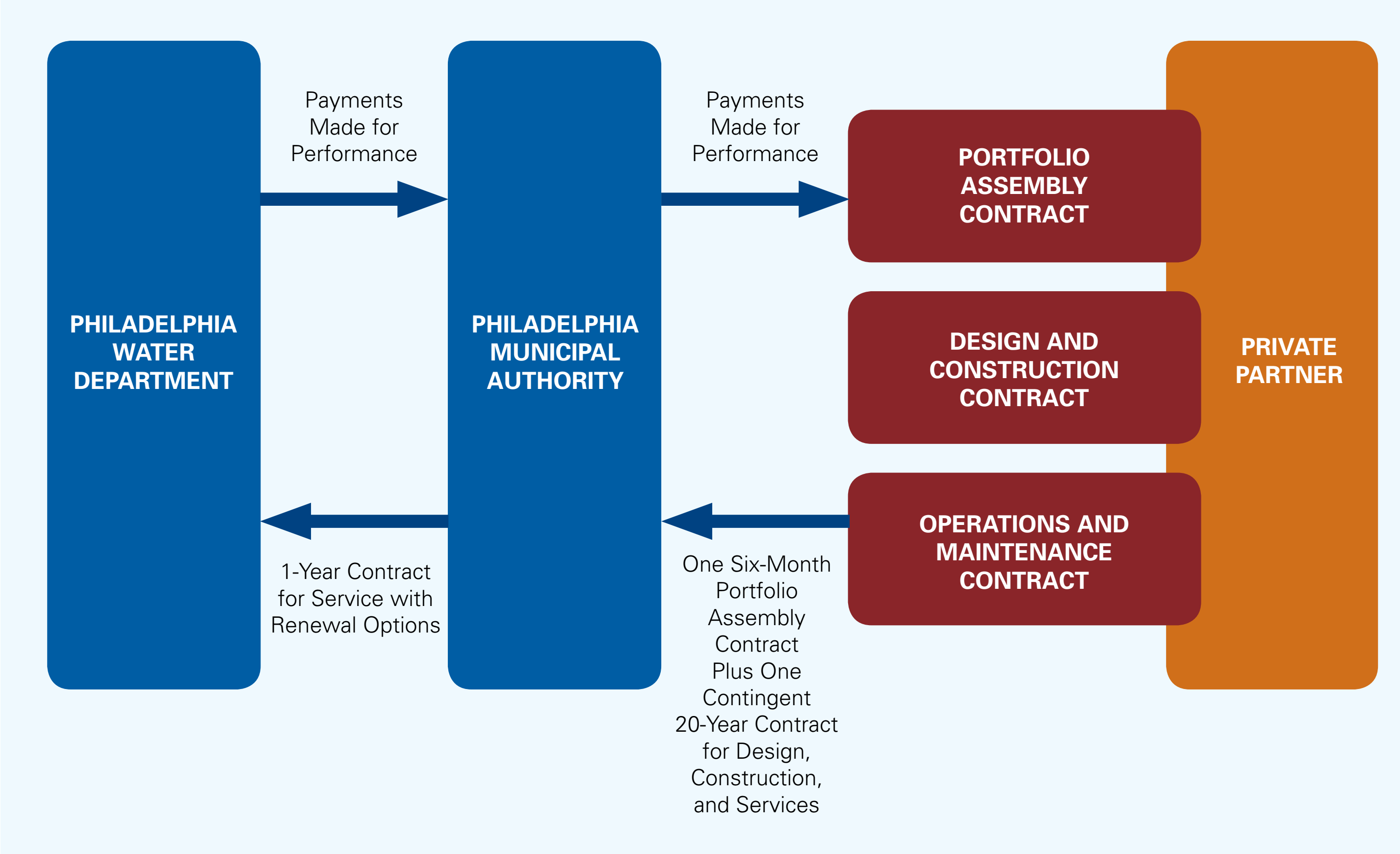
CONTRACT DESIGN

- Set performance requirements
- Establish payment mechanisms including bonuses and penalties
- Establish payment adjustment mechanisms
- Set forth termination provisions
- Determine dispute resolution mechanisms

CONTRACT MANAGEMENT

- Manage the PPP transaction including procurement strategy, marketing, RFP, and bid process
- Establish the contract management structures including monitoring over time

Figure 5.12: Sample PPP Contract



5.3.4 Ownership and Control of Greened Acre Assets

PWD is accustomed to owning the pipes and treatment plants that it operates to provide services in Philadelphia. It is not clear, however, how PWD currently intends to "own" greened acres across the city. Where implementing greened acres in the public right-of-way, PWD would effectively own the greened acre in such a way as to assure its ability to control that parcel over time in meeting its compliance requirements. However, relinquishing the need to own greened acres more broadly could open the door to more cost-effective delivery. For example, a private partner may identify a portfolio of potential greened acres that can be implemented at low cost on residential properties. Its business model could involve making a form of lease payment to the homeowner for use of the property to install a rain barrel or downspout system, but it could obviously not contemplate ownership of that greened acre site in a traditional sense. The authors recommend that PWD consider permitting such flexibility in order to generate the most cost-effective options possible. It may be possible to mitigate control and compliance risk by effectively over-greening (e.g., greening 1.2 acres for every acre of compliance required), which could still be more cost effective than greening only those sites that can be publicly controlled in the strictest sense and at higher cost.

5.4 A PRIVATE PARTNER BUSINESS MODEL

Potential bidders for a PPP focused on green stormwater infrastructure fall into three main categories: traditional engineering and design firms, firms specializing in water-related infrastructure, and firms further specializing in stormwater practice design and implementation. Numerous other players would likely submit qualifying bids for consideration as well. Though the authors have not engaged in dialogue with firms specializing in water-related infrastructure, such as United Water and Veolia, to gauge interest in a greened acre program, both are active in PPPs for traditional water infrastructure. Smaller firms specializing in stormwater practice implementation could also be invited to bid.

Private partners wishing to make proposals in response to a PPP RFP issued by PWD would need to develop a business model that a) delivers and maintains a portfolio of lower-cost greened acre projects; and b) finances that portfolio in such a way as to minimize the costs and avoid impacting PWD's credit rating and debt ceiling. Further research and development are required to assess whether firms can achieve either of those objectives, although a private partner should be able to capitalize itself in such a way as to offer a compelling financing cost as a component of the all-in payment schedule it could offer PWD based on the PPP financing markets more generally (see Section 5.5 for a discussion of financing premiums).

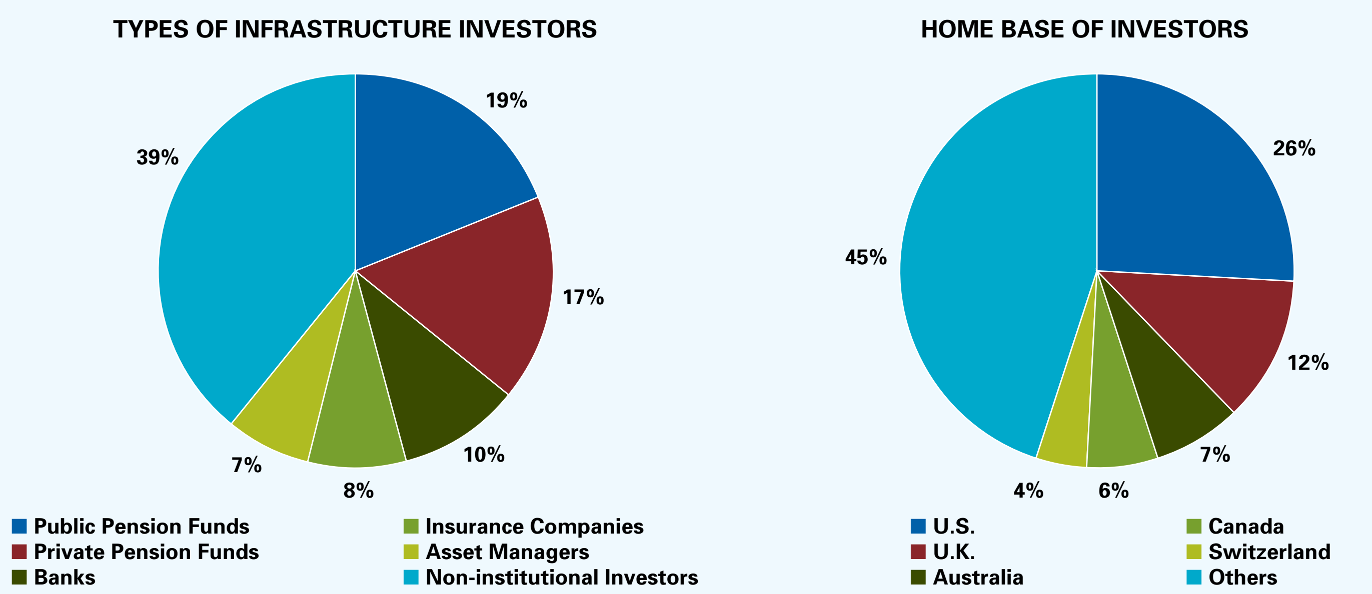
Assuming the PPP aims to deliver approximately 400 greened acres as described in Figure 5.7 above, with a cost range of $75,000 to $150,000 per greened acre, the capitalization required could range from $30 million to $60 million for design and construction plus an incremental amount of additional capital to fund initiation of operations. A private partner could consider a capital structure with a minimum of 60 percent debt financing. PPP structures tend to achieve higher levels of leverage in the range of 75 to 85 percent. Equity investors would in turn fund some 15 to 30 percent of capital required. Partners in a first-time green infrastructure PPP structure might also contemplate raising grant capital that could help mitigate performance risks associated with untested deployment of green technologies at scale. For example, grant capital could pay for "over-collateralization" of the PPP portfolio assembly to reduce the risk that certain properties will fall out of the portfolio over time. Or it could fund a capital expenditures fund pledged for use in the event of unforeseen maintenance costs. Assuming a grant pool constituted 10 percent of capitalization, a $3 million to $6 million grant fund could support the over-collateralization of an additional 40 greened acres, and potentially double the capital expenditures budget estimated as necessary for ongoing maintenance of the project.[95] As such, the grant capital would reduce uncertainty and risk in the structure that otherwise could inflate the long-term cost of the contract as the private partner and investors attempt to ensure sufficient cash flow to pay for unpredictable maintenance costs without compromising investor returns.

As contemplated, debt returns would be fixed payments with amortization over a 10-year period. AKRF estimates that the useful life of virtually all SMPs is well over 10 years, allowing pay-down of the capital used for design and construction in a timely manner. Equity returns would be driven by potential sources of upside structured into the compensation schedule set forth with PWD; these could include performance bonuses for delivery of completed projects, bonuses for technical and operating performance over time, inflation escalations in annual payments, and potential efficiencies gained by the private partner that generate operating margin improvements over time.

5.5 INVESTOR CAPACITY AND FEEDBACK

Significant capital has been raised in recent years for investments in infrastructure across all categories (including transportation, water, and energy), domestically and around the world. Between 2006 and 2011, private sector infrastructure equity capital committed has effectively quadrupled to $250 billion dollars in equity, implying an infrastructure purchasing power of $625 billion assuming 60% leverage, and growing from 15 to 60 separate funds.[96] As of January 2012, another 144 funds were fundraising, targeting an additional $93.2 billion.

Figure 5.13: Infrastructure Investors



Source: Preqin 2012 Infrastructure Investor Universe.

