HIGH PERFORMANCE LANDSCAPE GUIDELINES

21ST CENTURY PARKS FOR NYC

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A PROJECT OF

DESIGN TRUST FOR PUBLIC SPACE

City of New York Parks & Recreation

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FOR NYC
A PROJECT OF THE
DESIGN TRUST
FOR PUBLIC SPACE
AND THE
NEW YORK CITY
DEPARTMENT OF
PARKS & RECREATION

These principles have guided the development of this manual. They represent the values of the New York City Department of Parks & Recreation. They are compatible with the Sustainable Sites Initiative, the work of American Society of Landscape Architects, the Lady Bird Johnson Wildflower Center at the University of Texas at Austin, and the United States Botanic Garden.

DESIGN

ENGAGE ALL USERS

- Create delight, in any of its forms — seasonal beauty, discovery, aesthetic beauty, and even whimsy.
- Determine and address the cultural and age preferences of neighborhood users.
- Strive to integrate uses so that they benefit each other, rather than causing conflict.
- Pay particular attention to adjacent sources of users.
- Exceed requirements for accessibility to ensure delight in forms that can be perceived by people of differing abilities.

ENGAGE NATURE

- Create parks that reveal a range of landscape types.
- Offer a diversity of ways to engage with natural environments, beyond strolling and viewing.
- Do not harm the ecology of the place.

RESPOND TO SITE CONTEXT

- Understand the historic design intent of the site and respect it.
- Understand the natural and historic importance of the site and interpret it.
- Understand existing microclimates.
- Create new microclimates to accommodate site uses, extend their season, and mediate climate change.

ECOLOGY

SUPPORT ECOLOGICAL FUNCTION

- Maximize the benefits of ecosystem services by preserving existing environmental features.
- Restore and regenerate lost or damaged ecosystem services.

INCREASE DIVERSITY AND INTERCONNECTIVITY

- Understand and preserve the complex relationships between soil, water, vegetation and fauna in each ecosystem.
- Strengthen the city's ecological functioning by increasing the diversity of park vegetation and habitat.
- Create linkages between individual parks and natural areas that enhance larger-scale ecological functioning.

ECONOMY

RESILIENCY

- Work to maximize the economic efficiency and productivity of all design, construction and maintenance.
- Include maintenance considerations in all designs to assure that projects will thrive without extensive repair and modifications.

PERFORMANCE

- Consider the long-term impact of material selection, including source and production methods, whether a material is recycled or recyclable, how the material can be maintained, its carbon footprint and embedded energy, and how long it will last.
- Work with maintenance staff to learn from past problems and increase serviceability.

SOCIETY

COLLABORATION AND PARTICIPATION

- Encourage direct and open communication and collaboration throughout the Parks Department and with other City agencies.
- Engage the public in a consultative process so that their knowledge of the site and recreational preferences are incorporated into the design.
- Assist in the development of community stewardship.

PUBLIC HEALTH

- Design parks that encourage active recreation and improve the health and well-being of city residents.

EDUCATION

- Design to inform the public about the critical ecological benefits of parks.
- Teach future generations about the importance of parks for the city's well-being.
- Effect a transformation of social priorities about ecological and economic objectives.

LONG-TERM THINKING

- Provide future generations with a sustainable environment supported by regenerative systems.
- Avoid consumption of resources that contribute to habitat destruction and global warming.

DESIGN TRUST FOR PUBLIC SPACE
http://www.designtrust.org/

NEW YORK CITY DEPARTMENT OF PARKS & RECREATION
http://www.nyc.gov/parks

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DESIGN TRUST PROJECT FELLOWS
Michele Adams, Meloria Environmental Design
Steven Caputo, NYC Mayor's Office of Long Term Planning and Sustainability
Jeannette Compton, NYC Department of Parks & Recreation
Tavis Dockwiller, Viridian Landscape Studio
Andrew Lavallee, AECOM Design + Planning

DESIGN TRUST STAFF
Megan Canning, Deputy Director
Jerome Chou, Director of Programs
Stephanie Elson, former Director of Programs
Deborah Marton, Executive Director
Chris Kannen, Production Assistant
Kristin LaBuz, Development and Communications Associate

EDITORS
Charles McKinney, Principal Urban Designer, Department of Parks & Recreation, Editor
Chelsea Mauldin, Executive Editor
Cynthia Gardstein, Steven Winter Associates, Inc., Technical Editor

BOOK DESIGN
Claudia Brandenburg, Language Arts

INDEXER
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HIGH PERFORMANCE LANDSCAPE GUIDELINES

21ST CENTURY PARKS FOR NYC

DESIGN TRUST FOR PUBLIC SPACE

City of New York Parks & Recreation

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PART II: SITE ASSESSMENT

PART III: BEST PRACTICES IN SITE PROCESS

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MAYORAL FOREWORD

New York is an international metropolis, known for its towering buildings, bustling streets, and cultural attractions. But what few people outside the five boroughs know is that New York boasts the greatest percentage of parkland of any large city in the country. From Prospect Park to the High Line, we're home to some of the best parks in the world — green spaces that not only provide our residents with a sanctuary from the stresses of city life, but have also long defined the character of our city and its neighborhoods.

In 1859, New York City invited visionary designers Frederick Law Olmsted and Calvert Vaux to create Central Park. They produced an unprecedented public amenity — and one of our city's most beloved open spaces. Today, we have the opportunity to once again set a new national standard for open space. With *High Performance Landscape Guidelines: 21st Century Parks for NYC*, we've created a new blueprint for how parks are designed, built, and maintained. The book is the product of a partnership between the New York City Department of Parks & Recreation and the Design Trust for Public Space, with contributions from numerous city agencies, park advocates, and designers. In it, you'll find best practices in construction and maintenance, material selection, and resource management — from soils to stormwater to vegetation. You'll also find guidelines for implementing the goals of *PlaNYC*, ensuring that our parks are more ecologically and economically resilient and helping to maintain our status as one of the most livable cities in the world, even as we grow by another one million residents by 2030.

Parks are a crucial component of the urban infrastructure that will help our city address the challenges of the twenty-first century. They're also a smart investment: they give our residents places to play and relax, clean our air and water, provide habitat for wildlife, and open up opportunities for all New Yorkers to learn about and enjoy their environment. As the city grows, parks become more important than ever before, and we hope to continue to create the parks that will be treasured for generations to come.

Michael Bloomberg
Mayor, City of New York

NEW YORK CITY DEPARTMENT OF PARKS & RECREATION PREFACE

We are currently engaged in the greatest period of park making in New York City since the 1930s. Over the next twenty years — a blink of an eye in city history — we will prepare New York City for another million people, and our parks and streetscapes will be ready to meet the needs of over 9.1 million residents.

The city will rely on all of the Parks Department's projects to play a larger role than ever before. Mayor Bloomberg has charged every city agency with specific goals to make New York City a leader in environmental responsibility and urban quality of life. His *PlaNYC* charges the Parks Department with providing more recreational opportunities to an increasingly diverse population, connecting our parks and neighborhoods with greenways, making our waters and waterfronts available for recreational use, establishing a park within a ten-minute walk of every home, and improving our local environment.

It is abundantly clear that the livability of our city depends on the extent and vitality of our park system. It is critical that the Parks Department create high performance landscapes — landscapes that can perform many functions at once. They must provide cleaner air, a cooler environment and sinks for stormwater, in addition to more opportunities for healthy activities including more extensive walking and biking. Twenty-first century parks will not only be beautiful places, they will be healthy ecologies. They will connect the many people who design, build, and take care of the city's open spaces so that each project is resilient and thriving.

The fellows of the Design Trust, the landscape architects and specialists of the Parks Department, and the experienced professionals of our operations division have worked together to prepare this manual for creating twenty-first century high performance landscapes in New York City, setting forth best practices for park design, construction, and maintenance. Landscape architects and architects will use this manual to accomplish the goals of *PlaNYC*, improve the environment, and meet the changing and increasing open space and recreational needs of New York City.

This manual grows out of an extraordinary effort, unique for a municipality, and is another step in the Parks Department's history of innovation. It will improve every one of our projects. I support its goals, and I encourage designers to work with a sense of urgency toward their implementation.

Adrian Benepe
Commissioner
City of New York
Parks & Recreation

DESIGN TRUST PREFACE

High Performance Landscape Guidelines: 21st Century Parks for NYC is the third installment in a trilogy of sustainable design manuals produced collaboratively by the Design Trust, a nonprofit dedicated to improving public space for all New Yorkers, and the City of New York. The previous publications, *High Performance Building Guidelines* (1999) and *High Performance Infrastructure Guidelines* (2005) — produced with the New York City Department of Design & Construction — culminated in dozens of innovative city-sponsored building projects and the enactment of local laws encouraging high performance construction. These publications also provided an essential resource to the Mayoral Task Force on Sustainability in the creation of the City's long-term sustainability plan, *PlaNYC*.

High Performance Landscape Guidelines: 21st Century Parks for NYC was the result of an extraordinary three-year partnership between the Design Trust and the New York City Department of Parks & Recreation. Visionary leaders at Parks including Commissioner Adrian Benepe and Principal Urban Designer Charles McKinney conceived and championed this manual. Working closely with Design Trust staff, five Design Trust fellows — Michele Adams, Steven Caputo, Tavis Dockwiller, Andrew Lavallee, and Jeannette Compton — guided the manual to its completion, receiving invaluable contributions from dozens of Parks employees from every division, and feedback from more than 40 city, state, and federal agencies and private-sector professionals who generously offered their thoughts as peer reviewers.

High Performance Landscape Guidelines codifies an important shift in how we as a city think of our parks. In the past our municipal landscapes were conceived to look a certain way and stay that way — that is, to provide a safe and beautiful setting for recreation. We need 21st Century parks in New York City to expand their function beyond recreation — to store and clean water, filter air, help improve public health, and provide habitat and biotic connectivity to increase biodiversity, in essence to become organic infrastructure. To achieve these goals, our conception and construction of parks needs to shift from park as end-product to park as work-in-progress, and as such, their capacity to improve our city's environment can and should increase over time.

This evolution will be incremental. Of course Parks constructs new landscapes from time to time, but for the most part the strategies described in this manual will be implemented little by little as a path, lawn, or drainage system requires renovation. Given that 14% of New York City land is parkland — about 29,000 acres in total — the cumulative effect of these incremental improvements will be profound.

To take one of hundreds of examples described in this manual: expandng the size of tree pits improves the health and survival rates of street trees. In the context of one tree, this may seem a quotidian directive, but applied citywide, it provides dramatic benefits. Street trees not only provide the shade and beauty that are vital to our quality of life, they reduce urban heat island effect, filter air, store stormwater, and sequester carbon. Ensuring the proper sizing of tree pits will save energy, reduce asthma rates, raise property values, reduce the environmental impact from transporting and planting new trees, and decrease stormwater runoff to the combined sewer system. By describing and compiling incremental upgrades that can be implemented at scale, this manual and the others in the Design Trust *High Performance* series will help New York's built environment contribute to our environmental health.

This paradigm shift in the way we engage the built environment must include not only buildings and parks and the agencies that produce them, but also the people who will use them. This manual outlines the methods and benefits of engaging local communities in every Parks project, inviting their participation in the design process, educating stakeholders about innovations that improve park performance, and recruiting them to be active stewards and advocates for parks citywide. This emphasis on participation not only results in better design, but also creates a new constituency that understands why a field is maintained as a meadow rather than a manicured lawn, and how the changes in a local playground or neighborhood park contribute to the overall health and well-being of the city's ecology and its more than 8 million inhabitants. New York City's public realm in the 21st Century will be shaped by the next generation of newly renovated and constructed parks, which in turn will need the support of an engaged and educated public. This manual aims to foster both.

Deborah Marton
Executive Director, Design Trust for Public Space

INTRODUCTION

This manual is the first of its kind in the nation. No other municipality has produced comprehensive guidelines for sustainable, 21st century parks. The best practices outlined in this manual will become Parks' standards — to be employed in every project — and will revolutionize how New York City's green spaces are designed, constructed, and maintained.

Because 14% of the land in New York City is city parkland, the environmental impact of even incremental changes in park construction materials and techniques will be enormous. Our 21st century parks must improve the ecological viability of our city while providing a better quality of urban life, to attract people to cities. And because New York City's Parks system is so prominent nationally, these guidelines will become a model for other cities around the country.

Our department faces three critical tasks. First, we must understand the soil, water, and vegetation at a scientific level, where each component is optimized for maximum performance and ecological benefit. Second, we must respond to the changing cultural and recreational preferences of each community and the fitness and public health needs of society, in ways that are socially equitable. As we are a city of immigrants, we must respond to various cultural and recreational preferences as our city grows. Third, we must collaborate with our operations staff and other agencies to design resilient parks that save labor, reduce annual expenses, and require less frequent capital replacement. Incorporating the perspectives and priorities of Parks' gardeners and maintenance workers in every Parks project early on will make these projects last longer and will result in more successful public spaces.

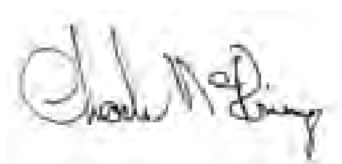
This manual provides a compendium of Best Practices to tackle these critical tasks. Each is presented in the same way, with an objective, a summary of the problem and solution, benefits and considerations, interrelationships with other best practices, and a bulleted description of tools to solve the problem.

The tools are divided into planning, design, construction, and maintenance sections, to make it easy for different professionals to see their role and to see how it is connected to all of the other work. This will help foster a culture of continuous innovation and integration, one where the most important meeting is a work session that includes planners, designers, and construction and operations staff who work together to find solutions. Few cities in the world match New York's level of park investment and professional design staff.

Most recommendations are practical and affordable. Others are more challenging, some because regulations lag behind the most forward-looking practices. All of the recommendations should stimulate new thinking and creativity. No doubt the manual will evolve as the Department builds on the Guidelines, gains knowledge through pilot programs, and tests new best practices. No doubt it will mean more work in the short term; we will need to expand our site analysis and testing, update our specifications and construction details, and correct things that don't work quite right. Ultimately, this manual represents a stage in the evolution of New York City park design.

We are thankful to the Design Trust, especially to the fellows of the Design Trust who gave us their best thinking and research efforts so that this manual could advance the profession. The Parks Department's talented and experienced Design staff, our Natural Resource division, and the Maintenance and Operations staff each integrated their best thinking and visions for 21st century parks in NYC. We greatly respect the work of the peer reviewers who reviewed early drafts of the manual, so we can say with conviction it represents as much as possible our shared goals and values.

New York City's determination to make and carry out long-term plans like the ones outlined in this manual are the source of its vitality and strength. Our extensive park system is one legacy of that type of forward thinking; it has shaped our identity and it will shape our future.



Charles McKinney
Principal Urban Designer
City of New York
Parks & Recreation

A radical invention when first conceived, Central Park has proven to be a vital piece of New York's green infrastructure. 21st Century parks will need to be as visionary, ambitious, and innovative as Central Park was.

PART I: CONTEXT

Part I provides an overview of the factors that have necessitated a change in park design practices, including mitigation of climate change and the implementation of PlaNYC. It describes the benefits of high performance landscapes, including their performance as a kind of infrastructure that contributes to the health of the city.

CLIMATE CHANGE AND 21ST CENTURY PARKS

In April 2007, Mayor Bloomberg released *PlaNYC*, a plan to improve New York City's urban environment and quality of life over the next 25 years. According to the plan, "Collectively these initiatives all address [the city's] greatest challenge: climate change."

Climate change threatens the stability and longevity of New York City's infrastructure, buildings, and parks; it also compromises the health and safety of the city's population. Unless the growth of greenhouse gas emissions is curbed and reversed, experts predict that climate change will result in significant sea level rise, increased storm intensity and frequency, and increased temperatures.

Two factors will exacerbate the impacts of climate change in New York City: the urban heat island effect and the city's overburdened stormwater infrastructure.

URBAN HEAT ISLAND EFFECT

Urban heat island (UHI) effect refers to the elevated temperatures that exist in highly urbanized environments. The presence of large areas of dark pavement and dense building materials causes extensive absorption of solar radiation during the daytime and re-radiation of heat at nighttime. This additional heat load increases air-conditioning use and energy demand — which leads to more greenhouse gas emissions — and it also reduces air quality. As the days grow hotter, the risks to public health increase, leading to a rise in heat-related asthma, strokes, other illnesses, and mortality. Currently the urban heat island effect elevates nighttime temperatures in the summer by 7 degrees in New York City.[1] By the end of the century, the combined effects of climate change and the urban heat island effect will, if left unchecked, triple or quadruple the days with temperatures over 90 degrees.[2]

OVERBURDENED STORMWATER INFRASTRUCTURE

Climate change will increase the frequency and intensity of storms. Even now, storms overwhelm the city's combined storm and sanitary sewer system, leading to flooding in low areas and discharge of untreated sewage in over 430 locations throughout the city. Over one half of the city is served by a combined sewer system.

Large areas of impervious surface — and low levels of vegetative cover — limit rainwater absorption. In the last century, the city's wetland area shrank by over 90 percent, and today three-fourths of the city's land area is covered with impervious surfaces.[3]

Increasing frequency and intensity of storms over the next century will necessitate comprehensive action to reduce stormwater runoff and minimize its impact on water quality. At the same time, New York City will have to plan for increased flooding due to sea level rise, which will periodically overtop shoreline properties and drainage outfalls.

NEW YORK CITY PANEL ON CLIMATE CHANGE: CLIMATE RISK INFORMATION

SEA LEVEL RISE

In the 20th century, sea levels rose over one foot in the Lower Manhattan Battery. Projections for sea level rise in this century are:

- 2 to 5 inches by the 2020s
- 7 to 12 inches by the 2050s
- 12 to 23 inches by the 2080s

GREATER STORM INTENSITY AND FREQUENCY

A "1 in 100 year flood" will likely occur four times more often by the end of the century. Projections for mean annual precipitation increases are:

- 0 to 5 percent by the 2020s
- 0 to 10 percent by the 2050s
- 5 to 10 percent by the 2080s

WARMER TEMPERATURES

Average temperatures in New York City rose 2.5 °F since 1900. In this century, mean annual temperatures are projected to increase by:

- 1.5 to 3 degrees F by the 2020s
- 3 to 5 degrees F by the 2050s
- 4 to 7.5 degrees F by the 2080s

PARKS AND CLIMATE CHANGE ADAPTATION

Healthy parks and landscapes provide a range of quantifiable ecosystem services including carbon storage, shading, evaporative cooling, air quality improvement, and stormwater management.[4] For these reasons, "greening the cityscape" is a central objective of *PlaNYC*. As the lead agency responsible for greening the cityscape, and as the steward of the city's 29,000 acres of parks and landscapes, the New York City Department of Parks & Recreation will play a critical role in mitigating and adapting to climate change.

According to a report prepared by the Columbia University Center for Climate Systems Research, planting along streets, in open spaces, on roof tops, and in other forms of "ecological infrastructure" has the greatest potential to reduce New York City's urban heat island effect. In fact, planting in these areas already decreases adjacent air temperatures by up to 5 degrees.

Ecological infrastructure can also play a major role in reducing flooding and combined sewer overflows (CSOs) by detaining and treating stormwater runoff. Parks planted with inundation-tolerant species can also serve as a buffer to inhabited areas, thus reducing the risk of flooding and storm damage.

Heavy rains overload the city's stormwater system. Reducing pavement or using porous pavement in hardscapes such as parking lots will reduce the likelihood of flooding.

FUTURE GOALS FOR CLIMATE CHANGE ADAPTATION

The NYC Department of Parks & Recreation intends to pursue the following goals:

- Collaborate with the USDA Forest Service to construct pilot landscapes to measure carbon capture and storage potential for different urban landscape types.
- Determine how citywide landscape management strategies could be used to offset municipal greenhouse gas emissions.
- Assess potential for urban landscapes to qualify as carbon sequestration offsets.
- Integrate park and landscape planning into the city's Climate Change Adaptation planning process.
- Assess the greenhouse gas liabilities of different strategies for dealing with dead or dying trees.
- Increase understory planting wherever possible to increase landscape biomass.

BENEFITS OF HIGH PERFORMANCE LANDSCAPES PARKS

New Yorkers value parks for many contributions to the public realm — as a green refuge from hard surfaces, as opportunities for recreation, as places to gather. Few people think of parks as infrastructure, a word usually associated with large-scale public works built of asphalt, concrete, and steel. But parks do the kind of work we rely on from urban infrastructure: like roads, bridges, and tunnels, parks help keep the city running.

The idea that parks are a kind of infrastructure is not new. More than 100 years ago, city officials in Boston recognized that parks could provide public health and engineering solutions to remove part of the burden from overwhelmed constructed systems. In the nineteenth century, the Back Bay (now one of the Boston's most desirable neighborhoods) was literally flooded with sewage during heavy rains. Frederick Law Olmsted, who had recently completed Prospect Park, worked with city officials to create a park that could absorb, store, filter, and release stormwater and sewage slowly, while also serving as a recreational amenity. The resulting Back Bay Fens used a complex system of underground channels, earthwork, and extensive planting to address Boston's problems. According to landscape designer and historian Kathy Poole, "Olmsted considered the constructed, park-like landscape of the Fens as a piece of infrastructure — a basic component of the urban fabric, a component that makes the city work."[5]

The interrelated challenges that Olmsted addressed in 1875 — public health and water quality, stormwater overflow, and the need for recreation opportunities for a heavily populated urban area — are still relevant in twenty first century New York and throughout the world. With the publication of *High Performance Landscape Guidelines: 21st Century Parks for NYC*, the New York City Department of Parks & Recreation embraces those challenges, and signals a paradigm shift in the way the City thinks about, designs, builds, and maintains parks. Because parks comprise 14 percent of the city's area, the potential environmental, social, and economic impacts of changes in park design, construction materials, and maintenance practices will be enormous.

Park landscapes provide valuable environmental services to the city: they store and clean stormwater, clean and cool the air, provide vital habitat for wildlife, and trap carbon emissions that contribute to global warming. Additionally, parks improve the city's quality of life by encouraging physical activity and offering psychological respite from dense urban neighborhoods. Finally, it is now well established that properly maintained and utilized parks improve the economic well-being of their surrounding neighborhoods. Optimizing the performance of New York City's parks will result in greater benefits in all of these areas.

ABOUT *PLANYC*

New York City's long-term plan and sustainability agenda, *PlaNYC*, outlines 127 initiatives for improving transportation, housing, open space, brownfield redevelopment, water, energy, and air quality. Among many environmental, social and economic initiatives, *PlaNYC* specifically calls for the improvement of underdeveloped park sites in all five boroughs, and articulates the significant and broad goals for the development of the city's parks and general landscape:

- Ensure that all New Yorkers live within a ten-minute walk of a park.
- Clean up all contaminated land in New York City.
- Green the cityscape.

In addition to these broad mandates, *PlaNYC* prescribes numerous specific policies that will guide park development in the coming decades, including efforts to:

- reclaim underutilized waterfronts
- open and redevelop schoolyards as public playgrounds
- increase options for competitive athletics
- complete eight underdeveloped regional destination parks
- provide more multi-purpose fields
- install new energy efficient lighting
- create or enhance a public plaza in every community
- promote green roofs
- promote cycling
- reforest targeted areas of our parkland
- increase tree plantings on lots
- capture the environmental benefits of the open space plan
- coordinate with other City agencies to create an Inter-Agency Taskforce to improve collaboration and efficiency in Best Practices (BPs) implementation, which has thus far resulted in the creation of the Sustainable Stormwater Management Plan

The Guidelines introduces a range of technical best practices, process improvements, and general strategies for achieving the ambitious goals of *PlaNYC*.

1 **Columbia University Center for Climate Systems Research, Climate Impacts Group. *Mitigating New York City's Heat Island with Urban Forestry, Living Roofs, and Light Surfaces*.**

2 **New York City Panel on Climate Change.**

3 **New York City Sustainable Stormwater Management Plan.**

4 **For example, the USDA Forest Service estimates that the 592,000 street trees in New York City are responsible for emission reduction and sequestration of 113,016 tons of CO_2, valued at \$27.8 million (\$6.68 per ton of CO_2,). The value of these services will likely increase if the United States implements a cap and trade system for carbon. Furthermore, the Million Trees initiative will greatly expand the carbon reduction potential of NYC's urban forest.**

This stormwater planter placed in a busy traffic intersection transforms an unused section of pavement into a high performance landscape that beautifies, infiltrates stormwater, and calms traffic.

LOOKING TO THE FUTURE: HIGH PERFORMANCE PARKS

The Parks Department now expects each one of New York City's parks to perform numerous ecological and social functions at the highest possible levels. These new expectations will require changes in attitude as well as practices. For instance, in the twenty first century, our shared understanding of urban landscape must include previously overlooked or neglected sites, including roadway medians and rooftops, abandoned railway tracks and former industrial areas.

The focus of this document is the urban landscape and its full range of open spaces, from planted traffic islands to urban forests, from pocket plazas to thousand-acre parks.[6] Parks should not be thought of as simply "natural" landscapes, because typically every aspect of a high performance landscape — the soils, the plants, the water levels, the installation — are as precisely engineered as a new bridge or road. High performance landscapes must be meticulously planned and seasonally orchestrated to get the most out of a limited parcel of land. They also require thoughtful, skilled, and ongoing evaluation and maintenance.

This manual emphasizes the design practices that are required to achieve this new standard of landscape performance. Hopefully, it will also help us reclaim the role of parks as a vital green infrastructure.

5 **Boston's Back Bay Fens: a Sectional Story, http://www2.iath.virginia.edu/backbay/fenssite/html/docs/story.html, accessed on July 15, 2010**

6 **Park buildings, such as recreation centers and pools, fall under other city guidelines and laws including the *High Performance Building Guidelines* and Local Law 86. Much work is being done within the Parks Department to improve the performance of even the smallest comfort station buildings. While these guidelines do not address buildings, they will improve their integration into the landscape.**

PART II: SITE ASSESSMENT

SITE INVENTORY & ANALYSIS

Designing any park begins with understanding the history, surroundings, and systems of a given site, including an analysis of water, vegetation, and soil resources. Part II outlines the site inventory and analysis necessary for all park landscapes. This upfront assessment of the site informs all elements of the design process to follow, and allows park designers to accommodate a site's natural carrying capacity when proposing program and use patterns.

INTRODUCTION

Site inventory and analysis are fundamental to designing and implementing park projects. Every park project involves modifying a given site to accommodate a given program. In order to determine the opportunities and constraints that will guide how the site is transformed, a designer must first investigate the existing conditions and capacities of the site.

This section offers three tools for practitioners. The first is a set of assessment guidelines that organizes site inventory into key categories (site history, site context, and site conditions) and then describes the process of site analysis. While the individual practices outlined here should be familiar to landscape professionals, this section is organized in a framework that emphasizes systems-based thinking and the interactive relationship between site inventory, analysis, and design goals.

The second tool is a checklist of site factors that should be considered on every project. While this is not an exhaustive list, and should not be treated as the only set of factors to be analyzed, it serves as a reference point for high performance landscapes.

The third tool comprises three detailed outlines of site assessment practices for soil, water, and vegetation systems.

GUIDELINES

SITE INVENTORY GUIDELINES

This book identifies three key categories for site inventory: site history, site context, and site conditions. Together, these categories lead a designer to consider the site at different points in time, at different scales, and in relation to multiple systems. Synthesis is then performed during site analysis.

SITE HISTORY

In a city as densely settled as New York, every site has a rich history of use and change. Was it a flood plain? Is there imported fill, a history of industrial use, previous activities that led to soil compaction, or loss of water courses? Understanding the many layers of an urban site's history — that is, how a site became the way it is now — reveals critical information that helps determine what can be created on the site.

SITE CONTEXT

Each site exists in relation to myriad systems that influence its performance. Where is the site in relation to its watershed and surrounding watersheds? What are the adjacent vegetation and habitat communities, and can the site be woven into a connected system? What kinds of infrastructure (sewer, water, power, etc.) run through the site? What are the circulation systems for bikes, pedestrians, automobiles, and service vehicles?

This category also addresses non-physical systems such as policy and permitting. For instance, which regulatory agencies (e.g., the State Department of Environmental Conservation or the Federal Army Corps of Engineers) have jurisdiction over the site, and what are the actions that will trigger their involvement (e.g., a requirement for a wetland permit)? What are the adjacent land uses and zoning regulations, and are these likely to change in the future?

SITE CONDITIONS

On the site itself, numerous conditions above- and below-ground will help establish physical, legal, and aesthetic parameters for developing a park project. For instance, an analysis of existing vegetation should determine, among other things, what is growing on site, whether that growth is healthy or not, and whether there are rare or extraordinary species. These findings provide important information about what is likely to grow well in the future, but should also help guide decisions about what should be preserved and what should be removed.

SITE ANALYSIS GUIDELINES

During site analysis, a designer begins to make qualitative judgments about the capacity of the site. Site analysis is also the point in the design process where the designer begins to evaluate the range of potential best practice strategies that may be appropriate for the proposed site and programming.

Key questions to ask at this juncture include: What sorts of planting strategies might be appropriate? What sorts of opportunities or constraints are there for on-site stormwater management? What are the capacities of the soils and/or do they need improvement? If there is soil contamination, what are the most cost effective remediation methods? How does the site fit into the larger constellation of parks within the local neighborhood, borough, or city?

Site assessment should identify existing high-value habitat and preserve its function for wildlife.

ASSESSMENT AND DESIGN

Site inventory and analysis are not one time exercises. In fact, the best park designs will result from an iterative process, where actual design solutions are tested once a proposed physical layout begins to emerge. Additional site inventory and analysis will need to take place prior to completion of the schematic design phase to confirm the appropriate location of specific site features. For example, once building locations are tentatively identified, borings will be required to design appropriate foundation systems. Prior to determining on-site stormwater feature locations, borings and test pits will be required to confirm depth to groundwater and bedrock, as well as infiltration and percolation rates.

SITE ASSESSMENT CHECKLIST

The following is a general checklist of items that should make up a first stage site assessment. See the practices sections that follow for more specific information related to soil, water, and vegetation assessment.

INVENTORY: SITE HISTORY

- past site use
  - industrial use
  - archeology
  - filling, dumping, other soil disturbance
  - existing or abandoned utilities
- historic topography
- historic soils
  - contamination
  - levels of contamination (relates to NYS and EPA assessment)
- historic drainage
  - lowland or upland
  - floodplain or wetland
  - history of flooding or erosion
  - historical movement of water through the site
  - historic vegetation
  - forest, wetland, or marsh
- key resources
  - historic maps (even hand-drawn maps that can be overlain on a base plan may indicate historic streams and springs)
  - historic site photos and other archival materials
  - historic aerial photos
  - names of places related to historic conditions or uses (i.e., "Yellow Springs" or "Stony Run")
  - oral histories provided by former maintenance workers and caretakers

INVENTORY: SITE CONTEXT

- social factors
  - user behavior
  - user desires
- circulation
  - pedestrian
  - vehicular
  - service
  - bicycle
  - mass transit
- views
  - on site
  - off site
  - bad views to be hidden
- hydrology
  - watershed
  - water table
  - wetlands
  - drainage patterns
  - surface water features
  - tidal conditions
  - neighboring context
  - sewers, whether combined sanitary sewers or stormwater sewers
- wildlife impacts
  - insects, fish, birds, land mammals
  - rare or endangered species
- landscape character
  - historic landscape
  - natural area
  - woodland
  - disturbed
  - formal garden
  - river corridor
  - wetland
- legal factors
  - zoning requirements
    - waterfront
    - parking area treatments
  - code requirements
    - required property line set backs
    - wetland delineations
    - floodplains restricting building locations or requiring elevations
  - utility or roadway easements
    - presence of mapped streets (NYCDCP restrictions)
    - waterlines (NYCDEP restrictions)
    - stormwater (NYCDEP restrictions)
    - private utility restrictions or suggested practices
  - roadway and utility offsets
    - streetlights
    - hydrants
    - driveways
    - corner off-sets
  - special natural area district (SNAD) requirements (Bronx and Staten Island)

INVENTORY: SITE CONDITIONS

- topography
  - slopes
  - low points
- soils/geology
  - geology, including depth to bedrock
  - subsurface and soil morphology
  - soil biology
- fertility analysis
- chemical analysis
  - percolation rates
  - hardpan
  - sinkholes
  - erosion potential
  - drainage rates
  - landfill or contaminated sites
- hydrology
  - existing streams and wetlands
  - setbacks and buffers, as necessary
  - floodplains and coastal erosion zones
- vegetation
  - existing vegetation
    - plant species
    - health of vegetation
    - plants as indicative of soil conditions
  - quality
    - rare
    - native
    - mixed native and/or invasive
    - invasive
  - trees
    - size
    - type
    - location
    - health
  - habitat presence
    - habitat type(s)
    - sort of habitat provided by plants
    - healthy and robust or unhealthy and stressed
  - understory types
  - stress indicators
    - small, scorched, or off-color foliage
    - early fall color or leaf drop
    - tip dieback
    - presence of insects or disease
    - suckering from the trunk
- climate
  - air quality, temperature, and humidity
  - sun/shade patterns and reflected heat
  - wind
  - precipitation rates for rain and snow
  - depth to frost
  - freeze and thaw
  - microclimate
  - fungus, mold, or insect problems
- urban
  - subsurface utilities
  - subsurface foundation remnants
  - subsurface transit ways
- noise

SITE ANALYSIS

- site opportunities and constraints
  - stormwater management
  - soil capacity
  - soil contamination
  - tree health and appropriate removals, pruning, and replacement
- design determinants and the capacity of the site to support program
  - appropriate planting strategies
  - fit of park into its larger context
- Best Management Practices to be applied
  - reduction of impervious surfaces
  - redirection of drainage to natural systems

SOIL ASSESSMENT PRACTICES

Soil testing is critical to achieving high performance landscapes. Soil characteristics are major factors in the health of vegetation and water management, and soil bearing capacity and soil contamination can be the largest design determinant on a project. All of these factors influence design, so it is necessary to determine soil conditions early.

It is important to consult with a soil scientist to tailor a site testing protocol. Soils must be accurately assessed to determine protection efforts, drainage rates, amendment requirements, and other characteristics. All urban sites should also be screened for contamination prior to the start of preliminary design. Site size is less of a determinant for amount of soil testing than site complexity. Visual inspection, site history and context, and discussions with locally knowledgeable people will strongly influence the number and types of tests needed.

SITE INVENTORY: HISTORY

Site soil history provides important clues to what may lay below the surface. Site history rarely indicates specific morphological information about soils, but it can provide valuable insights into anticipated problems. Site history can be useful in deciding which testing protocols to use. There are a number of resources that should be investigated:

- historic maps, including USGS maps (especially for projects along waterfront areas that may have been filled in over time)
- Sanborn and tax maps, which may show former street and building locations
- aerial photos (especially when taken over a period of decades), which can show changes in surface development
- historic surveys of the site, which may indicate the presence of easements that may have been created for utility or roadway construction
- historic surveys of surrounding streets, which can be good indicators of achievable depths of construction

These resources can provide information about buried subsurface utilities, railway beds, roadbeds, structures, waterfront bulkheads, and abandoned building foundations. They can also provide information about possible contaminating land uses, land filling, dumping, site grading operations, vegetation removal and shoreline and stream-bed manipulation. Of particular interest is information that may indicate potential problems with compaction, the movement of subsurface water, infiltration, percolation, soil pH, soil salinity, and soil contamination. Often times, site history can highlight specific locations for specialized testing to more fully inform preliminary site-planning decisions.

SITE INVENTORY: CONTEXT

It is difficult to draw firm conclusions about site soils from the surrounding context since soils can vary widely from site to site, even over relatively short distances. Since historic land uses vary across a site, it becomes complicated to draw broad conclusions about site soils. In general, the less a site has been manipulated over time, the more relevant site context information may be for soil considerations.

Hydrology, vegetation, and contamination are often coincident with site context. Hydrological context, even historic hydrological context, is a good indicator of drainage patterns and potential for alluvial soils, erosion, flooding and buried organic soils (as may occur with land filling over wetlands and marshes). Vegetative context is often informative of the underlying soil texture, chemistry, and nutrition of a localized area. If surrounding sites are contaminated, it is likely that there is contamination on the project site.

SITE INVENTORY: CONDITIONS

Site soil conditions should be evaluated qualitatively through on-site observation, and quantitatively through laboratory and on-site testing, to obtain a thorough understanding of a site's soil opportunities and constraints. Site soils are best explored prior to the start of a design and with the guidance of a soil scientist to ensure a thorough accounting of soil conditions. See *BP S.1 Provide Comprehensive Soil Testing and Analysis* for further discussion of requirements.

ON-SITE OBSERVATION

The design team should make a thorough visual analysis to identify potential soil problems, the need for more specific testing, or opportunities for design strategies.

VISUAL ASSESSMENT

Some things to look for:

- The presence and condition of existing pavements often suggest that the subgrade has been compacted as part of initial construction.
- Evidence of frost heaving, structural failures in pavements or walls, or sink holes may indicate poor subsurface drainage, past landfill activities with improper controls, or other types of previous site disturbance that may be contributing to soil subsidence.
- The presence of bedrock may indicate shallow soil depths and other subsurface complications associated with excavation, trenching, and foundation work.
- The disposition of drainage patterns and/or evidence of erosion can indicate general slope and stability of soils.
- Wet areas may indicate drainage problems, compaction, high water table, or susceptibility to flooding.
- The types and quality of vegetation are often very good indicators of underlying soil conditions, including compaction, drainage rate, pH, and general fertility.

TEXTURE ASSESSMENT

Use hand texture analysis to get a sense of the general soil types present on site. With practice, a site designer can gain an understanding of the soil texture sufficient to inform basic design thinking.

SOIL COMPACTION

Examine the site for evidence of soil compaction, including:

- worn or bare spots from foot or vehicular traffic
- excessive run-off
- poor plant growth including discolored or poor annual growth rates (as determined by intermodal observation), restricted plant rooting, excessive surface lateral root growth (with little, if any, penetration of roots into compacted layers), or flattened, turned, or stubby plant roots
- difficulty penetrating the soil with a soil auger or shovel

TEST PITS

Use test pits to observe soil conditions. These can be accomplished by hand or machine, depending upon the depths required or quantity of tests needed. Test pits should be dug to the anticipated depths and elevations of horticultural needs at final elevations (i.e., the depth at which the tree, shrub, and herbaceous roots will reach).

Test pits are extremely useful in that they quickly reveal:

- soil color, which is a good indicator of soil texture type, quality of drainage, and the presence of toxic materials (for example, soils that exhibit grey mottling are poorly drained)
- disposition of soil horizons (layers), indicating depths of topsoil and subsoil, evidence of soil disturbance, and the presence of compacted or hard-pan layers
- quality of the soil structure (the way soil aggregates into peds and fissures)
- presence of rubbish, debris, building materials, or other physical contaminants that may be detrimental to plants, be costly to clean up, and pose challenges to conventional earthwork operations

SOIL BORINGS

Use soil borings if structural or stormwater design work will be part of the proposed work. These are often required by code as a matter of course.

OTHER ON-SITE OBSERVATIONS

Other critical observations that can inform the design team about a soil's quality include:

- smell (foul smelling soils may be anaerobic, indicating poor drainage, or may suggest the presence of toxic chemicals)
- evidence of site disturbance or construction, including land filling, digging or grading of soils, and burying of topsoil
- evidence of physical or chemical contamination
- evidence of excessive salt use from roadways or inundation from tidal waters
- uses that lead to compaction, such a large crowd events, temporary parking, or sporting events
- elevation or structural adjacencies that will prevent proper drainage at horticultural depths, such as site and foundation walls, buildings, utility structures, and water bodies

LABORATORY TESTING

Quantitative analysis or lab testing of soils should include physical analysis, nutrient content and chemical analysis, compaction analysis, and biological testing to determine the quality of soil microbial conditions.

SUGGESTED PHYSICAL ANALYSIS

- USDA Textural Classification by combined Hydrometer Analysis of silts and clays and Dry Sieving of sands should be performed.
- Sand particles should then be analyzed as per USDA criteria (very coarse, coarse, medium, fine, and very fine sand gradations) to further determine how the soils may function.
- A textural test should also include a grain size distribution curve to graphically illustrate the soil make-up.
- Organic content
- Bulk Density

SUGGESTED NUTRIENT CONTENT AND CHEMICAL ANALYSIS

- pH
- Buffer pH
- Soluble Salts
- Total Nitrogen
- Nitrate Nitrogen
- Ammonium Nitrogen
- Extractable Nutrients (P, K, Ca, Mg, Fe, Mn, Zn, Cu, B),
- Cation Exchange Capacity

COMPACTION ANALYSIS

- Soil Bulk Density

SUGGESTED BIOLOGICAL TESTING

- Biological Organisms:
  - Active Bacterial Biomass
  - Total Bacterial Biomass
  - Active Fungal Biomass
  - Total Fungal Biomass
  - Hyphal Diameter
- Protozoa Numbers:
  - Flagellates
  - Amoebae
  - Ciliates
  - Total Beneficial Nematodes

NUMBER OF TESTS REQUIRED

For sites that appear uniform in both physical and vegetative cover, testing can often be covered by taking multiple samples and combining them into one soil composite. For more differentiated site conditions, multiple samples and composite samples will be required.

As part of the design process for a Bronx site with contaminated soil, Parks tested the impacts of planting Indian Mustard, a plant known to remove contaminants. This series of photos shows plant growth and uptake of toxins.

CONTAMINANT TESTING

Testing should be performed as indicated by site history and observed conditions. Check specific regulatory protocols for testing and reporting that need to be followed. See *BP S.5 Testing, Remediation, and Permitting for Sites with Contaminated Soils*.

ON-SITE TESTING

Quantitative analysis that should be undertaken in the field includes the following types.

COMPACTION

- measuring penetration resistance with a commercially available cone penetrometer or with in-place bulk density

DRAINAGE

- infiltration
- percolation/permeability as part of the test-pit program

SITE ANALYSIS

Soils analysis focuses on three main areas: design, remediation, and construction. Specific items for consideration are listed below.

DESIGN

- Are soils able to support plant communities and ecologies, based on textural analysis, drainage rate, pH, fertility or measured biological activity?
- Can soils support structures, walls, or other site features?
- If soils indicate deficiencies, are they suitable for stockpiling and reuse, or for rehabilitation (either in place or after stripping and stockpiling).
- If soils require significant remediation, or if they are of little value to the proposed program, would it be best to remove them from the site or bury them on site?
- Are there adequate depths and volumes of soil for the proposed site program?
- Are they sufficiently resistant to wear and compaction?

REMEDIATION

- How should contaminated conditions be remediated?

Options include:

  - isolation (soil capping with a warning layer)
  - containment (soil capping with a low-permeability membrane barrier and other methods)
  - removal from the site
  - fencing
  - on-site remediation

CONSTRUCTION

- Are soils susceptible to damage during construction, either through compaction, earthmoving, or other operations?
- What strategies for compaction protection, dewatering, limiting access, staging, or other means and methods are required to preserve the soil resources on site?
- See also construction and staging planning as described in *C.3 Create Construction Staging & Sequencing Plans*.

TESTING PROTOCOLS

The site conditions and proposed use of the site will determine the type and extent of soil testing. A site with a past history of industrial use or known potential contamination will require environmental quality testing to determine if a brownfield condition exists. Soils that are to be reused for planting and vegetation will require testing for nutrient content, pH, and soil structure. Soils to be used for infiltration or stormwater capture will require testing related to porosity and particle size. A soils scientist working as part of the design team is best qualified to determine the type and extent of specific soil tests needed on a site basis.

Below is a list of general soil testing standards that are recommended for use:

- American Society for Testing and Materials Standards and Methods
- Recommended Soil Testing Procedures for the Northeastern United States, 2nd Edition, Northeastern Regional Publication No. 493; revised - December 15, 1995; Agricultural Experiment Stations of Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont and West Virginia.

- ASA- American Society of Agronomy, Methods of Soil Analysis Part 1, 18th Ed. Revision 3, 2010.
- AOAC- Analyses by Association of Official Agricultural Chemists, Official Methods of Analysis

Note: While compost testing protocols are crucial to creating healthy soils, they are not part of the initial site analysis, but rather are tested as an amendment to existing soils. Please refer to the *BP S.4 Use Compost* for further information.

Below is a list of testing protocols to be used:

TEST TYPE	METHOD	USE
Soil Texture (Particle Size Distribution	USDA soil classification system	General
	Unified Soil Classification System (USCS) or AASHTO systems	engineering applications such as drainage systems, foundation soils, and pavement bases
	ASTM C136 - 06 Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates. (Dry Sieving)	aggregates used in structural soils, drainage, foundations or base courses
	ASTM D422 - 63(2007) Standard Test Method for Particle-Size Analysis of Soils (Hydrometer)	general engineering purposes
	ASTM D422 - 63(2007) Standard Test Method for Particle-Size Analysis of Soils (Hydrometer) NOTE: Amend testing to include the following sieve sizes to calibrate soil particle analysis with the USDA soil classification system: 4,10,18,35,60, 140,270	planting soils
	ASTM F 1632 - 03 Standard Test Method for Particle Size Analysis and Sand Shape Grading of Golf Course Putting Green and Sports Field Root zone Mixes	manufactured soils, sandy loams and courser soils
	American Society of Agronomy, Methods of Soil Analysis, Part 1 Pipette Method	naturally occurring topsoil, including silt and clay loams and other finer textured soils
Organic Content	American Society of Agronomy, Methods of Soil Analysis, Part 2 or Organic Matter by loss of weight on ignition, as described in Northeastern Regional Publication No. 493, p. 59	
Reaction (pH)	D4972-01 Standard Test Method for pH of Soils	
Nutrient Content	Analyses by Association of Official Agricultural Chemists (AOAC) Official Methods of Analysis or equivalent	
Soluble Salt Content	American Society of Agronomy, Methods of Soil Analysis, Part 2, 1986 or by the 1:2 (v:v) soil: water extract method as described in Northeastern Regional Publication No. 493, p. 74	
In-Place Bulk Density	American Society of Agronomy, Methods of Soil Analysis, Part 1, 1986	
In-Place Density	In-Situ Density: ASTM D2937 - 04 Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method or AASHTO T 180 Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) drop	can also be used during and after construction to determine contractor compliance with design specifications
In-Place Infiltration	Infiltration: ASTM D3385 - 03 Standard Test Method for Infiltration Rate of Soils in Field Using Double-Ring Infiltrometer	can also be used during and after construction to determine contractor compliance with design specifications
In-Place Percolation or Permeability	Methods of Soil analysis, Part 1 Hydraulic conductivity of saturated soils — field methods. Section 29-3.2, pp. 758-763. American Society of Agronomy, 1986 or ASTM D-2434	can also be used during and after construction to determine contractor compliance with design specifications
Soil Biology-population analysis	*Nematode Analysis:* This involves microscopic counting of different nematode types. Nematode populations include fungal, bacterial and root feeders, parasites and predators and *Food Web Analysis:* This analysis determines the numbers and types of protozoan, bacteria, nematode types, fungi, and actinomycetes.	population tests count the numbers and types of organisms in a soil

WATER ASSESSMENT PRACTICES

Water considerations for a park may include surface and storm water management, potable water needs, irrigation, water, and wastewater disposal. The presence or absence of water and related elements will affect decisions on the landscape design, the ability to infiltrate stormwater, and the ability to implement best practices. Design decisions for all water needs and water-related issues are informed by data gathered as part of the site inventory and analysis.

SITE INVENTORY: HISTORY

Review historic site conditions to identify previous drainage patterns, soil and vegetation conditions.

TOPOGRAPHY

What was the original topography of the site? Was the area originally upland or lowland? Was it once a wetland or floodplain?

- Areas of filled floodplain or high water table are likely to continually experience wet conditions.

Was it an upland area that was excavated?

- If the area was extensively excavated, topsoil may be lacking and bedrock may be at or near the surface and will affect site design and Best Practice selection.

What is the site's history of flooding, erosion, channelization, siltation, and sedimentation?

- If the site was once a stream valley, there may be many feet of fill material placed in the stream valley. It is likely that the original stream is buried in a pipe, the condition of which may be unknown, and that groundwater flow still moves along the path of the pipe bedding.

WATER FLOW

What water had been present at or flowed through the site?

- Very often streams were buried or culverted to become storm sewers or combined sewers. However, the geologic conditions that originally led to the formation of a stream and movement of groundwater are likely to still exist.
- Groundwater levels may be high or moving through the site along the former stream channel, which may affect both park construction and design decisions. For example, a high groundwater table could limit the use of an infiltration BP.
- Park designers may also wish to incorporate design components that remind users of "buried streams".
- Review the history of the site to determine development patterns and subsurface conditions including dumping, fill, and the potential for contamination.
- Examine areas where visible disturbance of historic hydrological patterns has occurred for potential contamination.

UTILITIES

Are there utilities related to past uses?

- In designing a new landscape, the presence of old utilities such as water or sewer lines that are no longer in use may affect both the construction and performance of BPs. Identify abandoned drainage and/or sewer lines where historic contamination might exist.

SITE INVENTORY: CONTEXT

DRAINAGE AREA

What is the watershed or drainage area of the site? Where is the site located within its larger drainage area?

- Identify the site's location within its watershed and map through Google Earth or city watershed maps.
- Sites located in the upper reaches of a watershed are less likely to have stormwater problems or flooding that originates off-site, and they are more likely to have better soils and conditions for infiltration.
- Understanding the issues of the watershed or drainage area — such as eroding stream banks, nutrient enrichment, and habitat loss — can inform design selections and contribute to watershed restoration.

NEIGHBORING SITES

What are the neighboring sites and conditions?

- Depending on adjacent land uses, the design of stormwater best practices may involve extensive structures or primarily vegetation and soil strategies. The site may be able to link water elements (such as stream buffers) or provide a water component that is missing in the area.
- Review the history of neighboring sites where sources of contamination could migrate onto the project site.

NEIGHBORING STRUCTURES

Are there adjacent building foundations, subway tunnels, or utility vaults?

- Depending on site conditions and project size, the design of stormwater measures must take into consideration potential impacts on adjacent structures.

SEWERS

Is the site served by combined sanitary and storm sewers or by separate storm sewers?

- Calculating and planning to capture runoff volume is important for water quality in both separated and combined sewer areas. If volume reduction is not possible, delaying the flow of stormwater to combined sewers will help to reduce the frequency and volume of combined sewer overflows into waterways.

TIDAL CONDITIONS

Is the site affected by tidal conditions, or are the sewers impacted by tidal conditions? Where is the water table?

- In older urban sites that were built along the waterfront, streams and wetland flows were often placed in pipes; in tidal areas, these pipes may include tide gates to prevent water from moving under the site. However, when this is either not the case or the tide gates have malfunctioned, water levels will vary. Understanding these conditions will inform the type and placement of BPs selected for the site.

ZONING AND CODE

How do the zoning and regulatory constraints relate to water?

- The site might be subject to floodplain high-water levels, a regulatory floodplain, or coastal zone setbacks. Additional issues related to mapped wetlands, steep slopes, protected habitat, or other regulations should be documented.

What code issues apply?

- Local codes may require that the downspouts or storm sewers connect directly to a public sewer. However, it may be possible to design stormwater systems that manage water on-site and only overflow to the public system.

SITE INVENTORY: CONDITIONS

An existing or new site survey is often the base map for park site design. This survey should include topography, hundred-year flood lines, wetlands, tidal setback lines, built features, trees, and existing utilities.

SUGGESTED CONDITIONS FOR MAPPING

The following information, when applicable, should be added to the base plan by the designer. Depending on the size, location, and typology of the park, not all information will be relevant.

HYDROLOGIC FEATURES AND FLOW PATHS

- existing streams and wetlands
  - Include any setbacks or buffers if applicable, preliminarily defined through NYSDEC and NWI wetland mapping resources.
- existing springs, seeps, and areas of flow drainage, such as swales
- mapped regulatory floodplains and areas of observed flooding
  - Floodplains are mapped on Flood Emergency Management Agency Flood Insurance Rate Maps.
- buried streams and seeps, or past historical water features of significance
  - Consult historic maps from USGS, the Army Corps of Engineers, and historic city infrastructure maps.

SUB-SURFACE CONDITIONS

- areas of well-draining soils or wet soils.
- any relevant information gathered from soils tests
- sub-surface soil, water, and geologic information
  - If structural borings or other tests have been conducted, map available information on the depth to water table, depth to rock, fill conditions, etc.
- all existing utilities

OTHER

- supplemental information
  - Any supplemental information gathered from review of historical or other documents should be included as available.
- areas of concern
  - Facility staff may indicate problem areas, such as wet basements, seeps, standing water, and localized flooding.

SITE ANALYSIS

Water analysis focuses on three main areas: absorptive capacity, surface permeability, and drainage. Specific items for consideration are listed below.

ABSORPTIVE CAPACITY

What is the absorptive capability of the landscape?

- Conduct bulk density testing to determine soil compaction.
- Conduct percolation tests.
- Conduct soil analysis to determine natural infiltration rates. Soil analysis can also determine if and what soil modifications are necessary to create an engineered soil mix that can absorb and filter water and also support the plants integral to system function.
- Assess surrounding infrastructure — including buildings, tunnels, and utilities — to ensure that infiltration areas do not compromise these structures.

SURFACE PERMEABILITY

What impervious surfaces exist, and where it is feasible to reduce or replace them with pervious surfaces?

- Examine street and sidewalk width requirements and reduce where possible, keeping site usage in mind.
- Assess parking requirements, and determine if peak loads can be accommodated with overflow parking using pervious surfaces.
- Consider replacement of asphalt or concrete pavements with porous pavements.
- Examine paving demands to determine minimum paving to meet need. In some cases, requested space may be larger than actually necessary, and paving can be reduced. In other areas, requested impervious land use may be inappropriate for a specific area. Propose a reduction or a new location for land use that better fits in with existing site hydrology.

DRAINAGE

Can drainage be redirected to natural systems or BPs?

- Determine if site drainage can be directed to adjacent Bluebelts or natural drainage systems or other stormwater best practice locations.
- Identify areas where there is erosion or over-burdened infrastructure, and find opportunities to detain or redirect the water.

HOW TO CREATE A WATER BUDGET

- For a 1-inch rainfall, estimate the increased volume of runoff as a result of impervious surfaces or manmade pervious surfaces compared to natural conditions.
- Estimate the amount of lost soil absorption as a result of impervious surfaces or manmade pervious surfaces:
  - Compare pervious and impervious areas for current conditions vs. proposed.
  - For undeveloped areas, impervious area should increase as little as possible while meeting design program goals.
  - For already developed areas, an increase in pervious area should be planned whenever possible.
- Estimate the amount of lost groundwater recharge.
- Determine estimated total precipitation onsite by month during the growing season.
- Review soil tests to determine soil type and infiltration rates.
  - Consider the use of soil amendments, which can be used to improve soil infiltration and available plant water.
- Evaluate the water requirements of the proposed design.
  - Be sure to estimate increased water demands during the establishment period.
- Determine if supplemental irrigation will be required, and, if necessary, determine the best options for supplemental water supply:
  - Consider on-site stormwater collection systems to supply supplemental water as required.
  - Review possibilities for stormwater collection from adjacent city property, such as sidewalks.
  - Consider greywater systems to supply supplemental water as required; note that re-use of greywater is subject to health regulations and requires proper filtration and monitoring systems to avoid damage to soil and plants.
  - Consider on-site, well-supplied water systems to supplement potable water, if available.

ADDITIONAL CONSIDERATIONS

- Identify areas of concentrated flow and erosion that are impacting natural hydrology.
- Develop a site preservation and protection plan:
  - See *D.3 Develop a Site Preservation and Protection Plan*
  - Locate construction activity zones. See *C.3 Create Construction Staging & Sequencing Plans*

VEGETATION ASSESSMENT PRACTICES

The existing trees and vegetation are a primary determinant of site character and future development. The health of the existing and surrounding vegetation can be used as indicators of site conditions to use in plant selection. The soils and water systems in a site, as well as the existing and desired programming for a park, will all influence decisions about plant choices and siting. To begin this process, an inventory of what exists and an analysis of vegetation condition is necessary.

SITE INVENTORY: CONDITIONS

SITE SURVEY

Prepare a site survey:

- Note existing trees over 6" Diameter at Breast Height (DBH) or 4.5 ft above grade within and immediately adjacent to the project limit lines. Show tree species and condition.
- Provide spot elevation grades at each tree base. Provide multiple spot elevations at trees on steep slopes or in cases of large caliper or multi-stem trees.
- Show only the outline of forest edges when they are not in the immediate project area.
- Show and note species for:
  - shrubs and shrub massings
  - grass lands
  - areas of invasive plants

VEGETATION REPORT

Engage the Capital Arborist, a certified arborist, or registered consulting arborist to prepare an existing vegetation report:

- Tag trees with weather resistant numbered tags and key existing tree tags to the tree assessment report.
- Calculate the Critical Root Zones for each tree based on the DBH, species tolerance to construction impacts, and age class.
- Create a CAD layer showing the tree ID number, the circle of the roots as modified by curbs, and other root obstructions.
- Estimate the tree height, canopy spread, and height of the lowest limb for each tree. This will inform design decisions regarding site access, view sheds, and other potential infrastructure and project conflicts.
- Estimate the age class of each tree, relevant to the life expectancy of species, where:
  - A tree estimated to be 20 percent of the species life expectancy is classified as "young."
  - A tree estimated to be anywhere from 20 percent to 80 percent of the species life expectancy is classified as "mature."
  - A tree estimated to be greater than 80 percent of the species life expectancy is classified as "over-mature."
- Note any special conditions or comments for each tree, such as stem decay, fungal fruiting bodies, disease, insect infestation, and any other potential areas of concern.
- For very large sites, map the individual trees near impacted areas or areas planned for construction; show the others as groups.

SITE ANALYSIS

Vegetation analysis focuses on three main areas: pruning needs, vegetation health, and vegetation appropriateness. Specific items for consideration are listed below.

PRUNING NEEDS

What are the pruning needs of each tree? Use the ANSI A-300 Pruning Standards:

- clean where dead, diseased, and/or broken branches are removed
- raise where branches are removed to obtain a specified clearance
- reduce where branches are removed to decrease the canopy spread and/or height
- thin where branches are selectively removed to reduce canopy density
- structural where branches are selectively removed to improve the branch architecture and structural integrity of the canopy
- restoration where branches are selectively removed to redevelop a canopy structure, form, and appearance that has been severely compromised by previous pruning, vandalism, or storm damage

VEGETATION HEALTH

How healthy is the existing vegetation?

- Use the Council for Tree and Landscape Appraisal (CTLA) Condition Rating system to assess vegetation.
- Include the structure and health of the roots, stem, and structural branches — as well as the smaller branches, buds, and foliage — on a standard scoring system.

VEGETATION APPROPRIATENESS

Is the vegetation appropriate for the site? Consider the following qualities:

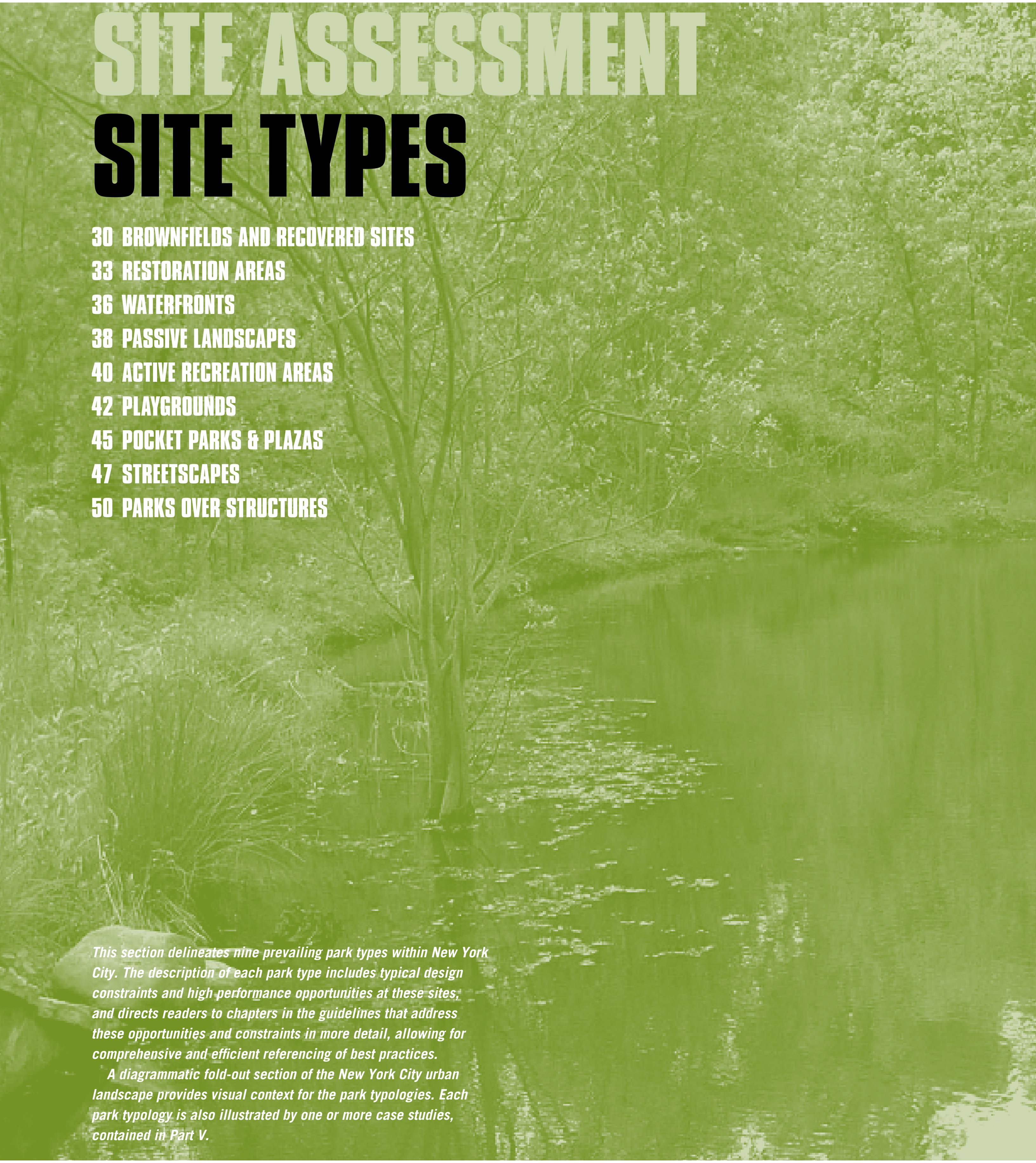
- growing conditions
- invasive tendency
- harm to other plants
- habitat value
- scenic value

What are the design goals for building on and enhancing existing vegetation? Consider the following options:

- allées
- planned groupings
- view filters and corridors

PART II: SITE ASSESSMENT

SITE TYPES



This section delineates nine prevailing park types within New York City. The description of each park type includes typical design constraints and high performance opportunities at these sites, and directs readers to chapters in the guidelines that address these opportunities and constraints in more detail, allowing for comprehensive and efficient referencing of best practices.

A diagrammatic fold-out section of the New York City urban landscape provides visual context for the park typologies. Each park typology is also illustrated by one or more case studies, contained in Part V.

INTRODUCTION

This section describes the opportunities and constraints found within nine major types of parkland in New York City:

- BROWNFIELDS AND RECOVERED SITES
- RESTORATION AREAS
- WATERFRONTS
- PASSIVE LANDSCAPES
- ACTIVE RECREATION AREAS
- PLAYGROUNDS
- POCKET PARKS AND PLAZAS
- STREETSCAPES
- PLANTINGS OVER STRUCTURES

While this list is not exhaustive, it does include a majority of the parks within the city. Large parks are usually made up of a collection of site types. As park design is complicated — and priorities must be established — it is hoped that these site type descriptions can guide designers to the concerns and Best Management Practices that are most relevant for each type of park. For instance, brownfields shift the priority of the design effort to soil remediation, pocket parks focus on the impact of surrounding buildings, and waterfronts emphasize shoreline conditions.

See also *Part V: Case Studies*, for examples of best practices within each of these site types, descriptions of project challenges, and lessons learned.

BROWNFIELDS AND RECOVERED SITES

Many properties acquired for park development by New York City are brownfields and recovered sites, including industrial areas, former municipal solid waste facilities, and historic fill disposal sites.[7] Unlike a park that is built on noncontaminated land, these sites often require remediation or other site preparation measures to ensure the safety and health of the public.

Even more so than other urban park sites, the success of brownfield and recovered sites as parks depends not only on their design, but also on the quality of the project manager's strategy for environmental regulatory compliance and that strategy's implementation. The design process for compromised sites is not straightforward nor is it linear, but it is an iterative process that begins with an environmental investigation.

Once the site soil contaminant levels have been assessed, the park design must take into consideration the costs and the time required to obtain approvals and remediate the park. Development of brownfield and recovered sites is regulated by various public agencies, including the US Army Corps of Engineers (US ACE), New York State Department of Environmental Conservation (NYSDEC), New York City Department of Environmental Protection (DEP), and the Mayor's Office of Environmental Remediation (OER). In addition, Parks Department development projects may be reviewed by the Department of Health and Mental Hygiene (DOH). Regulatory approval time frames are lengthy, and the additional measures required to make the site safe for public access can represent a large percentage of the park construction budget. Almost every stage of work, and the materials and methods used, will need approval by NYSDEC, DEP, and/or OER.

Factors that affect the environmental regulatory strategy and park design are presented below. If additional guidance is needed, contact the New York City Department of Parks & Recreation's Capital Projects office or the Mayor's Office of Environmental Remediation.

PRIORITY CONSIDERATIONS

There are six major considerations when working on contaminated land: selecting a design based on site conditions, limiting the amount of excavation, anticipating soil costs, locating park features strategically, anticipating security measures, and seeking sustainable design opportunities.

DEVELOP A DESIGN BASED ON SITE CONDITIONS

Determining which park features and designs are appropriate, cost effective, and sustainable will depend on which contaminants are found, their concentrations, and their depth.

- Applicable New York State regulations covering soil cleanup objectives for brownfields and recovered sites [i.e., 6 NYCRR Part 375-6(b), found at http://www.dec.ny.gov/regs/15507.html#15513] specify allowable concentrations of contaminants and depth of contaminants for various park recreational use types.
- The most restrictive objectives are for active recreational uses (e.g., ball fields, children's play areas) with a depth of contamination concern at 2 feet.
- Less restrictive objectives may be used for passive recreational uses (e.g., walking paths) with a depth of contamination concern at 1 foot.
- Nature-based recreational uses are not included in these regulations, so the Parks Department assumes that contamination in these areas may remain as long as a fence or other barrier directs the public away. However, habitat may not be created in areas of high contamination because of potential harm to wildlife.

LIMIT THE AMOUNT OF EXCAVATION

Excavation on brownfields or other compromised sites requires testing and special disposal of the contaminated soils. Please refer to *BP S.5 Testing, Remediation, and Permitting for Sites with Contaminated Soils* for further information.

- The discovery of hazardous waste (i.e., lead, mercury, or PCBs) will require excavation and removal.
- It is often less costly to leave the non-hazardous, but still contaminated, waste soil in place and cover it with clean fill. Four to six inches of mulch or clean soil may be adequate cover in this situation depending on the site and its future planned use.
- Excavating soil and/or waste from capped landfill areas requires significant regulatory review and should be avoided.
- A highly visible demarcation layer, such as orange plastic construction fencing, should be placed on top of impacted, in-place soils in order to prevent comingling of contaminated and clean fill. This layer can also limit the exposure of park employees or contractors to potential hazardous materials when performing maintenance activities.
- Contaminated soil that is removed or displaced during maintenance activities should be segregated and managed accordingly.

ANTICIPATE SOIL COVER COSTS

Adding clean fill soil on top of existing soils is often the easiest way to ameliorate sites. To contain costs, evaluate the soil depth and quality of soil required to cap park sites, and question the sources of clean fill used for these measures. In practicing sustainability, healthy land should not be robbed to heal compromised land. However, unless the existing soils are demonstrated to meet the Part 375-6(b) standards, NYSDEC and OER typically require the addition of 24 inches of soil to the entire area that is publicly accessible. This requirement can consume a significant portion of the construction budget.

- Be strategic in locating your contract limit line to maximize the park value within the smallest footprint by minimizing the need for imported clean fill.
- Impermeable pavements are also acceptable as cover material for contaminated soils. Use of impermeable pavements must be carefully assessed as often they lead to more stormwater runoff, increased urban heat island effect, and lack of vegetative cover.
- Investigate the possibility of using phytoremediation to reduce soil contaminant levels.
- Consider the depth of planting soils that will need to be added.
- Existing vegetated or wetland areas may not require additional soil cover if it can be established that these areas are not accessible by the public or that adding soil will negatively impact the existing natural area. For example, more than 6 inches of fill over roots will kill most trees. In those cases, a low fence or planting may be used to direct traffic away from the area.
- Transportation is a large portion of soil cost, so find sources of fill material that are close to the site.
- Investigate whether soil can be barged to a location close to the site to reduce the amount of truck traffic required.
- Look for fill material source, such as infrastructure and park construction projects, that do not require the destruction of greenfield sites.
- Take advantage of landscape views outside your remediated area to increase the perceived area of the remediated area, using areas that are fenced because they have yet to be remediated.

LOCATE PARK FEATURES STRATEGICALLY

Constructing a park on a brownfield or landfill site imposes many more constraints than those found on noncontaminated sites. Careful consideration should be given to locating features so as to offset site contamination or structural issues.

- For landfills, putting structures with deep footings or pile foundations on top of the capped landfill mound requires extensive review and may ultimately be denied. Rather, place buildings and other structures with deep foundations in uncapped areas.
- Though studies have shown that tree root systems do not typically penetrate the landfill capping membrane, a

minimum 36-inch planting soil depth on top of a landfill may be necessary for tree planting.

- Choose trees that have shallow lateral root systems over capped landfills so as to not penetrate the engineered clay cap.
- As containment, place necessary impervious features, such as parking lots and play courts, over non-hazardous (but contaminated) soils.
- Use a vegetated buffer to filter surface water runoff from uncapped waste areas and control contaminants from entering adjacent water bodies.

ANTICIPATE SECURITY MEASURES

Brownfields and landfills require a higher level of security than noncontaminated park sites because of concerns for chemical exposure risk and potential damage to landfill infrastructure features. Typically, areas that are not remediated or that do not have NYSDEC or OER approved soil cover need to be fenced off from the public.

- Locate fences in hidden areas, such as depressions or behind tree lines.
- Make the fence a design element.
- Screen fences with vegetation.
- Harden the fencing or barriers where possible.

SEEK SUSTAINABLE DESIGN OPPORTUNITIES

Often brownfields and other similar sites have interesting former uses — and relics of that use — that can be utilized in the park design.

- Reuse existing structures as park amenities or sculpture (e.g., Concrete Plant Park and Gantry Park).
- Select the types and numbers of park features that minimize soil disturbance and take advantage of existing grades and contours, thereby saving cost of offsite disposal and importing soil.
- Reference the history of the site through the proposed materials and layout (e.g., Elmhurst Gas Tank Park).
- Interpretive signage can be used as an educational feature to describe the site's history, remediation, and conversion to a park.

7 **A brownfield site is one that receives incentive funds for environmental remediation, without which the site developer would likely not entertain the cleanup. Recovered sites can be almost any other site requiring remediation, including such small scale efforts as the placement of mulch over soil in an urban park with passive recreational uses.**

RESTORATION AREAS

New York City parkland includes close to 12,000 acres of forests, scrubland, meadows, fields, riparian corridors, freshwater wetlands, and intertidal marshes. Although some of the most majestic of these areas are located in large, well-known parks, such as Pelham Bay and Inwood Parks, many of these areas are fractured, isolated in smaller parks across the city, and in various conditions.

Whether they are one of the designated 8,700 acres of preserved and protected Forever Wild lands — or an undesignated hill slope, swale, or streambank that connects to and protects downgradient soil and water resources — these restoration areas must be given careful consideration. They include remnant pieces of New York landscape that provide open space, greenery, and habitat.

In this manual, the term “restoration” does not necessarily mean restoring something to a previous state. Current conditions may no longer support the vegetation or drainage systems that existed in the past. Restoration is used here to refer to improving the ecological functions of a site to the maximum degree possible.

PRIORITY CONSIDERATIONS

PROTECT AND CONSERVE RESTORATION AREAS

Restoration areas should be protected.

- Place barriers to prevent dumping or car and all terrain vehicle access.
- Minimize development of hard surfaces, including bike trails and boardwalks, and strategically place them to avoid dissecting, diminishing, or disturbing preservation areas.
- Regulatory requirements restrict shading from elevated walkways and structures.

IDENTIFY THE ECOLOGICAL COMMUNITY AND ITS GENESIS

The type of vegetation community present in a restoration area, whether forest, shrubland, meadow, stream, tidal marsh, or wetland, will guide the restoration design for adjacent sites

Restoration of Aurora Pond in Queens included natural edge plantings to stabilize the shoreline. Adjacent bioswales reduced erosion and directed runoff to the pond.

and the design and construction practices required to protect the community. Designers should be familiar with the extent and history of disturbance at the site. Imported soils, the elimination of a surface water source, or nutrient inputs can drastically change the structure and function of the site flora or fauna, and these changes may or may not be reversible.

- Discuss the site history with park supervisors, Forestry, Natural Resources Group (NRG) staff, "Friends of" park groups, and local experts to learn about the current ecology of the site.
- Examine historical maps.
- Review available Lands Underwater mapping available from the State Office of General Services (OGS).

UNDERSTAND THE SITE PROCESSES AND SOILS

Whether designing to avoid impacts to a restoration area or to restore an ecological community, conduct the analysis needed to understand the dominant site processes and how the design could influence them. Processes to consider include:

- hydrology
- biotic vectors
  - Where do the plants and animals in the natural area come from?
- biogeochemical
  - What are the erosion and microbial processes that affect water quality, soil conditions, and vegetation? Soil conditions need to be evaluated as a basic component of this assessment. For further guidance, see the Soil Assessment Practices section above, and the technical references.

PROVIDE OPPORTUNITIES FOR PASSIVE RECREATION THAT MINIMIZE IMPACTS TO SENSITIVE NATURAL RESOURCES

- Seek opportunities to view restoration areas, but limit direct physical access.
- Restrict access to restoration areas through fencing or natural barricades, such as logs.

SEEK INPUT ON AND PROVIDE OPPORTUNITIES FOR ENVIRONMENTAL STEWARDSHIP

Often local citizen stewards will have valuable information on the restoration area. Contact them, build partnerships that will improve your understanding, and develop opportunities for existing or new stewards to protect restoration areas.

- Consult the Natural Resources Group and the Borough Commissioner's office to learn of existing restoration efforts and volunteer groups.
- Meet with Partnerships for Parks to find community groups in the area that may have an interest in helping to preserve restoration areas.
- Make connections with nearby schools to work with educators on incorporating environmental education into their curriculum.

IDENTIFY OPPORTUNITIES FOR ECOLOGICAL AND CONSERVATION RESEARCH

- By seeking input from the Parks Department's Forestry and Natural Resources Group science team, and other senior designers, valuable site information and opportunities for design excellence and site assessment and monitoring can be developed.

SEEK SCIENTIFIC GUIDANCE FROM THE NATURAL RESOURCES GROUP (NRG)

- The Parks Department's Natural Resources Group has staff ecologists, foresters, and environmental scientists who have conducted research and designed protection and restoration programs in all the ecosystems of New York City, from the forests to the intertidal mudflats.
- Consult manuals prepared and provided by NRG, including the Natural Area Restoration manual and the Forever Wild manual.

PROVIDE OPPORTUNITIES FOR EDUCATION

- Consider what educational information (signage, etc.) will help visitors interpret natural system functions and processes.

PROVIDE CLEAR DIRECTION IN CONSTRUCTION

- Be specific in the design, construction specifications, and plan annotations.
- Instruct the contractor and the resident engineer on the restoration area protection principles required for the construction and the protection of the restoration areas.

REDUCE ADJACENT IMPACTS

Design and construction staff working adjacent to restoration areas should design with the intention of decreasing any untreated stormwater runoff from entering a restoration area.