Several drivers are drawing capital to the infrastructure sector:

- **Demand for new projects:** The Organization for Economic Cooperation and Development (OECD) projects that annual infrastructure investment requirements will average some 3.5 percent of global GDP through 2030. The American Civil Society for Engineers reported in 2009 that U.S. states would need to spend $2.2 trillion over the subsequent five years to fund infrastructure needs, and approximately $286 billion annually through 2025.
- **Public funding shortfalls:** Already present budget constraints have been compounded by macroeconomic stresses in recent years. The Center on Budget and Policy Priorities reports that U.S. state budget shortfalls topped $280 billion for 2010 and 2011 alone.
- **Limited access to traditional financing:** Pressure by rating agencies constrains municipalities and states from issuing more debt. Rating agencies have downgraded government issuers of debt at record pace in recent years as states have struggled to maintain balanced budgets. Moody's downgraded municipal issuers at the fastest rate in 20 years in 2009. States including California, Arizona, and Illinois experienced downgrades that pushed the amount of downgraded state-backed bonds to $199 billion, the largest amount in 20 years.
- **Risk/return profile of assets and demand for yield:** Investors view infrastructure assets and programs as lower-risk investments with steady, long-term cash flows. Many projects are characterized as mission-critical assets with limited competition. Such assets represent an opportunity to create steady cash yields that also serve as a hedge against future inflation.

A total of 224 infrastructure investments were completed in 2011, a decrease from the 254 transactions completed in 2010.[97] Unlisted infrastructure fund managers with a total of $174 billion of capital committed had some $68 billion looking for opportunities as of 2011.[98]

Impact investors represent a new category of investor interest. These investors evaluate opportunities on the basis of financial return and social or environmental impact. Estimates of impact-oriented assets under management vary widely, with Monitor Group citing some $50 billion in current assets under management with the potential to grow to $500 billion over the next decade. It may be possible to identify an investor or group of investors with interest in other types of green infrastructure, such as clean energy or sustainable agriculture, willing to deploy capital to a green stormwater investment opportunity.

The authors conducted a series of meetings with leading financial institutions including Goldman Sachs, JPMorgan, Morgan Stanley, Deutsche Bank, and Citigroup to gauge institutional investor interest in the PPP structure as a proxy for investor interest and concerns more broadly. Participants in those meetings included a range of commercially oriented professionals involved in infrastructure investing and transaction structuring, corporate sustainability efforts, and corporate foundation grant-making. Feedback from these institutions suggests the following concerns, focused on performance risk, scale, and pricing.

- **Performance Risk:** Performance risk was highlighted as an area of primary concern. If PPP financing relies on a PWD contractual obligation for repayment, an institution's comfort with the likelihood of performance becomes a critical element of risk assessment. For green stormwater mitigation, there are two types of performance risk: failure to complete construction according to design specifications, and failure to provide ongoing maintenance of infrastructure particularly as related to compliance with environmental regulations and requirements.

  Investors are accustomed to assessing construction risk and would likely price that risk into any PPP structure. Ongoing maintenance risk presents a greater challenge, with three major risk drivers potentially impairing performance and, therefore, triggering the cessation of payment obligations of PWD under a PPP contract. First, it is difficult to evaluate and project the costs of ongoing maintenance operations, which are largely untested at any scale, given that there has been no widespread deployment and maintenance program for greened acres to date. Second, the technology of green stormwater infrastructure may be perceived as relatively new and its future effectiveness uncertain. Some parties interviewed suggested that the efficacy of certain technologies and practices may decrease over time, potentially requiring significant additional capital investment to replace the SMP in order to continue to deliver mitigation benefits and earn the contract performance fee. Third, depending on the specific contract terms, investors expressed concern that the compliance requirements driven by federal regulations could evolve and change over time, making certain greened acres obsolete or increasing the costs of maintenance.

  These performance-related risks stand as the largest impediment to a cost-effective pricing of the strategy and will need to be carefully evaluated and structured around in order to satisfy the needs of PWD and potential investors in green infrastructure. Such concerns do not suggest that investors would not have interest in a green stormwater infrastructure PPP. However, if left unmitigated, these concerns would increase the required return associated with financing the structure and project implementation.
- **Scale:** For most investors, the scale required to attract mainstream institutional capital into a single investment entity is likely at least $20 million, and ideally $50 million or more. We define mainstream institutional capital as pension funds, sovereign wealth funds, foundations/endowments, family offices, and private banks. Below the $20 million level, there are certain foundations, family and multifamily offices, and impact-oriented investors who are potential sources of capital. Infrastructure funds would need to make at least a $25 million commitment of resources to any potential PPP product. Around $75 million to $100 million would be an ideal amount of capital

to attempt to raise based on local demand for the capital in terms of project need and potential institutional supply of investment capital. These data are encouraging in that they indicate institutional-scale investors could be approached to finance PPP efforts.

Initial interactions with potential investors, including several of the largest investment banks, confirmed that special consideration might be given to a pilot project with community benefits and green attributes, particularly one with promise of replication in other cities. If additional cities could also be considered in the investment universe, one could consider aggregating capital for a larger green stormwater retrofit fund. Conventional fund-raising and investment allocation limitations suggest a fund of $150 million to $250 million would be ideal for a multicity effort. A fund as small as $75 million to $125 million might be able to achieve desired geographic diversification.

- **Pricing:** A PPP structured between PWD and a private-sector partner would have off-balance-sheet financing. Payments made through a contractual obligation do not imply the same liability to PWD as an on-balance-sheet loan obligation or bond issuance. Therefore, the return required by investors will necessarily need to incorporate the lower standard of obligation written into the contract. The weaker the PWD contractual obligation, the higher the return required. The stronger the obligation, the lower the return required. At the same time, the contract terms cannot be so strict as to mimic a traditional bond instrument in terms of PWD's liabilities therein, or the contract will be perceived by PWD's rating agencies to be debt-like, possibly resulting in a highly undesired impact on PWD's credit rating and debt ceiling.

5.6 PWD CREDIT RISK

Given that the contemplated PPP structure would involve availability payments made by PWD to the private partner and supported by PWD's general ratepayer revenue collections, investors would evaluate the credit risk of PWD, and financing premiums would be benchmarked against PWD bonds currently trading in the market. Given this, it is helpful to summarize the ratings and outlooks of recent and outstanding PWD bonds.

The water system serves all of the 1.5 million residents of the city as well as an additional 150,000 people in neighboring Bucks, Montgomery, and Delaware counties. Some 83 percent of water accounts are residential, with the 10 largest users representing 13 percent of total billings. The wastewater system serves a larger catchment area that includes nearly 2.2 million people. Below-average collection rates are a key credit concern. Annual collections currently average 85 percent, and delinquencies are budgeted into total revenue projections. Management is viewed as being highly tenured and capable. Annual rate hikes have averaged 5.5 percent, and revenue projections are thought to be credible and conservative. PWD maintains a Rate Stabilization Fund and a Residual Fund, which fluctuate in size but peaked in 2007 at $187 million and were projected to reach $174 million at the end of fiscal year 2011. Both funds are pledged as security for bondholders and serve as meaningful credit enhancement. Senior lien debt service coverage from net revenues has fluctuated over recent years, going as low as 1.12 times in fiscal 2009 but averaging 1.31 times from fiscal 2006 to fiscal 2010, and rising in 2010 to 1.4 times.[99] Finally, the debt ratio dropped to 72 percent from 84.4 percent in 2010, though it is still more than twice the national median for Moody's rated combined water and wastewater systems.[100] The figure below summarizes the relatively strong ratings given to PWD's bonds by Fitch Ratings, Moody's Investors Service, and Standard & Poor's Ratings Services.

Figure 5.14: PWD Bond Ratings

	Amount	Fitch	Moody's	S&P
Series 2011A	$135.0m	A+	A1	A
Series 2011B	$33.6m	A+	A1	A
Series 2011C	$12.4m	A+	A1	
Series 2011D	$18.9m	A+	A1	
All Other Outstanding Obligations	$1.6bn $1.77bn	A+	A1	A; AAA/A-; AAA/A-1+

Based on current market conditions in the U.S. infrastructure investing markets, the authors assume that all-in financing costs for a PPP capital structure, including both underlying debt financing and equity investment, might price between 250 basis points and 400 basis points above PWD's A-rated bonds, currently trading in the 3.8 percent to 4.2 percent range, implying an all-in cost of capital of 6.0 percent to 8.0 percent. Investors will benchmark the all-in cost of financing for the structure relative to the pricing of PWD's bonds, and will require higher rates of return depending on the embedded loan-to-value, perceived regulatory risk that would impact ratepayer revenues (e.g., new limits to rate increases), the risk of the private partners' execution capabilities, and the risks associated with PWD's obligation to pay under the terms of the PPP contract. U.S. PPP transactions tend to price higher than might be necessary given the limited expertise that U.S. municipal authorities have in managing an efficient PPP process. One investor stated that Canadian PPPs price more attractively given Canada's well-understood PPP process and transparent pipeline. As U.S.-based PPPs become more common, pricing will likely tighten further.

In any event, given that a PPP financing should always price higher than PWD bonds, even if PWD could achieve meaningful construction and O&M cost savings for a PPP-delivered portfolio, it would need to evaluate the all-in costs and benefits of greened acre delivery to see whether the financing premiums required relative to its own financing capacity would be justified, or whether utilizing an off-balance-sheet financing mechanism would offer other benefits that would warrant the additional costs.

5.7 CHAPTER CONCLUSIONS AND RECOMMENDATIONS

Public-private partnership structures offer PWD important potential benefits in the financing and implementation of its green stormwater infrastructure plan. PPPs can lower the costs of construction and maintenance, access new sources of investment capital, preserve balance sheet capacity, and incentivize optimal performance by shifting performance risk to private partners where payments are tied directly to performance.

In order to determine whether a PPP structure is appropriate for green stormwater infrastructure in Philadelphia, the authors recommend the following sequence of steps:

- **Complete a value-for-money analysis.** PWD should complete a value-for-money analysis that examines the costs, benefits, and risks associated with utilizing a PPP for green stormwater infrastructure.
- **Conduct a more comprehensive assessment of greened acre supply and cost estimates.** As discussed in Chapter 1, it would be useful to develop a more refined understanding of potential supply of greened acres with a narrower range of costs for purposes of determining the optimal cost benchmarks and focus for a green stormwater PPP.
- **Establish PPP contract terms.** Pending the conclusions drawn from recommendations 1 and 2, above, PWD should consider developing a draft PPP contract for use in engaging in further dialogue with potential private partners and investors.
- **Issue a request for qualifications or request for proposals.** Pending the conclusions drawn from recommendations 1 and 2, above, PWD may decide to issue an RFI or RFP to solicit specific proposals for consideration.

Endnotes

1 Philadelphia, like hundreds of other municipalities nationwide, is subject to Clean Water Act obligations to reduce raw sewage overflows from combined sanitary and storm sewers, as well as polluted runoff from separate storm sewers.

2 See Philadelphia Water Department), "Developer's Guide to Stormwater Management." Accessed at www.phillywatersheds.org/whats_in_it_for_you/businesses/developers-guide-stormwater-management; City of Philadelphia, Pennsylvania, Water and Wastewater Revenue Bonds, Series 2011A & 2011B, Appendix II, p. 57. Accessed at www.phila.gov/water/pdfs/bonds_2011a-b.pdf.

3 Green City Clean Waters Program Summary (June 2011). Accessed at www.phillywatersheds.org/doc/GCCW_AmendedJune2011_LOWRES-web.pdf.

4 See, e.g., NRDC, *Rooftops to Rivers II* (2011), pp. 7-8, available at www.nrdc.org/rooftops.

5 Under Philadelphia's meter-based billing structure, which is now being phased out through July 2013, nonresidential parcel owners' monthly stormwater utility fees were based directly on the diameter of a parcel's potable water pipe; relatively high potable water usage meant a wider pipe and a correspondingly higher stormwater fee. Under that fee structure, owners who utilized large amounts of potable water were charged higher stormwater fees regardless of how much (or how little) stormwater their parcel generated. Owners who had larger paved parcels but who used little or no potable water paid a relatively low stormwater fee, or none at all, despite the fact that they were generating substantial amounts of stormwater for the city to manage.

6 NRDC, "Financing Stormwater Retrofits in Philadelphia and Beyond" (February 2012). Accessed at www.nrdc.org/water/files/StormwaterFinancing-report.pdf.

7 During the phase-in period, the stormwater charge is a hybrid of the meter-based fee and a parcel-based fee.

8 "Impervious area" refers to the total square footage of any plane hard surface area—including the roofs of buildings, paved or hardscaped areas, and compacted dirt and gravel—that either prevents or restricts the absorption of water into the soil and thereby causes water to run off the surface. "Gross area" refers to the total area contained within the legally described boundaries of a property, excluding portions of sidewalk that are in the public right-of-way. See PWD, Frequently Asked Questions: Stormwater Management Service Charge (November 2010). Accessed at www.phila.gov/water/Stormwater/pdfs/Non-Res_FAQ.pdf.

9 The FY14 rates stated here are taken from a joint settlement proposal by PWD and the other parties to the rate proceeding; it is highly likely these rates will be adopted, since they are not being contested.

10 See PWD, "Green Guide for Property Management," p. 9. Accessed at www.phila.gov/water/Stormwater/pdfs/PWD_GreenGuide.pdf.

11 The maximum given credit that a parcel can achieve is 80 percent of the property's impervious area (IA) and gross area (GA) charges. Per PWD's proposed FY14 schedule detailed above, the combined annual IA and GA fee per square foot of impervious surface is $0.12Implementation of an SMP retrofit would allow for a maximum credit of 80 percent of $0.12, equal to 9.7 cents.

12 See Appendix V, Figure 2: SMP Unit Costs Per Square Foot of DCIA.

13 To date, no comprehensive study has been done of SMP costs in Philadelphia. For this report, the authors retained the engineering consulting firm AKRF to develop cost data using a combination of literature values and built projects. Literature costs were used for basins, ponds, wetlands, reduced impervious surface, swales, rainwater harvest and reuse, flow-through planters, and green roofs (national cost survey of built projects provided by the Center for Watershed Protection, 2007); infiltration trenches (EPA, 2004); and porous pavement (Urban Design Tools, 2012). Literature costs were then updated to 2012 dollars and adjusted using a regional construction index factor for Philadelphia (*Engineering News Record*, 2012). In addition, 20 percent was added for design and engineering, and another 50 percent for site-specific contingency. Rain garden costs were calculated using the AKRF cost curve used to assess residential properties discussed in Chapter 3 of this report. For downspout disconnections, which apply specifically to residential properties, costs were based on the assumption that the homeowner would redirect the downspout onto adjacent permeable area using simple tools and a plastic elbow attachment costing approximately $50. (As noted elsewhere in this report (see Sec. 3.18.1), PWD might determine that downspout disconnections require some limited professional oversight to ensure their effectiveness and safety; the costs of any such professional services are not included here.)

14 Conversion from cost per square foot to cost per acre was calculated by multiplying cost per square foot by the number of square feet in an acre (43,560).

Discounted cash flow analysis, or "net present value" (NPV) analysis, is used to take into account the time value of money—that is, the amount of money (on a percentage basis) that the invested capital could earn if it were allocated to an alternative investment. This percentage basis, or discount rate, differs by investor and project type, as investors will have their own "hurdle rate" (i.e., rate of return) they are seeking to meet or exceed given the relative risk and potential return of the project. For stormwater retrofit investments on nonresidential property, the authors have chosen to utilize an 8 percent discount rate. This choice is based on conversations with commercial real estate investors citing a traditional market convention of a 10 percent discount rate, modified by the low interest rates at the time of this writing as well as minimum required returns. The authors also took into account discount rate assumptions cited from the energy efficiency retrofit and solar project market of 5 to 8 percent. See Fuller, Portis, and Kammen, "Toward a Low-Carbon Economy: Municipal Financing for Energy Efficiency and Solar Power," *Environment Magazine* (2009); and Gillingham, Newell, and Palmer, "Energy Efficiency Economics and Policy," NBER Working Paper No. 15031(2009).

16 Though there is scant historical data on stormwater retrofit cost trends, one could also reasonably expect that additional projects will become more economically attractive over time, as economies of scale (achieved through project aggregation and project growth) and greater competition (via entrance of multiple contractors as the green infrastructure market grows) should cause the inflation-adjusted cost of retrofits to decline.

17 For a detailed methodological explanation, including a full explanation of project assumptions, see Appendix I.

18 For more information on the McKinsey cost curve, see "Pathways to a Low-Carbon Economy," accessed at solutions.mckinsey.com/ClimateDesk/default.aspx.

19 DCIA refers to impervious areas where water flow is continuous to the conveyance system (i.e., streets with curbs, catch basins, storm drains, etc.) and to the basin outlet point (i.e., a retention/detention pond, existing storm sewer/ditch system, natural water body, etc.) without flowing over pervious areas.

20 Certain SMPs that require large amounts of open space (i.e., constructed wetlands, basins, and ponds) were not included in this analysis because of methodological limitations. See Appendix I.

21 For all of the SMPs except downspout disconnection, the acreage estimates include only potential retrofit opportunities on nonresidential parcels; Appendix I provides the methodology for deriving these acreage estimates. For downspout disconnections, the acreage estimates include only potential retrofits on residential parcels; Appendix V provides the methodology.

22 There are two reasons to look at multiple SMP options for each individual property: 1) When assessing which SMP to install on a parcel, property owners will not necessarily use lowest cost as the only decision variable (e.g., while green roofs are cost prohibitive in a crediting scenario, they potentially offer additional benefits such as reduced energy costs or higher perceived real estate value. 2) The model utilized feasibility rather than least cost to derive total acres. Had the model been based solely on

the lowest-cost option feasible at a given property, it would have limited the SMP options to downspout disconnections, swales, and infiltration trenches, thereby creating a graph that had few real points of comparison.

23 873 acres includes all downspout disconnect opportunities (658 acres) in addition to the lower 25 percent cost quartile of swale projects (215 acres). These two project categories are the retrofits that achieve discounted payback based on avoided fees over a 10-year time horizon.

24 As discussed further in Chapter 4, these low costs are based on the assumption that homeowners can reliably install downspout disconnections, to PWD specifications, without the need for professional services that would add to the cost. Further investigation of this premise is recommended.

25 Valentova, Michaela, "Barriers to Energy Efficiency—Focus on Transaction Costs," *Acta Polytechnica*, Vol. 50, No. 4 (2010).

26 Woodward, Jenna, *Purchasing Power: Best Practices Guide to Collaborative Solar Procurement*, World Resources Institute and Joint Venture Silicon Valley (2011).

27 Conversation with staff from engineering and design firm AKRF.

28 Information on the methodology used to generate Figure 1.4 can be found in Appendix III.

29 Woodward, Jenna, *Purchasing Power: Best Practices Guide to Collaborative Solar Procurement*, World Resources Institute and Joint Venture Silicon Valley (2011).

30 PWD has allocated $1.67 billion, on an inflation-adjusted basis, over a 25-year period to green at least 9,564 acres across the city, pursuant to a consent order with the Pennsylvania Department of Environmental Protection. In a 2011 bond offering, PWD projected that private redevelopment projects would yield 3,000 greened acres over 25 years. This suggests PWD is planning for its $1.67 billion budget to cover the remaining 6,564 acres—approximately $250,000 of funding per greened acre on an undiscounted basis. See "Green City, Clean Waters Program Summary" (June 2011) and www.phila.gov/water/pdfs/bonds_2011a-b.pdf.

31 For ease of comparison, the authors assumed a 10-year investment period on the part of PWD for SMP installations in the public right-of-way. A more an accurate comparison would require knowing the expected life span of the greened acres in the public right-of-way.

32 For a more detailed explanation of the challenges that private parcel owners are likely to encounter when they seek financing for green infrastructure retrofits, see NRDC, "Financing Stormwater Retrofits in Philadelphia and Beyond," p. 10 (February 2012). Accessed at www.nrdc.org/water/files/StormwaterFinancing-report.pdf.

33 The structure is also similar to the performance contracting or "shared savings" model utilized by energy services companies (ESCOs). ESCOs, however, are structured somewhat differently in that they can often provide the capital, install, own, and maintain the retrofits as well as provide a guarantee to backstop stipulated energy savings during the life of the contract.

34 For a detailed description of the SWAPP program, see Philadelphia Water Department Regulations at page 36. Accessed at www.phila.gov/water/pdfs/pwd_regulations.pdf.

35 See Appendix III for a memo NRDC previously provided to PWD, presenting this analysis of the effect of the CAP.

36 See City of Philadelphia, Stormwater Credit Renewal Application, page 3. Accessed at www.phila.gov/water/Stormwater/pdfs/Form_C.pdf.

37 NRDC, "Financing Stormwater Retrofits," p. 10. Accessed at www.nrdc.org/water/files/StormwaterFinancing-report.pdf.

38 See above for a discussion of maximum dollar cost for retrofits that will pay back in 10 years or less. To generate the approximate total number of projects, the authors utilized the following formula: (0.80)(40M/$36,000)= 889 projects.

39 For a comprehensive primer describing on-bill programs in the energy retrofit sector, see Henderson, Philip, "On-Bill Financing: Overview and Key Consideration for Program Design," NRDC Issue Brief (August 2012). Accessed at www.nrdc.org/energy/on-bill-financing-programs/files/on-bill-financing-IB.pdf.

40 For more detail on PACE, see www.PACENOW.org.

41 NRDC, "Financing Stormwater Retrofits in Philadelphia and Beyond," p. 12 (February 2012). Accessed at www.nrdc.org/water/files/StormwaterFinancing-report.pdf.

42 Mitchell, Jake, and Price, Alan, *Economics: Principles in Action* (2003), p. 111. Upper Saddle River, New Jersey: Pearson Prentice Hall.

43 Coase, R. H., "The Problem of Social Cost," *Journal of Law and Economics* (1960), 3, 1-44, as cited in Mundaca, L., and Neij, L., "Energy-Economy Models and Energy Efficiency Policy Evaluation for the Household Sector," International Institute for Industrial Environmental Economics (IIIEE)(2009).

44 Valentová, Michaela, "Barriers to Energy Efficiency—Focus on Transaction Costs," *Acta Polytechnica* (2010), Vol. 50, No. 4.

45 For more information, see fund.pfnyc.org/about.html.

46 For more information, see www.nyceec.com/mission/.

47 PWD has released specific guidance for on-site credit applications at www.phila.gov/water/Stormwater/pdfs/SCAA_Manual.pdf.

48 Bahuguna, A.; Jentgen, M.; Ward, M.; and Wilson, G., "How Can Local Governments in NC Change Stormwater Management Policy to Encourage Downtown Redevelopment and Improve Environmental Outcomes?"(2010). Nicholas Institute for Environmental Policy Solutions, Durham, NC: Terry Sanford School of Public Policy, Duke University.

49 Email from Daryl Hammock, Charlotte-Mecklenburg Stormwater Services, to Craig Holland, EKO Asset Management Partners (September 7, 2012), on file with authors.

50 Phone conversation with Darryl Hammock. July 31, 2012.

51 www.phila.gov/water/Stormwater/pdfs/SCAA_Manual.pdf.

52 Francis, Sarah E., "Gray to Green: Jumpstarting Private Investment in Green Stormwater Infrastructure," p. 16. Green Economy Task Force, Greater Philadelphia Sustainable Business Network. Accessed at http://www.sbnphiladelphia.org/images/uploads/02-17-10_EIP_stormwater.pdf.

53 Draft DC regulations § 531.1.

54 Ibid. at § 531.9.

55 Ibid. at § 501.6.

56 Ibid. at § 531.13.

57 Ibid. at § 531.13.

58 Email from Brian Van Wye, District Department of the Environment, to Rebecca Hammer, NRDC (December 8, 2010), on file with authors.

59 Draft DC regulations § 527.3.

60 Ibid. at § 531.10.

61 U.S. EPA, *Water Quality Trading Toolkit for Permit Writers*, p. 34 (August 2007, updated June 2009), available at www.epa.gov/npdes/pubs/wqtradingtoolkit_fundamentals.pdf.

62 Draft DC regulations §§ 532.1, 527.11.

63 See Philadelphia Water Department, "Your Watershed," available at www.phillywatersheds.org/your_watershed.

64 Philadelphia Water Department, "Philadelphia's Watershed History," available at www.phillywatersheds.org/your_watershed/history.