- During construction, no sediment or construction debris should enter restoration areas.
- Best practices to prevent soil compaction and vegetation disturbance should be planned in the project design. See *S.2 Minimize Soil Disturbance* and *V.1 Protect Existing Vegetation*.
- Contain and/or treat all stormwater on site during and after a project.

MANAGE STORMWATER ADJACENT TO RESTORATION AREAS TO PREVENT ANY ADDITIONAL STORMWATER RUNOFF TO THESE AREAS

- Direct runoff towards designed bioretention systems (e.g., swales, rain gardens, or vegetated filters).
- Wherever possible, use stormwater as a resource and capture offsite impervious area runoff so that this stormwater can be used where it is needed.
- Increase planting areas that can capture stormwater.
- For further guidance on reducing impacts, see *Part 4: Best Practices in Site Systems: Water* and the technical references therein.

RULES OF THUMB FOR ECOSYSTEM TYPES

Different ecosystems suggest certain broad methods for restoration — these rules of thumb are outlined below. In general, however, it's always valuable to consult with specialists at NRG when beginning any restoration project, and to review performance of designs for similar landscapes.

SALT MARSH

- Use the tide to guide the grading and plant community selection.
  - Low marsh typically occupies elevations from Mid Tide to Mean High Tide.
  - High marsh is found between Mean High Tide and Mean Higher High Tide.
- Survey adjacent Low Marsh and High Marsh vegetation and utilize these as biological benchmarks for the design salt marsh elevation.
- Plant between April and June.
  - Assure a minimum of a 60-foot width to establish a sustainable salt marsh.

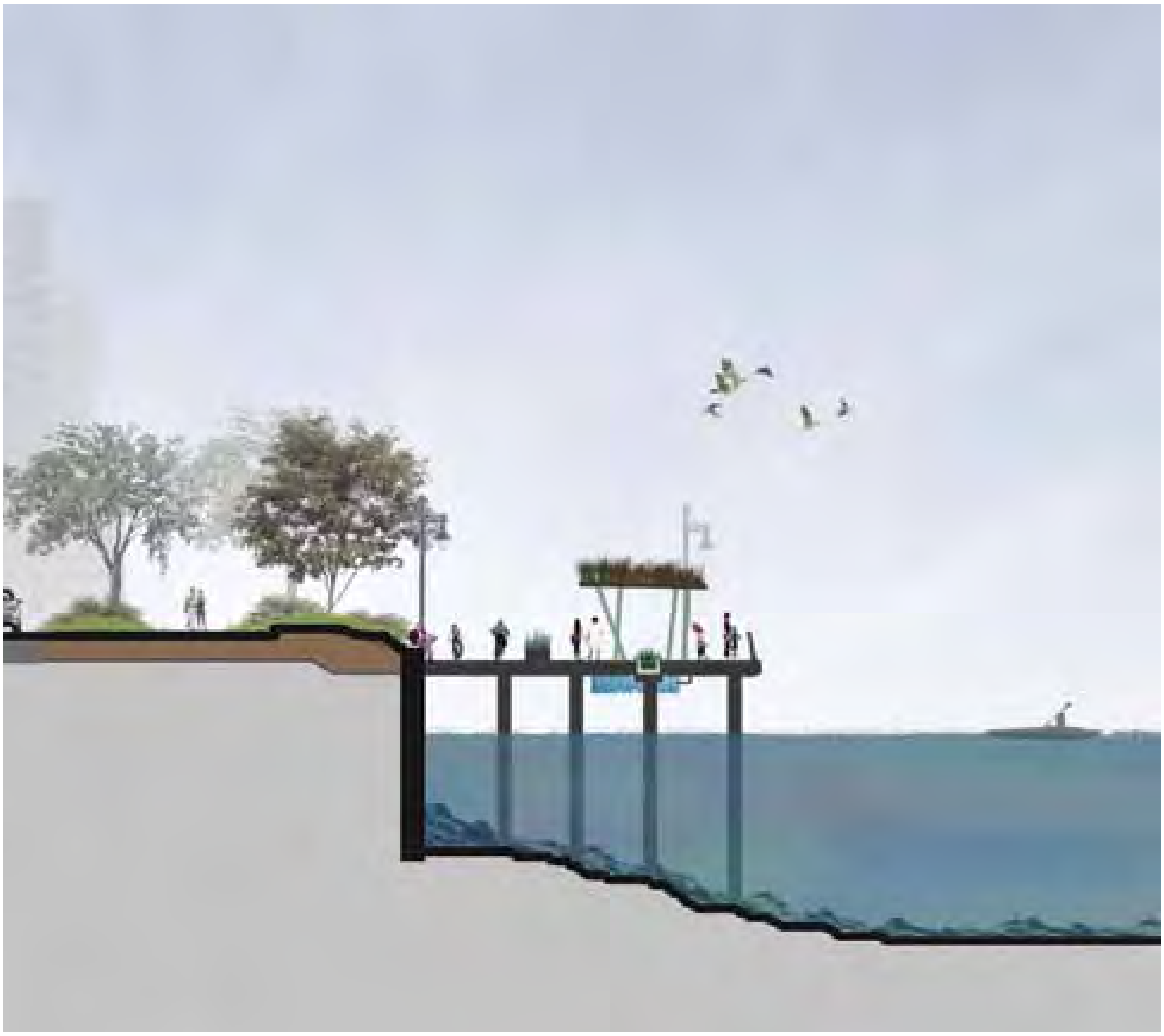
FRESHWATER WETLAND

- Estimate the depth, duration, and frequency of flooding through modeling and field measurement.
- Select native plants according to the flood frequency, the soil pH, organic matter, the biotic stressors, and the project objectives.

STREAM OR RIVERBANK

- Calculate the flow frequency, volume, and the shear stresses (based on the channel morphology). Assess how these will change with the design to determine the resilience of the channel material and the needed material size for stability.
- Estimate the past and future sedimentation loads to the site.
- Do not reduce the flood flow crosssectional area or the flood storage capacity.
- Do not shunt additional stormwater to stream systems. Instead, treat the stormwater where it is generated, as a resource.
- Maintain existing vegetation along stream banks, where feasible, to maximize bank stabilization.

WATERFRONTS



New York is surrounded by water bodies, and piers and wharfs for shipping, fishing, and boat building were once the city's connections to the world. As the city developed, the waterfront was converted to industrial uses and highways; gradually New Yorkers were cut off from the shorelines, the waters, and the adventures of the sea.

Today New York City is redefining its relationship to waterways, as evidenced by a wave of waterfront parks, greenways, ferries, kayak launches, marinas, and even residential development. Waterfront parks offer a tremendous opportunity for people to experience panoramic views to the horizon, the smell of salt water, the sound of waves. They can wade, fish, paddle, board, or launch a vessel.

At the same time these uses need to be balanced with the preservation of natural shorelines, wetlands, and scenic beauty. New York City's 1982 Waterfront Revitalization Program addressed the need for balance by establishing goals for protecting coastal ecological systems, providing water access, improving water quality, preventing flooding and erosion, and enhancing scenic, historical, and cultural resources.[8] This plan included a range of waterfront edge conditions, from restored planted and sloped edges to engineered bulkhead walls, all serving different functions and meeting different needs. Designers need to address both the public and ecological needs of waterfronts, looking for synergistic opportunities such as waterfront structures that improve marine habitat.

PRIORITY CONSIDERATIONS

REVIEW PRIOR PLANS, INITIATIVES, AND REGULATIONS

- Review existing master plans that may have defined uses, connections, materials or conventions.
- Review 197-a plans and research community initiatives. Waterfronts should address the concerns of the neighborhood and express the identities of the neighborhoods they pass through.

■ Review regulations that control waterfront development, including those of the Department of Environmental Conservation, the New York Department of State, and the US Army Corps of Engineers.

SOFTEN WATER EDGES

Natural shoreline edges can promote flood mitigation, provide marine habitat, and improve water quality.

- Where possible, remove bulkhead edges and pull back shorelines with shallow grading to create diverse shoreline habitats.
- In areas with limited space, consider creating wetlands along the waterside of bulkheads.

DESIGN FOR CONTINUITY BETWEEN MULTIPLE WATERFRONT PARKS

Linear waterfront parks can be used to provide continuous paths for bicycles and pedestrians.

- Research greenway plans, look for opportunities to connect greenway paths, and make connections to adjacent neighborhoods.
- Be wary of creating conflicts with pedestrians.
- Keep commuting or high speed bikes separated from pedestrian paths.
- Use consistent signage along multiple parks to guide users.

EXPLORE SURROUNDING AREAS FOR VEGETATION MOVEMENT OPPORTUNITIES OR CONCERNS

Linked parks provide connectivity for plant species to spread seed and for insects and birds to travel. However, this can be both problematic and beneficial, as both desirable and undesirable species can spread.

- Encourage native species to migrate to new areas by mimicking the conditions of successfully established habitat nearby.
- Create barriers for the spread of invasive species.
- Minimize site disturbance adjacent to invasive species, to discourage their spread.

ENHANCE HABITAT OPPORTUNITIES

- Connect with other patches of habitat whenever possible, prioritizing areas adjacent to existing habitat for expansion.
- For river corridors, consider enhancing conditions that encourage fish migration.
- Selectively remove overhead cover.
- Remove upstream migration blockages; provide mitigation such as fish ladders.
- Provide vegetation along water edges for fish protection from predators.
- In linear parks organized around water, consider watershed impacts.

The design for Harlem River Greenway replaced collapsing steel sheeting with porous edges (including gabion baskets filled with oyster shells) to help clean the river water, restore floodplain functions, improve near-shore habitat and allow a safer approach to Manhattan by kayak.

- Design for higher peak flows in areas where upstream development causes increased runoff.
- Increase planting areas that can capture stormwater.
- Design water edges that can withstand heavy flows and absorb and slow runoff.

COMPLY WITH THE WATERFRONT REVITALIZATION PROGRAM AND COASTAL MANAGEMENT PROGRAM POLICIES

- Restore underutilized areas.
- Maximize water-dependant and recreational uses.
- Minimize damage from flooding and erosion, focusing on nonstructural technologies.
- Implement nonstructural measures.
- Maximize the extent of natural resources.
- Adhere to water quality standards and avoid the discharge of hazardous substances into coastal waters.
- Promote compatible land uses with surrounding properties.
- Avoid impacts to navigable waters.

8 **City of New York Department of City Planning Waterfront Revitalization Program, http://home2.nyc.gov/html/dcp/html/wrp/wrp.shtml**

PASSIVE LANDSCAPES

Passive landscapes embody what the general population usually thinks of as a park — pathways and seating surrounded by lawns and trees, often containing active fields and playgrounds. For the most part, these parks owe their design to the nineteenth-century picturesque or Olmstedian aesthetic: their character is intended to evoke a natural setting.

In New York City many of these parks were designed by Frederick Law Olmsted, Calvert Vaux, or Gilmore D. Clarke. Today, designers in one of these spaces must determine the site history and intentions of the original designers, and create master plans for restoration. These parks should be treated with reverence; additions and modifications should maintain planned views and the original design intent.

Passive landscapes are almost always complex sites; they probably already host many active uses, and demand for more is always likely. There may be no local regard for the preservation of the ecological attributes, pastoral appearance, or the aesthetic of the original designer.

A direct accommodation of user needs will probably cause conflict with the original design intent, character, and site soil, water, and vegetation systems. A careful site analysis and assessment is necessary to make evident the opportunities to meet the programmatic needs while preserving the scenic appearance, expanding the ecological function, and employing Best Practices.

PRIORITY CONSIDERATIONS

UNDERSTAND THE CULTURAL IMPORTANCE OF THE SITE

Consider the history of a site, including original designs, past reconstructions, and master plans. It is of utmost importance to understand and preserve important cultural landscapes. A clear and well developed set of guidelines can be found in the Secretary of the Interior's Guidelines for the Treatment of Cultural Landscapes at www.nps.gov/history/hps/hli/landscape_guidelines/.

- Research past master plans.
- Prepare a cultural landscape report if the landscape is historically important.
- Consider archeological investigation and construction protection for sites with potential buried resources.
- Research site history.

PRESERVE THE CHARACTER OF EXISTING PASTORAL LANDSCAPES

In areas that were intended to provide scenic vistas and pastoral landscapes, the best design approach is to confirm, respect, and blend in with these existing conditions.

- Emphasize planting, maintaining, and enhancing vegetation.
- For cultural landscapes, preserve existing views through tree preservation, removal, and replanting.

PRESERVE AND ENHANCE WILDLIFE HABITAT

An important function of a passive park is to give people access to intact areas of natural vegetation, habitat, and wildlife. The more people feel engaged in this environment, the more likely they will be advocates for its survival. However, this goal must avoid disturbance to or fragmentation of habitat.

- Establish habitat areas where human usage is compatible or acceptably low.
- Provide or maintain contiguous, dedicated open spaces.
- Plant vegetation that is consistent with the site and native populations and that provides wildlife food.

DESIGN WITH A DIVERSE PLANT PALETTE

A diverse plant palette is less susceptible to pest infestations and disease than a monoculture, even one of native and adapted species. Plant diversity helps pest management control by providing for predator habitat and cover. This is especially important in large parks where a monoculture's susceptibility to a targeted pest could denude a landscape quickly. Diversity among plant selection builds resistance into the landscape that allows for the look of a large park to be preserved.

- Preserve existing view corridors when replacing trees.
- When a grouping of a single species has been used for scenic effect, consider disease and stress tolerant cultivars or species of similar form instead.

USE NATIVE SPECIES WHERE APPROPRIATE

Use or preserve regionally appropriate vegetation, with a special emphasis on vegetation native to the project's ecoregion.

- Eradicate exotic and invasive vegetation to the extent possible.
- Minimize clearing and damage to existing vegetation and limit movement of construction equipment.
- To extent possible, plant native species or other species which have become adapted to the region, but which are not invasive.

MINIMIZE GRADING

Heavy equipment compacts soil, encourages erosion, and disturbs the soil horizon. Grading alters hydrological runoff patterns.

- Work with the existing topography of the site as much as possible.
- When grading is unavoidable, mimic the natural topography of site.

STRUCTURES, UTILITIES, AND INFRASTRUCTURE

The impact of built elements should be minimized.

- Minimize the development site footprint and develop in areas away from view sheds.
- Maximize density of structural footprints.
- Minimize grading and stormwater infrastructure systems by respecting the natural hydrology of the site.
- Cluster underground utilities and group them with roads and paths.
- Locate site improvements close to park perimeters or near transportation access points.

MAXIMIZE SUSTAINABLE ACCESSIBILITY

Larger parks must be made accessible to a wide range of users, including pedestrians, cyclists, transit riders, and drivers, and they must connect safely and efficiently to surrounding bus and subway lines, neighborhood streets, and other regional routes. However, large expanses of paved surfaces are detrimental to the overall health of landscapes: they disturb habitats, increase stormwater runoff, concentrate nonpoint source pollutants, instigate soil erosion, negatively impact soil health, and contribute to the urban heat island effect. To reduce negative impacts of roads and parking, consider the following:

- Use semipermeable or permeable surfaces.
- Share parking with neighboring uses or use parking lots for multiple functions. For instance, paved surfaces can be used for community fairs, farmers' markets, etc.
- Reduce road and walkway widths to minimum acceptable dimensions.
- Downsize parking stalls.

USE LIGHTING WISELY

Excessive night lighting can disrupt circadian rhythms, disorient animals, discourage foraging in affected areas, and affect diurnal and breeding patterns of wildlife.

- Reduce or eliminate light pollution.
- Lower illumination levels if lighting is necessary.
- Use luminaires which direct light downward, not horizontally or upward.
- Reference the International Dark-Sky Association for information on design techniques and approved fixtures.

ACTIVE RECREATION AREAS

Active recreation areas play an important role in providing recreational and exercise opportunities, and the Parks Department makes every effort to address active recreational preferences. New York City facilities include a great variety of active recreation areas, including 2,129 basketball courts, 568 tennis courts, 2,042 handball courts, 91 bocce courts, 319 baseball fields, 418 softball fields, and 878 soccer and football fields, as well as a growing number of cricket fields, skate parks, and bicycle routes.

PRIORITY CONSIDERATIONS

ENCOURAGE ACTIVE RECREATION

In urban areas, parks often provide one of the few outlets for active recreation.

- Designs should encourage activity for all ages, ethnic groups, and ability levels.
- Provide the types of play desirable to the neighborhood while addressing the need for flexibility.
- Make integration of exercise into daily life possible through the creation of bike and walking routes to school, work, and entertainment destinations.
- Provide exercise opportunities, such as chin-up bars and sit-up platforms, for people to use while waiting for heavily used facilities such as basketball courts.
- Provide fitness opportunities for parents watching children play.
- Provide amenities that encourage extended use of a park, such as water fountains, shade trees and structures, and comfort stations.

DESIGN PLAY OPPORTUNITIES FOR POINT SOURCES OF SPECIAL NEEDS USERS

Consider user groups who cannot travel when selecting a site program.

- Provide playgrounds for daycare centers.

Millennium Skate Park is one of many different opportunities for active recreation in Owl's Head Park in Queens.

- Provide seating, exercise opportunities, and activity areas for the elderly.
- Provide sports fields for schools.

INCORPORATE NATURE INTO ACTIVE USE AREAS

Capitalize on the opportunity to include nature into active use areas.

- Create planting areas large enough for shade trees to reach their mature height.
- Minimize disturbance to existing valuable vegetation while constructing courts and fields.
- Incorporate retention areas to capture runoff from fields and courts.

CONSIDER USE OF SYNTHETIC TURF

Active recreation areas must be resilient to withstand the impacts of heavy use, as well as hyperfunctional to accommodate growing demand. Field areas that are in good condition attract use away from nearby lawns and natural areas, thereby improving their health and performance.

- When considering the use of artificial turf, review the latest data on turf manufacture, durability, and environmental impacts.
- Where possible, synthetic turf fields should be designed with a pervious system (e.g., porous bases below the turf) that increases the land's capacity for storage, infiltration, and cleaning of water.
- Synthetic turf fields should be graded to capture and slow runoff, allowing more time for infiltration or evaporation.
- Provide shade trees along the edges of fields to shade the field and players.
- Provide misting posts for player cooling.
- Avoid use of synthetic turf in baseball fields when not combined with soccer uses.
- Use natural turf in the center of and surrounding tracks, when the level of use allows.
- Monitor use and demand for fields and courts to determine the minimum size and quantity necessary to meet community needs.
- Inspect fields during construction to confirm compliance with specifications.
- Test turf and infill to confirm compliance with specifications.

PLAYGROUNDS

City playgrounds should offer a full range of social, physical, and educational opportunities for children of different ages and abilities, while also providing comfortable environments for their families and caregivers. Playgrounds can be the primary public environment for many young families, and they provide an opportunity for children and adults to form social bonds that can last a lifetime.

The social vitality of a playground will be increased by including the neighborhood in the design process. Neighbors have a finegrain understanding of the park and social environment; participation in design is also the first step towards a feeling of ownership, which encourages stewardship.

Playgrounds benefit from a high level of naturalness, shade, and seasonal beauty. They can also function as high performance landscapes by including stress-tolerant plantings, bioengineered water infiltration, and a sustainable materials palette. Design standards for sustainability, playground visibility, equipment safety, and issues such as material durability and resistance to vandalism must be considered as well.

PRIORITY CONSIDERATIONS

PROVIDE A RICH AND SAFE PLAY ENVIRONMENT

A designer has the opportunity to provide a wide variety of fitness, fun, and educational experiences for children of all ages and abilities. Play equipment is usually designed to provide an energetic outlet for children in age groups 2 to 5 and 5 to 12 years old. This separation provides play opportunities appropriate to the stage of development and avoids conflict between age groups.

- Provide a variety of play options for different ages and interests, allowing families with multiple children to enjoy one site.
- Provide a range of exercise, coordination, and confidence building opportunities.
- Design for different cultural recreation preferences, using community feedback to determine area needs.
- Provide amenities that encourage extended use, such as

water fountains, comfort stations, and picnic tables.

- Adhere to ASTM standards, such as fall zones, safety surface fall height, and entrapment concerns.
- Design for use by children of all abilities, including those using mobility aids (e.g., wheelchairs).
- Make it possible for all parents, including those who use mobility aids, to join their children in play.
- Use durable, easy to repair equipment and safety surfacing.

PROVIDE OPPORTUNITIES FOR FREE PLAY

Child's play is spontaneous and comes naturally. While it requires the proper environment, it does not necessarily require special toys or unique pieces of equipment. All that is required is a place that is safe and a range of materials that invite children to explore their environment and construct their own play scenarios. By playing without instructions or structure, children form intellectual connections — they create, discover, imagine, and innovate. During free play, children learn to understand and develop skills of invention, cooperation, and sharing. And, because free play settings do not require the exclusion or segregation of special needs children, all children benefit socially and psychologically from this type of integration. Opportunities for free play can include, but are not limited to:

- Loose parts — tools and materials that can be used in ways of a child's own choosing, such as wood and foam blocks, inner tubes, hay bales, tarps, poles, and ropes
- Raised beds or planting areas
- Plants for hiding and materials for making shelters
- Play shelters and niches
- Sand areas, especially sand areas that combine water
- Unrestricted messy and dirt areas

INCLUDE SCIENCE PLAY ELEMENTS

Look for opportunities to create appreciation for nature and the pleasure of discovering scientific phenomenon.

- Show how natural systems function within the site. For example, reveal hydrology and water flows that attract butterflies, birds, and frogs.
- Provide science play opportunities that stimulate curiosity about science. Suggested elements include:
  - centrifugal force
  - sound waves
  - sunlight refractors
  - weather stations
  - windmills
- Provide signage that gives cues to parents about things to show or teach their children using the equipment or other elements of the playground.
- Provide places for gardening.

PROVIDE NATURAL PLAY OPPORTUNITIES

Naturalistic play areas create opportunities to explore and discover nature. While playgrounds are usually too intensely used to provide natural areas, it is possible to create playgrounds in natural areas that provide ease of supervision and close proximity to real nature.

- Provide opportunities for children to explore imaginative play through interaction with natural elements of their environment.
- Make every effort to extend this opportunity to children of all abilities and ages by providing access to a variety of play features and using features that appeal to all of the senses.
- Provide natural elements for seating.

Webster Playground in the Bronx incorporates natural play elements such as boulders, play equipment that encourages exercise, and numerous stormwater features, including planting beds that infiltrate runoff.

PLAN FOR USE DURING DIFFERENT TIMES AND SEASONS

- Consider the seasonality of water play features and plan for the use of that area during different seasons.
- Site benches and water play areas to benefit from sunny and shady areas that will extend the season.
- Provide amenities that foster use throughout the day, such as comfort stations, water fountains, shade structures, baby changing stations, and food.
- Consider demands of use during peak times, such as weekends, school vacations, and summer.
- Schoolyards should be open to the neighborhood after school hours.

ALLOW FOR EASE OF SUPERVISION

- In areas for smaller children, limit the number of exits and place them so they are easily monitored by parents and guardians.
- Avoid creating hidden areas.
- Provide comfortable seating for parents and guardians.
- Provide open areas for playing catch and grass-based games within sight of playground benches, so that older children can play separately.

PROTECT EXISTING TREES

Large trees are the dominant resource to preserve in a playground reconstruction. Note that trees in existing playgrounds may have roots extended well beyond their original tree pit, over curbs and under pavement.

- Survey all of the trees and determine their critical root zone.
- Do not pave in the critical root zone.
- Avoid full depth paving and curbs that will require root cutting.
- Grade paving to direct water to planted areas.
- Protect root zones from compaction during construction and after the playground is in operation.

IMPLEMENT SUSTAINABLE DESIGN STRATEGIES

- Create water efficient landscapes.
- Provide fencing or other protection for planting in high traffic areas.
- Select plant material that can tolerate drought and reflected heat from play surfaces.
- Plant larger shade trees to provide shade and cooling over play areas.
- Use lighter colored pavements and safety surfacing.
- Spray features can reduce water use through low flow and misting sprays, and reduce water waste by directing runoff to planted areas.
- Make playgrounds easily accessible from bicycle and walking routes, and provide bike racks.

INCORPORATE STORMWATER MANAGEMENT SYSTEMS

Stormwater management can be part of a successful playground, even in areas of limited space. Creative strategies can mitigate impervious areas designated for play, or play areas themselves can become an active part of stormwater attenuation. These systems typically are more self-sufficient and can reduce maintenance costs.

- Reduce flow to storm sewers and combined sewers through water management techniques designed for smaller spaces such as rain gardens and infiltration planters.
- Grade impervious areas to drain into planting beds and tree pits, assuring that the volumes of water are appropriate for the size and infiltration rates of the planted zone.
- Increase planting areas to capture stormwater while providing shade and visual interest; these areas can be on the perimeter of the playground.

DESIGN FOR RESILIENCE AND EASE OF MAINTENANCE

- Avoid specialty items that will require frequent replacement.
- Be wary of moving parts that can wear out quickly.
- Use materials and design details that are resilient to high levels of use.
- Do not put drainage structures and valves under safety surfacing.
- Provide manuals for equipment operation and repair, necessary tools, and replacement parts in a locked cabinet on site.

POCKET PARKS & PLAZAS

In dense urban areas, where most available land has been developed, pocket parks and plazas are vitally important. These public spaces, when well designed, provide a valuable respite from traffic and street noise. Often built predominantly as hardscape, they can nonetheless provide a variety of vegetation and other climate-mediating elements that can dramatically improve the microclimate and help reduce the urban heat island effect. Pocket parks also provide places for outdoor eating and socializing, and they can be focal points of district identity and communal activity.

Design of these parks is complicated by the highly variable conditions of their sites, both above and below the surface. Structures and land uses adjacent to parks can block the sun, direct the wind adversely, reflect traffic noise, and subject the public to the noise and odors of building exhaust. Infrastructure below can impede efforts to infiltrate water and provide adequate space for healthy root zones. Small spaces, heavy shade, and wind present challenges to plant survival. Considering these myriad factors early in the design is important to successfully transforming these spaces. The payoff is particularly rewarding to users, who will value the pockets of sun and moments of respite they provide.

PRIORITY CONSIDERATIONS

UNDERSTAND THE MICROCLIMATE CREATED BY SURROUNDING BUILDINGS

Buildings change the direction and speed of wind dramatically. Buildings can also block sun at crucial use periods.

- When large developments are in the planning stage, arrange the building massing and placement to provide the best quality environment for outdoor public spaces.
- Avoid fragmentation of public space. Larger areas are more valuable and usable than an aggregation of incremental green spaces left over after a building is designed.
- In existing environments, analyze the site's sun and shadow patterns, as well as wind patterns, so activities can

be placed to capitalize on the limited pools of sun, at the proper times of day and season. Efforts must be made to ameliorate adverse wind conditions.

DESIGN SPACE AS A CATALYST FOR A VIBRANT PUBLIC REALM

Pocket parks and plazas can promote social activities and gatherings that are part of the city's vitality, including neighborhood festivals, farmers' markets, and spontaneous events. The design of urban plazas should prioritize the social aspect of the place. A good resource for this is Project for Public Spaces' 10 Principles for Successful Squares (http://www.pps.org/squaresprinciples), which discusses the need to provide amenities and flexible design, as well as management strategies such as obtaining diverse funding sources and emphasizing maintenance.

DESIGN PLANTED AREAS FOR SUCCESS

Every effort should be made to provide the proper soil volume, drainage, and water for plantings. A proper investment in the planting medium and location is crucial. A windy, dry site will desiccate inappropriate plantings; there will be no practical way to compensate for this condition once a landscape is installed.

- Choose plants for the actual growing conditions, which may even include heat from steam lines or exhaust from buildings.
- Design grading to direct stormwater into planted areas; calibrate the amount of water and adjacent drainage to avoid flooding and saturation of the soil for long periods.
- Create conditions that can protect plantings, such as planting hardier plants as windbreaks for more sensitive plants.

CREATE MICROCLIMATES AND POCKETS OF QUIET

- Strategically place trees and structures to create microclimate zones of warm or cool temperatures, shade or sun.
- Use walls to block noise and water features to camouflage it.

OFFER AMENITIES TO MAKE THE SPACE MORE INVITING

Amenities need not be permanent — anything from chairs and tables to performance stages can be temporary amenities — as long as there are places for storage and arrangements or budgets for their placement. In 2009, New York City implemented a popular program to reclaim portions of streets for pedestrian and passive uses. Temporary chairs, umbrellas, tables, planting, and street marking required minimal investment and installation but helped to transform the sites.

- Provide moveable seating. It gives people more choice about their experience, and makes the space more usable at different times of day and year. Comfortable seating in the right spot is probably the single greatest factor in determining whether or not a small public space is well used or not. People often seek refuge from the city, but at the same time look for ways to watch passersby.
- Place waste receptacles and lighting with care. Trash cans need to be commodious, visible, attractive, and located away from fixed seating due to the odor they can produce. Lights should be placed where illumination is needed, without lighting adjacent interior spaces or generating glare.

LOCATE UTILITIES, EASEMENTS, AND PROPERTY LINES

When designing in dense urban areas, myriad infrastructure and jurisdiction conflicts can exist. Locate these elements early in design process to avoid complicated changes and delays later on.

- Determine the detention requirements required by DEP for sewer connections.
- Identify underground utilities and manholes, determine the responsible agency, and contact them to coordinate necessary clearance and service access.
- Confirm property lines and easements; don't assume that the current conditions comply with current regulations or property rights.

THINK OF SMALL SPACES IN CONNECTION TO SURROUNDING OPEN SPACES AND USES

Because pocket parks and plazas are typically in the heart of densely built neighborhoods, it is critical to complete urban design gestures or circulation routes started by others, such as midblock crossings, view corridors, and collective building massings in new developments.

- Consider the many connections to adjacent lobbies, storefronts, café seating, and other urban uses.
- Consider views from adjacent buildings and sun access into adjacent open spaces.
- Expand on adjacent plantings to provide habitat for birds.
- Accommodate and incorporate desire lines — the routes you observe or anticipate people taking to and from surrounding destinations.

STREETSCAPES

Streets are more than transportation corridors — they're also public spaces. Elements of park design can be pulled into this public realm to improve both the pedestrian experience and ecological services. By transforming street medians, traffic triangles, and other road configurations into gardens with vegetative and canopy cover, streetscapes can reduce airborne particulates, carbon dioxide, the urban heat island effect, and groundlevel ozone by reducing ambient temperatures. Parks can also positively impact streetscapes through careful design of the interface between park properties and sidewalk trees.

Along urban streets, trees and other vegetation can provide shading, evaporative cooling, habitat, and stormwater capture. Greenstreets — a Parks Department program that places planting beds composed of trees, shrubs, perennials, and groundcovers in paved, vacant traffic islands and medians — can serve as small ecologically functional areas with a positive cumulative impact to the city's appearance and environmental quality.

Planting in the public right of way requires careful site assessment and design. Subgrade compaction, poor soil, poor infiltration rates, and underground utilities are common. There is often minimal maintenance and no source of water for irrigation. Sites with complex underground utilities and infrastructure have specific design constraints that are often compounded by other issues, such as high density land use, overlapping agency jurisdiction, complex permit requirements, and a lack of clarity in maintenance obligations.

PRIORITY CONSIDERATIONS

COLLABORATE WITH APPROPRIATE AGENCIES

Greenstreet plantings are governed by the Parks Department (DPR), but their location in the right of way necessitates coordination with and approval from the Department of Transportation (DOT). All New York City Greenstreets fall under a formal agreement between DPR and DOT. Therefore, all potential sites must be initially approved by both agencies. Greenstreet maintenance is automatically DPR's responsibility as dictated by this interagency agreement. Maintenance agreements with Business Improvement Districts (BIDs) or other entities will ease approval. Establish a relationship early in the design process to assure that designs are not in conflict with DOT objectives.

Street tree designs and species selection, while informed by other agency requirements, are determined by the Parks Department's Central Forestry Division. Contractors planting street trees are not required to get DOT design approval, but they are required to obtain DOT construction permits.

- Consult DOT for information on regulations and concerns affecting the project, including setbacks from various other street amenities and sightlines.
- Review Greenstreet designs with DOT early in the design phase.
- Determine if there are any DOT initiatives that can be advanced through the project, such as pedestrian refuges.
- Some small jobs that lack infrastructure and occur on DOT property, but that are not officially under the Greenstreets program, may be able to use the standing Greenstreets agreement with DOT to streamline permitting.

CONSIDER SURROUNDING CONTEXT

- Create connections within and to a park from nearby bike lanes and greenways.
- Provide curb cuts at street crossings.
- Provide map boards to direct users to surrounding amenities, e.g., greenways, bike lanes, and mass transit.
- Use signage consistent with connecting parks and bikeways to prevent confusion.
- Whenever possible, maintain consistency in path type, striping, and width.
- Select trees that resonate with the branching habit, crown size, and leaf texture of existing street trees. Strive to maintain consistency in allées.
- Select plants with appropriate mature heights, widths, and habits, and arrange them so as not to obstruct driver visibility or compromise pedestrian safety.
- When planting under utility lines, select species which achieve appropriate heights at maturity, so as not to interfere with utility lines and to avoid future disfiguration by clearance pruning.
- Identify locations of below ground structures and utilities that may be affected by planting, drainage, or new structures. Contact the appropriate agency based on the condition:
  - Metropolitan Transportation Authority for subways and other related facilities
  - DEP for stormwater detention facilities
  - One Call for utilities such as Con Edison, Keyspan, LIPA, and Verizon for electric, gas, telephone, and cable lines
  - Department of Finance for limited sidewalk vault information

MAXIMIZE ENVIRONMENTAL BENEFITS

Unpaved surfaces with multiple layers of healthy vegetation provide important stormwater quality and quantity benefits. An average sized Greenstreet of 1,500 square feet can capture approximately 1,894 gallons of stormwater per year. Large canopy trees with significant leaf areas also provide environmental benefits.

- Maximize soil volume to accommodate the largest canopy tree possible for the given space and to provide the best growing environment.
- Employ continuous tree pits wherever possible.
- Examine soils at a fine grain scale.
  - Typical urban fill soils come from a variety of sources and lack natural soil horizons and structure.
  - Take more samples to provide a more detailed review of these soils, as there is often little consistency between sample points.
  - Soil should be amended or changed completely where excavation uncovers poor soil, urban rubble, or construction fill, as is typical beneath concrete sidewalk and asphalt roadbeds.
- Cluster plantings to counter the urban heat island effect by creating cooler, shaded environments within the streetscape.
- Design for active stormwater capture to create low maintenance, self sustaining plantings.
- Obtain borings and percolation tests to determine amount of percolation that can be expected and to plan soil modifications to prevent creating pools of standing water.
- Where suitable, design sites to actively redirect stormwater runoff into the planting bed, for onsite storage and irrigation of plants.
- Employ gently sloping sidewalks, trench drains, pipe inlets, curb cuts, bioswales, deep excavation, and crushed stone storage reservoirs to manage stormwater.

SELECT APPROPRIATELY TOLERANT SPECIES

Planting adjacent to or in the midst of a roadbed poses many challenges. Vegetation faces drought, pollution, road salt, dog waste, litter, and foot traffic, as well as vandalism and vehicular damage. Designs must also balance multiple goals — aesthetics, species diversity, canopy cover, and stormwater capture — while taking into account traffic patterns and pedestrian needs.

- Select species for a wide range of tolerances: disease, pests, drought, salt, and pollution.
- Select species that require minimal maintenance.
- Select species with an ability to suppress or compete with weeds.
- Consult the Greenstreets division for suggestions on a plant palette able to withstand harsh urban conditions.
- Pay attention to restrictions on tree species imposed to prevent the spread of Asian Longhorned Beetle, Dutch Elm Disease, Emerald Ash Borer, and other pests.

KEEP ABREAST OF DEVELOPMENTS IN GREENSTREETS AND STREET TREES

- Work with the Forestry & Horticulture Division to learn their concerns and latest techniques for Greenstreet and street tree planting.
- Look for ways to advance Forestry & Horticulture goals.
- Pay attention to ways other communities have constructed right of way plantings and changed design policy and regulations to improve water infiltration, vegetation growth, and bike lanes.

PARKS OVER STRUCTURES

Parks built over structures can provide exceptional active and passive recreational space. The transformation of roofs, walls, and the tops of subterranean structures such as subways can increase vegetative and canopy coverage, increase evaporative cooling, detain stormwater, reduce airborne particulates, reduce ambient temperature, and limit the urban heat island effect.

Creating this kind of park requires an understanding of the structure, its load bearing capacity, and waterproofing, as well as easements and restrictions for utility servicing. Careful design of the planting depth and medium, choice of plantings, and irrigation medium are critical.

Maintenance responsibilities must also be coordinated. No green roof, however self sufficient, is free of maintenance. Parks Department divisions such as the Five Borough Shops and the horticultural department, which have experience maintaining planted roofs, can provide information on the City's newly formed green roof maintenance crews and their capabilities and capacity.

PRIORITY CONSIDERATIONS

THOROUGHLY ASSESS STRUCTURAL CONDITIONS

Building over structures requires thorough structural assessment.

- Engage a structural engineer to survey stability and load bearing capacity.
- Evaluate the structure's waterproofing, waterproofing protection, drainage flows, and water collection systems.
- Carefully design decking and planting areas to protect the roof and allow stormwater to reach drains.
- If the project involves belowground structures, contact relevant agencies to learn their restrictions and concerns:
  - Metropolitan Transportation Authority for subways and other related facilities
  - Department of Environmental Protection for stormwater structures

CONSIDER PLANT HEALTH ISSUES

Typically, plantings over structures must contend with a longer list of plant health impacts than other urban plantings. Take this into account when designing planting areas and selecting plant species. Issues include:

- limited root zone and depth
- increased heat from pavements and belowground structures
- poor drainage or engineered drainage with no access to water table
- soil freezing
- plant desiccation due to increased exposure to wind
- mulch loss due to wind
- need for more carefully calibrated irrigation to avoid soil saturation

USE ENGINEERED SYSTEMS FOR COMPLEX SITES

Incorporating sustainable design practices in parks on structures can be difficult, but the use of more engineered design solutions allows for increased benefits.