65 U.S. EPA, *Water Quality Trading Assessment Handbook,* p. 45-46 (November 2004), available at http://water.epa.gov/type/watersheds/trading/upload/2004_11_08_watershed_trading_handbook_national-wqt-handbook-2004.pdf.

66 U.S. EPA, *Water Quality Trading Toolkit for Permit Writers,* at p. 39-40. Pennsylvania's statewide policy for nutrient and sediment

trading, though problematic in other respects, does adopt many of these recommendations. The state's trading policy requires "a transparent system for review and approval of credits, and registration of trades." Pennsylvania Department of Environmental Protection, "Final Trading of Nutrient and Sediment Reduction Credits – Policy and Guidelines," p. 14 (2006), available at http://www.portal.state.pa.us/portal/server.pt?open=18&objID=437711&mode=2.67. Information on the exchange being set up in Washington, D.C., can be found at http://ddoe.dc.gov/node/224592.

67 Information on the exchange being set up in Washington, D.C., can be found at http://ddoe.dc.gov/node/224592.

68 PWD Regulations § 600.11(a).

69 Id. at §§ 600.11(b), 600.13(a).

70 Prince George's County, Md., Code § 32-201.03(f) (2012).

71 See, e.g., Spring Lake, North Carolina, Stormwater BMP Maintenance Agreement: Dry Detention/Retention Basin, available at www.spring-lake.org/documents/STORMWATER_BMP_MAINTENANCE_AGREEMENT_drydetentionbasin.pdf.

72 Suffolk, Virginia, BMP Maintenance Agreement, available at www.suffolkva.us/PCD/planning/docs/BMPMainAgreeSample.pdf; Mentor, Ohio, City of Mentor Best Management Practice (BMP) Maintenance Agreement, available at cityofmentor.com/wp-content/uploads/BMP-Maintenance-Agreement.pdf.

73 Proposed DC regulations § 531.3(e).

74 District Department of the Environment, "Notice of Proposed Rulemaking: Stormwater Management, and Soil Erosion and Sediment Control," p. 22 (August 10, 2012).

75 Beyond making the property more difficult to sell, an easement may also affect the property's value (easements can sometimes reduce the value of land by half or more).

76 Charlotte Post-Construction Stormwater Ordinance § 18-148; see also "Charlotte Post-Construction Stormwater Ordinance Administrative Manual," p. 20 (July 2012), available at charmeck.org/stormwater/regulations/Documents/PCCO percent20Documents/PCCOAdminMan0712.pdf (specifying that off-site mitigation BMPs shall be subject to the same maintenance requirements as other BMPs).

77 Draft DC regulations §§ 528.1, 529.1(a).

78 *See, e.g.,* City of Jacksonville, NC, *Phase II Stormwater Administrative Manual* 4 (Mar. 1, 2009, revised Feb. 2, 2010), *available at* http://www.ci.jacksonville.nc.us/getdoc/d6dbb9cc-a570-4e3f-9d69-35f8c0763a74/Stormwater-Administrative-Manual-Approved-3-1-09.aspx; Town of Lewisville, NC, *Phase II Stormwater Management and Watershed Protection Administrative Manual* 9-10, *available at* http://www.lewisvillenc.net/vertical/Sites/ percent7B05A58ADC-13A2-4B0E-8558-957F4B6AC6AF percent7D/uploads/ percent7BC8A3F0E3-AD72-4225-8C5C-1EE057842930 percent7D.PDF.

79 See Section 1.2 for a detailed explanation of the SMSC and its projected escalation over time; the logic behind the selection of an 8 percent discount rate; and how these factors impact the financial viability of stormwater retrofits, both for on-site SMSC credit and for property owners wishing to generate off-site SRCs.

80 www.phillywatersheds.org/whats_in_it_for_you/residents/raincheck.

81 Cost estimate provided by AKRF.

82 The $0.35 per square cost was derived by dividing the cost of the downspout disconnection ($50) by the average project size of 143 square feet. If the project was larger, the cost per square foot would drop.

83 See Section 1.3 for an explanation of how stormwater fees and credits are calculated.

84 The consent order currently states that, for purposes of generating greened acres, "[g]reen stormwater infrastructure designs will be aimed at controlling at least 1 inch of runoff, and up to 1.5 inches of runoff, unless otherwise deemed feasible by engineering design."

85 Brookings–Rockefeller Project on State and Metropolitan Innovation, "Moving Forward on Public-Private Partnerships, Accessed at http://www.brookings.edu/research/papers/2011/12/08-transportation-istrate-puentes.

86 Brookings–Rockefeller, "Moving Forward on Public Private Partnerships."

87 Hamilton Project, "Public-Private Partnerships to Revamp U.S. Infrastructure," accessed at http://www.hamiltonproject.org/files/downloads_and_links/Eduardo_Engel_Presentation.pdf .

88 Brookings–Rockefeller, "Moving Forward on Public Private Partnerships."

89 Brookings–Rockefeller, "Moving Forward on Public Private Partnerships."

90 92 National Council for Public-Private Partnerships, Case Studies. Accessed at www.ncppp.org/.

91 PMA is a special-purpose procurement entity that is permitted to engage in long-term contracts. Use of the PMA requires approval by the Philadelphia City Council.

92 Green City Clean Waters Program Summary (June 2011).

93 www.phila.gov/water/pdfs/bonds_2011a-b.pdf.

94 Estimated cost per acre shown in the data presented herein could vary significantly. See the Task 1 description of the cost curve for further detail.

95 Assuming that capital expenditure costs total approximately 2 percent of total cost of greened acres annually, as per analysis provided by AKRF.

96 Preqin 2012 Infrastructure Investor Universe. Accessed at http://www.preqin.com/blog/101/4674/infrastructure-investors-2012.

97 2012 Preqin Global Infrastructure Report.

98 2012 Preqin Global Infrastructure Report.

99 Moody's Investors Service – Global Credit Research October 20, 2011.

100 Ibid.

APPENDIX I: COST CURVE METHODOLOGY

The following is a report generated by AKRF – an environmental, planning, and engineering consultancy.

AKRF performed a desktop analysis to estimate the total directly-connected impervious area (DCIA) within non-residential properties in the CSO boundary that could be feasibly managed using each of the following ten PWD-approved SMPs:

- Subsurface Infiltration or Storage
- Green Roof
- Flow-Through Planter
- Rain Garden
- Rainwater Harvest and Reuse
- Porous Pavement
- Swale
- Reduce Impervious Surface
- Basin or Pond
- Created Wetland

AKRF used a sampling approach to estimate the DCIA that could be feasibly captured for each SMP type. AKRF selected a sample set of non-residential properties and determined, via desktop analysis, the DCIA that could be feasibly managed on each property using each SMP type. AKRF then scaled the sample results to all non-residential impervious area within the CSO boundary to estimate the total area that could be feasibly managed by each type of SMP and estimated the unit cost associated with each SMP type.

Methods

To estimate the DCIA that could be feasibly managed using each of the 10 SMP types, AKRF first selected a random sample of 25 properties from the population of 68,200 nonresidential properties within the CSO boundary. Given the sample and population sample sizes, AKRF was able to generate estimates of population characteristics with a 95% confidence level and a ±20% margin of error. For each property, AKRF used a desktop evaluation to estimate the DCIA that could be feasibly managed using each of the 10 commonly accepted SMP types (PWD *Green Guide for Property Management*). Several sources of information were used in the desktop assessment including PWD aerial photography and GIS data, Google Maps™ Streetview photography, and Bing Maps™ birds-eye view photography.

Several important feasibility assumptions were made in evaluating the sample sites. These include setback requirements for infiltrating practices; potential for volume reduction; need for additional conveyance infrastructure; availability of open space; and how these factors affect cost. Each of these assumptions is discussed in more detail below:

Setbacks: It was assumed that all ground-level infiltrating or vegetated SMPs (rain gardens, created wetlands, basins, porous pavement, planter boxes, and subsurface infiltration) required set backs from buildings of at least 10 feet (PWD 2010). It was assumed that no setback from the property line was required.

Volume Reduction: PWD regulations specify that in order to be eligible for stormwater fee credit, at least 20% of all DCIA managed on each parcel within the CSO boundary must be treated using volume-reducing practices (PWD 2010). PWD defines “volume-reducing practices” as any SMP that reduces the total volume of water entering the combined sewer system. Subsurface storage, for example, does not provide significant volume reduction, and therefore may not treat more than 80% of the treatable DCIA at a given site. Rainwater harvest, which includes the capture and reuse of rainwater, is defined by PWD as volume-reducing only if the owner/operator can prove that rainwater captured is being used for ongoing, non-seasonal irrigation or other uses that remove a significant volume of water. Since none of the parcels identified in the sample set appeared to have significant need for irrigation or process water, rainwater harvest as considered to be non-volume reducing for the purposes of this exercise; therefore, it was assumed that rainwater harvest may not treat more than 80% of the treatable DCIA at a given site.

Conveyance: It was assumed that significant conveyance piping may be required to convey drainage to subsurface infiltration facilities, based on observed constraints at most of the sample properties reviewed. For all other SMP types, it was assumed that the SMP would be sited near an existing discharge point (either a downspout or other drainage outlet) and hence would not require significant additional conveyance piping for capture.

Availability of Open Space: Open space was determined to be in use, and therefore not available for stormwater management, if the space appeared to be in use for recreation, community gardening, storage, or access purposes based on aerial imagery (PWD aerial imagery 2010; Bing Maps™; Google Maps™). If the space appeared to be in use for parking, it was assumed that this use would be maintained, and SMPs were selected accordingly. If the space appeared to be in use for materials storage or aesthetic landscape purposes, it was assumed that area was available for stormwater management.

Mid-Range SMP Costs: Mid-Range costs were derived from a combination of literature values and built projects. Wherever possible these mid-range values represent median costs for a SMP type. For those SMP types where median costs were not available due to a lack of data, mid-range project cost estimates were provided. Mid-range values for wetlands, reduced impervious surface, swales, rainwater harvest and reuse, flow-through planters, and green roofs were derived from the Center for Watershed Protection Report" Urban Stormwater Retrofit Practices Version 1" (CWP 2007). The CWP report provides median $/ft^2 cost estimates based on available built project data and project-derived cost equations. Similarly, the Rain garden mid-range cost is a median price derived from AKRF's project-derived rain garden cost curve (presented in Appendix V - Figures 1 & 2).[1] The mid-range value for Infiltration trenches was derived by inputting an average project size into the project cost equation provided by EPAs 2004 Report, "The Use of Best Management Practices (BMPs) in Urban Watersheds". [2] Finally, porous pavement mid-range cost estimates were derived from the cost range provided by Urban Design Tools 2012.[3] In all cases, the mid-range cost estimates were updated to 2012 dollars and adjusted using a regional construction index factor for Philadelphia (Engineering News Record, 2012). In addition, 20% was added for design and engineering, and another 50% for contingency.

SMP Cost Ranges: Cost ranges for reduced impervious surface, swales, rainwater harvest and reuse, flow-through planters, and green roofs, were derived by marking up the 25-75% quartile ranges provided in the CWP 2007 report by the design & engineering, contingency, inflation, and regional adjustment factors discussed in the *Mid-Range SMP Costs* section above. For SMP types that do not reference the CWP 2007 document (subsurface infiltration, rain gardens, porous pavement), literature ranges were not available. Instead, cost ranges for these SMPs were derived from the range observed in applying the AKRF Rain garden Cost Curve (Appendix V, Fig. 1 & 2) to the sample set of parcels considered. In order to be consistent with the CWP method, we obtained the median unit cost for rain gardens, as well as the first and third quartile values. We then calculated the percent deviation of the first and third quartile from the median, and applied this percent to the given unit cost values for infiltration trenches and porous pavement to obtain low and high end values. The methodology for how downspout disconnection cost ranges were generated is detailed in Appendix V.

1 For rain gardens, each of the suitable retrofit sites identified using AKRF's sampling methodology would drain under 5,000 s.f. of DCIA. Accordingly, AKRF utilized the cost curve—which depicts the relationship between rain garden costs and the size of the impervious area managed — to derive median costs for rain gardens in that particular size range. (For other SMPs that utilized literature-derived costs, the literature sources did not provide a basis for adjusting the median costs to reflect a particular size range.)

2 To estimate the mid-range price of an infiltration trench project, the following cost equation - provided in the 2004 EPA Report, "The Use of Best Management Practices (BMPs) in Urban Watersheds" - was utilized:

Infiltration Trench Cost =5V; where V equals the SMP volume in cubic feet.

A mid-range value for infiltration trenches was derived by feeding an average project size from AKRF's set of random projects through the cost equation above. See EPA 2004 pg. 6-4 through 6-6.

3 For porous pavement, it was assumed that any retrofits would occur on previously paved areas. As a result, the literature cost for porous pavement retrofit is a sum of the porous pavement installation cost provided in the Urban Design Tools report, and the asphalt removal costs provided in the CWP report. Asphalt removal costs were derived from CWP 2007 Report Appendix E, costs were adjusted to 2012 dollars using a regional construction index. In addition, 20% was added for design and engineering and another 50% for contingency costs.

Estimate of Acres managed be each SMP type. AKRF summed the treatment drainage areas associated with each SMP type across the 25 sample properties, and divided the DCIA estimates for each SMP type by the total DCIA within the sample set to compute the percent of DCIA that could potentially be managed be using each SMP type (Table 1, below). These percentages were then scaled as a percent of the total nonresidential DCIA located within the CSO boundary.

Table 1: Estimated Quantity DCIA Available for Management by SMP Type within Non-Residential Properties within the CSO Boundary

SMP Type	Sample DCIA Managed (sf)	Sample DCIA Managed (%)	Total DCIA Managed[1] (sf)	Total Cost[2] ($)	Unit Cost[2] ($/sf)
Infiltration Trench	38,100	64.10%	291,301,000	$425,299,460	$1.46
Green Roof	23,900	40.30%	183,092,000	$6,404,558,160	$34.98
Flow-Through Planter	19,500	32.80%	148,993,000	$879,058,700	$5.90
Rain Garden	17,900	30.10%	136,870,000	$562,535,700	$4.11
Rainwater Harvest and Reuse	17,500	29.40%	133,726,000	$438,621,280	$3.28
Porous Pavement	11,800	19.80%	89,913,000	$464,850,210	$5.17
Swale	4,900	8.20%	37,472,000	$44,966,400	$1.20
Reduce Impervious Surface	1,300	2.20%	10,158,000	$44,390,460	$4.37
Basin or Pond	-	0.00%	-	$0	$0.00
Created Wetland	-	0.00%	-	$0	$0.00

[1]All DCIA on nonresidential parcels within the CSO boundary.

[2] Includes design, and conveyance as appropriate

Results

The estimated percentage of DCIA that could be feasibly managed by various SMP types ranged from 64.1% for subsurface infiltration or storage to 2.2% for reducing impervious cover (Table 1). Because none of the sampled properties was large enough to provide a suitably large treatment drainage area for a basin, pond, or wetland SMP (typically these SMPs require treatment drainage areas several acres in size), no feasible treatment drainage areas were identified for these SMPs. Thus the CSO-wide estimates of feasible DCIA were also zero for these SMPs. This result is likely to be statistical anomaly associated with the relatively small sample size compared with the population size. In reality, the quantity of DCIA that could be feasibly managed using basins, ponds, and wetland SMPs is non-zero. However, this quantity could not be estimated using the study methodology. Median unit management costs ranged from $1.20 per square foot of runoff for swales to $34.98 per square foot of runoff for green roofs, assuming management of the first inch of runoff.

Study Limitations

Most cost data used in this study were derived from literature values based on a large survey of built projects conducted prior to 2007 and adjusted for inflation (CWP 2007). However, variability in unit costs in general is not well understood, and in some cases costs may vary by more than an order of magnitude for drainage areas less than one acre (CWP 2007). For rain gardens, AKRF used an exponential cost equation based on drainage area that was developed from in-house costs for built projects and detailed cost estimates. This cost equation was based on a limited data set of built projects. Despite the limited number of data points, however, AKRF feels that it is preferable to the literature unit costs for bioretention-type practices, which AKRF has found to be generally poor predictors of actual costs for bioretention-type practices in Philadelphia.

The study was limited further by the margin of error associated with using a sampling approach to estimate CSO-wide acreage and costs for SMP retrofits. As noted above, the margin of error for extrapolating characteristics of sampled non-residential parcels to the broader population of all non-residential parcels (Table 1) is approximately 20%.

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APPENDIX II: PROJECTED FEE SCHEDULE (FISCAL YEARS 2014-2031)

	FEE SCHEDULE																		BY SQUARE FOOT		BY ACRE	
FISCAL YEAR	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	TOTALS* Non-Discounted	TOTALS Discounted	TOTALS Non-Discounted	TOTALS Discounted
2014	$0.10	$0.10	$0.11	$0.12	$0.12	$0.13	$0.14	$0.15	$0.15	$0.16									$ 1.27	$ 0.91	$ 55,513	$ 39,737
2015		$0.10	$0.11	$0.12	$0.12	$0.13	$0.14	$0.15	$0.15	$0.16	$0.17								$ 1.35	$ 0.97	$ 58,823	$ 42,102
2016			$0.11	$0.12	$0.12	$0.13	$0.14	$0.15	$0.15	$0.16	$0.17	$0.18							$ 1.43	$ 1.02	$ 62,352	$ 44,628
2017				$0.12	$0.12	$0.13	$0.14	$0.15	$0.15	$0.16	$0.17	$0.18	$0.19						$ 1.52	$ 1.09	$ 66,093	$ 47,305
2018					$0.12	$0.13	$0.14	$0.15	$0.15	$0.16	$0.17	$0.18	$0.19	$0.21					$ 1.61	$ 1.15	$ 70,059	$ 50,144
2019						$0.13	$0.14	$0.15	$0.15	$0.16	$0.17	$0.18	$0.19	$0.21	$0.22				$ 1.70	$ 1.22	$ 74,263	$ 53,152
2020							$0.14	$0.15	$0.15	$0.16	$0.17	$0.18	$0.19	$0.21	$0.22	$0.23			$ 1.81	$ 1.29	$ 78,718	$ 56,341
2021								$0.15	$0.15	$0.16	$0.17	$0.18	$0.19	$0.21	$0.22	$0.23	$0.25		$ 1.92	$ 1.37	$ 83,441	$ 59,722
2022									$0.15	$0.16	$0.17	$0.18	$0.19	$0.21	$0.22	$0.23	$0.25	$0.26	$ 2.03	$ 1.45	$ 88,448	$ 63,305

The figure above represents the total fee credit per square foot for fiscal years 2014-2031. Each colored row represents a 10-year fee schedule for the fiscal year starting on the far left column. The beige column (second from the far right) represents the total value of the fee credit, per square foot, over 10 years both on a discounted and non-discounted basis. The discount rate used was 8%.

APPENDIX III: BUILDING A GREENED ACRE MARKET

Figure 1.4, *Building a Greened Acre Market* illustrates how different policy strategies could improve the economic viability of green acre projects. This chart builds upon the analysis conducted for the Cost curve with some slight modifications. Below is a list of the major assumptions driving the development of the *Building a Greened Acre Market* diagram.

Cumulative Greened Acres: The cost curve (Fig. 1.3) includes, for any given impervious area, each type of SMP that could be used to manage a site's stormwater runoff. Since runoff in some locations could feasibly be managed by any one of several SMPs, the "greened acre" amounts presented in the Cost Curve, for each SMP, cannot be summed to derive an estimate of the total "greened acre" opportunity within the CSO watershed.

To construct the *Building a Greened Acre Market* diagram, a slightly different methodology was utilized. Each impervious area in the sample plots analyzed by AKRF was assigned to only the SMP retrofit category with the lowest mid-range cost. On parcels where multiple SMP types were technically viable according to AKRF's site analysis, the lowest mid-range cost SMP was selected; the assumption being that the lowest cost option would always be implemented first. Using this approach to select one retrofit project for any given impervious area, the results presented in Table A3.1, below, illustrate the marginal additional number of "greened acres" that would come online if SMP projects were implemented sequentially from the least to most expensive.

Table A3.1 Marginal Additional Acres Analysis by SMP | Cost Driven

RETROFIT PROJECT	Mid-Range Costs	Marginal Additional Acres
Downspout Disconnection	$0.35	658
Swales	$1.20	860
Infiltration Trench	$1.46	4503
Rainwater Harvest & Reuse	$3.28	261
Rain Gardens	$4.11	688
Reducing Impervious (Hard) Surf	$4.37	0
Flow-Through Planters	$5.90	702
Porous Pavements	$5.17	0
Green Roofs	$34.98	2501
Total Acres		10,173

Note in A3.1 that porous pavement and reduced impervious surface solutions are projected to provide no marginal additional green acreage; this is because for every sample site where those solutions were technically feasible, AKRF's methodology also identified a retrofit with a lower mid-range cost as technically feasible.

Economically Attractive Green Acres. To determine when a SMP type would become "economically viable" as a potential private investment, a discounted cash flow analysis was conducted for each retrofit type assuming cost savings through project aggregation (10% drop in capital costs) and various levels of upfront capital subsidy ($0.50, $1.00, $3.00 and $3.50). Similar to all other analyses presented within this report, the sole source of future cash flows considered was the abated stormwater fees resulting from the reduction in impervious area. Other major assumptions driving the cash flow analysis are projected stormwater fee increases of 6% per year and a discount rate of 8%. For this analysis the impact of depreciation and taxes were not considered.[4]

4 The cumulative impact of depreciation and taxes would likely be a decrease in the annual future cash flows realized by the investment, and an extension of the project payback timeline. Due to the highly variable tax rates facing businesses in Philadelphia, the impact of taxes and the depreciation tax shield were not considered as part of this analysis.

A sample cash flow for Infiltration Trenches is presented below. This particular analysis assumes management of 1 acre of DCIA, mid-range costs of construction ($1.46/ft^2), a $1.00 /ft^2 subsidy of DCIA managed and capital cost savings of 10% resulting from aggregation. (The net upfront capital cost to the capital provider, after accounting for subsidy and aggregation, is $0.31/ft^2.)

Infiltration Trench Cash Flows

	0	1	2	3	4	5	6	7	8	9	10
Capital Costs	(63,598)										
Subsidy	43,560										
Aggregation	6,360										
Fee Abatement	0	4,225	4,479	4,748	5,032	5,334	5,654	5,994	6,353	6,735	7,139
Annual PreTax Cash Flows	(13,678)	4,225	4,479	4,748	5,032	5,334	5,654	5,994	6,353	6,735	7,139
Discounted	(13,678)	3,912	3,840	3,769	3,699	3,630	3,563	3,497	3,433	3,369	3,307
Cum Cash Flows	(13,678)	(9,766)	(5,926)	(2,157)	1,542	5,173	8,736	12,233	15,666	19,035	22,341

The discounted cash flows for 25% quartile, mid-range and 75% quartile projects for each SMP type (using the quartile cost ranges in Chapter 1, Figure 1.1) were considered under each policy scenario presented in the *Building a Greened Acre Market* chart. When a given **SMP quartile** achieved a discounted payback in less than 10 years, projects at and below that cost were considered to be economically viable for private investment.

The market size of ***New Potential Greened Acres*** (appearing in red at the bottom of Chart 1.4) increases as new SMP types become economically viable. For each SMP type, economic viability is added in quartile segments. When the 25% quartile boundary of a SMP achieves payback in 10 years or less, a quarter acre icon ( ) appears in the SMP row and 25% of the total green acres in that SMP category is added to the ***New Potential Greened Acres*** total. For example, at a $0.50 subsidy, the lower cost quartile of Rainwater Harvest & Reuse projects achieve discounted payback periods of less than 10 years. As a result a quarter acre ( ) appears in the Rainwater Harvest & Reuse row and 65 additional green acres (25% * 261) are added to the market size of economically viable greened acres. Note, in the marginal additional acres analysis presented in A3.1 above, that the additional acres provided by Rainwater Harvest and Reuse acres is 261.