- Increase planting areas
  - Connect planting areas under pavements when possible.
  - Protect planting areas from heavy traffic.
  - If necessary, limit planting to shallow rooted and smaller plant material.
- Utilize infiltration systems whenever possible.
  - Higher rates of infiltration in engineered systems allow for the surrounding areas to be less pervious while still managing water on site.
- Consider detention when infiltration is not possible due to underground structures.
  - Design systems to delay discharge to sewers through storage.
  - Use stormwater for planting areas with underdrain structures to remove excess runoff.
  - Account for the different soil freezing patterns over structures.
  - Provide for increased wind protection.

CONSIDER GREEN ROOF INSTALLATION

There are many incentives that make green roofs an attractive option for city buildings. However, feasibility must be considered, including cost of installation.

- Assess the capacity for a structure to bear additional weight.
  - Retrofitted buildings may require lighter green roof options; however, some older buildings were constructed with higher loading capacity than more modern buildings.
  - A structural engineer is required to determine live and dead load limits.
- Perform a cost benefit analysis for a green roof vs. other design options.
  - Green roofs are often the most viable option in dense areas, or on constrained sites.
  - Where space is available and buildings are smaller, it may be better to simply shade the structures with surrounding large trees and manage stormwater onsite surrounding the building.

DESIGN TO OPTIMIZE BENEFITS OF A GREEN ROOF

Some of the benefits green roofs provide are directly related to the way in which they are designed.

- By selecting plant species to provide optimized evapotranspiration over succulants such as sedum, the evaporative cooling benefits of the roof are increased.
- Deeper growing media can hold larger volumes of water and support a more diverse plant palette. These systems also have higher rates of evaporative cooling due to more water availability and to the greater size and species of plant types supported.

DESIGN FOR RESILIENCE AND EASE OF MAINTENANCE

- Consult members of the Parks Department's Five Borough office on green roof design experiences at their facility.
- Contact the horticultural department for information on the newly formed green roof maintenance crew to discuss capabilities and capacity.
- Provide detailed drawings that show locations of all hidden utilities for the park and the structure. Show the waterproofing and protection layer details to the maintenance crew and provide copies to them.
- Design an easy to maintain and winterized irrigation system.
- Provide hose bibs no more than 75 feet from all planting areas to minimize hose runs.
- Design to conserve maintenance time and funding.
- Learn the amount of maintenance funding and staffing levels for a park before beginning a design, and then design within the maintenance budget.
- Do not include specialty items that will require frequent replacement.
- Use materials and design details that are resilient.
- Do not put drainage structures and valves under safety surfacing.
- Provide manuals for equipment operation and repair, tools, and replacement parts in a locked cabinet on site.
- Provide training to operations personnel and gardeners.
- See *W.8 Create Green and Blue Roofs*.

PART III: BEST PRACTICES IN SITE PROCESS

DESIGN

Part III contains Best Practices (BPs) in planning and design, construction, and maintenance. Opportunities and considerations for improving park design and decreasing maintenance costs are described, as well as increasing the lifespan of park projects. Upfront acknowledgment of site constraints and future maintenance costs will improve the success of the design and reduce maintenance and reconstruction costs. Construction best practices will minimize construction damage. Maintenance and operations are the most important component of any successful park, and incorporation of maintenance concerns will improve the ability of the operations division to operate the site successfully.

INTRODUCTION

Designers are well-suited to the challenges of creating high performance parks. They are educated to understand and respond creatively to an extremely broad range of factors including the site context as well as scientific and social problems. Designers choreograph dozens of elements: the experiential effects of light, texture, color, and sound; the sequence of visitor movement and rest, view and enclosure. They anticipate changes to the site over time from day to night, through seasons, and over many years.

All the while designers are looking for relationships between the problems, seeking responses that are appropriate, economical, and artistic. They don't automatically accept the standard way of doing things; they know innovative solutions can have powerful social and environmental effects, changing the way we think about and use familiar park places, features, and typologies. Good designers are opportunistic, seeing possibilities that others may overlook.

This manual asks designers to deepen their understanding of the biological and social issues that affect the performance of a park, and tackle a host of increasingly important issues, including public health and climate change. Projects that can successfully integrate this expanded field of concerns into design will last longer, enjoy more support, and be more cost efficient than projects that fail to do so. Designers who embrace the broad scope of high performance landscape design will be more effective in creating the open spaces needed for the 21st century city.

KEY PRINCIPLES

High performance projects require a designer to address the site at a biological level. The designer must understand the soil, water, and vegetation at a scientific level. In order to achieve the highest level of performance, and benefit to the climate, natural systems must be protected; constructed landscapes must be highly considered.

In public projects, especially large scale projects, there is no single author. Designers cannot work in isolation; they need to consult with experts, the park operators, and community members. Each brings expertise and knowledge to increasingly complex sites and existing conditions. There are also many invested stakeholders in even the smallest projects. Reaching out to and engaging the appropriate spectrum of stakeholders will bring more ideas, resources, and support to a project, from design to construction to maintenance.

Know your constraints and work creatively within them. Sustainable design begins with a tough assessment of constraints — site, capital and operational budgets, regulatory, and others. Within this envelope, designers can exercise their full creativity. The best designs use the constraints as an organizing or generative principle.

Parks help cultivate good stewardship and civic responsibility. Good park design heightens people's experience of their surroundings, broadens their understanding of urban systems, and inspires them to become stewards of park projects. Ideally, people using these parks are more engaged in how that park functions — where stormwater goes, how green spaces offset carbon emissions, how open spaces help bolster confidence in investment in surrounding neighborhoods. Informed and engaged people are better equipped to talk about and take action on these issues in the broader public realm.

D.1 INTEGRATE MAINTENANCE PLANNING INTO THE DESIGN PROCESS

OBJECTIVE

Integrate maintenance considerations into the planning and design process as decision making rather than after the completion of the proposed design. This will produce designs that are more resilient, attractive, and cost effective over time.

BENEFITS

- Allows the design team to acknowledge and address maintenance concerns early in the planning and design process in order to inform critical design and material decisions
- Decreases maintenance costs by requiring the design team to understand and weigh initial construction costs versus life cycle costs as part of the design process, especially during value engineering
- Increases the probability that projects will be maintained properly by requiring the design team to anticipate maintenance costs and design to stay within the operating budget
- Increases the probability that site and operational knowledge will be incorporated into the design, and the gardeners and maintenance personnel will be more vested in the project by including them in the design process

CONSIDERATIONS

- Meaningful collaboration of maintenance and design personnel will require scheduled time to work together.
- Productive collaboration will require the development of a shared set of goals and objectives.
- Detailed maintenance plans require specialized skills and experience and therefore requires additional design time and fees to complete if undertaken by outside consultants.
- Accurately priced maintenance plans can show that maintenance costs over the life of the project (typically 30 to 50 years) will be higher than construction costs.

INTEGRATION

BACKGROUND

Maintenance costs for a built project usually exceed the cost of construction. It is not unusual for a project's annual maintenance and long term capital maintenance costs to exceed construction costs by 10 to 20 times over the life cycle of a project.[9] For this reason any reduction in maintenance costs, when multiplied over time, can be truly significant.

PRACTICES

PLANNING

DEVELOP A CONSENSUS ON ACCEPTABLE LEVELS OF SERVICE

To be effective as part of the design process, maintenance planning requires consensus on maintenance goals and objectives among park system administrators, capital planners and designers, and park maintenance managers.

- A general consensus on the acceptable levels of maintenance (often referred to as levels of service) is required. They are generally applied to a variety of park types and locations throughout the city.
  - Clear articulation of these levels of service is essential for maintenance decision making.
  - Defines acceptable maintenance practices and serves as a baseline for design and operational decisions moving forward
- The idea of levels of service is generally understood within the parks and recreation industry; the National Recreation and Park Association (NRPA) developed a tiered level of service standards that have been used across the country for many decades. NRPA standards identify six levels of maintenance that range from highest (1) to lowest (6). These standards have been benchmarked against current and past practices and acknowledge the unique nature and needs of each type of park area.[10]
  - Level 1 is reserved for special, high visibility areas that require the highest level of maintenance.
  - Level 2 is the norm one expects to see on a regular, recurring basis. It is the desired standard.
  - Levels 3 and 4 are just below the norm and result from staffing or funding limitations.
  - Level 5 is one step before the land is allowed to return to its original state.
  - Level 6 is land that is allowed to return to its original natural state or that already exists in that state.
  - Further refinement and articulation of what each of these levels entails, as well as the identification of representative parks within each of the five boroughs, would allow administrators, designers, and managers across the parks system to gain collective understanding of what acceptable maintenance practices would be.

PROJECT MAINTENANCE COSTS

For existing parks, it is satisfactory to understand the staff required to provide the current level of service and then determine what additional or fewer services will be required. For new parks, a more detailed projection is needed. The data that are required to accurately project maintenance costs include:

- □ Current site specific and borough wide staffing levels
- □ Description of staff positions, including labor rates and benefits
- □ Description of maintenance crew types
- □ Identification of typical maintenance tasks by park area specialty element
- □ Identification of maintenance task frequencies as defined by the levels of service
- □ Identification of maintenance equipment required by maintenance task and crew type
- □ Identification of what additional equipment will be needed
- □ Identification of typical utility charges for various facilities and features
- □ Identification of security staffing
- □ Identification of management costs

CONSIDER HISTORICAL MAINTENANCE NEEDS IN PROJECTING NEW ONES

Develop historical data related to past maintenance efforts to serve as a baseline comparison for designers as they begin to evaluate the maintenance implications of their plans.

- ■ This maintenance programming resource database might include, but not be limited to, the following:
  - □ Maintenance facilities as a typical cost by park type
  - □ Historic maintenance unit costs per acre, by level of maintenance
  - □ Cost to maintain specialty items on a square foot, linear foot, or per item basis
  - □ Historic maintenance cost escalation factors
  - □ Historic contracted services costs
  - □ Historic maintenance equipment costs
  - □ Historic replacement life cycles for key materials or facilities

DEVELOP AN ACCESSIBLE, REGULARLY UPDATED MAINTENANCE DATABASE FOR USE BY DESIGN STAFF IN THE DEVELOPMENT OF MAINTENANCE PLANNING EFFORTS AND SCOPE OF WORK DESCRIPTIONS

- ■ Include data referenced above in an easily located and up-to-date format.
- ■ Develop comparable costs by facility and level of service.

DESIGN

PROVIDE A MAINTENANCE BUDGET IMPACT STATEMENT

- ■ Estimate levels of service, staffing, material, and equipment costs required, both during the establishment period and over the anticipated life cycle, at the master plan, schematic design, design development, and final construction document phases
- ■ Budget impact statements should differentiate between programmatic elements and major material assemblies within the park that may have varying life expectancies or user wear.
- ■ Impact statements should realistically anticipate levels of usage by the public as part of the anticipated life cycle analysis for each area or major element.
- ■ Specialty elements should be individually itemized or expressed on a linear foot, square foot, or acre basis to allow designers to make both qualitative and quantitative adjustments to proposed designs.
- ■ Impact statements should provide data on space requirements for anticipated materials, equipment, staff, and staging areas required for regular park maintenance.
- ■ Use the final maintenance budget impact statement and supporting data generated from the final construction documents to form the basis of the comprehensive park management plan for use by the staff after the completion of the project.

MAINTENANCE PROJECTIONS SHOULD TAKE INTO ACCOUNT THAT LEVELS OF MAINTENANCE WILL VARY BY SEASON

- ■ Selectively maintaining some areas more and some areas less can lead to long term cost efficiencies.
- ■ For landscape areas, clearly define anticipated visibility and levels of service anticipated as part of the park's design aesthetic intent.
- ■ Plan site circulation to allow some paths to be left uncleared during winter seasons.
- ■ Reduce the need for regularly mown lawns in all areas. Introduce low frequency mown meadows and turf mixes where appropriate.
- ■ See further *V.9 Reduce Turf Grass*

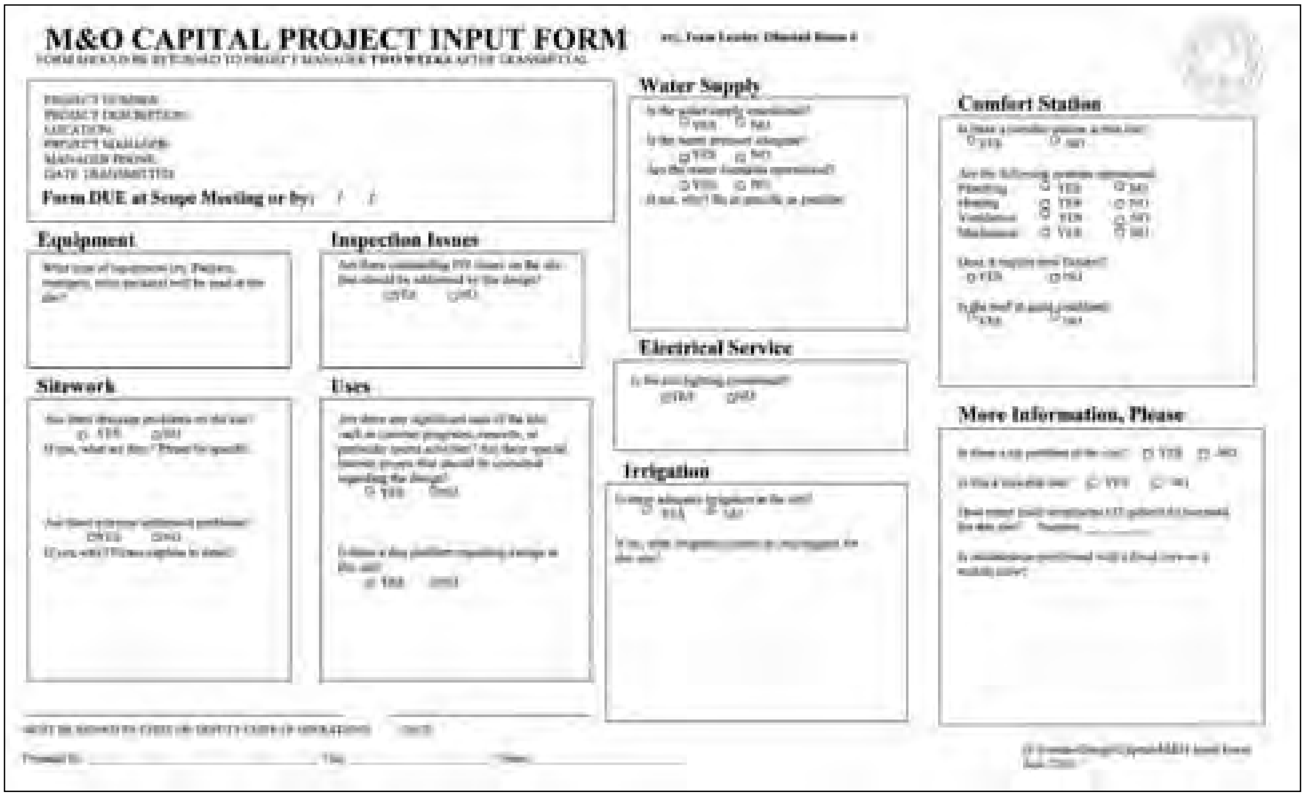
LOOK AT THE DESIGN FROM THE MAINTENANCE STANDPOINT

- ■ Understand just how much of a burden the project will place on the existing system.
  - □ In some cases, it may be possible to reduce maintenance staffing or material resources through careful coordination and consideration.
  - □ If a project increases maintenance needs, the design process should clearly articulate those needs for budgeting and staffing purposes so that the park's facilities will be properly maintained.

INCORPORATE MAINTENANCE NEEDS INTO DESIGNS

A sample of typical concerns:

- ■ Plan walkway and roadway widths to accommodate anticipated maintenance vehicle widths and turning radii without damage to curbing or softscape areas.
- ■ Do not use vulnerable pavements such as bluestone in vehicle areas.
- ■ Provide access gates for all enclosed planting beds.
- ■ Provide water access points that allow all areas to be reached by a 100' hose.
  - □ In areas inaccessible by hose, design accordingly, as watering will not be feasible.
  - □ Design planted areas to receive an appropriate amount of stormwater from paved areas in order to enhance plant vitality.


M&O CAPITAL PROJECT INPUT FORM

Form DUE at Scope Meeting or by:

Equipment

Inspection Issues

Sitework

Uses

Water Supply

Electrical Service

Irrigation

Comfort Station

More Information, Please

Designers should look to M&O staff as a resource for existing conditions and needs for a given site during the design process. The Parks Department's M&O Capital Project Input Form quickly aggregates pertinent information about the current state and uses of a given park.

- Coordinate utility infrastructure for easy access and maintenance.
  - Coordinate utility corridors with walkway and roadway locations to allow for future vehicle access and repairs without significantly damaging landscape areas.
  - Provide adequate clear space around pump stations, transformers, storage tanks, and other fixed equipment to allow for regular access, ventilation and repair.
  - To the extent possible, locate utility vaults and boxes within pavement areas rather than lawn or planting beds.
  - Avoid locating drains or other utility boxes within safety surface areas or areas with high volume traffic desire lines.
  - Place water lines below the frost line, and use water fountains that do not require winterization.

CONSULT MAINTENANCE PARTNERS SUCH AS THE DEPARTMENT OF TRANSPORTATION

- Coordinate pole placement for easy access and maintenance, away from areas vulnerable to vehicle damage.
- Choose luminairs that are not vulnerable to vandalism.

FOR FURTHER INFORMATION

References:

- City of Oakland, CA, *Lake Merritt Park Master Plan*, 2002. http://www.oaklandnet.com/community/Chapter6MaintenancePlan.pdf
- Earth Plan Associates, Inc. "Chapter 4 Park Maintenance" in 2006-2010 Parks and Recreation Master Plan, Auburn Indiana Parks and Recreation Department, 2005. http://www.ci.auburn.in.us/departments/parks&recreation/2006_2010_VisionPlan/4-Maintenance.pdf
- Feliciani, Et. Al. Operational Guidelines for Grounds Management. Ashburn, VA: Published jointly by APPA, National Recreation and Park Association, and Professional Grounds Management Society, 2001.
- Fickes, Michael. "Six Steps to Grounds Maintenance Master Planning". College Planning & Management April 2000: v3 n4 p47-50 http://www.peterli.com/cpm/resources/articles/archive.php?article_id=49
- Lavallee, Andrew. *"Sustainable Parks—Design and Planning"* in Recreation Management Magazine, April 2005. http://www.recmanagement.com/2005olgc03.php
- Palmer, Dave. *Landscape Installation & Maintenance - Are the Rules Changing?* The Institute of Food and Agricultural Sciences Cooperative Extension Service, University of Florida http://prohort.ifas.ufl.edu/files/pdf/publications/HC-RulesChanging.pdf
- U.S. National Park Service, *100+ Best Management Practices: Defining What a Green Park Looks Like*, May, 2006. http://www.fs.fed.us/sustainableoperations/documents/BestManagementPractices.pdf
- Professional Grounds Management Society Professional Grounds Management Society, 720 Light Street, Baltimore, MD 21230 (410) 223-2861 http://www.pgms.org/

9 **Palmer, Dave. *Landscape Installation & Maintenance - Are the Rules Changing?* The Institute of Food and Agricultural Sciences Cooperative Extension Service (IFAS), University of Florida**

10 **Earth Plan Associates, Inc. "Chapter 4 Park Maintenance" in 2006-2010 Parks and Recreation Master Plan, Auburn Indiana Parks and Recreation Department, 2005.**

D.2 PLAN FOR CONNECTIVITY AND SYNERGY

OBJECTIVE

Connect parks to other circulation routes, ecological areas and social systems to increase the vitality and functionality of all. Connect to nearby green spaces such as blue belts, waterways, and wildlife sanctuaries, to provide greater habitat connectivity, and watershed functionality. Connect parks to greenways and bike routes to expand those routes, and provide easy access to parks, as well as opportunities for recreation by bicycle commuters. Connect to social networks as well, such as adjacent streetscapes, land uses, and character creating opportunities for synergy with existing activities, commercial areas and special needs populations.

BENEFITS

- Expands bicycle networks
- Allows for better access to and through parks
- Connected areas of natural vegetation will improve habitat quality and transfer of native vegetation.
- Connected parks provide more opportunity for neighbor-hoods to share complementary resources.
- Increases tree canopy coverage
- Increases the function of the watershed
- Increasing access to parks by connecting park lands to each other as well as to population centers improves park vitality and encourages greater use.

CONSIDERATIONS

- Bicycle and pedestrian conflict
- Spread of invasive species
- Local program needs can shift over time

INTEGRATION

- *V.1 Protect Existing Vegetation*
- *V.3 Protect and Enhance Ecological Connectivity and Habitat*

BACKGROUND

Adjacent land uses will largely determine predominant user groups for parks. With attention paid to transportation accessibility and neighborhood connectivity, park spaces can become greater than the sum of their parts. Park connectivity efforts can be planned in tandem with, and reinforce, efforts to increase tree canopy coverage, develop green infrastructure,

Sited in the underserved Hunts Point neighborhood in the Bronx, Barretto Point Park created a destination along a planned waterfront greenway.

revitalize streetscapes and commercial corridors, and bolster active modes of transportation.

PRACTICES

EVALUATE THE SITE'S PROXIMITY TO GREEN AREAS, NETWORKS AND COMPLEMENTARY LAND USES

- Map the area near the park, identifying:
  - Other park lands and public open spaces
  - Greenways, blue belts and wildlife sanctuaries
  - Bicycle routes and storage racks
  - Program sites such as sports fields and playgrounds
  - Waterways and waterfront parks
  - Cultural sites such as museums and performance halls
  - Schools and college campuses
  - Point sources for special needs users such as senior centers, day care, and handicapped service providers
  - Commercial corridors and pedestrian attractors
  - Green markets and other street-level commerce
  - Other points of interest that complement and encourage park use
  - Public transportation stops and stations
- Map existing pedestrian, bicycle, and auto circulation in the site and surrounding areas.
- Evaluate and prioritize opportunities for enhancing park access and connectivity.
- Create opportunities for cross-programming, collaboration, and engagement with nearby organizations and resources.

PROMOTE ECOLOGICAL CONNECTIVITY TO ENHANCE ECOLOGICAL CONNECTIVITY FOR NATIVE PLANT SPECIES, BIRDS, INSECTS AND OTHER FAUNA

- Create habitat connectivity to waterfronts, wetlands, bird migration corridors
  - See *V.3 Protect and Enhance Ecological Connectivity and Habitat*
- Work with Parks foresters to increase tree canopy cover in the neighborhood surrounding the park

- See *V.10 Improve Street Tree Health*
- Preserve existing plant communities and trees when possible and beneficial, especially if they are unique to the area.
  - See *V.1 Protect Existing Vegetation*
- Protect site features during construction.
  - See *C.3 Create Construction Staging & Sequencing Plans*

PROMOTE WATERSHED CONNECTIVITY

- Examine water flows across the site and look for opportunities to allow water to pass over the site or into adjacent drainage areas.

ENHANCE PARK CONNECTIONS FOR PEDESTRIANS AND CYCLISTS

- Use greenways and bikeways to link parks to areas of population to increase use and access.
- Provide bike racks and water fountains along greenways.

DESIGN PARK CIRCULATION FOR ACCESSIBILITY

- Determine critical obstacles to accessibility to park entrances along major access corridors.
- Work with appropriate jurisdictions to minimize obstacles.
- Ensure that sidewalks providing access to parks have curb cuts.
- If a park entrance is not accessible, install signage indicating the nearest accessible entrance.
- Make every effort to integrate ramps into the path system in such a way as to avoid the need for separate routes and ramps with an obtrusive appearance.
- Design accessible routes between entry and exit points to accessible park features.

PROVIDE PLEASANT PATHWAYS AND VIEWS TO ENCOURAGE PARK USE AND MOVEMENT THROUGH PARKS

- Provide amenities that encourage prolonged use of park space, such as benches, water fountains, and comfort stations.
- Provide designated walking path circuits or trails with resting areas.
- See also *D.5 Design for Broad Appeal and Accessibility*.
- Consider safety concerns in remote parks or areas of parks and address through design and programming.
- Separate bicycles from pedestrians whenever possible.
- When bicycles are mixed with pedestrians, increase sightlines at potential points of conflict such as intersections and entrances.
- Connect remote areas to more trafficked portions of the park and allow for easy travel and destination sightlines.
- Evaluate needs for lighting, visibility, comfort stations, and emergency services.

PROVIDE OUTDOOR ACTIVITY AREAS FOR ADJACENT USES

- Provide activities for nearby populations with limited mobility.
  - Senior centers
  - Day care centers
  - Handicapped care or training centers
- Merchants associations
- Cultural institutions
- Schools in need of athletic and cultural venues

EXPAND VISUAL AND CHARACTER CONNECTIVITY

- Connect to visually appealing corridors that contain landscape and streetscape features in order to extend park qualities into the surrounding urban fabric.
- Greenstreets and bicycle paths can extend the landscape quality of park lands into the surrounding urban fabric, creating visually appealing and robust landscaped approaches to parks.
- Capitalize on borrowed views and long range vistas.

FOR FURTHER INFORMATION

- New York City Trees and Greenstreets Program. http://www.nycgovparks.org/sub_your_park/trees_greenstreets.html

The Greenstreets program is a partnership between the Department of Parks & Recreation and the Department of Transportation. Launched in 1996, Greenstreets is a citywide program to convert paved, vacant traffic islands and medians into greenspaces filled with shade trees, flowering trees, shrubs, and groundcover.

- http://www.nyc.gov/html/dcp/html/bike/home.shtml
- Coutts, C. "Greenway Accessibility and Physical Activity Behavior." Environment and Planning B, (2008) 35(3), 552-563 http://www.envplan.com/abstract.cgi?id=b3406

D.3
DEVELOP A SITE PRESERVATION AND PROTECTION PLAN

OBJECTIVE

Avoid damaging the site during construction

BENEFITS

- Prevents irreversible soil compaction and tree damage
- Preserves soil profiles and micro fauna
- Preserves natural features

CONSIDERATIONS

- Restricting site access and staging will increase cost of construction if the site is overly constrained.

PRACTICES

PLANNING

- Have a small footprint. Consolidate higher impact design elements such as buildings and pavement areas in order to preserve large swaths of existing ecosystem or to allow for areas of hydrologic restoration.
- As part of the early concept and master planning phase, develop a preservation and protection plan diagram coordinated with soil and vegetation preservation that divides the site into five basic zone types:
  - Zones of protection where existing hydrology will not be disturbed, which include appropriate buffer zones for surface water features such as, streams, lakes, wetlands
  - Zones that, based on site program, will have minimal disturbance
  - Zones for built elements
  - Zones where construction traffic (both vehicular and pedestrian) will be allowed and, to the extent possible, coincide with planned building locations, parking lots, roadways, and walks
  - Zones of construction operation and materials stockpiling, which should be limited to areas where planned building locations, parking lots, roadways, and walks would occur
- Design the first two zones as large as possible to protect them from construction traffic.
- Consider the possibility of zones of soil where residual or managed contamination may be present, where specially managed zones could be required to be overlaid on the above five zones.
  - See *S.5 Testing, Remediation and Permitting for Sites with Contaminated Soils*

When this sidewalk was reconstructed, existing street trees were not incorporated into site protection plans. During the design phase, include methods and plans to preserve existing trees during construction.

DESIGN

- Contract documents should clearly indicate the extent and requirement of site preservation and protection in order to allow the contractor to easily identify costs and schedules to perform their work. Clear documents allow for ease of enforcement of the requirements and, ultimately, lead to better results.
- Prepare site staging and sequencing plan as part of the contract documents.
- Include tree protection and fencing as a pay item in the contract.

LOCATE CONSTRUCTION ACTIVITY ZONES AFTER DEVELOPING A SITE PRESERVATION AND PROTECTION PLAN

Coordinate with other design consultants, including architects, site utility engineers, construction managers and/or resident engineers, to ensure that protection and preservation zone locations and sizes allow sufficient room for the construction of the proposed site improvements and not just the improvements themselves. Unrealistic preservation and protection zones create undue hardship for contractors leading to inflated bids and unenforceable site restrictions during construction.

- Be sure to consider the needs for equipment access and maneuverability in and around buildings, utility trenches, rock outcroppings, stairs, walls, and other new or existing site features when establishing protection and preservation zones.
- Work with contractors early in the process to stress the importance of protection zones and to develop a plan for minimizing the construction area.

CONSTRUCTION

- Be sure to consider the needs for equipment access and maneuverability in and around buildings, utility trenches, rock outcroppings, stairs, walls and other new or existing site features when establishing protection and preservation zones.
- Consider the sequence of work.

D.4 ENGAGE PUBLIC PARTICIPATION

OBJECTIVE

Engage public participation and awareness early on and throughout the process of park design.

BENEFITS

- Promotes community ownership of the park
- Encourages involvement of volunteers in park upkeep
- Incorporates valuable, local knowledge that can inspire design innovation
- Promotes awareness about sustainable design considerations that may be invisible but are essential
- Community support helps obtain required approvals.

CONSIDERATIONS

- Requires time for designer to engage with the public
- Public participation can slow down the design process if not well managed.
- Even if the designer attempts to reach all user groups some people might feel excluded.
- Not everyone's preferences can be accommodated, and there is a danger or creating unrealizable expectations.

BACKGROUND

Community involvement is the most important ingredient in vibrant public spaces. A participatory design process engages local residents and stakeholders in the creation of their park, which leads to a sense of ownership and ideally inspires long term stewardship. Community members can also help the designer obtain a depth of understanding about the site and the neighborhood that site visits cannot provide.

Identifying "the community" can be challenging. The NYC Department of Parks & Recreation, in collaboration with the City Parks Foundation, supports Partnerships for Parks (PfP) that facilitates community involvement in city parks. Partnerships for Parks staff work with a network of volunteers and local groups devoted to caring for parks, and can connect designers to key stakeholders who can inform the design process.

PRACTICES

PLAN FOR A PARTICIPATORY DESIGN PROCESS

- Work with the Borough Commissioner's office to identify local stakeholders and with Partnership for Parks staff to assemble community representatives.
- Seek participation from park users, volunteers, and stakeholder organizations, and adjacent point sources of users such as schools and friends of the park groups.
- Go to where user groups congregate to interview them, as a full range of users don't always attend public meetings.
    - Skate parks
    - Schools
    - Elder homes
- Determine ways to engage community participation in each step of the park design process.
- Ensure that the participatory design process is inclusive of underrepresented groups such as immigrants and youth.
- Plan to hold public meetings at times and places that are convenient to the public.
- Schedule meetings well in advance, and communicate the invitations effectively.
- On large projects it is important to report back at intervals so stakeholders may participate in the establishment of priorities.

ANALYZE THE PARK SITE AND THE NEIGHBORHOOD

- Reach out to locals who know the site best and can share knowledge that the designer might miss.
- Ask about site conditions and how the space is used.
    - For example, useful information includes 'this spot gets muddy after a rain,' or 'seniors gather at those benches in the shade.'
- Encourage community members to provide cultural, historical, and neighborhood context to inform a locally resonant design.

COLLECT COMMUNITY INPUT AND FEEDBACK

- Research existing community agendas for open space, such as 197a plans, community board statements of need, etc. Many communities have already prioritized their open space needs, which provide good background for new sites.
- Encourage committed participants to speak with their neighbors and fellow park users and then report back.
- Communicate what kinds of input are useful.
- Depending on the size of a project, designers can use a variety of tools to collect input from a wide range of users, including:
    - Individual interviews
    - Surveys, gathering only useful information, and formatted for easy correlation such as multiple choice
    - Web sites
    - Community design meetings
    - Creative activities or games that allow people to show their vision of their ideal park
    - Interactive maps
    - Non-language based methods of providing feedback (important in efforts to involve new immigrants).

PUBLIC MEETINGS

- Clearly communicate the purpose of the meeting, design timeline, and budget.
- Present the site analysis, and constraints of the project, to participants in an accessible way.
- Help the public interpret what they are looking at to ensure

that the designer receives relevant comments.

- Encourage community members to share what they know about the current use of the site, its problems and opportunities, as well as their needs and aspirations.
- Avoid creating a simple wish list, as you need to know less tangible concerns as well.
- Ask probing questions to tease out specifics.
- Designate a notetaker, create a record of information gathered, problems identified, decisions made, and next steps.
- Keep notes on a flip chart so there is a visible record of everyone's comments regardless of significance.
- As designs progress, describe how community input from earlier in the design process has informed the design.
- Establish a sign-in sheet with contact information, especially email addresses for future invitations and follow up questions.
- Be accessible to participants before and after the meeting.
- Introduce yourself to individuals and get to know their concerns, make notes so you can contact them later for follow up questions and to report progress in their areas of interest.

OVERCOME OBSTACLES OF PARTICIPATORY PROCESSES

- Treat the community as a partner in seeking the best design solutions within constraints, rather than as a client.
- Encourage the public to understand and accommodate the design schedule.
- Manage expectations of local participants and inform them about budget and design constraints.
- Encourage the community to respect the designer's role and use input-gathering to incorporate the community's expertise.
- Identify opinion leaders and consult with them on difficult issues prior to public meetings.

COMMUNITY PROJECTS

- Consider opportunities for the community to aid in planning, building, and/or maintaining elements of the park.
  - Gardens
  - Tree plantings
  - It's My Park Day
- If applicable, work out the community's responsibilities for maintaining and caring for the project.
- Consider community-created art and signage to reflect local culture and history.
- Consider allocating space for community gardening or tree planting to give participants the opportunity to cultivate the park.
- Be wary of challenges to hands-on projects, including:
  - Organizational complexities and rivalries
  - Slow timing
  - Approval complications
  - Exclusivity of themes that lack relevance to some park users
  - Lack of sustained commitment to project upkeep, which would burden agency maintenance staff.

USE THE CAPITAL PROCESS TO INCREASE COMMUNITY INVOLVEMENT IN PARKS

- Encourage the community surrounding a park to use the space for activities and events.

In NYC's Chinatown, Parks worked with Hester Street Collaborative, a local nonprofit, to hold a day of workshops that engaged local participants to develop new park ideas.

- Foster a sense of park ownership within the community that encourages long term commitment to park health and maintenance.
- Seek Partnerships for Park's help in encouraging community groups to better organize and promote themselves.
- Seek partnerships with existing groups and institutions such as schools and community centers.
- Create a relationship with local organizations to achieve a better understanding of the site ecology and history.
- Promote local support of the proposed design to minimize conflict during regulatory approval reviews and public comment periods.

DESIGN PARKS WITH SPACE FOR FLEXIBLE USE

- Design parks that permit a variety of programming and uses.
- Encourage a greater diversity of park users, as well as allow different uses to evolve as neighborhoods change.

STAY CONNECTED AND INFORMED DURING CONSTRUCTION

- Engage key stakeholders to inform neighbors about the capital project and the incorporation of community input into the design.
- On large projects use the Parks web site to keep the community informed about the project's construction.
- Create signage in appropriate languages and post on the construction site fence:
  - Inform people about plans for the new park and when it will reopen.
  - Refer people to other neighborhood parks to visit during construction.

CELEBRATE THE PARK OPENING

- The Borough offices and Partnerships for Parks can invite community members to help plan a ribbon cutting event that is inclusive of all local stakeholders.
- At the opening, acknowledge the contributions of community members and make the event memorable for everyone who attends.

ENSURE ONGOING MAINTENANCE AND PROGRAMMING

- Encourage community volunteers who played a role in design to become long term park stewards, contributing to planting, cleaning, programming and other activities.
- For more information, refer to *M.4 Partner with Private Sector and Local Community to Assist with Maintenance*.

FOR FURTHER INFORMATION

- Faga, Barbara. *Designing Public Consensus: The Civic Theater of Community Participation for Architects, Landscape Architects, Planners and Urban Designers* (Wiley, 2006)
This publication examines public process implemented in projects of different scales, and reveals the lessons learned by the design practitioners. http://www.designingpublicconsensus.com/
- *People Make Parks Kit*: Partnerships for Parks and Hester Street Collaborative — a non-profit that engages residents and students in underserved NYC neighborhoods in participatory architectural projects — are working together to produce the *People Make Parks Kit*, a guide to community involvement in park design. Contact kate.louis@parks.nyc.gov for more information.
- *Allen and Pike Street Malls*: In the summer 2008, the United Neighbors to Revitalize Allen and Pike Coalition and Hester Street Collaborative organized an innovative input-gathering process to inform the renovation of this median park. For more information visit: www.hesterstreet.org/newsletters/october08.html#allen
- *PlaNYC Regional Parks*: In the summer of 2007, Partnerships for Parks coordinated efforts to collect surveys and hold community meetings about plans for regional parks slated for reconstruction with funding through the Mayor's *PlaNYC* initiative. Read about these efforts in Partnerships for Parks' newsletter, *The Leaflet*: www.partnershipsforparks.org/4058/Partnerships_for_Parks_Winter_2008_Leaflet
- *Grant Park and Dred Scott Bird Sanctuary:* Volunteers at this site in the Bronx demonstrated the power of community input in park design simply by attending a planning meeting and sharing their local knowledge.
- http://www.partnershipsforparks.org/3951/Partnerships_for_Parks_Summer_2007_Leaflet

D.5
DESIGN FOR BROAD APPEAL AND ACCESSIBILITY

OBJECTIVE

Accommodate the full range of recreational and park use preferences expected from the local community — including projected future residents — throughout the planning and design of parks. Use Universal Design concepts to ensure access for users of a variety of ages and abilities, including persons with mobility, visual, hearing, or cognitive impairments.

BENEFITS

- Increases participation in park facilities and open spaces
- Flexibility of use allows parks to evolve as user groups do
- Provides recreational opportunities for diverse groups
- Encourages park use by less engaged groups
- Promotes social interaction and integration
- Provides a variety of safe and challenging ground level and elevated activities for all children, including those with disabilities
- Ensures compliance with ADA guidelines and best practices for accessibility

CONSIDERATIONS

- Not everyone's preferences can be accommodated, especially in smaller neighborhood parks.
- Identifying user groups can be time consuming and challenging, especially if language barriers exist.
- Requires time for designer to interface with the public
- Even if the designer attempts to reach all user groups, some people might feel excluded.
- Implementation may be challenging in developing accessible solutions for older facilities built before the current accessibility standards existed.
- May increase cost of project and lead to tradeoffs.

INTEGRATION

- *D.2 Plan for Connectivity & Synergy*

BACKGROUND

While young children and seniors are often given specific use areas, other ages and stages of life have equally valid needs, which are crucial to a park's success. Cultural preferences are powerful determinants of active and passive park use. Neighborhood demographics change over the life of a park, sometimes rapidly, so it is important to understand how a neighborhood is changing so the park can accommodate that change.

People's physical abilities are highly varied. It is important to understand park use from the point of view of the disabled user, who could be a child, a parent, a caregiver or a visitor. Title II of the Americans with Disabilities Act (ADA) requires that each program, service, or activity conducted by a public entity, when viewed in its entirety, be readily accessible to and usable by individuals with disabilities. This program accessibility standard — providing access to programs, not just to facilities — permits a broader and more flexible range of solutions to existing access problems. Program accessibility may be achieved through structural methods, or by relocating a program to an alternate, accessible facility. Local governments are not required to remove physical barriers in every one of their existing buildings and facilities so long as they make their programs accessible to individuals who are unable to use an inaccessible existing facility. The ADA Design Guidelines established requirements for barrier free design in new construction and planned alterations.

Parks must ensure that newly constructed and reconstructed buildings and facilities are free of architectural and communication barriers that restrict access or use by individuals with disabilities. When Parks undertakes alterations to an existing facility, the reconstructed portions are designed to comply with ADA guidelines.

PRACTICES

PLANNING

CONSIDER SITE CONTEXT AND NEIGHBORHOOD INPUT IN SELECTING SITE PROGRAMMING

- Evaluate use of the site
  - User surveys in the park and community can be a valuable tool to determine who is using the park.
  - Often certain groups don't show up at outreach meetings, yet the desires and needs of these invisible groups are important to represent in the design.
- Consider the extent to which certain amenities are overused at the site or in nearby parks, indicating a demand for additional amenities.
- Consider the extent to which certain amenities are underused, indicating a shift in demand.
- Review community board district needs statements and demographic trends.
- Work with Friends groups, Partnerships for Parks, and Borough Commissioners' offices to identify local park advocates and community leaders.
- Based on community input, consider and prioritize other amenities, landscape features, or types of recreation.
  - See *D.4 Engage Public Participation*.
- See *D.2 Plan for Connectivity & Synergy*.

PROVIDE BOTH SPECIFIC USE AREAS AND FLEXIBLE ONES

- Pay particular attention to the recreational and developmental needs of children of all ages, including adolescents who do not participate in team sports.
- Address cultural preferences of new immigrants such as cricket, soccer, tai chi.
- Anticipate infrastructural and spatial needs for programming by different user groups.
- Anticipate how demand for amenities will change as neighborhood demographics and context shift.
- Design parks with flexible spaces that can accommodate a variety of users and changes in use.
- Do not create conflict between user groups.
  - Noisy activities should not be next to quiet passive areas.
  - Activities such as dog runs and basketball courts should not be located close to residential areas due to potential noise problems.

ENCOURAGE AWARENESS OF NATURAL, CULTURAL, HISTORICAL, AND ENVIRONMENTAL ASPECTS OF SITE

- Investigate site history, including:
  - Previous site uses
  - Historically significant events at or near site
  - Ecologically significant plant or animal communities
- Include significant site elements within site analysis, and respond as necessary within design.

PROVIDE PLEASANT PATHWAYS AND VIEWS TO ENCOURAGE PARK USE AND MOVEMENT THROUGH PARKS

- Provide amenities such as benches, water fountains and bathrooms.
- Provide designated walking path circuits or trails with resting areas.

APPEAL TO OLDER USERS AND THOSE WITH PHYSICAL IMPAIRMENTS

- Provide an age friendly bench design with full back support and armrests.
- Provide a two-tier drinking fountain for people of varying heights and those who have trouble bending.
- In restrooms, provide an ambulatory accessible toilet for people who use canes or walkers.
- Foster intergenerational activities and opportunities to help encourage interaction among all users.

DEVELOP PARTNERSHIPS TO INFORM PUBLIC ABOUT PARK AMENITIES AND ACTIVITIES

- Expand partnerships between Parks, senior centers, public libraries, and other local institutions to foster stewardship of the park as well as lifelong learning and cultural engagement.
- Understand the demographics of the community you are communicating with.
- Translate and post information about park events and resources broadly.
- Include bulletin boards in recreation centers, libraries, and community centers.
- Make use of media including the Parks website and community newspapers.

DESIGNING FOR ACCESSIBILITY

PLAN FOR INDEPENDENT, BARRIER-FREE ACCESS TO PUBLIC RECREATIONAL FACILITIES

- Consider accessibility needs in all park projects, including:
  - Playgrounds
  - Sports fields
  - Tennis courts
  - Recreation centers
  - Boat slips, docks, and fishing piers
  - Beaches
  - Restaurants
  - Golf courses
  - Swimming pools
  - Restrooms
  - Natural areas and trails
- Wherever possible and desirable, exceed accessibility requirements.

DESIGN ACCESSIBLE FEATURES

- Consult Parks' in-house ADA contact person, who can be used as a resource for designers.
- Provide accessible routes and entrances.
- When renovating restrooms, provide at least one standard wheelchair-accessible toilet if feasible.
- For projects involving historic properties, provide access while preserving special building features and finishes.
- Incorporate accessible features, including:
  - Drinking fountains
  - Picnic tables
  - Bleachers
  - Benches with adjacent wheelchair spaces
  - Accessible parking spaces
  - Accessible playground equipment
  - Ramps, curb-ramps, and transfer platforms
  - Directional signage, doorway hardware
  - Detectable warnings
  - Handrails, elevated planters
  - Elevated sand boxes.

IF NECESSARY, CONSIDER EQUIVALENT FACILITATION

- Ensure that designs, products or technologies that depart from guidelines provide equivalent access.
- Ensure substantially equivalent or greater accessibility and usability is provided.

PROVIDE ACCESSIBLE WORK AREAS

- Design employee work areas so that employees with disabilities can approach, enter, and exit the areas.
- Modify work stations as needed to include maneuvering space and adjustable shelving, as reasonable accommodations for employees with disabilities.

DESIGN FOR ACCESSIBILITY

- Ensure that all primary entrances in new park sites and buildings — those used for day-to-day pedestrian ingress and egress — are accessible.
- Ensure accessible routes to park buildings coincide with general circulation paths.
- In new park structures, ensure that the accessible route does not pass through kitchens, storage rooms, restrooms, closets or similar spaces, if it is the only accessible route.
- Regrade portions of sites, where necessary, to avoid step barriers.
- Raise the grades around comfort stations and other buildings to eliminate the need for a step.

FOR FURTHER INFORMATION

- Hooper Leonard *J. Landscape Architectural Graphic Standards*. Wiley and Sons, October 2006.
- Americans with Disabilities Act and Architectural Barriers Act Accessibility Guidelines (2004), The United States Access Board (*Architectural and Transportation Barriers Compliance Board*) (800) 872-2253. www.access-board.gov
- ICC/ANSI A117.1-2003, Accessible and Usable Buildings and Facilities, American National Standards Institute, Inc. www.iccsafe.org
- Proposed ADA Standards for Accessible Design, June 2008. U.S. Department of Justice, Civil Rights Division, Public Access Section. (800) 514-0301, (202) 514-0301. www.ada.gov
- Universal Design New York 2, Danise Levine, Editor in Chief, 2003, Center for Inclusive Design and Environmental Access, University at Buffalo, The State University of New York, Buffalo, NY, ISBN 0-9714202-3-8.
- The City of New York Building Code, July 2008, ISBN-978-1-58001-716-9.
- City of New York Parks and Recreation http://www.nycgovparks.org/facilities/playgrounds
- Accessible playgrounds include:
  Playground for All Children, Flushing Meadows-Corona Park
  World Ice Arena & Natatorium, Flushing Meadows-Corona Park
  Morningside Park Playground, 116th St, Manhattan
  Al Oerter Recreation Center, Queens
  Mullaly Park, Bronx
  Sorrentino Recreation Center, Queens

Boardwalks like this one allow universal access to views and habitat, giving all visitors direct experience of environmental aspects of site.

The play equipment at this playground on Manhattan's Upper West Side is designed to allow access to all children, including those with wheelchairs.

D.6 IMPROVE PUBLIC HEALTH

OBJECTIVE

Plan and design parks and landscapes to promote active fitness, improve air quality and microclimate, and enhance the health and wellbeing of park users.

BENEFITS

- Encourages healthy behavior
- Provides access to fitness and recreation
- Encourages neighborhood interaction
- Citywide changes in park design can have a cumulative impact on city air quality.
- Mitigating urban heat island effect within parks can cool surrounding neighborhoods.
- Addresses the emerging health epidemic of obesity

CONSIDERATIONS

- Difficult to quantify benefits created by individual parks on city as a whole
- Accommodating the recreational preferences for all park users is challenging.
- Choosing between creating recreation areas and landscape can be challenging, especially in areas that are underserved in both.
- Overuse of recreational fields creates maintenance issues and additional costs.
- Poorly constructed or maintained landscapes will fail to improve air quality and microclimate.

BACKGROUND

Parks play a unique role in urban public health. They are the nexus of passive and active recreational activities, which provide fitness opportunities that offer a range of health benefits, including improved cardiovascular health, stress reduction, enhancement of physical strength and flexibility, and improved coordination. At the same time parks and landscapes contain vegetation that provides valuable ecosystem services and health benefits such as air quality improvement and evaporative cooling. Quality park design and programming can help improve fitness and reduce obesity, improve air quality, mitigate the urban heat island effect, and reduce asthma rates.

PRACTICES

FITNESS

EVALUATE HEALTH AND WELLNESS OPPORTUNITIES

- Research local public health and wellness concerns, such as fitness or asthma rates.
- Reach out to local participants as well as public health experts.
  - See *D.4 Engage Public Participation*.
- In areas where health issues are evident, consider how the design and programming of the park site could help.

CREATE FITNESS OPPORTUNITIES FOR ALL POPULATIONS

- Determine what fitness facilities are available, and supplement those with needed facilities.
- Encourage active recreation for a diversity of user groups. Suggestions include:
  - Play opportunities for children that build coordination, flexibility, and strength
  - Address the preferences of new immigrants such as cricket, soccer, tai chi
  - Exercise opportunities for parents adjacent to or within playgrounds and sports fields
  - Incidental areas for stretching and strength building for adults, especially senior citizens
  - Bikeways
  - Attractive stairs that encourage use
  - Attractive areas for exercising, and exercise classes.
- Encourage passive recreation, including:
  - Walking trails
  - Nature trails.
- Use materials that enhance the exercise activity such as soft surfaces for running and exercising.

ENCOURAGE ACTIVITY THROUGH CONNECTIVITY

- Encourage use through connecting different open spaces, work places, schools, and residential areas with bikeways and pedestrian networks.

AIR QUALITY & MICROCLIMATE

ASSESS TREE CANOPY COVERAGE

- Survey existing trees within the site.
  - Assess species type, canopy coverage, degree of coverage, and tree health status.
- Survey trees surrounding the site to assess need for increased canopy cover.
- Work with the Forestry Division to determine the street tree canopy coverage in the park's neighborhood.
- Create a plan indicating current shading patterns and proposed additions.
  - Overlay shading with site features to analyze which areas receive adequate shade and which are in need of greater coverage.

> The Department of Health and Mental Hygiene (DOHMH) has finalized the New York City Community Air Survey (NYCCAS) after collaboration with specialists and community stakeholders. NYCCAS will measure, at a minimum of 130 street level locations in each season each year, nitrogen oxide, ozone, sulfur dioxide, fine particle mass, elemental carbon, and the metal content of air. These collaborative air quality monitoring efforts could inform park and landscape design initiatives.

Greenways like this one along Manhattan's West Side, provide connections between parks to a variety of users and provide opportunities for many kinds of physical activity.

■ Seek to increase canopy cover in areas with low overall cover, particularly in underserved areas.

REDUCE SUMMERTIME SURFACE TEMPERATURES THROUGH REDUCED SOLAR ABSORPTION AND HEAT RETENTION

■ Assess urban heat islands on or near the site.
■ Where possible, replace paved areas with permeable coverage, allowing for infiltration of groundwater.
■ Consider reradiated heat from walls and ground planes.
■ Increase the albedo and emissivity of paved sections to reduce solar absorption and heat retention.
■ Plant additional vegetation in paved areas receiving substantial sunlight to reduce urban heat island effects as well as cool the park in warmer months.
■ Consider incorporating water features during summer months to increase evaporative cooling.
■ In general, seek to create comfortable microclimates throughout the site, especially in seating areas, recreational areas, and child play areas.

CONDUCT COLLABORATIVE LOCAL AIR QUALITY STUDY

■ In problem areas evaluate studies and consult experts, or conduct studies to assess air quality and identify sources of pollution impacting park site.
  □ Assess impacts of park design or reconstruction.
■ These studies can be compared with assessment after park designs have been implemented.

ASSESS LOCAL POLLUTANT SOURCES

■ Assess site and surroundings for sources of localized air pollutants.
  □ Evaluate impacts of active roadways, especially those with commercial traffic.
  □ Evaluate neighboring industries and land uses.
  □ Engage public stakeholders in these efforts.

PLAN PARK PROGRAMS AND LANDSCAPE FEATURES TO MINIMIZE IMPACT OF LOCAL POLLUTION

■ At sites adjacent to pollution sources, design park edge features to serve as buffers to reduce wind, filter large particles and exhaust from the air, and reduce noise.
■ Locate seating areas, playgrounds, athletic fields and other areas of sensitive use as far as possible from sources of pollution. Distance greatly reduces exposure to ground level polluters such as vehicles.
■ Preserve valuable existing vegetation and soils.
■ Maximize vegetation on site.
  □ See *V.6 Use an Ecological Approach to Planting*.
■ When installing vegetation, design planting beds to encourage long term growth and vitality.

ENCOURAGE OUTDOOR COMFORT

■ Provide seating areas around amenities such as playgrounds, gardens, and sports fields.
■ Provide seating areas in attractive and comfortable locations.
■ Provide shade trees near seating areas and ensure that planting beds are large enough for mature canopy development.
■ Integrate other landscape design features with seating and activity areas to create comfortable microclimates and pleasing spaces.

USE ENVIRONMENTALLY BENIGN MATERIALS

■ Minimize volatile organic compounds in park materials.
■ Consider the health of park workers as well as park users when selecting materials and cleaning products.
■ Reuse materials onsite or from nearby sites to reduce transportation related impacts on air quality.
■ Reduce the use of harmful chemical products and soil amendments.
  □ See *S.3 Prioritize the Rejuvenation of Existing Soils Before Importing New Soil Materials*.
■ See *D.8 Choose Materials Wisely*.

CONDUCT A HEALTH IMPACT ASSESSMENT (HIA)

■ Assess your project's design criteria in order to reveal quantifiable health/safety impacts that will accrue from the redesigning of the parkland and maximizing its sustainable features.

FOR FURTHER INFORMATION

- Dee Merriam, FASLA / Centers for Disease Control / 4770 Buford Highway, MS-F60 / Atlanta, GA 30341 / dmerriam@cdc.gov
- Martha Droge, AICP, ASLA, LEED AP / Coordinator / Kitsap County Parks and Recreation Dept, / 614 Division Street, MS-1 / Port Orchard, WA 98366 / 360-337-5362 / mdroge@co.kitsap.wa.us
- A PDF of the PowerPoint presentation that Dee Merriam and Martha Droge delivered at ASLA's National Convention, October 2008, is available online:
- "Wellness by Design: Applying Health Impact Assessments to Community Planning and Design Projects" http://www.asla.org/uploadedFiles/CMS/Resources/TueB3.pdf
- *PlaNYC* Air Quality Goals, http://www.nyc.gov/html/*planyc*2030/html/plan/air.shtml
- Air Quality Index: www.airnow.gov
- Physical Fitness Guidelines: www.cdc.gov/nccdphp/dnpa/physical/recommendations/older_adults.htm
- Health Effects Institute: www.healtheffects.org/about.htm
- Cardiovascular Health: www.cdc.gov/cvh
- EPA Aging Initiative: www.epa.gov/aging
- Designing Healthy Places: www.cdc.gov/healthyplaces
- Health Statistics: www.cdc.gov/nchs/hus.htm
- Place Making Tools for Health and Community Design, Project for Public Spaces: http://www.pps.org/info/placemakingtools/issuepapers/health_community
- Enrique Penalosa, Why Parks are Important to Cities: A transcript of a keynote address at the Urban Parks Institute's "Great Parks/Great Cities" Conference, July 30, 2001: http://urbanparks.pps.org/topics/whyneed/newvisions/penalosa_speech_2001
- Brown, Robert; Gillespie, Terry. *Microclimatic Landscape Design: Creating Thermal Comfort and Energy Efficiency*. Wiley and Sons, August 1995. http://www.wiley.com/WileyCDA/WileyTitle/productCd-0471056677.html
- California Asthma Partnership Strategic Plan: http://www.asthmapartners.org

D.7 MITIGATE AND ADAPT TO CLIMATE CHANGE

OBJECTIVE

Anticipate changes at park sites and surrounding areas that may result from climate change. Determine strategies to mitigate and adapt to the affects of climate change while promoting the long term resilience of parks and landscapes.

BENEFITS

- Enables parks and landscapes to adapt to and remain resilient in the face of climate change
- Creating parks can be an efficient means of addressing flood control.
- Well designed, constructed and maintained landscapes can help sequester carbon dioxide.
- Landscapes can also reduce ambient temperatures by provide shading and evaporative cooling.
- Helps reduce energy use

CONSIDERATIONS

- Quantifying the benefits of individual parks in citywide mitigation and adaptation is challenging.
- It is difficult to predict all of the impacts of climate change, particularly regarding flooding and extreme weather events, particularly whether changes in precipitation levels will hinder, alter or even enhance natural vegetation growth.
- Storm frequencies and flooding levels anticipated due to climate change may exceed existing codes.
- Higher costs of more extensive infrastructure may be difficult to justify.

BACKGROUND

According to the New York City Panel on Climate Change, the metropolitan region is extremely likely to experience warmer temperatures in the coming decades, more likely than not to experience increased precipitation, and extremely likely to experience sea level rise.[11] Furthermore, the likely increase in the frequency of extreme weather events is expected to create a variety of conditions that could harm the city's population as well as its infrastructure, parks, and landscapes. These impacts include heat waves that are more frequent, intense, and longer lasting; brief and intense precipitation events that can cause flooding and sewage overflows; storm related coastal flooding; and possibly increased drought periods. Based on these projected impacts, the New York City Panel on Climate Change is currently working to devise strategies that can be implemented citywide to protect the city and adapt to changes caused by climate change.

GLOBAL CLIMATE MODEL PROJECTIONS FOR THE NEW YORK CITY REGION

Mean annual temperature increases:
- 1.5 to 3 F° by the 2020s
- 3 to 5 F° by the 2050s
- 4 to 7.5 F° by the 2080s

Mean annual precipitation increases:
- 0 to 5% by the 2020s
- 0 to 10% by the 2050s
- 5 to 10% by the 2080s

Mean annual sea level rise:
- 2 to 5 inches by the 2020s
- 7 to 12 inches by the 2050s
- 12 to 23 inches by the 2080s
- Rapid Ice Melt scenario: 41 to 55 inches by the 2080s

PRACTICES

PLANNING

CONDUCT A CITYWIDE CLIMATE CHANGE IMPACT SURVEY FOR PARK AREAS

- Identify park sites and other landscaped amenities that are vulnerable to:
  - Sea level rise
  - Damage from violent storms
  - Invasive species and pests
  - Landscape succession
  - Temperature related impacts
  - Salt water intrusion
- Give special attention to waterfront landscapes, geographically exposed landscapes, and sites with a history of flooding.
- Evaluate presence of invasive species as climatic conditions change.
- Determine strategies for increasing the resistance and resilience of specific park and landscape assets.
- In areas that have high risk for future flooding, consider developing adaptation plans to offer protection and increase resilience.
- Consider how natural areas or constructed landscapes along waterways could serve as buffers to surrounding inhabited areas.
- Assess potential for new and expanded disease vectors and their habitats in parks and natural landscapes.

DEVELOP CLIMATE ADAPTATION PLANS FOR VULNERABLE EXISTING PARKS AND LANDSCAPES

- Hard Infrastructure
  - Drainage
  - Utilities
  - Asphalt design and materials
  - Pile and pier design
  - Fixed playground structures
- Assess site's risk of flooding due to 50 and 100 year storms or larger.

- Examine maps that predict floods and coastal erosion hazard areas.
- Use flood estimates for larger design storms and account for increased intensity of storms.
- Keep abreast of updates to flood projections.

- Determine acceptable levels of risk for the site.
- Consider how flooding events would impact the site.
  - Pay particular attention to sensitive features including buildings, ornamental plantings, large trees, storage areas, and historic assets.
- Determine if any of the following practices will offer increased protection:
  - Engineering solutions such as regrading and stormwalls
  - Altered plantings
    - Salt-tolerant species
    - Inundation-tolerant species
    - Hearty species
  - Stormwater best management practices
  - Management / maintenance changes
  - Increasing tidal wetland coverage in coastal locations.
- Determine strategies for remediating damaged landscape features, including fallen trees and invasive species.
- Identify the most effective site adaptation measures and create an adaptation plan for the site that could either be undertaken incrementally or as part of future work plans.

ASSESS AND SEEK TO ENHANCE THE CARBON CAPTURE AND STORAGE POTENTIAL OF LANDSCAPE AND SOIL FEATURES

- Seek to increase understory planting wherever possible to increase biomass.
- Assess the greenhouse gas liabilities of different strategies for dealing with dead or dying trees.

DESIGN

CONDUCT A CLIMATE IMPACT ASSESSMENT FOR NEW PARKS AND LANDSCAPES

- Determine future risks related to climate change and opportunities for mitigation.
- Determine acceptable levels of risk for the site.
- Consider exceeding requirements for storm frequencies and sizes.
- Consider onsite stormwater management strategies.
- Consider how the site could aid in citywide adaptation to climate change.
- When possible, engage the public (residents, stakeholders, local environmental groups) in climate impact assessment.

DESIGN TO MINIMIZE RISKS RELATED TO CLIMATE CHANGE

- In site planning, locate sensitive site features in locations that are less prone to flooding.
- Create absorbent landscapes and utilize onsite stormwater management.
  - See *Part 4: Water*, in particular *W.3 Create Absorbent Landscapes*.
- Select species that can tolerate the anticipated range of temperatures, rainfall patterns, and potential inundation from sea level rise.
- In situations where inundation may become a problem, utilize species that tolerate intermittent flooding and are less sensitive to salt water.
- Select trees with special care, especially along waterfronts.
- Use proactive park design as an opportunity for public education on flooding.
  - Explain anticipated changes and how the park is planned for long term viability.
- Design landscapes to provide canopy cover, shading, and evaporative cooling in order to reduce the urban heat island effect.

MINIMIZE IMPACT OF SITE CONSTRUCTION ON NEW YORK CITY'S MUNICIPAL CARBON FOOTPRINT AND THE GLOBAL CARBON BUDGET

- Research materials with low carbon footprints and surfaces with high reflectance and emissivity.
  - See *D.8 Choose Materials Wisely*.
- Source materials locally whenever possible.
- Minimize soil disturbance during construction.
  - See *S.2 Minimize Soil Disturbance*.
- Use energy efficient and low emissions construction equipment that meet and exceed the requirements of Local Law 77.

MAINTENANCE & OPERATIONS

- Evaluate presence of invasive species as climatic conditions change.
- Periodically monitor and assess the effectiveness of the site's Climate Adaptation Plan.
- Asses site for damage following extreme weather events.
- Track climate impacts on site over time in an easily accessible registry or database.
- Reassess and modify the Climate Adaptation Plan as new climate data become available or as changes to the site necessitate modification.

FOR FURTHER INFORMATION

- Carbon Footprint and Redesign of Pedestrian Pathways for the New York City Parks and Recreation Department: Final Report (April, 2008) http://community.seas.columbia.edu/cslp/presentations/spring08/Material%20Pathwaycarbon%20Footprint%20And%20Redesign%20Of%20Pedestrian%20Pathways.pdf
- The level of flooding risk is available through the city's Hurricane Evacuation Zone Finder: http://home2.nyc.gov/html/oem/downloads/pdf/hurricane_map_english_06.pdf
- NYC Department of Environmental Protection Climate Change Program Assessment and Action Plan
  A Report Based on the Ongoing Work of the DEP Climate Change Task Force; May 2008, Report 1
  http://www.nyc.gov/html/dep/html/news/climate_change_report_05-08.shtml
- New York City's Climate Change Adaptation Plans and documents, http://www.nyc.gov/html/*planyc*2030/html/plan/climate.shtml

11 **New York City Panel on Climate Change (2009). Climate Risk Information. http://www.nyc.gov/html/om/pdf/2009/NPCC_CRI.pdf**

D.8 CHOOSE MATERIALS WISELY

OBJECTIVES

Decrease damage to the environment caused by material harvesting, production, installation, and use. Increase material resilience and ease of maintenance.

BENEFITS

- Preserves the rain forest and other ecosystems
- Reduces carbon dioxide and pollution emission
- Decreases the heat island effect and stormwater runoff
- Reduces construction waste disposal
- Reduces energy consumption
- Reduces hazardous emissions and fumes
- Use of local resources and manufacturing facilities reduces transport costs and benefits the local economy.
- Using recycled materials reduces landfill burdens, carbon emissions, and mining of raw materials.
- Use of locally available recycled materials may reduce cost.
- Specification of a material that can provide employment and habitat preservation, such as sustainably grown wood, can increase its production and availability.
- Properly specified materials are resistant to rot, and vandalism, decreasing repair and replacement costs.

CONSIDERATIONS

- Quality assurance and quality control are required with new materials.
- New materials must be tested before use and evaluated after installation, before they can be widely specified.
- The use of unique designs, non standard materials or unusual methods may require reengineering.
- Can be difficult and more expensive to source sustainably managed or certified materials.

BACKGROUND

The careful selection of site materials and assemblies is a critical part of high performance landscapes. Historically, designers have chosen site materials primarily based on performance criteria, initial cost, and aesthetics. The urgency of climate change, air pollution, rising fuel costs, ecological destruction, and loss of natural resources is changing the focus of critical selection criteria.[12] Three aspects of sustainability — environmental, social and economic — impact material's production and use are now important to consider.

The full life span of environmental, social, and economic considerations include extraction of raw materials associated with renewability and extraction of raw materials, fabrication and shipping of elements, installation side effects, maintenance methods and frequency, and potential for recycling and reuse should be fully considered.

Materials selection needs to be considered in tandem with overall high performance goals for a site and the specific BMP strategies to achieve those goals. Some materials are justified solely based on their environmental benefits such as reduced embodied energy, low toxicity or durability. Others materials or assemblies may not be entirely green or sustainable when judged on their own, but when they contribute to the overall success of a site strategy or goal they may actually be justified. For example, a locally produced material may have a higher initial cost, yet the material's use may be contributing to the well-being of the local economy, supporting local industry and livelihoods, which is of long term benefit to the community as a whole.

Quantity is an important factor. The material with the least impact is one that is not used at all. Reducing the volume of material used can have a large effect on the overall environmental impact of a project. Quality and longevity are important as well. Materials that need little repair conserve scarce maintenance resources, and can prolong the capital replacement cycle.

PRACTICES

Meg Calkins outlined key principles to be considered when selecting materials that contribute to high performance landscapes:[13]

CHOOSE MATERIALS AND PRODUCTS THAT MINIMIZE RESOURCE USE

- Choose products and assemblies that use fewer materials.
- Use reused materials and products.
- Use recycled materials.
- Use materials that favor high levels of both pre- and post-consumer recycled content.
- Use materials that are made from agricultural waste.
- Use materials or products with reuse potential.
- Use renewable materials.
- Use materials or products from manufacturers with product take-back programs.

CHOOSE MATERIALS AND PRODUCTS WITH LOW ENVIRONMENTAL IMPACTS

- Use materials that do not cause environmental harm in their harvesting or production.
- Use sustainably harvested or mined materials.
- Use minimally processed materials.
- Use materials that are low polluting and require low water or low energy use in their extraction, manufacture, use or disposal.
- Use materials that are made with energy from renewable sources such as wind or solar power.
- Use local materials.

CHOOSE MATERIALS OR PRODUCTS POSING NO OR LOW HUMAN AND ENVIRONMENTAL HEALTH RISKS

- Use low emitting materials or products.

- Use materials or products that avoid toxic chemicals or by-products in their entire life cycle.

CHOOSE MATERIALS THAT ASSIST WITH SUSTAINABLE SITE DESIGN STRATEGIES

- Use products that promote a site's hydrological, soil, vegetative, habitat or climatic health and improve overall ecological functioning.
- Use products and assemblies that reduce the urban heat island effect.
- Use products and assemblies that reduce energy and water consumption during site operations.

CHOOSE MATERIALS OR PRODUCTS FROM COMPANIES WITH SUSTAINABLE SOCIAL, ENVIRONMENTAL AND CORPORATE PRACTICES

WHEN CHOOSING MATERIALS, CONSIDER THE SERVICE LIFE OF THE MATERIAL

- Choose materials that are resilient in the park environment, resistant to rot and vandalism.
- Service life costs are critical to high performing landscapes.
- Initial material costs need to be balanced against durability of a material when considering the long term cost of a park's upkeep so as to not burden the city with high maintenance and capital replacement costs.

LET "REUSE BE REINSPIRATION"[14]

The reuse of materials can lead to aesthetic and educational opportunities that challenge viewers, redefining how materials are perceived and utilized in the landscape. The reuse of onsite materials provides an opportunity to celebrate a site's past and give it a unique character due to the patina of wear.

PAVING

PAVE LESS

Decreased pavement can help decrease stormwater runoff volume and velocity. It can also improve water quality, infiltration and recharge for vegetative areas. One of the simplest ways to reduce pavement impact is to reduce pavement areas. Consider the following strategies to reduce pavement areas:

- Reduce parking space sizes, including the designation of 30% of all spaces for compact vehicles.
  - Reduce width of driving lanes on roadways and within parking lot aisles.
- Reduce parking space sizes by allowing cars to overhang planting areas or porous aggregate stone strips at the edge of parking areas.
- Reduce the number of paved parking spaces by developing shared parking strategies with adjacent property owners.
- Base parking space counts on average use rather than peak or maximum use needs, while still adhering to local codes.
- Consider the use of stabilized grass paving areas for infrequent use areas.
- Be aware reductions in roadway width or parking area sizes or mandated parking space counts often requires variances from code requirements.

USE POROUS PAVING

Use porous pavement such as stabilized gravel, porous concrete, porous aggregate unit pavers, stone or concrete unit pavers, and decks in hardscape areas that are suitable for infiltration. Consider:

- Clogging of cells in porous pavements
- Possible adverse changes to the soil pH caused by leaching from pavers and crushed stone
- The need to change the design of the subgrade to favor a porous sub base and minimally compacted subgrade
- Existing tree root impact
- Pavement lifting caused by roots

MINIMIZE THE URBAN HEAT ISLAND EFFECT

The urban heat island affect is the increase in ambient temperature due to heat absorption and storage by urban areas. This causes longer and hotter days. Pavement is a primary cause of this phenomenon. One way to measure a pavement's potential for urban heat island effect is to measure its albedo, or solar reflectance index (SRI). SRI is measured on a scale of 0 (0% for full absorption) to 100 (100% reflectance).

Dark pavement has a lower albedo, meaning it will absorb solar energy and will likely convert it into stored heat. Light pavement has a higher albedo. It will reflect solar energy and therefore has less potential to absorb light and store heat. New asphalt typically has an SRI of 0. Even with aging and associated lightening of color, over time asphalt pavement will only achieve an SRI of 12 to 14. The U.S. Green Building Council Leadership in Energy and Environment (LEED®) rating systems encourage an SRI of 29 or better as a performance benchmark as a way of reducing overall urban heat island effect.

The best way to decrease the heat absorption of pavement is to decrease its area, to shade it with trees, or place it in areas shaded by buildings or park structures.

CONCRETE

The manufacture of cement is highly energy intensive, and releases high levels of CO_2 in the calcination process. One percent of the total greenhouse gas emissions in the United States are due to cement production. Also, the components to make cement and the aggregates used in concrete must be excavated from the earth, which can have negative effects on habitat and water quality.

At the same time, concrete is a convenient and relatively inexpensive construction material, and it will most likely be continued to be used. With that in mind, it is important to reduce the environmental impact of concrete to make it a more sustainable construction material. The most effective tactics are to use less concrete, and to use concrete with recycled aggregate.

The Parks Department used recycled fly ash, an industrial byproduct, in new concrete boardwalks throughout New York City, including this one at Coney Island.

USE RECYCLED MATERIALS

Recycled materials can be used in place of virgin materials for the fuel, cement, and aggregate components of concrete. By partially replacing cement with industrial byproducts, greenhouse gas emissions can be reduced, and disposal of these byproducts is reduced as well.

- Concrete is generally composed of 7% to 15% cement. A portion of this cement can be replaced by supplementary cementitious materials (SCMs) such as fly ash (up to 25%), slag cement (up to 60%), and silica fume (5% to 7%).

Recycled aggregates, such as recycled concrete or asphalt, can be used in place of virgin aggregates in concrete.

- Coarse aggregates in concrete can be replaced 100% by recycled aggregates, assuming they meet ASTM standards.
- Only 10% to 20% of fine aggregates in concrete should be replaced with recycled fine aggregates.

There are a number of things to consider when using recycled aggregates:

- Changes in water absorption properties
- The chloride content of recycled concrete
- Concrete that uses recycled concrete as aggregates can have a higher shrinkage and creep potential. This should be considered in the design process.
- Obtaining a mixture that will meet ASTM standards
  - Testing of concrete mixtures including recycled content is required to ensure they meet standards and project requirements.
  - Implement a process during construction for the contractor to submit all required testing data.

REDUCE ENERGY USE

- Local manufacturers of concrete produced with recycled materials should be used as suppliers to limit as much as possible energy consumed in transport.
- Locating a concrete supplier in the region that regularly uses local materials and recycled content to make concrete mixtures that are tested and perform adequately can reduce the time and effort required to create new concrete mixtures for each new project.
- When demolishing existing concrete, determine the feasibility of reusing these waste materials to manufacture concrete onsite or nearby rather than disposal in a landfill.

USE MORE SUSTAINABLE COMPONENTS

- Consider specifying steel and fiber reinforcement and supports that contain high percentages of recycled content.

- When using wood formwork for concrete, consider using wood that is certified by the Forest Stewardship Council (FSC) for sustainability.
- Concrete admixtures, release agents, vapor retarders, and curing materials that are water, vegetable, or soy based and have low toxicity and VOC emissions should be used whenever possible.
- Waterstops that do not contain VOCs and do not require additional solvents and adhesives are preferable.
- Natural clay or mineral coloring pigments should be used if possible.

USE LESS CONCRETE

The most effective measure is to reduce the quantities used. Every effort should be made to rethink standard details to find ways to decrease widths of curbs and thicknesses of slabs when practical.

REDUCE ALBEDO

Concrete has a high albedo or reflective value and, thus, can reduce urban heat island effects by reflecting rather than absorbing sunlight. When choosing surface materials, the benefits of concrete to reduce urban heat island effect should be considered. New white Portland cement concrete pavement has an SRI of 86.[15]

USE POROUS CONCRETE WHENEVER POSSIBLE

Opportunities to use porous concrete for stormwater infiltration should be considered when conditions are suitable. See *BMP W.7 Use Porous Pavements*.

ASPHALT

Asphalt pavement is typically composed of a mix of virgin stone and sand aggregates and a liquid petroleum based asphaltic binder. Asphalt pavement is the most commonly used site and road construction material, accounting for some 90% of new roads. It is inexpensive, flexible, easily placed without formwork, and it is reasonably durable. Additionally, asphalt pavement can accommodate a wide range of surface finishes which affect its aesthetic characteristics and extend its life cycle. A properly installed asphalt pavement will last between 15 and 20 years and can be resurfaced without removal of its full paving section.[16]

Despite asphalt pavement's benefits, its use has numerous environmental and human health impacts including the use of nonrenewable petroleum and aggregate resources, potentially hazardous air emissions, and fumes from mixing and placement. Asphalt pavements are almost always installed as impermeable surfaces, concentrating runoff quantities and nonpoint source pollutants. Asphalt pavement is also a significant contributor to urban heat island effect resulting from its dark surface.[17]

In recent years a number of new approaches to the use and design of asphalt have been developed, which greatly reduce its negative impacts. Recycled aggregate can reduce the amount of virgin aggregate and asphalt binder. Light colored aggregate can be rolled into the top course with a tack coat or a light colored aggregate can be specified for the top course to decrease the darkness of the asphalt. Many of these improvements can be easily applied to the renovation and new construction of parks facilities.

LEAVE EXISTING ASPHALT IN PLACE

In existing parks, the top of the existing asphalt can be milled and a new top course applied. Care must be taken to bridge cracks with engineering fabric, and use sufficient tack coat to ensure proper bonding.

USE THINNER PAVEMENT SECTIONS

Study design alternatives that allow for a reduction of asphalt pavement thicknesses.

- Consider anticipated traffic volume and vehicle weights.
- Modify pavement resiliency with mix design including the use of flexible aggregates and other admixtures.
- Use geotextile fabrics between pavement courses to provide additional cracking resistance.
- Use geotextile fabrics and/or geogrids as part of the aggregate base design to increase foundation stability.

USE RECYCLED MATERIALS

A simple way to green asphalt is to incorporate recycled products into mix designs to reduce the use of virgin petroleum, sand, and stone aggregates. It is fairly common practice to make use of some recycled materials in asphalt. According to the U.S. Environmental Protection Agency and the Federal Highway Administration, about 90 million tons of asphalt pavement is reclaimed each year, and over 80 percent of that total is recycled.[18]

Reclaimed asphalt pavement (RAP) is the most commonly used recycled component in asphalt pavements. RAP can be recycled into pavement that is as high, or even higher, in quality as pavements made of all virgin materials.