A half acre bar ( ) indicates that the mid-range price project for a SMP became economically viable. This resulted in the addition of 50% of total project category to the ***New Potential Greened Acres*** total.

Finally, when the 75% quartile project for any SMP type became viable, it was assumed that 100% of projects were economically viable. A full acre icon ( ) would thus appear in the SMP Row and the full value of SMP Acres appearing in A3.1 above was added to the ***New Potential Greened Acres*** total.

Subsidy Policy Scenarios. For each of the subsidy policy scenarios presented, it is assumed that a Project Aggregation program has already been implemented and that each SMP is realizing 10% reductions in base capital costs as a result.

Total Greened Acres. This row presents the total potential market of economically viable Greened Acres created by the policies presented. The analysis presented assumes that the policies build upon each other from left to right. For example, the ***Total Greened Acres*** presented at the bottom of the Aggregation column assumes that an Offsite Mitigation program has already been implemented.

Progress towards Goal. The City of Philadelphia has a binding target of constructing 9,564 Green Acres within the next 25 years in an effort to reach their Clean Water Act obligations. The progress bar presented at the bottom of the chart represents the ***Total Greened Acres*** market size as a percentage of Philadelphia's target of 9,564 acres.

APPENDIX IV: CAP AND "ENHANCED CAP" ANALYSIS

PART I: CAP ANALYSIS

Memorandum

To: Erin Williams, Chris Crockett, (Philadelphia Water Department)

From: Alisa Valderrama, Larry Levine, and Starla Yeh (Natural Resources Defense Council)

Subject: Scenario Analysis for Proposed 10% Annual Stormwater Fee Increase CAP --

Potential to Decrease Incentives for Private Investment in Stormwater Retrofits

Date: February 28, 2012

Summary of Findings

We find that among the case studies provided by AKRF, on average the CAP program will reduce pre-tax IRRs for equity investments in stormwater retrofits by 32.3%. If we assume that the 32.3% average reduction in equity returns is representative of the broader universe of Philadelphia properties eligible for the CAP program, we can conclude that the CAP is likely to reduce the number of property owners who opt to undertake a retrofit.

Background

In order to ease the transition from meter-based stormwater bills to parcel-based stormwater bills, the Philadelphia Water Department opted to phase-in the parcel-based charges over a four year period (FY11-FY14). In addition, the Water Department created the Stormwater Assistance Phase-in Program (SWAPP) in order to provide temporary payment assistance to nonresidential properties that have been highly impacted by the transition to parcel-based billing. An eligible property owner opting-in to the SWAPP would have the total annual increase on the property's stormwater bill capped at 10%. The existing SWAPP program is set to expire in 2012, and the Water Department is now contemplating a renewal of the program, to be known as the "CAP" program.

As part of Philadelphia's transition to parcel-based billing, the opportunity for property owners to earn a substantial credit against their stormwater fees provides an incentive for property owners to retrofit their property and, from the perspective of potential third-party investors, creates a "cash flow" of avoided stormwater fees.[5] The returns to stormwater retrofit investors (both debt and equity) will be based largely on the "avoided stormwater fees" that result from the approved retrofit.

In order to better understand the impact of CAP on the level of private investment in stormwater retrofits, we conducted a simple comparison of the internal rate of return (IRR) for retrofit projects without the 10% per year cap in place, as well as those same projects if they were to participate in the CAP program.

IRR Analysis and Assumptions

To illustrate returns to property owners who invest in stormwater retrofit projects, we chose to conduct an IRR analysis, both with and without the proposed CAP, on the 27 retrofit case studies provided by AKRF to NRDC in 2011. For each property, we utilized the retrofit investment scenario ("high," medium," or "low") that, according to our models, yielded the highest return on investment without a rate cap. Under the "with-CAP" scenario, our analysis assumes that all CAP-eligible properties apply to the CAP program in Fiscal Year 2012, when the properties are already at 50% phase-in of the parcel-based fee, and are approved to enter the CAP program beginning in FY13.[6]

5 See NRDC, *Financing Stormwater Retrofits in Philadelphia and Beyond* (Jan. 2012) (http://www.nrdc.org/water/stormwater-financing.asp).

6 We applied the basic CAP eligibility requirement established by PWD -- *i.e.*, a property is CAP-eligible if, pursuant to the 4-year phase-in of the parcel-based charge, and after applying any credit for installing stormwater retrofits, it would have an annual stormwater fee increase of $100 and 10% per year. We assumed that properties meeting this core requirement would also meet any other relevant CAP requirements, such as being current on all PWD monthly bills.

In the prior analysis we undertook for our recently published "Financing Stormwater Retrofits" paper, we calculated IRRs for projects financed with 100% equity, projects financed with 80% debt, and projects financed 100% by third-party off balance sheet financing. For the present analysis, we aimed to provide PWD with estimates of the most near-term impacts the CAP program could have on private greened acres. On the rationale that debt and third-party financing for stormwater retrofit projects may be unavailable in the near term for the reasons we described in our Financing Stormwater Retrofits paper, for this analysis we modeled the returns to retrofit projects where 100% equity is provided by the property owner. (At the request of PWD we may analyze IRRs under the CAP program for debt-financed projects, in order to illustrate more directly the extent to which the cap on rate increases may reduce incentives for third-party or debt investment in retrofits.)

Our analysis assumed a 6% discount rate, a 5% per year stormwater fee escalation rate through 2016, and 6% stormwater fee escalation rate thereafter.[7] As per PWD's FY13-16 rate proposal, under the "with-CAP" scenario, the annual stormwater fee escalation would be additional to the 10% annual CAP increase, such that the total annual increase would be 15% through 2016, and 16% thereafter, until such time as the property "graduates" from the CAP (i.e., when the capped rate for that property meets or exceeds the uncapped rate).

For purposes of calculating IRR, we assumed an investment period of 12 years. Owing to the diverse tax treatment each of the case study properties would face in practice, we indicate pre-tax IRRs.[8] We also assumed annual operations and maintenance expenses equal to 0.95 % of the retrofit capital cost.[9]

Findings

Of the 27 AKRF case study properties, 18 met the CAP eligibility requirements. Of those 18 properties, without the CAP in place, ten financing scenarios produced pre-tax IRRs higher than 15%.[10] With the CAP in place, only seven financing scenarios produced pre-tax IRRs of higher than 15%, a reduction of nearly one-third.

Additionally, for the 18 properties, the average reduction in IRR resulting from participation in the CAP program is 32.3%, or about one-third. (More detailed summaries of this analysis are provided in the summary tables attached.)

If we assume that the 32.3% average reduction in equity returns is representative of the broader universe of Philadelphia properties eligible for the CAP program, we can conclude that the CAP is likely to reduce the number of property owners who opt to undertake a retrofit.

Additional analysis of the 27 case studies utilizing traditional debt or third-party off balance sheet financing models would likely indicate a higher number of properties in which the best-case investment scenario provides an attractive IRR, both with and without the CAP. However, with a larger number of properties presenting attractive investments in a debt-financed scenario, it may also mean that CAP would adversely affect the attractiveness of a larger number of retrofit projects, as compared to the findings from our analysis of 100% equity-financed projects.

Finally, we note that over 300 properties have already taken advantage of PWD's existing SWAPP program, with the 10% cap on annual increases applied when the properties were only at 25% phase-in of parcel-based rates. These properties would be starting from a lower baseline fee that would be subject to the 10% cap on annual increases under the new CAP program. Therefore, for the properties already participating in SWAPP, the CAP program would have a greater adverse effect on the incentives for debt- or equity-financed investment, as compared to the scenarios analyzed herein.

7 PWD provided a copy of its rate proposal for FY13-16. Although the annual rate increase in the parcel-based charges varied from year-to-year, the total increase over the 4-year period is equivalent to a compounded annual rate of approximately 5%. For years after 2016, PWD recommended that we assume a 6% annual rate increase.

8 In the Stormwater Retrofit Financing Paper, we were able to utilize actual tax rate estimates for Newman Paper provided by AKRF and were thus able to provide post-tax IRR details.

9 This is an estimate derived from the Newman Paper case study provided by AKRF.

10 While 15% is not a necessary hurdle rate that all investors require, it is one reasonable yardstick for what a typical investor (debt or equity) might consider a viable project.

PART II: ENHANCED CAP ANALYSIS

[Note: This memo is an updated version of an analysis presented in a memo from NRDC to PWD dated 2/28/12. In that earlier analysis, we examined the effect of the proposed "CAP" as defined in the PWD's original rate proposal for FY13-16. In this updated version, we examine the effect of the Enhanced CAP that PWD has more recently proposed.]

Summary of findings

Among property owners already participating in the existing SWAPP program (all of whom would have entered that program at the 25% or 50% phase-in stage of parcel-based billing), the Enhanced CAP is likely to substantially reduce the number of property owners who opt to undertake a retrofit. For property owners that did not participate in the SWAPP program but enter the proposed Enhanced CAP program at the 75% phase-in stage of parcel-based billing, application of the Enhanced CAP may not significantly reduce the number of property owners who opt to undertake a retrofit.

Specifically, we found that, among 27 retrofit case studies provided by AKRF, on average PWD's proposed "Enhanced CAP" program will reduce pre-tax IRRs for equity investments in stormwater retrofits by 41.4% for properties entering the program midway through phase-in of the parcel-based charge. This average reduction in pre-tax IRR attributable to the Enhanced CAP is 1.4 times as great as the reduction attributable to PWD's original CAP proposal. As alternative scenarios, we compared IRRs assuming the properties entered the CAP program at 25% phase-in of the parcel-based charge, and assuming they entered the program at 75% phase-in. These scenarios resulted in an 84.4% average reduction in equity returns, and a 10.2% reduction, respectively.

In each scenario, the Enhanced CAP reduced the proportion of properties for which an equity investment would realize at least a 15% IRR (a reasonable rule-of-thumb for a viable project). In the extreme, for properties that became subject to a "capped" annual rate increase at the 25% phase-in point of parcel-based billing (*i.e.*, pursuant to SWAPP, the precursor to the Enhanced CAP), application of the Enhanced CAP would eliminate nearly all viable investments at this time.

Background

In order to ease the transition from meter-based stormwater bills to parcel-based stormwater bills, the Philadelphia Water Department opted to phase-in the parcel-based charges over a four year period (FY11-FY14). In addition, the Water Department created the Stormwater Assistance Phase-in Program (SWAPP) in order to provide temporary payment assistance to nonresidential properties that have been highly impacted by the transition to parcel-based billing. An eligible property owner opting-in to the SWAPP would have the total annual increase in the property's stormwater bill capped at 10%. The existing SWAPP program is set to expire in 2012, and the Water Department is now contemplating a renewal of the program, to be known as the "Enhanced CAP" program.[11]

As part of Philadelphia's transition to parcel-based billing, the opportunity for property owners to earn a substantial credit against their stormwater fees provides an incentive for property owners to retrofit their property and, from the perspective of potential third-party investors, creates a "cash flow" of avoided stormwater fees.[12] The returns to stormwater retrofit investors (both debt and equity) will be based largely on the "avoided stormwater fees" that result from the approved retrofit.

In order to better understand the impact of the Enhanced CAP on the level of private investment in stormwater retrofits, we conducted a simple comparison of the internal rate of return (IRR) for retrofit projects without the 10% per year cap in place, as well as those same projects if they were to participate in the Enhanced CAP program.

11 "Enhanced CAP" refers to a modified version of the "CAP" program that PWD originally proposed in early 2012, at the start of the pending rate-setting proceeding. As compared to the originally proposed "CAP," the "Enhanced CAP" would even further limit the maximum annual fee increases for participating property owners.

12 See NRDC, *Financing Stormwater Retrofits in Philadelphia and Beyond* (Jan. 2012) (http://www.nrdc.org/water/stormwater-financing.asp).

IRR Analysis and Assumptions

To illustrate returns to property owners who invest in stormwater retrofit projects, we chose to conduct an IRR analysis, both with and without the proposed CAP, on the 27 retrofit case studies provided by AKRF to NRDC in 2011. For each property, we utilized the retrofit investment scenario ("high," medium," or "low") that, according to our models, yielded the highest return on investment without a rate cap. Under the "with-CAP" scenario, our analysis assumes that all Enhanced CAP-eligible properties apply to the Enhanced CAP program in Fiscal Year 2012, when the properties are already at 50% phase-in of the parcel-based fee, and are approved to enter the Enhanced CAP program beginning in FY13.[13]

We repeated the analysis under two alternative scenarios, the first assuming that the same properties apply to the CAP program in FY11 at only 25% phase-in (many properties have already been capped at this rate through participation in PWD's SWAPP program) and are approved to enter the CAP in FY12; and the second assuming that the properties apply to the CAP program in FY13 at 75% phase-in, and enter the CAP at that rate in FY14.

All of these analyses (regardless of the year a property enters the CAP) also assume that impervious area credits are available at a rate of 100% of the impervious area charge[14].

In the analysis we presented in our Feb. 2012 "Financing Stormwater Retrofits" paper (which does not account for the CAP), we calculated IRRs for projects financed with 100% equity, projects financed with 80% debt, and projects financed 100% by third-party off balance sheet financing. For the present analysis, we aimed to provide PWD with estimates of the most near-term impacts the Enhanced CAP program could have on private greened acres. On the rationale that debt and third-party financing for stormwater retrofit projects may be unavailable in the near term for the reasons we described in our Financing Stormwater Retrofits paper, for this analysis we modeled the returns to retrofit projects where 100% equity is provided by the property owner.

Our analysis assumed a 6% discount rate. As per PWD's FY13-16 rate proposal, under the "without-CAP" scenario, an annual fee escalation[15] of 5% through 2016 and 6% after 2016 was applied,[16] in addition to increases attributable in FY13 and FY14 to the continued phase-in of parcel-based billing. Under the "with-CAP" scenario (as per 6/8/2012 email from J. Dahme (PWD) to L. Levine (NRDC), describing the Enhanced CAP), a property owner's total annual increase would be limited to 10%, until such time as the property "graduates" from the CAP (*i.e.*, when the capped rate for that property meets or exceeds the uncapped rate).

For purposes of calculating IRR, we assumed an investment period of 12 years. Owing to the diverse tax treatment each of the case study properties would face in practice, we indicate pre-tax IRRs.[17] We also assumed annual operations and maintenance expenses equal to 0.95 % of the retrofit capital cost.[18]

Findings

Of the 27 AKRF case study properties, 18 met the Enhanced CAP eligibility requirements. Of those 18 properties, without any cap on rate increases in place, eleven had a best-case financing scenario that produced a pre-tax IRR higher than 15%.[19] With the Enhanced CAP in place, pre-tax IRRs varied greatly according to the point in the phase-in period at which

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13 We applied the basic Enhanced CAP eligibility requirement proposed by PWD -- *i.e.*, a property is Enhanced CAP-eligible if, pursuant to the 4-year phase-in of the parcel-based charge, and after applying any credit for installing stormwater retrofits, it would have an annual stormwater fee increase of $100 and 10% per year. We assumed that properties meeting this core requirement would also meet any other relevant Enhanced CAP requirements, such as being current on all PWD monthly bills.

14 PWD has indicated that in the future, impervious area credits may be granted at a rate of 80% of the impervious area charge, rather than at the current rate of 100%. However, PWD has also indicated that this new method of calculating the impervious area charge would include an 80% gross area credit, resulting in very little net change to the current impervious area credit approach. For this reason we assumed that 100% impervious area credit is available.

15 The "fee escalation" refers to the increased rates that all ratepayers would pay to meet PWD's increasing revenue needs, as distinct from increases for particular property owners that are attributable to the phase-in of parcel-based billing.

16 PWD provided a copy of its rate proposal for FY13-16. Although the annual rate increase in the parcel-based charges varied from year-to-year, the total increase over the 4-year period is equivalent to a compounded annual rate of approximately 5%. For years after 2016, PWD recommended that we assume a 6% annual rate increase.

17 In the Stormwater Retrofit Financing Paper, we were able to utilize actual tax rate estimates for Newman Paper provided by AKRF and were thus able to provide post-tax IRR details.

18 This is an estimate derived from the Newman Paper case study provided by AKRF.

19 While 15% is not a necessary hurdle rate that all investors require, it is one reasonable yardstick for what a typical investor (debt or equity) might consider a viable project.

the Enhanced CAP was applied (at 50%, 25%, or 75% phase-in of the parcel-based charge).

Our findings for each scenario are described below.

50% Phase-in Scenario

In the 50% phase-in scenario, only five of the 18 Enhanced CAP-eligible properties produced pre-tax IRRs of higher than 15%, down from 11 without the cap on rate increases, a reduction of greater than one half. This is greater than the approximately one-third reduction we have previously attributed to PWD's original version of the proposed CAP program, under which participants in the CAP would have been subject to a rate escalation of 5-6% per year *in addition* to a 10% annual increase attributable to the phase-in of parcel-based billing.[20]

Additionally, for the 18 Enhanced CAP-eligible properties we examined, the average reduction in IRR resulting from participation in the Enhanced CAP program is 41.4%, or just less than one half, for properties entering the program at 50% phase-in. Again, this represents a significant decrease in investment potential as compared to PWD's original version of the proposed CAP program; on average, at 50% phase-in of the parcel-based charge the Enhanced CAP was found to decrease the investment potential of the properties analyzed nearly 1.4 times as much as the original proposed CAP.[21]

25% Phase-in Scenario

In the 25% phase-in scenario, only two of the 18 Enhanced CAP-eligible properties produced pre-tax IRRs of higher than 15%, down from 11 without the cap on rate increases, a reduction of 81.8%. Among the 18 Enhanced CAP-eligible properties, we calculated an average reduction in IRR of 84.4% resulting from participation in the Enhanced CAP program.

75% Phase-in Scenario

In the 75% phase-in scenario, ten of the 18 Enhanced CAP-eligible properties produced pre-tax IRRs of higher than 15%, down from 11 without the cap on rate increases, a reduction of 9.1%. Among the 18 Enhanced CAP-eligible properties, we calculated an average reduction in IRR of 10.2%.

Conclusions

If we assume that the 10.2%, 41.4%, or 84.4% average reductions in equity returns exhibited respectively by the 75%, 50%, and 25% phase-in scenarios are representative of the broader universe of Philadelphia properties eligible for the Enhanced CAP program, we can conclude that, among property owners already participating in the existing SWAPP program (all of whom would have entered that program at the 25% or 50% phase-in stage of parcel-based billing), the Enhanced CAP is likely to substantially reduce the number of property owners who opt to undertake a retrofit. For property owners that did not participate in the SWAPP program but enter the proposed Enhanced CAP program at the 75% phase-in stage of parcel-based billing, application of the Enhanced CAP may not significantly reduce the number of property owners who opt to undertake a retrofit.

Additional analysis of the 27 case studies utilizing traditional debt or third-party off balance sheet financing models would likely indicate a higher number of properties in which the best-case investment scenario provides an attractive IRR, both with and without the Enhanced CAP. However, with a larger number of properties presenting attractive investments in a debt-financed scenario, it may also mean that the Enhanced CAP would adversely affect the attractiveness of a larger number of retrofit projects, as compared to the findings from our analysis of 100% equity-financed projects.

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20 *See* memo from NRDC to PWD dated 2/28/12. Our analysis of the "with-CAP" scenario under PWD's originally proposed CAP program, resulted in seven properties having financing scenarios with a pre-tax IRR of greater than 15%. (In that prior analysis, we assumed that CAP-eligible properties would enter the CAP program at 50% phase-in mark for parcel-based billing. Unlike the further analysis presented below in this memo, we did not, in that prior analysis, evaluate scenarios that involved properties entering the CAP at the 25% or 75% phase-in points.)

21 *Id*. In our analysis of the originally proposed CAP program, the average reduction in pre-tax IRR resulting from participation in the CAP was 30.0%.

APPENDIX V: THEORETICAL SUPPLY/DEMAND METHODS FOR ANALYSIS

The following is a report generated by AKRF – an environmental, planning, and engineering consultancy.

1.1. Residential Properties

To estimate the stormwater credit supply associated with residential property retrofits, AKRF selected a random sample of 20 residential parcels within the CSO boundary having a total impervious area from 1-97% of the gross property area (parcels with 98-100% impervious cover were specifically eliminated assuming these parcels would lack potential for relatively low-cost retrofits due to the paucity of pervious areas within which to locate treatment practices). Given this sample size, AKRF estimates that the margin of error associated with the analysis is approximately ±22%.

Within each subject property AKRF estimated the impervious area that could be managed using each of two potentially low cost retrofit alternatives, downspout disconnection and rain gardens. Because downspout disconnections have a significantly lower unit cost than do rain gardens, AKRF first identified impervious areas that could be managed using downspout disconnections and subsequently identified impervious areas that could be managed using rain gardens. Drainage patterns and potential management areas (e.g., rain garden locations, pervious areas that could receive disconnected roof runoff, etc.) were assessed using available GIS data and aerial photographs provided by PWD as well as online imagery including Google Maps and Bing Maps imagery. Field visits to subject properties were not performed. For downspout disconnections, AKRF checked to make sure that downslope pervious areas met PWD requirements for slope length and slope gradient. If slope length and gradient requirements were not met, AKRF did consider the potential for partial credit per PWD requirements. Rain gardens were sited in relatively flat, open, pervious areas of sufficient size (based on a loading ratio of 12:1 or less to manage adjacent roof areas). AKRF assumed that roof areas could not be subdivided or partially managed within rain gardens.

Unit costs for residential downspout disconnections and rain gardens were estimated to be $0.35 and $4.11 per square foot of impervious drainage area, respectively, for management of the first inch of runoff from directly connected impervious area (DCIA).[22] For disconnection, AKRF assumed that the homeowner would redirect the downspout onto adjacent permeable area using simple tools and a plastic elbow attachment costing approximately $50. For rain gardens, AKRF assumed that the homeowner or volunteers would perform infiltration testing, earthwork, and installation of a simple under drain system; and that landscaping and additional piping would be minimized. AKRF also assumed that minimal engineering services would be required to certify functionality and apply for credits, not to exceed $1,500.

1.2. Redevelopment Properties

To estimate the credit supply associated with redevelopment properties managing a surplus runoff volume, AKRF assumed that most properties will opt to manage stormwater using subsurface infiltration in order to maximize the property's usable area. To determine the unit cost associated with subsurface infiltration, AKRF obtained the construction costs and managed DCIA for several subsurface infiltration SMPs associated with recent redevelopment projects. Hunt Engineering, a local partner firm, provided cost data for subsurface SMPs associated with four large redevelopment projects at Temple University, the Pennsylvania State Police Barracks, Saint Joseph's University, and The Barnes Foundation, all located in Philadelphia. Project costs excluded design. To account for design and engineering services, AKRF added an additional 20% to the base construction cost for each project. AKRF added an additional $0.99 per cubic foot of static storage for haul off and excavation, as needed, for projects that did not include these costs in values reported by Hunt Engineering.

22 In Chapter 1 of this report, 25th and 75th percentile costs are also provided for residential downspout disconnections. The method used to derive those cost ranges is the same as explained in Appendix I for the derivation of subsurface infiltration, rain garden, and porous pavement cost ranges.

Approximately 1% of all DCIA in Philadelphia is redeveloped each year (PWD 2009). First, AKRF estimated the annual surplus runoff volume associated with managing an additional 0.5 inches of runoff from the estimated redevelopment DCIA within the CSO boundary. AKRF then calculated the approximate supply of off-site stormwater mitigation credit associated with this surplus volume, assuming that the surplus volume would be credited at the same rate as the first inch of runoff from DCIA (approximately $1.20 per cubic foot of runoff per year, or $0.10 per square foot of impervious area managed). AKRF applied the estimated unit cost for subsurface infiltration to estimate the annual estimated cost associated with generating offsite stormwater mitigation credit through managing an additional 0.5 inches of runoff within redevelopment sites.