- Asphalt pavements made with RAP can be recycled repeatedly.
- The asphalt cement — the glue that holds the pavement together — retains its ability to function as glue or cement, so that it is reused for its original purpose.
- The aggregates in the original pavement (sand and gravel) are also conserved through repeated use.
- Dedicated supply often requires careful coordination with asphalt plants and often incurs significant additional expense, which can be mitigated by identifying insufficient installation areas at one time to maximize cost/benefit.
- Scheduling issues with non-standard mix designs and construction techniques may occur.
- There are a variety of products that can be used to significantly reduce the use of virgin stone aggregate including:
  - Asphalt roofing shingles
  - Recycled tire aggregate
  - Air cooled blast furnace slag
  - Glass cullet

CONSIDER THE USE OF POROUS ASPHALT TO ENCOURAGE STORMWATER INFILTRATION

Porous asphalt pavement has been successfully used in low traffic areas for more than two decades in the United States.

- In addition to its obvious stormwater management and water quality benefits, porous asphalt pavements have been shown to be cooler, less prone to damage from freeze thaw cycles, and to provide better traction during heavy rains or in freezing conditions.

- Coordinate porous asphalt with pavement base course and under drainage details.
- Consider use of porous asphalt under hex block and other unit pavers that offer surface porosity.

INCREASE PAVEMENT SURFACE ALBEDO

Standard asphalt pavement's black color has been shown to be a significant contributor to urban heat island effect. There are a number of surface treatments that can be used to improve asphalt pavement's SRI including:

- Light colored aggregate in the top course
- Light colored aggregate rolled into the wearing course with a tack coat
- Shot-blasting to remove black asphalt surface and expose lighter aggregate
- Epoxy bonded aggregate wearing courses
- Painted surfaces

In addition to reduced urban heat island contribution, surface treatments benefits also include:

- Extended pavement life by reducing asphaltic cement oxidation from UV exposure
- Depending on the type of coating surfaces, can be made softer, or more slip resistant
- Surface treatment installation should be coordinated with overall construction to avoid damage from subsequent construction activities.

LOWER ASPHALT INSTALLATION TEMPERATURES

Asphalt paving techniques now include warm mix asphalt pavement. Hot asphalt paving is mixed at a temperature of 275°F-325°F. At these temperatures there are visible emissions and considerable risk to workers installing the materials. Warm mix asphalt pavement is mixed at 140°F to 275°F. This reduces installation emissions, energy use, and provides cooler working conditions for workers.

MAXIMIZE THE LIFE OF PAVEMENT WITH PREVENTATIVE MAINTENANCE SUCH AS CRACK FILLING, RESURFACING, AND REPAIRS

Preventative maintenance is the key to long lasting asphalt pavement. A study by the Wisconsin DOT of preventative maintenance programs in Arizona, Montana, and Pennsylvania found a cost savings ranging between $4 and $10 in rehabilitation costs with every dollar spent on preventative maintenance. The same study also concluded that the earlier the preventative maintenance was conducted, the lower the costs.[19]

SUBBASE AGGREGATES AND BEDDING MATERIALS

There are a number of materials that can be used in place of or as a supplement to new crushed stone.

RECYCLED CONCRETE AGGREGATE

Use of Recycled Concrete Aggregate (RCA) is particularly advantageous in metropolitan areas such as New York City, where sources of waste concrete are plentiful, landfill space is at a premium, and disposal costs are high. Consider benefits of using RCA in the subbase, such as:

- New York City does not limit the percentage of RCA used in its specifications.
- Can stabilize soft, wet soils early in construction by virtue of the porosity of aggregates
- RCA derived from air-entrained concrete has double the absorptivity of virgin aggregates.
- Drainage is better and subbase is more permeable than conventional granular subbase because of lower fines content.
- RCA used in subbase layer exhibits beneficial engineering performance.
- Provides a cost savings

Consider limitations of using RCA in the subbase:

- It is important to wash the RCA aggregates to decrease alkaline leachate.
    - Alkaline leachate may occur if there is free lime and/or unhydrated cement, raising the pH of adjacent soil and water and potentially harming plants and trees.
    - Alkaline leachate has the potential to cause chlorosis in street trees.
- Consider using high alkaline plants if leaching is predicted.
- Leachates may form precipitates that clog geotextiles and prevent free drainage from the pavement structure.

RECYCLED ASPHALT PAVEMENT

Recycled Asphalt Pavement (RAP) can be crushed and blended with conventional aggregates for use as coarse and/or fine aggregate in the pavement subbase layer.

Benefits of using RAP in the subbase include the following:

- Adhesive presence of asphalt results in a better bearing capacity over time.
- Drainage is better and subbase is more permeable than conventional granular sub-base because of lower fines content.
- RAP is plentiful in New York City.

Limitations of using RAP in the subbase include:

- Grinding or pulverizing (rather than crushing) may result in the generation of undesirable fines.
- Adhesiveness of asphalt can make placement and finish grading difficult.
- Adequate compaction must be ensured to avoid post construction settlement.
- Stockpiled aggregate can agglomerate and harden; it may have to be recrushed and rescreened.
- The optimum moisture content for RAP blended aggregates is reported to be higher than for conventional granular material.

AIR COOLED BLAST FURNACE SLAG

Air Cooled Blast Furnace Slag (ACBFS) referred to simply as slag in many specifications, is a by-product of iron manufacturing that is crushed and screened and then used as a subbase material.

Beneficial properties of using ACBFS in the subbase:

- New York City does not limit the percentage of ACBFS use in its specifications. Conventional design procedures can be used.
- Lower compacted unit weight of ACBFS aggregate yields greater volume for a weight equivalent to conventional aggregates.
- High level of stability of ACBFS aggregates provides good load transfer even when placed on weak subgrade.

Limiting properties of using ACBFS in the subbase:

- Adequate separation from water must be maintained. When ACBFS is placed in strata with poor drainage conditions or with exposure to slow moving water, sulfurous leachates are possible.

GLASS CULLET

Since there is a reliable, dedicated supply of recycled glass and ceramics in NYC, consider its use in subbase applications. When crushed to a fine aggregate size, glass cullet exhibits properties similar to conventional fine aggregates or sand.

Beneficial properties of using glass cullet in the subbase:

- 15% by mass additions of glass cullet yield bearing capacities nearly equal to conventional aggregate.

Beneficial properties of using glass cullet in the subbase:

- Poor durability is exhibited by large particles. The use of glass cullet for coarse aggregate is not recommended.
- Recommended limit is 20% by mass.
- Deleterious substances such as labels and food residue must be controlled at the materials recovery facility. There should be no more than 1% by mass, of which no more than 0.05% is paper.

FLOWABLE FILL

Flowable fill is a low strength material that is mixed to slurry and is used as an economical fill or backfill material. It can be designed to support traffic without settling and still have the ability to be readily excavated at a later date. The basic composition is a mixture of coal fly ash (95%), water, coarse aggregate, and Portland cement. It gains strength in 20 minutes, and is also selfleveling. It is particularly useful for backfill in utility trenches, building excavations, bridge abutments, foundation subbase, pipe bedding, and filling abandoned utilities and voids under pavements.

WOOD

Wood is used primarily for park benches, tables, and decking. It is one of the hardest park materials to substitute. The most rot resistant and attractive woods are from rain forest environments, however their harvesting is detrimental to the tropical forests. Domestic substitutes do not match the strength, dimensional stability, rot resistance, and appearance of tropical hardwoods. Plastic lumber has limiting tactile, appearance, and strength attributes. Steel for furniture and concrete for decking are emerging as the most viable alternatives.

DESIGN FOR PARKS DEPARTMENT SALVAGED WOOD

- Recycle onsite or offsite used wood before purchasing new.
- Always inspect site furniture, decking, and structures to see if the wood is in good condition and can be salvaged for other park projects. If so, this must be called out in the construction documents, including the level of care that must be taken in its removal, storage, and transport.
- Work with park maintenance staff to find an appropriate location to store or supply recycled wood.

USE SMALLEST SIZE AND LOWEST GRADE WOOD POSSIBLE FOR APPLICATION

- Using the minimum quality necessary reduces demand for old growth wood harvesting, and supports the production of smaller, more renewable material. The smaller the wood size and more rapid its growth, the faster that resource can replace itself.
- Design to use nominal board sizes, which assures less wasted wood from cutting.
- Design to lengths and sizes that are regularly available.
- Do not sacrifice rot protection or dimensional stability.

USE WOOD FROM SUSTAINABLY MANAGED FORESTS

- Depending on production and harvesting method, wood can be a renewable resource, as well as a carbon sink, so source and method of harvesting is critical.
- Look for Forest Stewardship Council (FSC) certified wood. This material is more expensive and harder to source, but guarantees that: “forests have to be managed to meet the social, economic, ecological, cultural and spiritual needs of present and future generations”.[20] Some consider this wood to be of a higher quality than plantation grown wood due to longer rotation cycles and the superior quality of older trees. FSC criteria include:
  - Compliance with all international laws and treaties
  - Long term land rights
  - Recognition of indigenous peoples’ rights
  - Long term well being of workers
  - Sharing of forest benefits
  - Reduction of environmental impact and maintenance of ecological function
  - Appropriate management plans
  - Appropriate monitoring and assessment
  - Maintenance of High Conservation Value Forests[21]
  - Promotion of conservation and restoration of natural forests

CONSIDER WHAT TREATMENTS ARE NECESSARY

- In cases where wood preservation is necessary, select the technique with the lowest toxicity and environmental impact that will accomplish desired effect. Reference Table 10-10 Wood Preservative Treatment Summary Table of Materials for Sustainable Sites (p.310-312)[22]
- Advances in waterborne wood preservatives and wood modified by heat have opened up a variety of alternatives to copper and chromate-based preservatives.
- Heat treated or “Torrified” wood is a promising wood

treatment to consider for bench slats and decking.

- Specify decay-resistant woods if possible and suitable. Reference Table 10-8 of Materials for Sustainable Sites (p. 302-304).[23]
- Use natural and low VOC wood finishes.
- Consider impacts of finish on the health of the installer and end user.
- Engineered wood products use smaller wood and wood scraps to create larger and stronger wood materials. They reduce waste and demand of less renewable larger wood.
- Avoid materials with binders containing formaldehyde, a known carcinogen.

RECLAIMED TROPICAL WOOD

- If tropical wood is determined to be the only choice due to rot resistance, dimensional stability, strength, and appearance criteria, use the minimum amount and specify reclaimed wood.
  - Consider cypress as an alternative.
- Decrease the quantity required by examining all feasible substitutes and decreasing the member size.
- Tropical woods are commercially available from salvage of ships and structures, but may be blemished.
- Rot resistant woods such as cypress are available from salvage of structures and from sunken logs.

PARK FURNITURE AND DECKING

Bench slats and decking planks are hard to specify due to the requirements for rot resistance, strength, appearance, and tactile quality. As we are phasing out the use of tropical woods we are exploring alternatives. The Parks' Specification office is engaged in ongoing research for alternatives, and should be consulted. Current thinking at the time of publication is:

- Plastic lumber is satisfactory for benches and tables when it is reinforced or the span is reduced so the slats will not deflect.
  - It is problematic when used for decking due to structural deflection, flammability, and coefficient of expansion.
  - It is satisfactory in small deck installations where it can be adequately supported and there are no vehicular loads.
  - There are different types of plastic lumber, so it is important to review the plastic section of this document.
- White oak is satisfactory for bench slats only if it is to be painted. It is strong, rot resistant and dimensionally stable, but lacks the longevity of other options and secretes tannins, which stain.
- Torrified poplar, yellow pine, or red oak can be used for decking and bench slats. This heat treated wood is strong, dimensionally stable, rot resistant, and attractive without painting.
- Steel furniture is an ideal wood alternative for park furniture.
  - Care must be given to the choice of the size, composition, and coating of the seating members
  - Smaller, lighter colored steel slats hold less heat than dark and heavy ones.
  - The quality of the coating is of extreme importance in order to prevent corrosion.
  - Aluminum is less desirable due to its scrap value.
- Black locust is satisfactory for decking or other applications when cupping and twisting of the plank can be tolerated. It is strong and rot resistant, but not dimensionally stable.
- White cedar is satisfactory for cladding and large planks when its softness is not a problem. It is rot resistant, dimensionally stable and attractive.
- Structural concrete decking seems to be the most sustainable choice for boardwalks. The storm and sun effects on wood on ocean front boardwalks are extreme, and the replacement cycle of twenty years is unsustainable.
  - Where the budget allows, decorative pavers may be installed on top of the decking.
  - When the budget is lower, decorative patterns may be cast into the planks, or into a topping slab of concrete.
- Some treated lumber is satisfactory for marine applications. However, it deteriorates under sunlight and must be periodically replaced. This is another instance where concrete alternatives should be considered.

PLASTICS

While plastics offer many benefits, some pose risks to human and environmental health. The manufacture of virgin plastics from fossil fuels is causing serious damage to our environment. Refining petroleum and manufacturing virgin plastics consumes energy and releases pollution, some of which is highly toxic. All fossil fuel-based plastics contain or release some carcinogens at some point in their lifecycle. Some — such as PVC and polystyrene — rely upon additional toxic chemicals, which make their environmental health impact even greater. On the other hand, plastic lumber reduces demand for other materials having serious environmental impacts. Clearly some plastics, such as PVC and polystyrene, are easily replaced by other materials, including other plastics, and can be phased out of production and use.

Phasing out some plastics, halting the indiscriminate use of plastics, increasing the societal commitment to mandatory plastics recycling, and increasing investment in biobased plastics holds out the prospect that some plastics may have a role in a sustainable economy. In that context, recycled plastic could play a role in reducing the demand for virgin plastic resin and the volume of plastic waste.[24]

Composite products are usually more difficult to recycle than single resin products, have fewer end markets, and are therefore inherently less valuable to secondary markets than a pure product. There is no evidence to suggest that there will be an end market for synthetic composite lumber products, other than the original manufacturer. It is not likely to be economically feasible to systematically return all plastic lumber to the manufacturer at the end of its service life. At the present time, however, all plastic lumber products suitable for demanding structural or high load bearing applications rely upon one of these combinations for added strength. These applications include bridge supports and railroad ties. Composite plastic lumber has advantages in these applications that may outweigh the disadvantages of these composites, such as leaching while in service.[25]

FAVOR CERTAIN PLASTICS OVER OTHERS

- High recycled content, specifically high post-consumer recycled content
- Polypropylene is comparatively benign.
- Polyethylene both high density (HDPE) and low density (LDPE), are recyclable resins associated with fewer chemical hazards and impacts.
- Produced from resins from local municipal recycling programs, cutting transportation costs and supporting the local economy

LIMIT USE OF CERTAIN PLASTICS

- Fiberglass-reinforced or polystyrene-blended structural plastic lumber can be used for structural applications such as railroad ties and bridge supports, as a less toxic alternative to chemically treated wood.
- Products with multiple commingled recycled consumer plastics will have more contaminants and inconsistent properties. They also support token markets for plastics that otherwise are largely unrecyclable, and many of which are highly toxic. This perpetuates the use of plastics that should be phased out.
- Wood-plastic composites are a blend of wood fiber with plastics. It is believed that blending the polyethylene with another material is likely to limit long term recycling options.
- It is unknown whether or not a plastic lumber product containing biodegradable materials can be technically recycled after 10 or more years of exposure to the elements.[26]

AVOID PLASTICS MADE WITH:

- Fiberglass for nonstructural applications (such as decking boards, benches, and tables)
- Predominantly nonrecycled plastics (alternatives with high recycled content are readily available)
- Synthetic composites (with the exception of high load-bearing or demanding structural applications)
  - There appears to be no clear environmental advantage and numerous environmental disadvantages to these mixtures, because of the chemical hazards and associated impacts.
- PVC and polystyrene are associated with more chemical hazards and impacts throughout their lifecycle than other plastics.
- Lack of a viable recycling option after the service life of the product

CONSIDER END-OF-LIFE RECYCLABILITY

In order to make a significant long term impact on reducing resource use and disposal, it is not only important that plastic lumber include recycled content, but also that the lumber product itself be recyclable at the end of its life.

CONSIDER HIGH VOLUME PURCHASING

Government agencies and other high volume purchasers can specify environmentally preferable products in their purchasing policies.

- Procurement contracts with plastic lumber vendors can encourage collection and recycling of plastic lumber products once they have served their intended use.
- The Commonwealth of Massachusetts, Operational Services Division, specifies in its procurement language for recycled plastic equipment that "it is desirable that bidders offer recycling options" for such products.[27]

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D.9 USE SYNTHETIC TURF WISELY

OBJECTIVE

Provide safe and playable athletic fields to meet the increasing demand and societal health need for active recreation without expanding fields into lawns and other natural areas of parks valued for passive use and ecological benefit. Use synthetic turf on fields only when the anticipated soil compaction, levels of use, or length of season make grass impractical. Favor designs that provide excellent playing surface, stormwater infiltration, lowest heat retention, and meet appropriate environmental guidelines.

BENEFITS

- Allows for 25 to 50% more use of sports fields than natural turf fields due to reliable playability, elimination of the need to close the fields for wet and soggy field conditions, and required closures for annual reseeding and periodic grass reestablishment.
- Provides trip hazard free and smooth playing surface with good traction and reliable shock absorption, improving quality of play and reducing risk of impact related injuries.
- Reduces energy consumption and pollution from internal combustion powered equipment required for mowing and aeration.
- Reduces water usage due to elimination of irrigation requirements.
- Reduces the use of fertilizers, herbicides, and pesticides associated with turf maintenance.
- Potential to serve as a stormwater management device providing onsite detention, filtration, and infiltration.
- Potential to incorporate recycled material including infill, turf fibers, and backing if properly selected and specified.

CONSIDERATIONS

- Synthetic turf components consist of a variety of natural and man-made chemicals. Several scientific research studies carried out in the United States and Europe have assessed potential exposures and health risks for people using turf fields containing crumb rubber. According to the Department of Health and Mental Hygiene's (DOHMH) review of these research findings, health effects are unlikely from exposure to the levels of chemicals found in crumb rubber. DOHMH also completed an air quality survey to measure the air above synthetic turf fields containing crumb rubber infill for chemicals. Results show that air quality at the synthetic turf fields surveyed is similar to the air quality at natural grass fields. Others have reported similar findings. Testing of synthetic turf products preinstallation will ensure products meet appropriate environmental guidelines.
- There has been press concerning the potential of synthetic turf to spread methicillin-resistant Staphylcoccus aureus (MRSA) among players. Bacterial infections, such as MRSA, have not been shown to be caused by synthetic turf fields.
- While an increased risk for human health effects as a result of exposure to chemicals in crumb rubber was not identified by the review, heat has been identified as a concern. Synthetic turf fields absorb heat from the sun and get hotter than soil or natural grass. Measures should be taken to reduce potential for heat related illness:
    - Shade and drinking water should be made accessible for field users to stay cool and hydrated.
    - Heat warning signs should be posted at all athletic fields.
    - Field staff should be instructed about potential heat related risks involving synthetic turf, including overheating and dehydration.
    - New technologies should be assessed as they become available that help to reduce the field temperature.
- Infill type cannot be located in areas prone to flooding.
- While made from highly recyclable materials, few opportunities exist for recycling synthetic turf and infill at the end of product life.
- Field installations are prone to seam failure due to poor installation.
- Warranties are at times unreliable due to installers going out of business.
- Designers must stay aware of emerging issues and assess newer generation synthetic turf materials and construction assembly strategies.
- Use purchasing protocols to select the best synthetic turf products and require suppliers to provide information on chemical content, heating absorbency properties, environmental factors, and health and safety factors.

BACKGROUND

People generally like to see grass in their parks, and it is important to provide high quality lawns so that real nature with all of its environmental and psychological benefits can be experienced. This requires enforcing rules which prohibit active uses on passive use lawns in order to prevent them from being compacted and turned into dust bowls. It is important to have alternative places for active recreation sports nearby.

Natural turf fields cannot be maintained in heavily used active use areas unless they are closed when wet and closed annually in September, October, and November for grass reestablishment. The soil structure required for premier grass fields such as the Great Lawn in Central Park require a soil high in sand to reduce compaction, the use of irrigation and fertilizer, and a closely monitored closure system when fields are wet. This level of care is beyond the means of most park operations budgets and staff allocations.

Synthetic surface allows maximum use of the fields without closure, so they can be reliably permitted constantly, decreasing the need for additional fields required to meet growing demand. Permittees may use the fields in any weather condition, year round, avoiding closures required for rain or grass reestablishment.


Synthetic turf fields offer resilient year-round play in for high-demand sports in heavily-used areas, such as this soccer field in Flushing Meadows-Corona Park in Queens.

PRACTICES

PLANNING

CONSIDER THE USE OF SYNTHETIC TURF IN AREAS WHERE THE BENEFITS ARE MAXIMIZED SUCH AS HEAVILY USED ATHLETIC FOOTBALL, SOCCER, AND OTHER SPORTS

- The numerous performance benefits of synthetic turf allow high use programmatic demands on a consistent basis in locations where play field demand is so high and natural turf fields simply are not feasible.
- Synthetic turf use may be appropriate in those locations where not using synthetic turf would mean a complete loss of active open space programming for a neighborhood.
- Synthetic turf fields should not be considered a primary response to programming needs. Before considering the use of synthetic turf, if budgets allow and park space is available consider these alternatives:
  - Construction of multiple fields to allow rotating field closure enabling natural turf areas to recover and regenerate between high utilization periods
  - Construction of over sized field configurations to allow play areas to periodically shift to allow natural turf areas to recover and regenerate between high utilization periods
  - Construction of sand-based engineered soil natural turf fields that are compaction resistant and rapid draining
  - Consider the viability of rigorous management and maintenance of fields where high use is anticipated, potentially requiring some sort of public/private funding arrangements to pay for the high costs of non-standard care
- Maintenance costs
- Replacement frequency

CONSIDER BROWNFIELD MANAGEMENT POTENTIAL OF SYNTHETIC TURF

Since synthetic turf fields require a sandwich of turf and drained aggregate base, they can be easily modified to act as a barrier between people and contaminated ground conditions. The advantage of synthetic turf systems as a barrier system is that they may minimize the need for deeper imported soil fills, saving environmental and construction costs without compromising public health.

CONSIDER SITE LOCATION AND PROXIMITY TO FLOOD ZONES OR AREAS OF HIGH GROUND WATER

Synthetic turf fields are designed to allow stormwater to rapidly move through the surface into the basecourse system. For this reason, synthetic turf fields should not be located in areas where they are prone to flooding, since floodwaters may lead to clogging of the turf grass carpet.

- Overland surface flows associated with flooding lead to the flotation and washout of the infill material, exposing the turfgrass fibers and leading to increased wear, more rapid aging, and increased maintenance costs.
- In locations of fluctuating high groundwater, where the subsurface drain system does not mitigate subsurface flows, there is potential for upward moving water to lead to the flotation and washout of the infill material, exposing the turfgrass fibers and leading to increased wear, more rapid aging, and increased maintenance costs.
- Where synthetic turf is used as an infiltration and groundwater recharge system, adequate filtration depth and separation from seasonal high groundwater should be considered.

DESIGN

CONSIDER THE PROPERTIES OF THE FIELD WHEN DESIGNING AND SPECIFYING THE TURF SYSTEM

- Turf height and infill weight
- Shock pads
- Gmax rating (impact attenuation)
- Heat absorption
- Life span
- Playability

CONSIDER THE STORMWATER MANAGEMENT POTENTIAL OF SYNTHETIC TURF

Unfortunately, the benefits of synthetic turf as a porous pavement system are not always harnessed for stormwater management. The base course of a traditional synthetic turf system is usually designed as a six inch aggregate base with a regularized subsurface drain pipe system for evacuating stormwater as quickly as possible to a storm sewer. However, a porous surface system can be designed to allow stormwater to pass through the turf carpet and then be stored and infiltrated into the subsurface soil. Given the large size of a sports field area, the subsurface detention is quite cost efficient.

- Given the proper subsoil conditions, the base course of a synthetic turf field can be designed to act as a retention system for stormwater, allowing for filtration, infiltration, and groundwater recharge.
- Stormwater retention requires that the field system be designed to accommodate stormwater retention and infiltration without flooding the field and dispersing infill materials.
- By properly calculating stormwater events and modifying the base course depth and aggregate composition as well as the subsurface piping design, the underside of synthetic turf systems can be modified to allow for stormwater detention

and infiltration.

- Backing of the turf must be porous.
- Subgrade must not be overly compacted.
- Provision should be made for overflow into the stormwater system.

SPECIFY RECYCLABLE AND NONTOXIC SYNTHETIC TURF MATERIALS

- To the extent possible, specify recyclable materials.
- Require certified testing of all materials before installation.
- Meet Parks specifications for testing synthetic turf fibers and infill materials for heavy metals and semi-volatile organic content when applicable.
- Synthetic turf fibers should meet ASTM F2765 specifications for lead content.

DECREASE HEAT EXPOSURE

- Provide shade on the field perimeter for cooling areas for field users.
- Provide misting posts and drinking fountains.
- Evaluate innovative strategies that can reduce the field temperature (e.g., allow water to transpire through the field from the drainage area below, and use infill materials that are designed to reflect and not store radiant energy).

CAREFULLY CONSIDER PERMANENT MARKING OPTIONS

- Field marking for multiple sports must be carefully considered to avoid confusion.
- Permanent glued-down striping is vulnerable to ripping out and lifting, which can be hazardous.
- In many instances, it is most practical to install permanent tic marks which facilitate annually repainted markings.

CONSTRUCTION

REQUIRE THE CONTRACTOR TO PROVIDE QUALITY TESTS AFTER INSTALLATION AS NECESSARY

- Fiber
- Infill
- Gmax

REQUIRE THE USE OF LASER GUIDED GRADING EQUIPMENT TO CONSTRUCT SYNTHETIC TURF FIELDS

Since synthetic turf fields are highly porous surfaces, they are typically designed to be only slightly contoured, with slopes less than one percent. Construction of such a flat surface over a large area is extremely difficult to achieve and costly using conventional tripod and transit surveying equipment. Additionally, such flat areas are nearly impossible to grade or check by eye.

- Experienced sports field contractors have found that it is considerably more cost effective and easier to construct synthetic turf fields using laser guided grading equipment.
- The use of laser guided equipment is especially important in the grading the field's subgrade which determines the proper slope of the field's subsurface drainage system.

PROTECT THE SUBSURFACE DRAINAGE SYSTEM DURING CONSTRUCTION

After the preparation of the field's subgrade, the subsurface drainage piping grid is installed and then covered by the aggregate base course. Since the subsurface drainage system is a critical component to the functioning of the field system, care should be taken to protect the drainage pipe from being crushed or moved during the installation of the aggregate base.

- The layout of the pipe system and the subsequent delivery and placement of the aggregate should be sequenced so that delivery trucks are not driving or turning over the installed pipes.
- Only lightweight grading equipment should be operated over the aggregate once it has been placed on top of the piping system to avoid crushing or shifting pipe alignment.

TEST TURF PRIOR TO FINAL ACCEPTANCE

Prior to the final acceptance of the synthetic turf field, tests should be taken at numerous points across the field to ensure acceptable and consistent Gmax performance across the field.

- Gmax testing on synthetic turf fields should be completed by an independent testing lab using ASTM F355-A. Do not use the Clegg Test method (ASTM F1702), which is intended for use on natural turf fields and requires calibration for comparative testing on synthetic turf testing.[28]
- Gmax tests should be taken on a regular grid spacing allowing for at least one reading per 7,500 square feet
- Upon completion of installation, an average synthetic turf field Gmax should be 100 +/-10 with no one point testing greater than 115.

MONITOR CONSTRUCTION CLOSELY

The glue used to fasten seams together is a costly component of the job, with climatic restrictions. This is a frequent area of failure due to improper application rates and methods.

- A resident engineer should be present during all gluing operations to confirm that seams are properly glued with the correct amount of glue. The contractor's work and glue application rates must be closely monitored during installation.

OPERATION

TRAIN AND EQUIP STAFF TO PROPERLY MAINTAIN SYNTHETIC TURF FIELD

- Specialty equipment required to maintain the field should be included in the capital project.
- Field supervision and staff should receive training in the maintenance and inspection of the field.
- Guarantee information should be copied and provided to the staff.
- Maintain shade, drinking water, and heat warning signs at all athletic fields.
- Train field staff about potential heat related risks involving synthetic turf, including overheating and dehydration
  - Field staff should be able to recognize symptoms of heat related illness.

- Routinely inspect older generation grass fiber fields and assess for lead dust if grass fibers are visibly deteriorated.

EVALUATION

ALL FIELDS THAT USE NEW SYSTEMS SHOULD BE INSPECTED TO CONFIRM COMPLIANCE WITH THE GUARANTEE, AND TO DETERMINE IF THE FIELD PERFORMANCE WARRANTS FUTURE USE

- Require annual Gmax testing by an independent testing lab to determine the performance of the synthetic turf.
  - It is anticipated that the Gmax of a field will increase over time due to compaction under normal use, especially if the infill material includes sand.
  - Dramatic increases in Gmax readings may indicate a need for more specialized maintenance or removal and replacement of infill in a localized area.
  - At no point should Gmax be allowed to exceed 200 in any area, though 175 is a recommended maximum average rating for a field.
- Look for all of the items covered by the guarantee, including:
  - Wear
  - Lifting
  - Unraveling

FOR FURTHER INFORMATION

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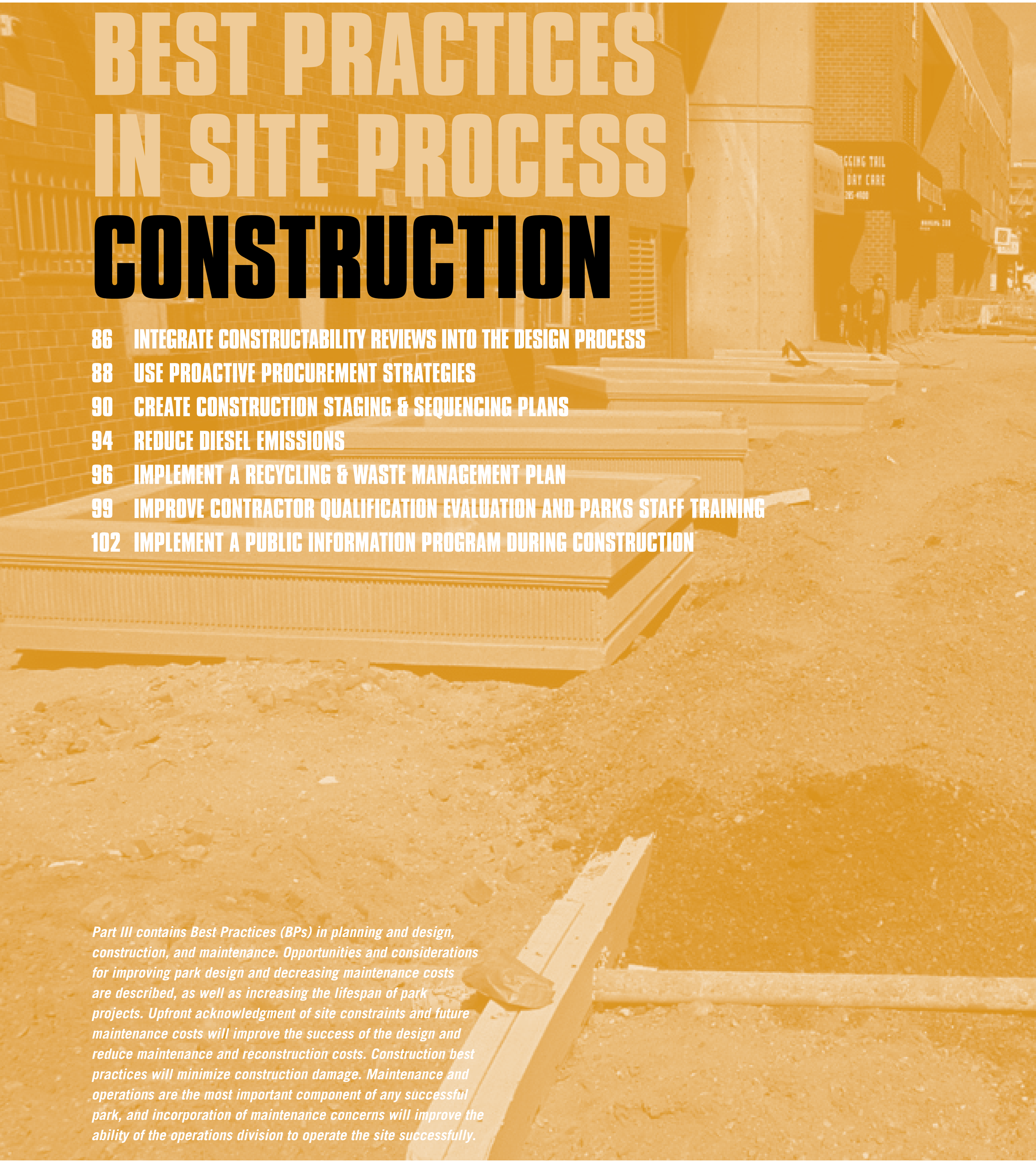
28 **Andrew McNitt and Dianne Petrunak. "Evaluation of Playing Surface Characteristics of Various In-Filled Systems" State College, PA: The Pennsylvania State University. Website accessed 02/01/09.**

PART III: BEST PRACTICES IN SITE PROCESS CONSTRUCTION



Part III contains Best Practices (BPs) in planning and design, construction, and maintenance. Opportunities and considerations for improving park design and decreasing maintenance costs are described, as well as increasing the lifespan of park projects. Upfront acknowledgment of site constraints and future maintenance costs will improve the success of the design and reduce maintenance and reconstruction costs. Construction best practices will minimize construction damage. Maintenance and operations are the most important component of any successful park, and incorporation of maintenance concerns will improve the ability of the operations division to operate the site successfully.

INTRODUCTION

Design alone does not make a park sustainable. Parks must be built in such a way that the sustainable features function properly. Often long term maintenance problems can be directly attributed to poor construction practices that damage vegetation or result in irreversibly compacted soils. Unfortunately, the effects of this damage may not become visible for a year or two after a contractor has completed the work.

Improper construction planning, lax oversight, or lack of expertise among contractors or supervising resident engineers all contribute to poor long term performance of park facilities. Inadequate building practices along with improper design or material selections are symptomatic of a larger problem: construction thinking — the ways in which we build our parks and the materials choices we make — is not well integrated in the design process. Design teams need to think through how a project is built in order to maximize its long term performance. Anticipating potential construction problems or site logistics constraints can result in more sustainable parks.

High performance landscape guidelines seek to make construction practices more sustainable or “greener.” The environmental impacts of construction can be greatly improved by adopting more stringent contractor performance requirements. City agencies including LMCC, DOT, and DDC now mandate these practices and the local construction industry has adopted them. In the end improving the way we build parks should improve the performance of park facilities, help conserve resources, and mitigate unintended environmental degradation associated with construction.

KEY PRINCIPLES

INTEGRATE CONSTRUCTION THINKING INTO THE DESIGN PROCESS. Designers should understand how things are constructed. Constructability reviews should happen early enough and often enough in the design process to allow designers and construction staff to avoid creating problems. Designers should review new methods or materials with the Specifications and Construction Divisions to determine and review past use or recommendations for application.

DEVELOP CONTRACT DOCUMENTS THAT CAREFULLY ARTICULATE CONTRACTOR PERFORMANCE REQUIREMENTS. Contract documents that include specific equipment and operational criteria, materials requirements, recycling programs, work limit lines, site protections, and proper scheduling and sequencing of work will allow for closer management of site construction practices. Clear requirements and benchmarks for performance will make it easier for Parks to hold contractors accountable for the quality of their work. Unless contract documents set the standard for acceptable practices, it will be virtually impossible to change the method of construction while the work is in progress.

ENCOURAGE AND SUPPORT TRAINING OF CONTRACTORS AND PARKS CONSTRUCTION OVERSIGHT STAFF. Contractors will tend to favor older, less sustainable construction methods and materials unless they are trained to build in more responsible ways. Parks construction professionals and supervising designers need to be sufficiently trained to oversee sustainable construction techniques and materials handling. They need to be able to direct contractors who are not familiar with sustainable practices and to enforce new contract requirements. By improving overall understanding of sustainable goals and the critical interrelationships between soil, vegetation, and water systems all parties will have a better sense of how to operate sustainably.

CELEBRATE CONSTRUCTION SUCCESSES AND REWARD INNOVATION. IT IS CRITICAL TO ELEVATE THE IMPORTANCE OF GOOD CONSTRUCTION PRACTICES AND CRITICAL PROBLEM SOLVING SKILLS. Too often we only reward projects that look good immediately upon completion. We often fail to appreciate less glamorous projects that are properly built and actually improve economic, environmental or social metrics within our city. As sustainable requirements and practices are worked into the Parks design and construction process, design and construction staff as well as contractors will develop skills and techniques that will benefit future projects. It is important to share this wisdom with the capital design staff on a regular basis, in order to build a culture of continuous improvement.

KEEP RECORDS AND MAKE DATA EASILY AVAILABLE. It is critical for the design staff to understand what works and what does not during construction, especially as they begin to try new, more sustainable approaches to design and materials selection. Keeping track of what works will allow for the development of better standard drawings, details, and specifications. Careful more detailed recording of the costs associated with new features is also important to allow design staff to better budget for sustainable construction features. Documenting costs trends over multiple years will also be important to see if the local construction industry is able to improve costs as they become more familiar with sustainable practices and materials.

TAKE ADVANTAGE OF CONSTRUCTION’S VISIBILITY TO EDUCATE THE PUBLIC. Construction in parks presents an important opportunity to show a public commitment to improving the quality of life in the city. Let the public know what is going on and how and why projects will improve environmental, social and economic performance. Educating the public about each new park project promotes an understanding of how parks function within the larger city-wide ecological and social system. Publicizing the sustainability goals and objective for new park construction projects is a way to build the public’s appreciation of the environmental benefits.

C.1
INTEGRATE CONSTRUCTABILITY REVIEWS INTO THE DESIGN PROCESS

OBJECTIVE

Ensure that Parks projects are cost-effective and easily buildable.

BENEFITS

- Informs design decisions with realistic considerations of building construction methods and logistics
- Comprehensively conceived plans have fewer cost and scheduling overruns.
- Facilitates implementation of high performance goals
- Construction Managers can help work around constraints.
- Uncovers contradictions and ambiguities in construction documents

CONSIDERATIONS

- The creation of a constructability review team will be a burden for existing staff or require new staffing.
- If staff or staff expertise is not available, consultants would add soft costs to individual projects.

BACKGROUND

The integration of construction planning into the design phase can be useful in establishing project goals, budgets, schedules and cost or time-saving strategies. Discussions can lead to creative solutions to project challenges.

Constructability reviews insure clarity and coordination of construction documents and specifications. These reviews verify correctness of construction details and material choices.

Constructability reviews assure coordination of drawings and specifications among all trades. For complex projects and especially with projects that include buildings, constructability reviews serve to unify all aspects of the project. Cross-referencing the trades also helps avoid possible conflicts and overlapping jurisdictions among the various trade contracts. Reviews can be used to identify code compliance issues and their impact on design details and cost.

Other issues highlighted during the constructability review process include phasing, coordination with facilities operations, and the sequencing of construction operations. Additionally, the review assures compliance with regulatory criteria, such as proper submission format and procedure, adherence to Wick's Law, and Procurement Policy Board issues. Common inconsistencies recognized by the review team include missing or incomplete building code analysis and improper use of standardized drawings and specifications.

PRACTICES

PLANNING & DESIGN

ESTABLISH CONSTRUCTABILITY REVIEW TEAMS

Constructability reviews require skilled and experienced people who understand how contractors work and how drawings and specifications might be interpreted by the contractor.

- Ideally, constructability review teams would come from in-house staff that are familiar with Parks standards as well as common goals and concerns.
- If in-house staff are not available, consider hiring both design and construction management consultants to assist with reviews.
  - Consultant reviewers should have specialized skills in contracting, park building, construction of sustainable landscapes, and the necessary subspecialty skills needed for specific projects including architects, engineers, ecologists, landscape architects, stormwater specialists, soil scientists, and so on.

ENGAGE CONSTRUCTABILITY REVIEWERS EARLY IN THE DESIGN PROCESS

Ideally constructability review should begin as early in the process as possible, but no later than the traditional design development phase (approximately 65-70% project completion) phase.

- Often constructability reviews are useful at a concept development or master planning stage to identify basic issues of access, budgetary contingencies for anticipated complications, schedules or other unusual concerns that may be specific to the proposed project program or site.
  - Constructability review teams can be useful in setting place-holder allowances early in the planning process before design decisions are fully worked out.
- Obtain assistance from construction managers to identify key logistical, scheduling, budgeting and bidding issues.
- Determine whether internal construction staff could provide necessary expertise or whether it would be preferable to hire construction managers.

USE CONSTRUCTABILITY REVIEW TEAMS TO ASSIST WITH DEVELOPING AND REVIEWING COST ESTIMATES, SCHEDULES AND FINAL BID DOCUMENTS

Design projects need to be considered in context of how and when they will be constructed. Often the skills needed to plan a project from start to completion lay outside of the design staff assigned to the project. Constructability review teams can assist design staff in:

- Minimize situations that could lead to contractor disputes, cost over-runs, change orders and unexpected bid prices
- Developing detailed project schedules
  - Advertizing of bids
  - Realistic duration of bids

- Length of time required for the procurement of goods, preparation of shop drawings, completion of material deliveries and site mobilization
- Duration of various construction phases, including site preparation, utility installation, rough grading, building construction, interface with public utilities, and final contract close-out

FOR LARGER OR COMPLEX PROJECTS CONSIDER USING A CONSTRUCTION MANAGER IN LIEU OF IN-HOUSE DESIGN STAFF

Determine whether internal construction staff can provide the necessary expertise (and time commitment) or whether it would be preferable to hire a construction manager (CM) to act as an owner's representative for Parks to coordinate the project from the design development phase through end of construction.

CMs can be used to assist with:

- The "front-end" documents including administrative, specifications and bidding documents
- Development and coordination of multiple contractor bid packages if necessary, especially if the project triggers Wicks Law compliance.
- Considering the viability of issuing accelerated or "early start" bid packages that can be used to shorten the duration of construction work.
- Overseeing other bid related logistics including:
  - Requirements for bonds and insurance
  - Prevailing wage requirements
  - Mobilization requirements
- Assisting with the bid phase work including:
  - Identification of well-suited contractors
  - Conducting pre-bid meetings and site visits
  - Evaluation of contractor bids and post-bid interviews

CONSTRUCTION

CONSIDER THE USE OF A CM AS A GENERAL CONTRACTOR AS WELL AS A CONSTRUCTION MANAGER

- Consider whether this arrangement would be advantageous by allowing greater flexibility in the procurement of work among a variety of specialty subcontractors.
- Learn from the construction process.
- Designers should observe the construction of critical or novel construction operations to obtain first-hand knowledge of construction operations. This knowledge can then inform future designs, cost estimates and specifications.

POST CONSTRUCTION

DEVELOP FEEDBACK FORMS TO INFORM DESIGN STAFF ABOUT MISTAKES AND INEFFICIENCIES THAT CAN BE CORRECTED ON DRAWINGS AND SPECIFICATIONS ON SUBSEQUENT PROJECTS

The development of high performance guidelines should not be static. Agency staff should continue to strive for improved ways to design and deliver projects.

- Consider implementing a formal project "lessons learned" meeting for each project as it is being closed out with the contractor.
  - Include designers, managers, construction, maintenance and operations staff and even the contractor in the meeting to encourage open dialog about the ways things might be done better the next time.
  - Identify possible contractor innovations that may result in improvements to standard specifications and drawings.
  - Identify possible products or suppliers who may be good resources for future projects.
  - Require Parks designer, construction staff and the contractor to complete a questionnaire after each project, to include: questions about the capital process in general and customized questions about the project specifically and any piloted or otherwise novel features.

EXAMPLES

Battery Park City, Hudson River Park, the Highline, the United Nations and other projects within New York have engaged both design and construction management firms during the design and construction process to assist project design teams and owner-agency with the development of construction schedules, phasing and logistics plans, bid packages, and cost estimates.

C.2 USE PROACTIVE PROCUREMENT STRATEGIES

OBJECTIVE

Improve procurement of sustainable materials and specialized construction services.

BENEFITS

- Potentially broadens the pool of contracting companies
- Potentially eliminates general contractor mark-ups on specialty contractor work such as soil remediation, invasive species removal, and green roof construction
- Allows for a direct contractual relationship with specialty contractors
- Potentially increases control over selection of quality contractors and the scheduling and administration of their work

CONSIDERATIONS

- Some of the recommendations contained in this section go beyond the power and authority of the Parks Department. The suggestions are included to create an awareness of what might be possible.
- State and City-wide Law prescribe how projects have to be bid.
- Changes in procurement strategies would require City and possibly state approvals.
- Pre-purchasing for multiple projects requires increased planning and coordination of capital project schedules.
- Use of multiple contracts requires increased construction coordination.
- May increase resident engineer or construction management fees
- Policy changes may be needed to change the procurement processes.

BACKGROUND

High performance landscapes are dependent on skilled contractors who can operate without damaging existing soils, vegetation, and waterbodies. Contractors need to be experienced in the performance of specialized tasks such as invasive species control, natural area restoration, and green roof construction. Use of sustainable products such as porous concrete and low temperature asphalt require a willing contractor who is familiar with the product. Prior to awarding them contracts for work, contractors should be required to demonstrate experience in these areas to ensure that they will be able to follow specifications and bid the job competently and competitively. This requires some manner of qualifying the contractors, either before bidding or before award.

Some materials (such as trees of a particular species) need to be ordered well in advance because they need to be propagated. Other materials such as soil need to be sourced ahead of time because they need to meet a detailed specification. In both instances it would be desirable for Parks to have suppliers who have agreed to provide these materials at a fixed price for periods of time, so that any contractor working on a Parks project would be able to incorporate those materials into their job without being encumbered by lengthy procurements. This would potentially yield significant project savings.

PRACTICES

DEVELOP A PRE-PURCHASING PROGRAM OR SUPPLY-ONLY CONTRACTS FOR MATERIALS

Often, projects will require specific materials in order to meet their sustainability goals. For example, for the *PlaNYC* Reforestation initiative undertaken by Parks, a procurement contract was created for multiple nurseries to produce 8,000 trees annually of specific species and genotype over an 8 year period. The nurseries produced the plant material and were required to deliver minimum numbers of truckloads within City limits. Similar approaches could be used for soil materials, compost, mulch, native plants, and materials that require high levels of quality control.

- Pre-plan and combine common material needs across multiple contracts.
  - Seek to leverage competitive prices for materials that might be too costly to order on a per-project basis.
  - Seek to reduce manufacturing and supply lead times, improve shipping efficiencies and streamline contractor submittals.
  - Use large scale pre-purchasing for multiple projects annually to entice suppliers to provide more sustainable products that would otherwise be considered “custom.”
  - Pre-purchasing from a range of suppliers may also provide Parks with a greater ability to provide quality control since Parks inspectors would only need to visit and test a limited number of suppliers. Contractors would then be able to purchase materials that have effectively completed the Quality Assurance process typically accommodated by contractor submittals.

ENCOURAGE OR REQUIRE PURCHASE OF LOCALLY AVAILABLE AND / OR SUSTAINABLE MATERIALS OR SERVICES TO THE EXTENT LEGALLY AND LOGISTICALLY POSSIBLE

The purchase of locally produced goods serves important sustainability goals of minimizing excessive transportation costs and associated pollution and gasoline consumption. The use of local companies to manufacture goods and provide services helps develop local green jobs. Purchasing goals would be incentives to the development of local nurseries, recycling facilities, site furnishing manufacturers and a variety of specialty contracting companies.

- Investigate existing or proposed tax incentives, public financing and other means of encouraging local green jobs.
- Consider providing specific contract target goals for

percentages of materials or services purchased from manufactures or suppliers within New York City or surrounding region.

- ☐ Follow a similar approach used by City and State agencies for meeting WBE/MBE goals.

- Reference NYC's Environmentally Preferred Purchasing law: http://www.nyc.gov/html/nycwasteless/downloads/pdf/eppmanual.pdf
- Promote awareness within the Department and the local contracting community of sources of locally available and sustainably produced materials, products and services through newsletters, pre-bid meetings and comprehensive listing of sustainable suppliers and specialty contractors.
- Use combined agency purchasing power to increase demand for locally produced materials and supplies.

IMPROVE THE QUALITY OF CONTRACTORS PERFORMING SPECIALTY WORK

Hiring experienced and high quality contractors who are capable of constructing high performance landscapes can be challenging within the standard New York City bidding practices. Typically competitive bidding in New York City results in the selection of contractors based on the lowest price bid with limited assurance of actual ability of the contractor to perform the work in a way that it is specified. Requirements contracts and pre-qualified contractors are two strategies that could be explored to allow Parks to improve the quality of contractors.

REQUIREMENTS CONTRACTS

In requirements contract projects, bidders provide unit prices based on standard specifications and drawings with minimal site or project-specific information. These contracts are used primarily to advance contractor bidding while projects are still in design, shortening the time from conception to construction. Typically successful requirements contractors then build park projects and Parks pays the contractor based on the unit prices in his bid for a range of expected construction items. Requirements contracts have historically been awarded to general contractors who use either in-house staff or specialty subcontractor to perform work. The disadvantage is that projects requiring more specialized work will end up paying more for the work since it will be run through a general contractor who is entitled to mark up the price of their work.

This requirements contract system, which is very successful for Parks, could be further refined to develop requirements contracts for specialty work, thereby encouraging specialty contractors to bid on work they are both qualified to do and interested in, giving Parks greater flexibility to award critical, high performance work, or ecologically sensitive items to more qualified contractors.

PRE-QUALIFY CONTRACTORS

Parks could consider a formal specialty contractor pre-qualifying program. The NYC Department of Design and Construction has successfully used a contractor pre-qualification process to select contractors for highly specialized construction work where it is essential that only competent and experienced vendors be invited to bid.

The pre-qualification process, which has been vetted by the Procurement Policy Board, offers a new approach to contracting that may offer improved results over the traditional Parks approach of selecting contractors based on the lowest responsible bid. Typically specialty contractors have a hard time competing with larger general contractors. Specialty contractors also are often not interested in bidding on large projects that only include a small portion of work that they focus on.

Interested firms can respond to advertisements for pre-qualified bidders by requesting the pre-qualification requirements package which details the qualification and experience needed to undertake the work of specific contract types. The response is evaluated; firms that have met the criteria for pre-qualification are selected. Once final bid documents are available for bid, only those firms who have been pre-qualified will be invited to submit competitive bids. After a bid opening, which all pre-qualified firms can attend, the firm with the lowest responsible bid will be awarded the contract.[29] Pre-qualification would be especially useful for projects involving specialized skills including:

- Invasive plant management
- Stormwater management systems including constructed wetlands, infiltration basins and other devices
- Green roof construction
- Porous pavement installation
- Ecological plantings
- Brownfield restoration
- Abatement of hazardous materials

TO ENCOURAGE MORE BIDDERS TO PREPARE BETTER BIDS, PLAN THE BID SEQUENCE TO COINCIDE WITH CONTRACTOR "DOWN TIME"

- Whenever possible, avoid site contractors' busy periods during the early spring or late fall seasons since contractors are often too preoccupied to spend the time required to carefully plan their bid responses.
  - ☐ Site work bids are generally best when due in January and February, when contactors are looking to secure work for the coming season.
  - ☐ Bidding during the mid summer is an alternative since work is already in place and contactors are looking for work for the mid to late fall seasons.

REALISTICALLY PLAN THE TIMING OF CONTRACTOR BIDS AND AWARDS ON COMPLEX PROJECTS

- For projects requiring extensive planning, soil work, plant material purchasing or other specialized construction, consider bidding and awarding the projects a full season ahead of the actual start of construction.
- Allow contractors sufficient time to source materials and obtain submittal approvals required for construction.
- Stipulate milestones for completion of early lead items in the bid documents and project schedules to coincide with anticipated construction start and end dates.

EXAMPLES

Hudson River Park Trust uses multiple contracts to optimize the purchasing of construction services. Park construction has been parceled into a number of construction contracts including general site work, marine construction, stone masonry, paving, irrigation, landscaping. It is common practice for building contracts to separate furniture and equipment purchases from the actual building contracts.

FOR FURTHER INFORMATION

New York City of Design and Construction, "*Design + Construction Excellence: July 2007 Progress Report*." July 2007. http://www.nyc.gov/html/ddc/downloads/pdf/dcei_2007.pdf

29 **New York City of Design and Construction, "*Design + Construction Excellence: July 2007 Progress Report*." July 2007, p. 13.**

C.3 CREATE CONSTRUCTION STAGING & SEQUENCING PLANS

OBJECTIVE

Create detailed construction staging and sequencing plans to understand and control how contractors will perform their work on the site with the specific goals of protecting soil, vegetation, and water resources throughout the duration of construction.

BENEFITS

- Improves the design team's understanding of the scope of work, results in clearer construction documentation and more accurate bidding and scheduling
- Elevates the importance of best management practices and their required use to the construction managers, resident engineers, and contractors during construction
- Clearly identifies and protects zones of existing stormwater management, vegetation, soil or water resources

CONSIDERATIONS

- The preparation of additional plans and specifications can sometimes increase project design costs.
- If staging and sequencing plans are too rigid they will not allow for a contractor to propose more innovative or efficient alternatives.
- Requirements to protect site features, to sequence construction in particular ways or to increase documentation requirements can increase construction costs.

BACKGROUND

High performance construction requires careful preconstruction planning to achieve environmental, economic, and maintenance / operations goals. The development of sequencing and staging plans serves several purposes.

- As design documents, they inform the design team about the full extent of construction impacts on the site, including space planning requirements and post construction restoration needs.
- As bid documents, they inform the contractor of the basic operational requirements and coordination necessary to complete the work properly.
- As submittal documents, they confirm the contractor's commitment and understanding of high performance

requirements prior to the start of work, while reserving flexibility and control over means and methods of construction.
- During construction, they serve as the contractor's work plan and framework to achieve goals and meet requirements.

PRACTICES

PLANNING

PREPARE CONSTRUCTION STAGING, SITE PROTECTION, AND SEQUENCING PLANS AS PART OF THE PRELIMINARY DESIGN PROCESS

- Establish the baseline assumptions, goals, and requirements associated with building the project.
- Ensure that the plan provides sufficient room to allow for the construction of the proposed design and includes appropriate mitigations for impacts resulting from the construction process.
- Include plan diagram(s) that indicate:
  - Location of construction fencing to secure the site
  - Areas to be protected with no contractor access
  - Tree protection plan showing tree guards, fenced off zones, critical root zones, mulch and plywood protection
  - Areas with restricted access, including vehicle weights or types
  - Areas for staging, storage, and stockpiling (based on calculated soil volumes required for the project)
  - Field office locations
  - Site access locations and circulation routes required to construct the project
  - Concrete washout locations
  - Fueling locations
- Include in specifications:
  - Acceptable equipment
  - Weight and/or compaction restrictions
  - Protective materials and measures for soil, water, and vegetation
  - Critical sequencing of operations
  - Testing and/or inspection requirements during construction
  - Construction and demolition waste management
  - Environmental controls
  - Other operational or constraining parameters
  - Penalties associated with unnecessary damage or repairs
- Coordinate work plan requirements with plans and specifications for:
  - Erosion and sedimentation controls
  - Soil placement and protection
    - See *S.8 Provide Soil Placement Plans as Part of Contract Documents*
  - Vegetation and soil protection
    - See *V.1 Protect Existing Vegetation*

DEVELOP WORK PLAN OPTIONS TO MINIMIZE SITE DAMAGE WHERE POSSIBLE

- Consider staging project to make use of existing paved roadways and parking areas for the location of storage, stockpiling, and staging areas to avoid soil compaction.
- Sequence construction in such a way that a contractor can complete work without driving over protected areas, newly installed utilities, and soil areas.
- Consider the use of multiple access points or moving access points to avoid vehicles crossing over protected or newly constructed areas.

Even a small project, like this neighborhood park in Manhattan, requires a complex sequence of subcontractors' work and schedules. Creating a staging and sequencing plan will prevent potential conflicts and allow construction to proceed smoothly.

CONSIDER GRADING AND EARTHWORK IMPACTS ON EXISTING VEGETATION AND WATER BODIES

- Avoid disturbing watersheds that direct critical water volume towards trees, vernal pools, streams and ponds.
- Ensure sufficient size of protection and buffer zones.
- For utility trenching work, plan sufficient room for equipment access and soil stockpiling along trench.
- Consider tunneling or pneumatic excavation for trenching through critical tree root zones.
- Consider use of deep mulch blankets, plating, bridging or other methods to minimize soil compaction and damage to vegetation.
- Consider timing of proposed work in relation to breeding and nesting, as well as fish spawning.
  - Consult habitat agencies and regulator mandates for nondisturbance periods.

PLAN REALISTIC AND APPROPRIATE REMEDIATION PROCEDURES WHERE WORK WILL UNAVOIDABLY DAMAGE AREAS

- If equipment access roads, staging or storage will result in soil compaction, plan to remove and replace the soil, including subsoil ripping if necessary.
- If trees are to be unavoidably damaged and cannot be protected, remove the trees rather than allow them to slowly decline and become hazards requiring costly removal and replacement after the project is complete.

INVOLVE CONSTRUCTION PROFESSIONALS IN THE DEVELOPMENT OF PRELIMINARY WORK PLANS

- See *C.1 Integrate Constructability Reviews into the Design Process*
- Engage construction managers and resident engineers' expertise in planning sites for the following factors:
  - Equipment access requirements
  - Turning radii
  - Dimensions to accommodate loading and unloading
- Engage construction professionals to review a plan, especially scheduling and budgetary implications associated with restricted access.

DESIGN

Once the preliminary plans have been developed, the design team should create schematic sequencing and staging plans, specifications, and schedules for use in the bid document set. The plans specifications and schedule requirements should be carefully coordinated to be as descriptive as possible to foster contractor creativity and to allow flexibility to control the means and methods of the work.

PRELIMINARY PROJECT SCHEDULES SHOULD INCLUDE NECESSARY DURATIONS FOR:

BID/AWARD/REGISTRATION PROCESS:

- Advertising of bids
- Contractor bidding
- Bid review and approval
- Contract award and registration
- Approval of contractor submittals

PREPARATION AND APPROVAL OF SHOP DRAWINGS:

- Construction staging and sequencing plans
- Erosion and sedimentation control plans
- Utility drawings

OFFSITE CONSTRUCTION PROCESSES:

- Procurement of materials
- Fabrication of products
- Mobilization

ONSITE CONSTRUCTION PROCESSES:

- Site preparation
- Rough grading
- Utility installations
- Surface and subsurface drainage installation
- Buildings and other structures
- Walls, stairs, and curbing
- Pavements
- Irrigation
- Soil installation
- Vegetation
- Site furnishings
- Site clean-up

CREATE DIAGRAMMATIC PLANS AND DETAILED SPECIFICATIONS AS PART OF BID DOCUMENTS

It is extremely difficult to enforce site protections if there are not clear requirements for contractor performance. However, designers need to be careful not to overreach with site protection requirements. Deciding what is important and should be protected is an important design function.

- Draw plans as diagrammatically as possible showing general areas with critical dimensions and restrictions. The intent is to suggest approaches and to outline key concerns so that the contractor can adapt the requirements in a logical way based on site needs.
  - Clearly delineate where flexibility is allowed and where it is not.
- Key diagram areas to details or other plans, including:
  - Erosion control plans
  - Soil placement plans
  - Tree protection
  - Existing utility protection and other protective plans
- Show construction and protective fencing and details on the construction staging and sequencing plans.
- Specifically state that vehicles may not drive over installed soils unless using specifically approved equipment.
- Specifically state unacceptable conditions that will require removal and replacement of soils or vegetation.
- Provide clear formulas for tree replacement.
- Specifically state that Parks determines acceptable or unacceptable conditions.

PREPARE A PRELIMINARY CONSTRUCTION SCHEDULE TO AID IN REVIEW OF CONTRACTOR BIDS AND SCHEDULING OF CONSTRUCTION PHASES

- Design team should work with construction professionals to develop an itemized preliminary work plan schedule for use by contractors in developing bid proposals.
- Evaluate the contractor's work plan as part of determining the validity and responsibility of a contractor's bid.
- During construction, encourage all participants to use the work schedule to understand sequencing of operations, potential conflicts, and opportunities for improvement.
- Review detailed schedule to identify critical seasonal restrictions for planting or soil work.
- Review planting schedules to identify scheduling implications of fall bulb planting or using trees and shrubs that are fall planting hazards.
- Include time contingencies within schedule to account for weather delays, delayed submittals, and other common reasons for work stoppage.

IDENTIFY IF SEQUENCING OF WORK WILL BE REQUIRED

- Organize project around seasonally or calendar based activities that may impact a contractor's performance, such as:
  - Required environmental permits
  - Invasive species management
  - Planting operations
- Identify work that will likely require sequencing so that the contractor can accurately plan the work.

- Include instructions in the project specifications or in detailed notes on the drawings.
- Identify specific requirements and approvals associated with sequencing of work including:
  - Preparation of detailed schedules
  - Preparation of shop drawings

- Do not seek to control the contractor's means and methods, but rather develop a work sequence that ensures the delivery of a product that complies with the requirements.
  - For example, it is not uncommon to require the installation of all trees prior to the installation of subsequent understory and lawn materials to avoid contractor trampling of the approved installed work.
- Consider the need for sequencing in multiphase projects or ones that include the following:
  - Limited, changing or multiple points of site access
  - Trees and other vegetation that must be installed in advance or concurrent with planting soils
  - Vegetated stormwater facilities that require diversion until establishment
  - Projects with early delivery of key facilities, such as sports fields, in advance of adjacent park areas
  - Waterfront parks with extensive shoreline stabilization work that must be completed before upland work can begin
  - Rooftop work that requires soil and planting installation while the building crane is still on site
  - Occupation of buildings prior to the completion of surrounding landscaping
  - Maintenance of building or site access throughout construction, such as:
    - Transit sites and highways
    - Schools and community centers
    - Recreation seasons (baseball, soccer, etc.)
- Use sequencing for projects spanning multiple seasons.
  - Mobilization and demobilization as well as winterization of water and irrigation utilities
  - Storage and heeling in of plantings scheduled for replanting on site at completion of construction
  - Long term management of protected planting zones (weeding, watering, and pest monitoring)

CONSTRUCTION

DISCUSS OBJECTIVES AND REQUIREMENTS FOR CONSTRUCTION STAGING AND SEQUENCING

- At prebid meetings:
  - Discuss project goals and objectives
  - Ensure that contractors clearly understand the full extent of the work and properly cover the time and costs associated with these items.
  - Conduct a two stage bidding process — paper bid, then interview with the lowest price bidders in order from lowest to highest as needed — to determine if the bid is complete and properly thought out.
- Post bid / preaward meetings:
  - After bids have been received hold a postbid / preaward meeting with one or two of the lowest bid contractors to determine:
    - The extent to which they have thought through the staging requirements of the project
    - Whether they have a clear understanding of project needs based on how they describe their proposed work plan and schedule
    - Whether they satisfy the requirements of lowest responsible bid
  - If the contractor is unable to articulate a proper understanding of the project needs, operational criteria, or realistic work schedule, they may not be the lowest responsible bidder.
- Preconstruction meetings
  - Before each critical work sequence begins, the design team and construction manager should meet with the contractor to review the following:
    - Anticipated and approved procedures
    - Schedules
    - Methods and equipment to be used
    - General high performance objectives
  - Remind the contractor of critical issues such as soil, water, and vegetation protections.
  - Allow contractor to suggest alternatives that may have unforeseen benefits to the project delivery schedule and overall work quality.
  - Hold periodic progress meetings during construction.

REQUIRE CONTRACTOR TO PREPARE CONSTRUCTION STAGING AND SEQUENCING PLANS AS PART OF THE SHOP DRAWING SUBMITTAL PROCESS

- Require the contractor to provide the same level of information as is provided in the schematic plan prepared as part of the bid documents to ensure that all requirements are met prior to the start of construction.
  - Require contractor to include line items for staging and sequencing plans within the submittal schedule.
  - Require the contractor to identify timing associated with staging and sequencing within the project work schedule, including time required for approval of shop drawings if required.

ENFORCE CONSTRUCTION STAGING PLAN AND SEQUENCING PLANS

Parks currently requires that construction and staging plans be developed as part of the standard submittal process. Unfortunately these plans typically are generic and not carefully evaluated nor enforced.

- Require that Parks construction and resident engineering staff as well as design staff are fully apprised of the contractor's intent.
- Require inspection of site protection at each site visit to ensure that the contractor is in compliance with the agreed to plans.

FOR FURTHER INFORMATION

- City of Bellevue (WA) Parks and Community Services Department, *Environmental Best Management Practices and Design Standards Manual*,

2006. http://www.ci.bellevue.wa.us/Parks_Env_Best_Mgmt_Practices.htm
- Craul, Phillip and Craul, Timothy. Soil Design Protocols for Landscape Architects and Contractors. Hoboken, NJ: John Wiley & Sons, Inc., 2006.
- King County Parks and Recreation Division, *Best Management Practices Manual*, Seattle, WA, 2004. http://www.metrokc.gov/parks/bmp/
- New York City Department of Design and Construction and Design Trust for Public Space. High Performance Infrastructure Guidelines: Best Practices for the Public Right of Way. New York: New York City Department of Design and Construction and Design Trust for Public Space, 2005.
- New York City Department of Transportation. *Street Design Manual*. 2009. http://www.nyc.gov/html/dot/html/about/streetdesignmanual.shtml
- NYCDDC Sustainable Urban Sites Manual (2009) http://www.nyc.gov/html/ddc/downloads/pdf/ddc_sd-sitedesignmanual.pdf

C.4 REDUCE DIESEL EMISSIONS

BACKGROUND

Reduce diesel emissions from construction equipment through vehicle retrofits and the use of cleaner alternatives to traditional diesel fuel.

BENEFITS

- Reduces ground level ozone formation and particulate matter emissions.
- Improves public health.
- Use of ultralow sulfur diesel (ULSD) fuel is federal law for private and public, so that no additional cost will be incurred.
- Reduces emissions of gaseous toxins.
- Promotes investment in hybrid diesel equipment by Parks and contractors.

CONSIDERATIONS

- Premature wear of engine components may occur if minimum fuel specifications are not met.
- Initial diesel distillate may have slightly lower energy content, increasing costs.
- Requires additional oversight to enforce with outside contractors.
- Biodiesel fuel offerings could gel in lower temperatures in winter months.

BACKGROUND

In urban areas, diesel exhaust from construction vehicles may comprise as much as 36% of the fine particulate matter mass, 10% of all nitrogen oxide (NOx) pollution, and may contain a variety of other toxins that create a serious threat to public health. Emissions from heavy duty diesel vehicles (HDDVs) can be reduced using a combination of cleaner fuel technologies, hybrid diesel electric vehicles and emission control retrofit devices. However, emission controls have not been widely implemented in the construction sector. In 2003, New York City passed Local Law 77, legislation requiring the use of cleaner, ULSD, in conjunction with Best Available Technology (BAT), or retrofit devices such as oxidation catalysts, filters and absorbers. Local Law 77 is part of the same legislative family as the US EPA Clean Air Nonroad Diesel rule, which will also significantly reduce the risk that diesel emissions pose to public health.

PRACTICES

DEVELOP AN AGENCY TASKFORCE INCLUDING BOTH PARKS CONSTRUCTION & MAINTENANCE AND CITY DOT AND DEP

REPRESENTATIVES TO DISCUSS SPECIFIC WAYS PARKS CAN IMPROVE PERFORMANCE

- Identify potential additional costs (or savings) of compliance, as well as additional sources of funding.
- Develop an agency performance tracking system to ensure that contractors adhere to Local Law 77 and other contractual requirements relating to emissions.

USE ULTRALOW SULFUR DIESEL (ULSD) FUEL

ULSD is a widely available petroleum diesel that has been modified in the refinery to reduce its sulfur content. The EPA mandates use of ULSD fuel in all nonroad construction equipment by 2010. Biodiesel blends including B5 and B20 can be used as a substitute for synthetic additives to increase lubricity.

- Use ULSD alone to yield modest emission improvements.
- Use ULSD in conjunction with after treatment technologies to reduce particulate emissions by up to 90%.
- Consider blending ULSD with other substances to produce lower impact ULSD fuel blends, including:
  - Emulsified diesel
  - Biodiesel
  - Oxygenated diesel
  - Fuel borne catalysts

OPTIMIZE EMISSION CONTROL WITH FUEL/TECHNOLOGY COMBINATIONS

Use after treatment retrofits to reduce both PM and NOx. These devices clean the exhaust after it leaves the engine but before it exits into the atmosphere. Usage of these technologies can reduce NOx and PM emissions by as much as 90%.

- Diesel oxidation catalysts (DOC)
- Catalyzed diesel particulate filters (DPF)
- Active diesel particulate filters (Active DPF)

EVALUATE ALTERNATIVE FUEL AND AFTER TREATMENT TECHNOLOGY COMBINATIONS FOR EACH TYPE OF DIESEL POWERED CONSTRUCTION VEHICLE OR EQUIPMENT

- Invest in antiidling equipment and training for staff regarding idling.
- Use the right-size equipment: the smallest and least emitting equipment that will fulfill a construction need.
- Improve preventive maintenance and tire maintenance practices.
- Invest in hybrid electric trucks.
- Reevaluate regularly to incorporate technological advancements.

CONSIDER APPLYING EXISTING REGULATIONS TO ALL CONSTRUCTION EQUIPMENT

- Regulate unnecessary idling or operation.
- Perform opacity, or smoke tests, on all equipment as part of required safety inspections.
- When feasible, use alternative fuels and after treatment retrofits on all generators, temporary and permanent, using combinations of technology as appropriate.
- Install diesel oxidation catalysts and particulate filters.

EXAMPLES

New York City Parks uses B20 for all operations equipment. Parks has also installed DOCS or DPFs on half of all equipment with new installations in progress. Parks is investing $2 million in hybrid electric dump and rack truck equipment that will be combined with these other solutions.

The Central Artery/Tunnel Project (aka Big Dig) in Boston, Massachusetts included construction vehicle detours, designation of truck routes, idling prohibitions, dust control measures, and retrofitted construction equipment. See http://www.epa.gov/otaq/retrofit/retrobigdig.htm

The Lower Manhattan Development Corporation (LMDC) and the US EPA have formally entered into an agreement outlining requirements for contractors working in Lower Manhattan. This plan, with very specific air quality, noise, and vibration requirements, has been accepted for use by the Port Authority and Hudson River Park. See Lower Manhattan Recovery Projects Environmental Performance Commitments, 2005. http://www.lowermanhattan.info/extras/pdf/lmrp_environmentalperfcommitments.pdf

FOR FURTHER INFORMATION

- DDC Office of Sustainable Design. Low Sulfur Diesel Fuel Manual. June 2004, http://nyc.gov/html/ddc/html/ddcgreen/reports.html
- EPA Voluntary Diesel Retrofit Program Website is designed to help fleet owners/operators, state/local government air quality planners, and retrofit manufacturers understand the diesel retrofit program and obtain information needed to create effective retrofit projects. http://www.epa.gov/otaq/retrofit/overview.htm
- EPA Nonroad Diesel Equipment Home Pagehttp://www.epa.gov/otaq/regs/nonroad/equip-hd/basicinfo.htm
- New York City Department of Design and Construction and Design Trust for Public Space. High Performance Infrastructure Guidelines: Best Practices for the Public Right of Way. New York: New York City Department of Design and Construction and Design Trust for Public Space, 2005.
- United States Environmental Protection Agency. Health Assessment Document for Diesel Engine Exhaust, USEPA/600/8-90/057F, May 2002.
- Northeast States for Coordinated Air Use Management Construction Equipment Retrofit Project Summary Report. Available at http://www.nescaum.org/pdf/CACI/retrosumm.pdf

C.5 IMPLEMENT A RECYCLING AND WASTE MANAGEMENT PLAN

OBJECTIVE

Implement a construction and demolition waste management plan for park construction to reduce the amount of materials entering the waste stream and increase recovery of recyclable materials.

BENEFITS

- Conserves and reduces pressure on local landfills.
- Decreases transportation costs and reduces pollution.
- If materials can be recycled and reused on site, it may reduce construction time and costs.
- Reduces soil, water and air pollution.
- Reduces use of virgin materials.
- Promotes local economic development.
- Strengthens the market for recycled materials.

CONSIDERATIONS

- Some types of recycling may increase construction costs until they become more widely used.
- Lack of availability of markets for recycled materials could minimize effectiveness of recycling plan.
- May be ineffective without contractor compliance and agency enforcement.

BACKGROUND

More than 60% of New York City's solid waste stream consists of construction and demolition (C&D) debris generated from land clearing and excavation, as well as work performed on structures, roads, and utilities. Approximately 19,500 tons of fill and 13,500 tons of other C&D material are generated daily. Most of the disposal or recycling of this waste is handled by private companies. Thanks to the favorable economics of C&D waste management in infrastructure projects, many contractors have developed effective recycling routines. In doing so, they avoid landfill tipping fees and costs associated with waste transportation out of the city. Additionally many contractors save money by recycling asphalt, concrete, metals, fill, and other materials common to infrastructure from one job to the next. It is estimated that approximately 60% of fill and 40% of nonfill materials are taken to waste processors, which recycle almost 100% of the C&D waste received. Implementing a waste management plan will help reduce exported city waste, reduce air pollution, realize cost savings through material recovery, and create more market opportunities in the waste processing industry. In general, waste management decisions should be made in accordance with the preferred hierarchy of 1) reuse onsite, 2) recycle onsite, 3) reuse offsite, and 4) recycle offsite.

PRACTICES

DEVELOP AN AGENCY-WIDE WASTE MANAGEMENT PLAN THAT INCLUDES SPECIFIC GOALS FOR PARK'S WASTE MANAGEMENT, FOR BOTH CONSTRUCTION AND ONGOING MAINTENANCE

- Develop the plan with staff or hire a consultant on a temporary basis.

USE AGENCY PURCHASING POWER TO ENCOURAGE CONTRACTORS, VENDORS AND SUPPLIERS TO IMPLEMENT RECYCLING AND WASTE MANAGEMENT PROGRAMS

- Identify local and regional manufacturers, vendors, and suppliers who have active programs or have indicated an interest in supporting programs.
- Identify coincident needs within Parks or at other city agencies to increase leverage.
- Complete a hierarchical analysis of which materials contribute most to the waste stream and where there are opportunities for targeted improvements and resource recovery opportunities.
  - Consider the largest sources of waste for a particular project and examine alternatives to disposal.
    - Can the material remain onsite rather than be removed?
    - Can the material be reused on site?
    - Can the material be reused by other ongoing construction projects?
    - Can the material be salvaged by the maintenance staff of the borough?

DEVELOP STANDARD C&D WASTE SPECIFICATIONS

- Include requirements in contract documents, editable on a per project basis.
  - Consider establishing general waste management goals (in cubic yards or percentage of total weight).
  - Consider using percentages of waste targets similar to the way MBE/BE targets are required for contractor teams.
  - Require submittal of a C&D waste management plan.
  - Require submittal of delivery receipts for recovered and waste materials sent to waste processing or landfill facilities.
  - Specify acceptable site management practices.

DURING THE DESIGN REVIEW PROCESS, SUBMIT A REMOVALS PLAN TO THE BOROUGH CAPITAL TEAM MAINTENANCE DIVISION TO PROVIDE THEM THE OPPORTUNITY TO REQUEST MATERIALS

- Specifically identify quantities of soil, vegetation, and site furnishing materials (pavers, benches, etc.) that might be worked into other ongoing or future projects.