1.3. Off-site Stormwater Mitigation Supply on Non-Residential Properties

In order to estimate credit supply associated with nonresidential properties, it was first assumed that relatively low-cost opportunities to manage more than 1 inch of runoff from onsite DCIA (or the 1 inch of runoff from public right-of-way DCIA) would be limited to large properties. This assumption was made because AKRF's current cost models suggest that, due to economies of scale, management costs of less than $12 per cubic foot (or $1 per square foot DCIA) are only possible when relatively large areas of DCIA (i.e., greater than roughly 8 acres) can be managed within a single facility with limited additional conveyance requirements (i.e., additional piping). Therefore, the investigation was limited to nonresidential, non city-owned sites within the CSO boundary containing more than 10 acres of impervious area (assuming that continuous drainage areas of 8 acres or more would be exceedingly rare in properties with less than 10 acres of total impervious cover). Of those properties, highly impervious properties (98% impervious or greater) were then eliminated due to the paucity of open space within which to site SMPs.

Within the list of candidate sites, AKRF identified potential cost-effective SMPs and drainage areas from both onsite (privately-owned property) and the adjacent street right-of-way (publicly-owned). It was assumed that cost effective options (i.e., those that could potentially generate salable credit) would be associated with vegetated surface practices (e.g., infiltration or extended detention basins, etc.) having an implementation cost of $1 per square foot of DCIA for 1 inch of runoff, or $12 per cubic foot of static storage or less. Using PWD aerial photographs, Google Maps™ Streetview photography, and Bing Maps™ birds-eye view photography, AKRF delineated all drainage areas that could feasibly be conveyed to and managed within existing green space, and subsequently eliminated all practices with drainage areas of less than 8 acres (i.e., for which estimated costs would be greater than $1 per square foot of DCIA for 1 inch of runoff or $12 per cubic foot of static storage).

Because feasibility assessments were conducted using remotely sensed products without the benefit of a field view or engineering drawings of each site, it was necessary to make some assumptions regarding the feasibility of conveying runoff from potential treatment drainage areas to the existing green space. Our assumptions were as follows.

- Drainage from the street right-of-way was limited to those areas that could be easily redirected via direct connection from a single inlet without additional piping in the right-of -way.
- In the absence of site-specific plumbing data for private properties, it was assumed that private plumbing followed topographic inclines.
- Ground-level DCIA was assumed to be accessible via the existing pipe network; it was assumed that limited additional piping would be required to convey runoff from existing storm inlets to the SMP.
- Runoff from roof drains in warehouse-type buildings was assumed to be conveyed within separate sewer systems prior to introduction to combined sewer systems external to the building. Therefore roof drains associated with warehouse-type buildings were included in the treatment drainage areas.
- Runoff from roof drains in office buildings and other similarly finished spaces were assumed to be comingled with sanitary flow at multiple points within the building and therefore unavailable for capture without significant additional re-plumbing costs. Therefore roofs associated with finished buildings were not included as a part of the identified treatment drainage areas.

AKRF estimated retrofit design and construction costs using a cost curve developed by AKRF based on design and construction costs for several recently built stormwater retrofit projects in Philadelphia. The cost curve, which is presented in Figure 1, relates implementation cost to static storage volume. Figure 2 presents the cost curve in terms of unit cost. Using the cost curve, the cost associated with managing the first of inch of on-site runoff was first determined. AKRF used the cost curve to estimate the total cost associated with both the first inch of on-site runoff and managing surplus runoff that could generate off-site credit (private runoff up to 1.5 inches and the first inch of runoff from adjacent right-of-way). The cost associated with off-site credit volume was then determined by subtraction.

Figure 1. SMP Cost per Square Foot of DCIA

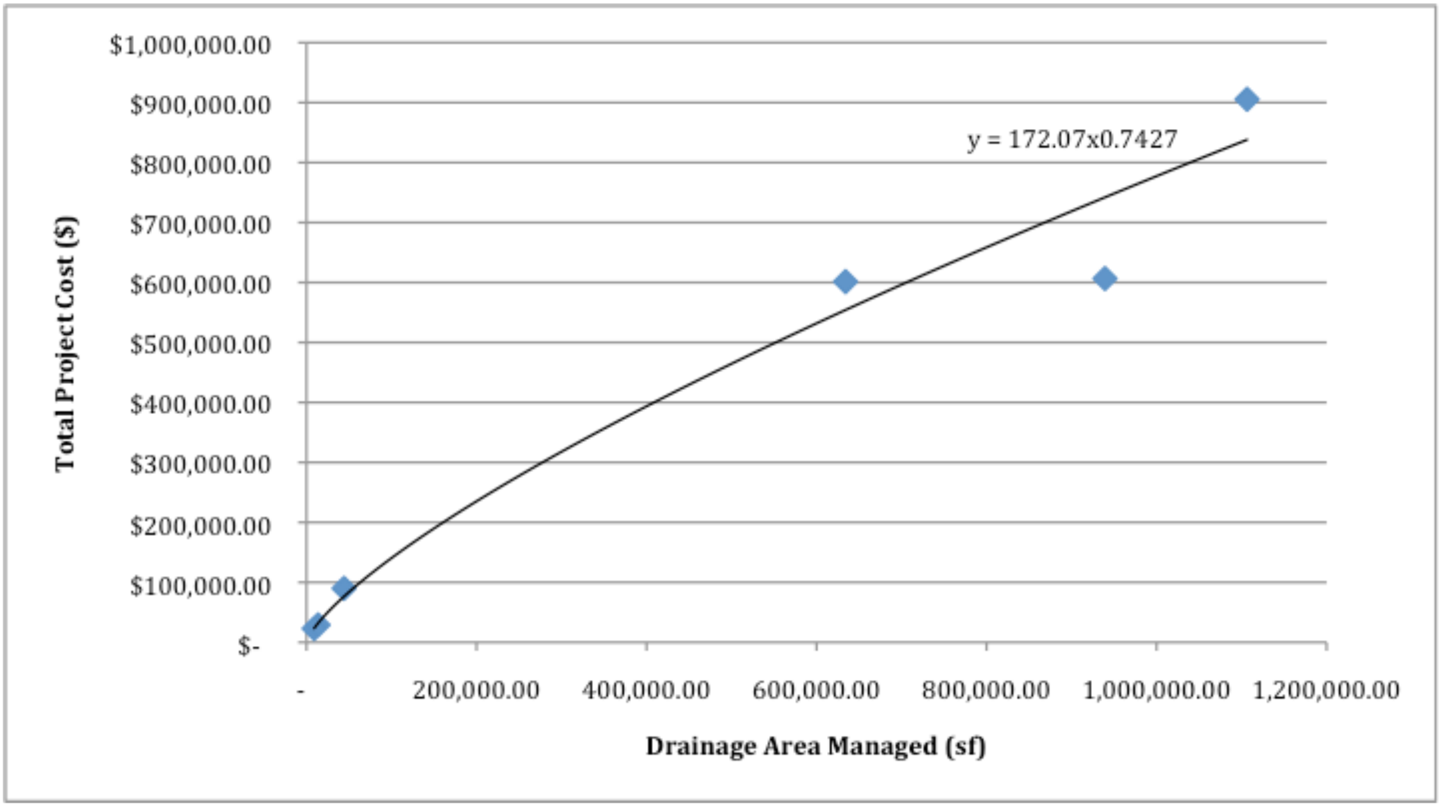
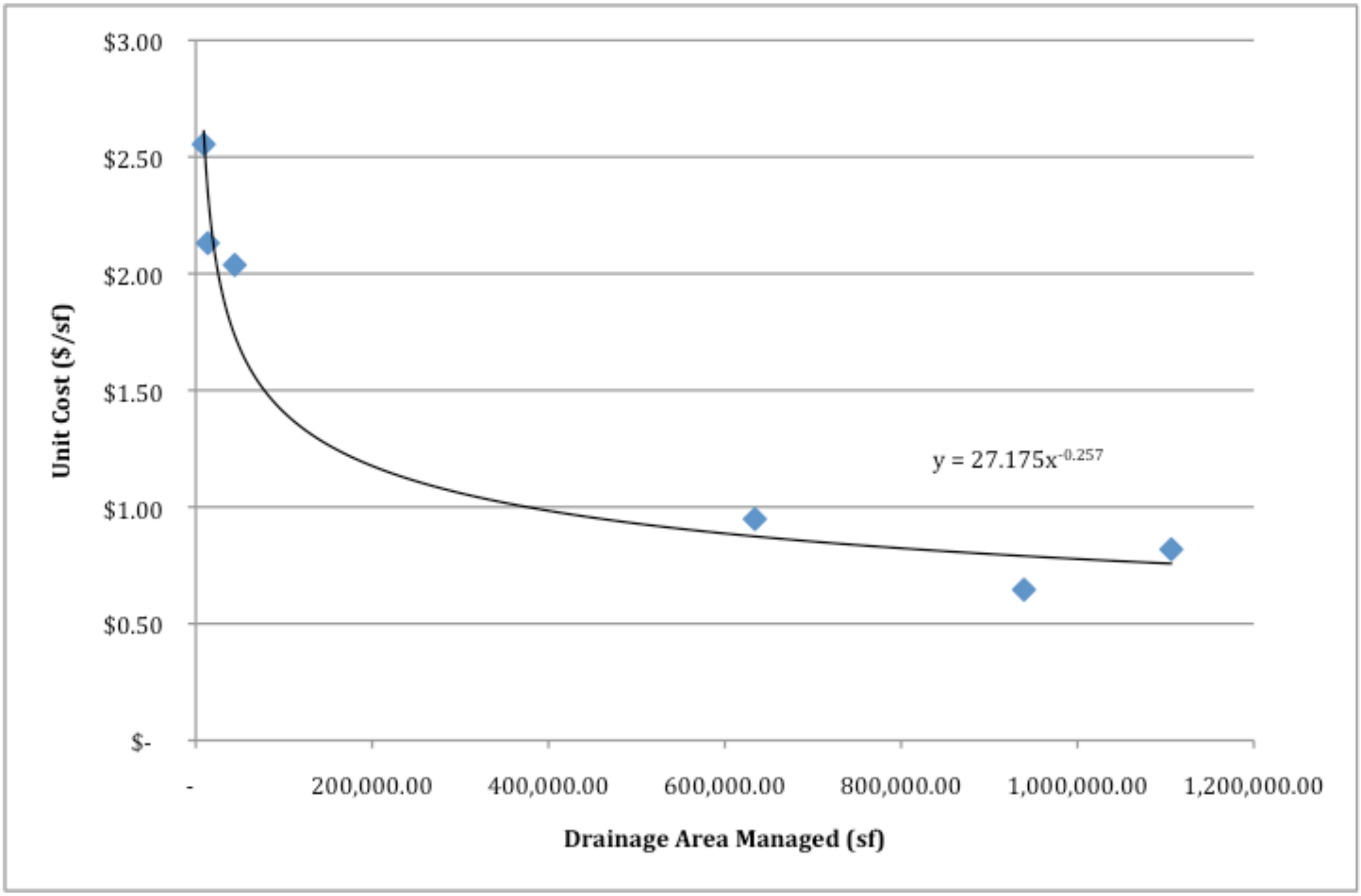


Figure 2. SMP Unit Cost per Square Foot of DCIA



Study Limitations

Cost estimates used for residential rain gardens (section 1.1) and for “non-residential projects” (section 1.3) are derived from an exponential cost equation based on drainage area that AKRF developed from in-house costs for built projects and detailed cost estimates. This cost equation was based on a limited data set of built projects. Despite the limited number of data points, however, AKRF feels that it is preferable to the literature unit costs for bioretention-type practices, which AKRF has found to be generally poor predictors of actual costs for bioretention-type practices in Philadelphia.

The study was limited further by the margin of error associated with using a sampling approach to estimate CSO-wide acreage and costs for residential SMP retrofits. As noted above, the margin of error for extrapolating characteristics of sampled residential parcels to the broader population of all residential parcels (Section 1.1) is approximately ±22%.