HIERARCHY OF DPR'S MATERIAL USAGE

IN HIERARCHICAL ORDER OF COST, THE TEN MATERIALS DPR SPENT THE MOST ON IN FY-2007 ARE:

- Metal
- Concrete
- Asphalt
- Wood
- Vegetation
- Synthetic turf
- Stone
- Plastics
- Electrical
- Safety surface

Note: Removal of existing material accounted for a larger portion of cost that any new material except metals and concrete

DEVELOP A C&D WASTE MANAGEMENT PLAN

- At project outset, require the contractor to submittal plan that includes:
  - Proposal for how the contractor will recover a specified percentage of C&D waste for reuse and recycling
  - Identification of anticipated materials to be reused or recycled, and estimate of amount by weight
  - Identification of anticipated materials that are not reusable or recyclable
  - Coordination of material recovery with construction and demolition schedule
  - List of insured and licensed waste processors to be used, organized by location and ranked by C&D recycling rates
  - Indication of situations in which compliance with standard C&D waste specifications do not apply or are not possible

DOCUMENT C&D WASTE MANAGEMENT EFFORTS

- Track recycling and waste disposal receipts to aid in estimating the quantities generated on future projects.
- Fill out a recycling economics worksheet for each project to track the cost of implementing a C&D waste management plan versus conventional waste disposal process (see King County, Washington below).
- Generate a post construction report documenting waste diverted (by weight and type) and money saved, for future reference on other projects.

MANAGE SITE TO REDUCE WASTE

- Make decisions in accordance with the waste management hierarchy of reuse onsite, recycle onsite, reuse offsite, and recycle offsite.
  - This hierarchical approach emphasizes methods that provide the greatest reductions in energy use, resource depletion, and cost savings.
- Review and modify storage/handling practices to reduce material loss from weather, theft or other damage.
- Verify the correct amount of material is delivered to the site.
- Consider allowing the public to remove materials for their own use.

MANAGE ONGOING SITE WASTE

- Require vendors to take back packaging when products are unpacked upon delivery, or when multiple deliveries make it possible to retrieve packing from a prior delivery.
- Recycle packaging materials and other miscellaneous site waste.
- Ensure waste materials do not get contaminated.
- Clearly label all recycling bins and waste containers.
- Post lists of recyclable and non recyclable materials
- Conduct regular site visits to verify that bins are not contaminated or overflowing.
- Provide feedback to the crew and subcontractors on the results of their efforts.

SEPARATE MATERIALS ONSITE WHEN POSSIBLE

Separation of materials onsite generally yields a better price for materials and results in better recycling rates.

- Use the following factors to determine whether onsite separation is feasible:
  - Availability of space
  - Volume of C&D waste
  - Relative proportions of C&D waste

ENSURE HIGH RECYCLING RATES OF MIXED C&D WASTE

- When onsite separation is not possible, the following practices will help ensure higher recycling rates of commingled waste.
  - Clearly designate and label container for placement of recyclables.
  - Place a separate, clearly labeled dumpster designated for waste disposal adjacent to recycling container to avoid confusion and contamination.
  - When providing the contractor with list of approved area waste processors, indicate recycling rates.
  - Require prehauling verification and approval of mixed C&D waste processor.

WORK WITH OTHER CITY AGENCIES TO CREATE AND MAINTAIN A CITYWIDE DATABASE OF CONSTRUCTION WASTE MANAGEMENT SUPPLIERS, RECYCLERS, AND CONTRACTORS WHO USE SUSTAINABLE RECOVERY METHODS

- Develop an outreach program in coordination with other city agencies to ensure that the waste management and recycling business is aware of specific Parks needs.
- Place a link to the standard specifications that reference this database so that contractors can easily access this information.

EMPLOY CREATIVE WASTE MANAGEMENT STRATEGIES

- Promote zero waste in private and public sector.
  - Develop partnerships between local government entities, industry, and the public to reduce waste when possible, achieve highest and best use of all materials, and find markets for recycled materials.

■ Offer training to contractors to show them how they can save money by recycling.
■ Write specs with options for recycled materials:
  □ For disposal of removed materials by the contractor, including a separate bid price for delivery to another Parks site (capital or maintenance)
  □ For acceptance of materials that have been removed from another project, including a separate bid price for work to install without having to furnish new material
■ Prevent waste in design and material procurement.
  □ Define material efficiency as a primary design parameter.
  □ Consult recycled material market directory when selecting materials of construction.
  □ Choose materials with little or no packaging.
  □ Request vendors deliver materials in reusable containers.

COORDINATE C&D EFFORTS TO REDUCE VEHICULAR MILES TRAVELED

■ Encourage rail-and-barge served transfer facilities.
  □ Consider feasibility of managing C&D waste transfer at Marine Transfer Stations.
■ Maintain area lists of licensed local haulers and waste processors.
  □ Organize on basis of location.
  □ Designate materials accepted at facility.
  □ Designate whether facilities accept source-separated or commingled waste.

EXAMPLES

Construction Works, a program administered by the King County (WA) Solid Waste Division, provides one-on-one technical assistance to contractors setting up jobsite recycling and waste reduction programs. In order to participate, the contractor must agree to meet the following requirements:

■ Implement six waste prevention strategies
■ Recycle at least 60 percent of its construction waste
■ Use six or more recycled-content building materials
■ Conduct at least three activities that promote waste prevention, recycling and/or the use of recycled-content products to their employees, customers and/or the community

In exchange for participation, the contractor receives recognition in local business and industry publications, as well as awards for outstanding participants from the County.

FOR FURTHER INFORMATION

➔ California Integrated Waste Management Board, "Construction and Demolition Debris Recycling," http://www.ciwmb.ca.gov/ConDemo/
➔ King County, Washington, "Waste Management Specifications" http://www.metrokc.gov/dnrp/swd/construction-recycling/documents/const_waste_management_2003.pdf
➔ King County, Washington, "Construction Works: Program for Recognizing Jobsites that Recycle and Reduce Waste" http://www.metrokc.gov/dnrp/swd/construction-recycling/constructionworks.asp
➔ King County, Washington, "Sample Recycling Economics Worksheet" http://www.metrokc.gov/dnrp/swd/construction-recycling/documents/economics_worksheet.xls
➔ New York Department of Design and Construction, Office of Sustainable Design, Construction and Demolition Waste Manual, May 2003http://nyc.gov/html/ddc/html/ddcgreen/reports.html
➔ New York City Department of Design and Construction (NYCDDC). Sustainable Urban Site Design Manual, Draft Copy, New York: NYCDDC, April 2008.
➔ New York City Department of Design and Construction and Design Trust for Public Space. High Performance Infrastructure Guidelines: Best Practices for the Public Right of Way. New York: New York City Department of Design and Construction and Design Trust for Public Space, 2005.
➔ New York City Department of Design and Construction, "Sample C&D Waste Management Plan" and "C&D Waste Specifications for Typical DDC Projects"
http://www.nyc.gov/html/ddc/downloads/pdf/wastemgmt.pdf and
http://www.nyc.gov/html/ddc/downloads/word/typicalspec.doc

C.6 IMPROVE CONTRACTOR QUALIFICATION EVALUATION AND PARKS STAFF TRAINING

OBJECTIVE

Improve contractor and Parks staff training to foster more sustainable construction practices.

BENEFITS

- Improve contractor and construction staff understanding of high performance objectives.
- Demonstrate agency's commitment to sustainability.
- Develop expertise with new technologies and practices.
- Improve the pool of available contractors.
- Improve Parks design and construction managers.
- Improve the quality of construction operations.

CONSIDERATIONS

- The development of incentive based programs and the use of bidding scoring systems that recognize improved contractor education and training need to be carefully vetted prior to implementation to ensure legal compliance.
- The use of liquidated damages has the potential to increase bid prices when damages are tied to unrealistic schedules and site conditions.

BACKGROUND

Achieving high performance goals and objectives for new projects requires that expectations are raised consistently across the industry. Not only do designers need to improve the quality of the thinking behind their work, but contractors need to improve the way projects are executed. Improving contractor and construction staff education and training requires commitment by the agency on multiple levels. Parks needs to devise creative ways to work within current bid laws and regulations to ensure that contractors are encouraged to do a better job. If necessary, the agency should consider a long range advocacy program to improve the building requirements and restrictions within New York City so that contractors are willing to improve their staff training levels. Parks should work with other agencies to attack this problem citywide.

PRACTICES

PLANNING

IDENTIFY WHERE CONTRACTORS AND STAFF PERFORMANCE NEEDS IMPROVEMENT

- Create an in-house task force to develop goals and guidelines for contractor and Parks staff training.
- Encourage certification of staff through industry recognized organizations such as:
  - International Arboricultural Society
    - Certified Master Arborist
    - Utility Specialist
    - Municipal Specialist
    - Certified Arborist
    - Certified Tree Worker
  - Irrigation Association (Certified Irrigation Designer)
  - US Green Building Council (LEED®)
  - Construction Management Association of America
  - Construction Specifications Institute
  - NYSDEP (certified pesticide applicator)
  - Specific materials installation certifications, such as porous concrete
- Review in-house and consultant staff performance and identify priorities for additional training.
- Create a budget for contractor and Parks staff education and training.

DEVELOP TARGETED CONTRACTOR AND STAFF EDUCATION PROGRAMS

- Explain the goals and strategies behind the *High Performance Landscape Guidelines*.
  - Use a variety of speakers (contract administrators, designers, stormwater engineers, construction managers, soil scientists, arborists, and contractors).
  - Emphasize real world applications and not only theoretical conversations.
  - Explain high performance in contractor terms including:
    - Bidding and pricing requirements
    - Submittals
    - Material procurement
    - Equipment and equipment use
    - Field performance, including testing and verification
  - Focus seminars on key topics to encourage specialty contractors or specialized staff to attend.
    - Erosion control
    - Stormwater management
    - Soil management
    - Planting practices
    - Construction operations including environmental compliance, recycling, and waste management
- Provide additional training for Parks construction staff including:
  - Review and evaluation of contractor qualifications and performance

Pre-qualified contractors are well-suited for complex restoration projects, such as Canarsie Park in Brooklyn, because they have experience on related projects. The pre-qualified contractor was required to hire a restoration specialist to oversee work and provide a monitoring report that evaluates establishment rates.

Members of Green Apple Corps, a division of AmeriCorps within the Parks Department, are shown proper green roof installation techniques on the Arsenal building, Parks' headquarters

- □ Use of liquidated damages during construction operations
- □ Review and evaluation of soil and soil amendment testing
- □ Appraising and evaluating tree and plant damage according to International Society for Arboriculture standards

■ Identify outside seminars that provide similar or more advanced training.

■ Publicize a regularly updated list of recommended seminars and appropriate contact information.

ENCOURAGE CONTRACTORS TO IMPROVE THEIR SKILLS

■ Investigate developing a contractor bid evaluation system and scoring with points given for staff education levels as an incentive to encourage contractor staff attendance at educational seminars.

- □ If contractors can receive bid points for staff education levels based on documented attendance of training seminars, and certification of owner, site superintendent, foreman or staff, there will be an incentive for contractors to improve their skills.

INVESTIGATE DEVELOPING A CONTRACTOR AND PARKS CONSULTANT CONSTRUCTION STAFF PREQUALIFICATION PROGRAM

■ Investigate developing a training program where contractors and consultant construction staff can learn how to improve their ratings.

- Model prequalification on the Design and Construction Excellence (D+CE) Program currently used by the city.

IMPROVE PARKS EXISTING CONTRACTOR PERFORMANCE EVALUATION PROGRAM AND PROVIDE CLEAR DIRECTION TO CONTRACTORS ON HOW THEY CAN IMPROVE THEIR PERFORMANCE ON FUTURE JOBS

- Penalize contractors who fail to perform in accordance with high performance guidelines and reward contractors who make greater efforts to be successful.
- Develop contractor training seminars and newsletter mailings reinforcing ways to do a better, more sustainable job.
    - Contractors often want to do the right thing, but need coaching as to what is important and how to comply in the best way. Explaining the goals and values behind scoring rating system makes it easier for contractors to comply with the intent of the system and not just check off items on a list.

DEVELOP A SYSTEM TO IMPOSE FINANCIAL PENALTIES FOR FAILURE TO FOLLOW HIGH PERFORMANCE GUIDELINES

- Communicate a clear message to the contracting community that the agency is committed to its goals.
- Train in-house design staff, consultants, and construction staff how to set realistic and consistent construction damage thresholds and monetary penalties

CONSTRUCTION

USE CONTRACTOR MEETINGS AS A WAY TO FURTHER REINFORCE EDUCATION AND TRAINING

- Periodically review ideas behind high performance design and its associated best management practices.
- Review high performance requirements in a variety of contexts to reach a cross section of contractor staff.
- Affect change not just at a management level but at the staff level, since they are the actual workers onsite.
    - Strategies for formal meetings:
        - At prebid and preconstruction meetings, review the requirements of the contract documents and explain the importance of unusual detailing or practices intended to protect existing plant, soil, and storm water resources.
        - Review the importance and reasoning behind contract submittals, work plans, phasing diagrams, and other drawings.
        - Review penalties associated with not following proper procedures.
    - Strategies for informal meetings:
        - Capitalize on tailgate meetings and site walks to discuss high performance goals and objectives.
        - Discuss practices with construction managers and staff while they are actually doing the work.
        - Use mockups and other preinstallation methods to allow contractors to test new approaches to construction.
        - Encourage questions and discussion on the challenges of undertaking new practices.

CELEBRATE CONTRACTOR AND CONSTRUCTION STAFF SUCCESSES

- Provide encouragement and recognition for improved outcomes.
- Recognize the accomplishments of key companies and staff members.
- Encourage a spirit of competition among participants.
- Recognize on the job innovations that could be emulated on other projects.
- Recognize achievements in staff training.
- Conduct outreach and educational events during and after construction to promote improved community understanding of high performance goals.
- Develop marketing material to get the word out about contractor, construction staff, and project successes.
- Create an annual awards event to assemble key agency and community leaders to recognize company and staff achievements.

C.7
IMPLEMENT A PUBLIC INFORMATION PROGRAM DURING CONSTRUCTION

BACKGROUND

Develop and implement a public information and education program to raise awareness of the project during the construction period.

BENEFITS

- Builds public awareness of high performance construction initiatives as they are happening
- Emphasizes the project's benefits for local neighborhood
- Explains construction process and avoids perception of work delays when progress is not readily apparent

CONSIDERATIONS

- Adds cost to construction phase services
- Can bring unwanted attention to controversial or unpopular projects

BACKGROUND

It has long been understood that a pubic that is educated about the value of its open spaces is more invested in their long term success. The construction process is a particularly good time to build public awareness and understanding — particularly about high performance objectives — since people can more readily identify with a project as it is becoming a physical reality.

Community members often have mixed responses to new park and landscape improvement projects, especially if they take a long time to implement. An education program can help manage public expectation during the construction process so that enthusiasm is maintained and ill will and anxiety are avoided. Community outreach is especially important when there may be real or perceived site contamination and mitigation activities involved with the project. A public outreach program can provide critical health and safety information, assuage neighborhood concerns about potential risks, and communicate goals and achievements.

PRACTICES

USE READILY UNDERSTANDABLE CONSTRUCTION SIGNS

Signs need to get the word out about how the city and neighborhood will be a better place with the improvements. Clear communication of goals and objectives is often the first way that the general public begins to believe in the benefits of a project. Consider employing graphic and community outreach experts rather than the project designers when creating signs to ensure that points are concise and explained without acronyms, jargon, or intimidating, alienating or otherwise off-putting prose.

- Incorporate easy to read plans or perspective illustrations of the intended improvements to help the public visualize the completed project and its benefits.
- If possible, enumerate some of the benefits to the community, such as:
  - Numbers of new trees
  - Gallons of stormwater diverted from local sewers
  - Amount of oxygen generated
  - Amount of new or refurbished recreational space
  - Energy savings, especially with new buildings
- Identify the project budget and funding sources so people see the extent of investment in their community.
- Require maintenance and upkeep of signage as a part of contractor payments.
- Provide phone numbers, websites, or locations where the public can get more detailed information from the agency.

USE A DYNAMIC TIMELINE THAT IS UPDATED ON THE CONSTRUCTION SIGN PERIODICALLY

- Show progress by phase or by areas completed.
- Highlight tangible progress (excavation, building construction, paving, landscape installation).
- Explain incidents of tree removal due to disease or decline and describe replacement process.
- Include upkeep of sign information as a requirement for the contactor in the construction sign specification.

CREATE PROJECT WEB SITES TO PROVIDE DYNAMIC UPDATES ON CONSTRUCTION PROGRESS

- Provide links to updated site photos (often supplied as part of a contractor's record documents).
- Provide time lapse webcams if feasible.
- Use the Parks website consistently.
- Regularly update the website to provide accurate information and to ensure credibility.

UNDERTAKE A VARIETY OR COMMUNITY OUTREACH INITIATIVES

- Distribute pamphlets outlining the project, budget, timeline, and photos of progress.
- Enlist friends of parks groups or other partnerships to assist in community outreach initiatives.
  - Make information available at local schools, community centers, libraries, houses of worship, and other neighborhood gathering places.
- Project scoping meetings are a critical first step in Parks' development process; make sure they are well attended and

that there is a clear forum for constituents to comment during the meeting and after so concerns are voiced early enough in the process to allow for change.

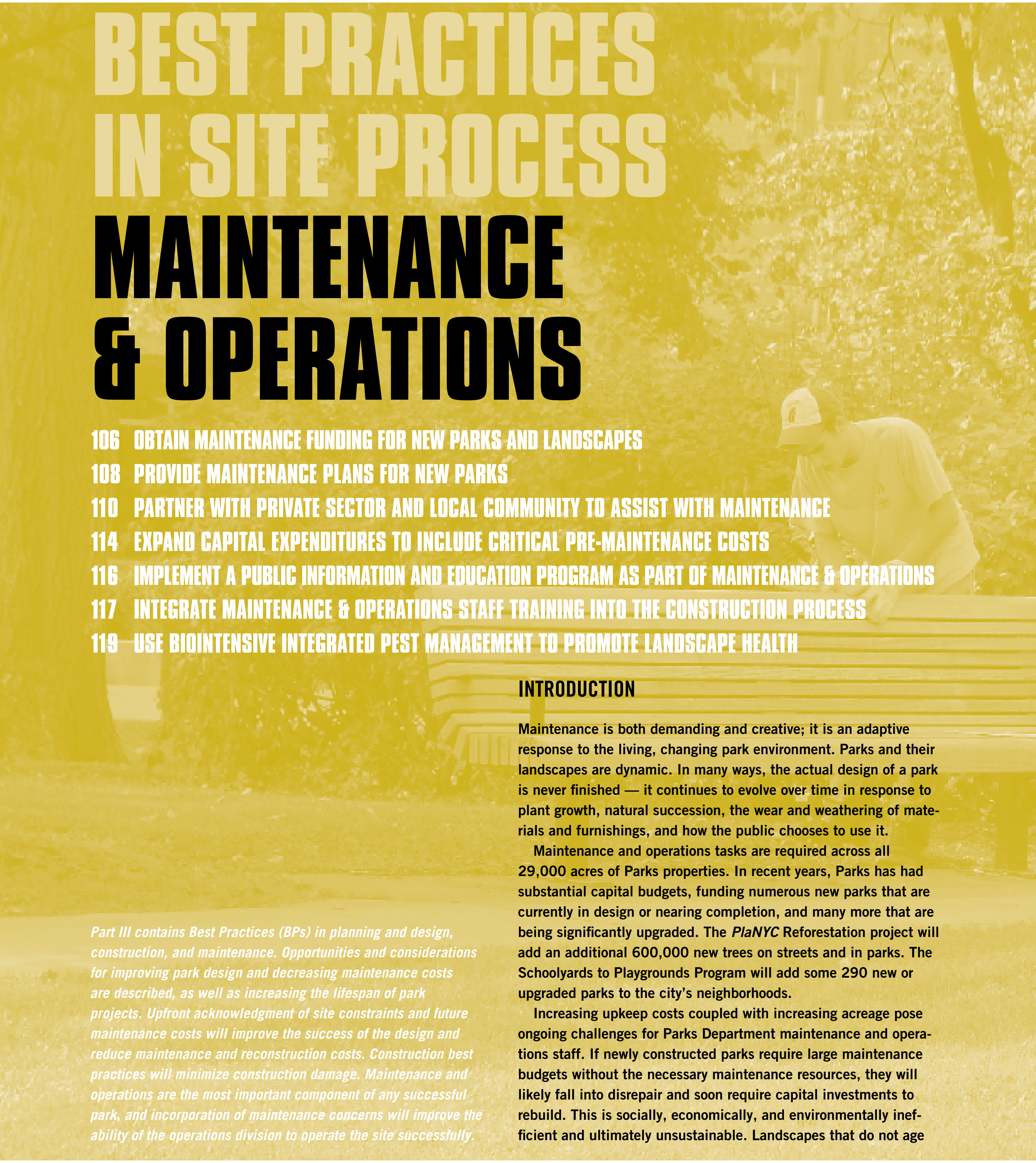
- Hold periodic community update meetings.
  - Invite the project designer and construction manager or resident engineer.
  - Give updates and show photos of construction progress, review schedules, and answer questions.
- Offer site tours.
  - Encourage local community leaders and representatives to schedule periodic site visits.
  - Use site visits to maintain interest and enthusiasm for a project.
  - Encourage site visitors to raise awareness about park development progress among their neighbors.

EXAMPLES

Million Trees Outreach Material

- General material
- Neighborhood street tree planting

PART III: BEST PRACTICES IN SITE PROCESS



MAINTENANCE & OPERATIONS

Part III contains Best Practices (BPs) in planning and design, construction, and maintenance. Opportunities and considerations for improving park design and decreasing maintenance costs are described, as well as increasing the lifespan of park projects. Upfront acknowledgment of site constraints and future maintenance costs will improve the success of the design and reduce maintenance and reconstruction costs. Construction best practices will minimize construction damage. Maintenance and operations are the most important component of any successful park, and incorporation of maintenance concerns will improve the ability of the operations division to operate the site successfully.

INTRODUCTION

Maintenance is both demanding and creative; it is an adaptive response to the living, changing park environment. Parks and their landscapes are dynamic. In many ways, the actual design of a park is never finished — it continues to evolve over time in response to plant growth, natural succession, the wear and weathering of materials and furnishings, and how the public chooses to use it.

Maintenance and operations tasks are required across all 29,000 acres of Parks properties. In recent years, Parks has had substantial capital budgets, funding numerous new parks that are currently in design or nearing completion, and many more that are being significantly upgraded. The *PlaNYC* Reforestation project will add an additional 600,000 new trees on streets and in parks. The Schoolyards to Playgrounds Program will add some 290 new or upgraded parks to the city's neighborhoods.

Increasing upkeep costs coupled with increasing acreage pose ongoing challenges for Parks Department maintenance and operations staff. If newly constructed parks require large maintenance budgets without the necessary maintenance resources, they will likely fall into disrepair and soon require capital investments to rebuild. This is socially, economically, and environmentally inefficient and ultimately unsustainable. Landscapes that do not age gracefully fall short of their intended purposes, no matter how environmentally sound their original design or construction.[30]

By integrating maintenance and operations thinking into the capital improvement design process, we can develop designs and new maintenance practices that allow parks to maintain or improve their environmental functioning without significantly increasing cost burdens associated with upkeep. At the same time, high performance maintenance operations present themselves as a unique opportunity to demonstrate sustainable practices, educating the public about the importance of changing the ways we interact with the outdoor world.

KEY PRINCIPLES

INTEGRATE PARK MAINTENANCE AND OPERATIONS THINKING INTO THE DESIGN PROCESS. Every effort should be made to view a park design through the lens of the maintenance staff. It is far simpler and more cost effective to incorporate upkeep considerations into the design of a project rather than trying to retrofit a built project. This integration will not squelch the design process, but rather inform it. To ensure the long term success of the park system, it is important to design parks that can be maintained in an efficient, cost effective manner.

DEVELOP COMMON GOALS AND SYSTEMATIC METHODS OF COMMUNICATION BETWEEN DESIGN AND MAINTENANCE & OPERATIONS STAFF. There should be scheduled interview and review sessions with maintenance and operations personnel. It is important for Design and Maintenance & Operations (M&O) to work together to develop a set of shared goals and objectives, so that each group appreciates the other's concerns and methods of operation. This will help the M&O staff to contribute to a project's long term success, by sharing the sustainability goals, and understanding the objectives for managing the critical interrelationships between soil, vegetation, and water systems. Designers need to understand how park maintenance is rated by park inspectors, which ultimately drives maintenance priorities. There also needs to be an agreement on levels of maintenance for each type of park space, under a variety of levels of use. The design of the park must acknowledge and work within the limitations of the maintenance that is available to each park.

ENCOURAGE AND SUPPORT EDUCATION AND TRAINING OF MAINTENANCE AND OPERATIONS STAFF. Staff will tend to favor older, less sustainable but known maintenance methods and materials unless they are given the opportunity to learn new ways. It is especially important that maintenance and operations staff understand new planting and maintenance techniques, since many sustainable park design solutions may introduce new aesthetics that may at first be hard to appreciate.

CELEBRATE MAINTENANCE AND OPERATION SUCCESSES AND REWARD INNOVATION. It is critical to elevate the importance of good maintenance practices. Maintenance is not just about making sure parks look good. Efficient delivery of seasonal and cyclical repairs and keeping a facility operating as intended contributes to long term economic, environmental, and social goals within our city. M&O staff have already begun to incorporate sustainable practices into their work in many ways. Continuing this important progress will allow the staff members to develop further skills and techniques that would be of benefit to future projects. Capturing and sharing this collective wisdom with the capital design staff on a regular basis will be an important way to sustain a culture of continuous improvement.

EVALUATE NEW METHODS AND TRACK PERFORMANCE. While Parks often does a good job of keeping a record of each park design contract document set, often what happens after construction is not so carefully recorded. Documenting the successes and failures of specific design features and the actual staff time and costs associated with new, sustainable features in particular, would allow both design and maintenance staff to make more informed decisions about what works and what does not. Park by park record keeping would also allow the agency to better track and document costs on a typology basis, better informing budget projections for existing and proposed facilities.

It should be expected that some design features or construction assemblies that are intended to be more cost effective may, in fact, turn out not to be so. Similarly, there may well be some very subtle or unintended benefits to more sustainable park design that turn out to be extremely cost efficient over the long run. Accurate and site specific records allow Parks to substantiate the success of new approaches to park design over the long term.

TAKE ADVANTAGE OF M&O VISIBILITY TO EDUCATE AND ENGAGE THE PUBLIC. Maintenance and operations activities within parks are highly visible to the public. These activities should be seen as a unique opportunity to educate the public about the need to maintain parks and the importance of sustainable systems. This is important to improve the collective public understanding of providing consistent funding for annual upkeep. Moreover, greater visibility of daily and seasonal activities and engagement of the public in this process in discrete ways encourage the public to develop a sense of ownership for their neighborhood parks.

DEVELOP A MAINTENANCE PLAN FOR EVERY PARK AS AN INTEGRAL PART OF THE PARK DESIGN PROCESS. Sometimes, parks are built that cannot be properly maintained with existing resources and budgets. The best way to protect the design intent of a park is to design a park that can be maintained within the allocated budget. New parks must have a maintenance plan and budget. Maintenance plans can be used to substantiate the need for specific maintenance activities and their associated costs.

By using a maintenance plan as a performance benchmark, the M&O staff can track maintenance efforts and costs. Carefully recording maintenance costs on a park by park basis can provide valuable insights on an agency-wide basis when data from multiple parks are reviewed. Planning on a park by park basis can create and fine tune performance benchmarks allowing the agency to track and document the effects of budget cuts, or the benefits of budget increases.

30 Calkin, p. 285.

M.1
OBTAIN MAINTENANCE FUNDING FOR NEW PARKS AND LANDSCAPES

OBJECTIVE

As the park system expands to serve growing neighborhoods, and as new landscape elements are introduced to improve environmental quality, it is important to develop sources of funding to maintain the parks in accordance with maintenance plans. At the same time it is important to develop funding to care for sustainable features and other needed maintenance throughout the system.

BENEFITS

- Parks that are well maintained serve the community better and inspire neighborhood investment.
- Well maintained natural infrastructure has greater environmental benefits.
- Well maintained parks last longer without additional capital investment.
- Skilled zone gardeners and staff can fine tune a landscape and equipment operation protecting the capital investment.
- Park maintenance is an opportunity for entry level people to gain job skills and obtain training in green careers.
- Appropriate concessions can supplement park funding by providing amenities park visitors desire.

CONSIDERATIONS

- Municipal funding of parks operation has to compete with countless other equally pressing budgetary pressures, and will fluctuate with the economy.
- Alternative funding mechanisms such as business improvement districts (BIDs), local development corporations, adjacent land owner payments in lieu of taxes, and land lease payments require a high level of coordination and negotiation with private and nongovernmental entities.
- Private funding is suitable more as a catalyst than as a long term solution for most parks.

BACKGROUND

New parks, facilities, and landscapes, especially green roofs and stormwater management areas, require funding in addition to the Parks Departments existing budget. New parks require maintenance funding immediately in order to care for plants during the establishment period and obtain needed maintenance equipment for startup.

It is important to identify sources of funding in addition to the municipal budget. Maintenance dollars are subject to the city's annual budgetary process and periodic privation due to economic downturns, leaving parks with a backlog of maintenance needs. Moreover, since capital dollars are restricted, it is difficult to plan for and expand maintenance services for new park facilities within the existing budget.

Central Park, Battery Park City, and Bryant Park have raised public expectations and set high standards for the Parks Department to meet. In recent years park operations budgets have been supplemented by alternative funding mechanisms such as business improvement districts, local development corporations, adjacent land owner payments in lieu of taxes, and land lease payments. New waterfront parks cost upwards of $100,000 per acre / per year to maintain. Brooklyn Bridge Park will be funded through payments in lieu of taxes from adjacent properties controlled by a local development corporation. Bryant Park is supported by a business improvement district; Battery Park City is supported from income from adjacent properties.

Parks Department funds are supplemented for many of the more successful parks such as Central Park, Prospect Park, Riverside Park, and Randall's Island through strong nonprofit group support.

All parks benefit from the revenue generated by concessions. Concessions in parks include a variety of types such as hot dog vendors, cafes, tennis bubbles, ice rinks, stables, and marinas. In a report entitled "Making the Most of Our Parks," the Citizens Budget Commission has noted that the Parks Department generated $48 million through the operations of concessions in FY 2006. This amount of money was roughly equal to 20% of the agency's operating budget for that same period. These are crucial dollars for Parks maintenance and help leaven periodic economic downturns.

PLANNING

The surest, most direct way toward improving park maintenance is to increase the Parks & Recreation general operating budget.[31]

SEEK TO INCREASE CURRENT LEVELS OF PARK MAINTENANCE FUNDING, ESPECIALLY FUNDS EARMARKED FOR MAINTENANCE OF NEW PARKS

- Adequate investment in the maintenance of parks ensures that fewer capital dollars will need to be spent on costly replacements in the future.
- Seek city funding for all new park facilities, and for the maintenance of stormwater management systems in parks.
- All new development projects that include parks should have a mechanism for adjacent properties to support the operation of the park.
  - Business Improvement Districts

This park maintenance worker is removing graffiti from a wooden bench. Sanding rather than painting the bench helps preserve its character and extends the longevity of the wood.

- Local Development Corporations
- Property owner payments in lieu of taxes
- Land lease payments
- Obligations for park maintenance support included in zoning changes

INCORPORATE REVENUE GENERATING FACILITIES IN NEW PARKS

When designing new parks and facilities, include park amenities for users that generate revenue to supplement park operations costs.

- It is important not to commercialize the park system, but at the same time providing food and drink or the opportunity for private parties in a park setting is generally appreciated by the public.
- Amenities such as boat and bike rentals make it possible for a wide variety of visitors to enjoy a park.
- Accommodate the needs for event tents in proximity to food concessions to allow catered events that generate revenue.

PREPARE A DATABASE OF THE DEPARTMENT'S CAPITAL AND MAINTENANCE EXPENDITURES AND NEEDS BY PARK

Develop a database of the outstanding capital and maintenance needs by park. Use this to support requests for capital and operations funding.

- Update the database annually.
- Use critical backlog items to assist in the planning of future park capital improvements and annual maintenance appropriations.
- Use the database to determine costs specific to park types or individual features so as to better target design and operational improvements.

CASE STUDIES

There are numerous examples of both governmental and nonprofit groups across the country that advocate for greater fiscal support for parks.

Parks and Trails New York (PTNY) is a nonprofit organization based in Albany whose mission is to lobby for the improvement of New York State parks. In November 2006, PTNY prepared a comprehensive plan for improving the maintenance, funding, and public outreach associated with the State's parks. Many of the ideas contained in the action plan are directly applicable to New York City's Parks & Recreation Department.

FOR FURTHER INFORMATION

- Parks and Trails New York. "Parks at a Turning Point: Restoring and Enhancing New York's State Park System." November 2006. http://www.ptny.org/pdfs/advocacy/State_parks_report.pdf
- The National Parks Service (NPS) has long struggled with estimating and tracking its facility maintenance backlog. In 1984, NPS implemented a maintenance management system design to track the deferred maintenance workload. After sending some $11 million, the effort was abandoned since park managers found that it did not provide them with the information needed to manage their deferred maintenance work load. In 1998, at the urging of Congress, the NPS undertook a new asset management process that, after three years in development, began to be used within the agency as part of a new pilot program. As part of the development process, the NPS implemented the use of MAXIMO™ tracking software. Standards for tracking the condition of the department's facility assets were implemented and NPS began formal cost estimating of their actual backlog. Many of the lessons learned by the NPS and the methods developed to evaluate the state of repair of facilities and estimation of costs to maintain and restore the facilities to functional use can be of great value to Parks in developing a more systemized approach to the documentation of the department's pressing annual maintenance needs.
- United States General Accountability Office. "*Efforts Underway to Address Its Maintenance Backlog.*"Highlights of GAO-03-1177T, a testimony to the Subcommittee on National Parks, Recreation and Public Lands, Committee on Resources, House of Representatives September 2003.GAO-03-1177T. http://www.gao.gov/new.items/d031177t.pdf
- Citizens Budget Commission. *Making the Most of Our Parks*, June 2007. http://www.cbcny.org/final%20draft%20of%20parks%20report%2015.pdf
- Regional Plan Association. On the Verge: Caring for New York City's Emerging Waterfront Parks & Public Spaces. Spring 2007.http://www.rpa.org/pdf/waterfrontparksreport.pdf

31 **Regional Plan Association, On the Verge: Caring for New York City's Emerging Waterfront Parks & Public Space, Spring 2007.**

M.2 PROVIDE MAINTENANCE PLANS FOR NEW PARKS

OBJECTIVE

As an integrated part of the design of new parks, prepare a written and illustrated park maintenance plan for use by the future maintenance and operations staff, emphasizing focus areas and areas that require new or unconventional methods.

BENEFITS

- Collaboration with M&O staff during the design phase encourages learning from past difficulties and allows for realistic input on maintenance plans.
- Identifies the future staffing needs along with costs and equipment associated with the proposed design, allowing for more accurate staff and budget planning.
- Provides a detailed schedule of operations over time, serving as a staffing work plan.
- Can be used to identify the budgets required for equipment and materials.
- Provides a basis for budgeting specialty maintenance and capital replacement.
- Provides a baseline against which to judge the management and performance of the operation.

CONSIDERATIONS

- Management plans must include assumptions about maintenance staff levels and future costs; if staffing availability or costs change, maintenance plans will not be accurate and will require adjustment.
- Conflicts between design intent and maintenance capabilities may occur, however these should be worked out during design as the management plan is being created.
- Management plans should be adaptive to respond to changing conditions at the park. The designer should be contacted when any notable changes occur.

BACKGROUND

Park management plans serve as detailed work plans for future use by park administration and staff. Plans should include clear how-to methods and resource needs, including anticipated maintenance activities identified in the final maintenance budget impact statement projected over the assumed lifecycle for the project.

PRACTICES

PLANNING

DEVELOP A MAINTENANCE PLAN TEMPLATE THAT CAN BE CUSTOMIZED FOR EACH PARK TYPE

- This will aid in the development of consistent maintenance plans by in-house design staff and outside consultants.
- The template should require that the design and construction teams provide:
  - The park's design intent
  - Scaled plan diagrams with area sizes
  - Photos of the park upon completion of the design for comparison purposes for park inspectors; note that parks that use new materials, design approaches or nonstandard approaches require greater documentation so that inspectors and staff understand how the park is supposed to look and function.
- Guidelines that include levels of service descriptions, task descriptions, hourly and cost rates (both in-house and outsourced) that can be regularly reviewed and updated based on citywide trends
- Work sheets for use in the development of hourly and cost estimates

PROVIDE CLEAR DOCUMENTATION OF THE PARK DESIGN FOR FUTURE PLANNING AND EVALUATION

- Documentation should include not just original design documents, but also critical construction records including:
  - Construction drawings and specifications
  - Copies of submittals for materials and systems used as part of the installation
  - As-built drawings including original plan and details with noted modification as well as contractor-prepared shop drawings used in the fabrication or further detailing of items
  - Directory of the names, addresses, phone numbers of design team members, construction supervisors, resident engineers, and contractors
  - Copies of operating manuals
- Provide scalable and editable electronic files of the park plan that can be used for future maintenance planning.
  - Scalable plans serve as critical tools in the delineation and estimating of work activities.
  - Include as-built utilities.

DESIGN

FOR NEW PARKS DEVELOP A PARK MAINTENANCE PLAN IN COLLABORATION WITH M&O SUPERVISORS AND HORTICULTURAL STAFF

The development of a comprehensive park maintenance plan is a multistep, iterative process that must include all relevant participants to be realistic and effective.

- Meet with future maintenance staff during the development of the park plan.
  - Develop common goals and objectives for park

sustainability and maintenance to be incorporated into the design.
- Discuss anticipated levels of service for different areas based on anticipated usage and visibility.
- Discuss design ideas and types of maintenance required.
- Identify standard, nonstandard, and specialized maintenance procedures.
  - Make sure that M&O staff are able to repair items that are susceptible to damage.
- Discuss anticipated staffing and equipment needs.
- Discuss the need for onsite maintenance facilities, staging, and storage areas.
- Identify other agency properties in the immediate area that may have maintenance and operations overlaps that could enable some staffing or resource efficiencies.

- Divide the park into maintenance zones.
  - Use two key criteria for establishing maintenance zones: visibility and levels of use.
  - Determine levels of service for maintenance within these zones based on NRPA guidelines.[32]
  - Develop an accurate, scalable zone diagram on a park plan for use in communicating zone locations and further estimating work and cost requirements.
- Quantify and document the tasks necessary to maintain each zone.
  - Specify work required based on the intended levels of service for a landscape zone.
  - Develop an itemized list of tasks for each zone.
  - For each task within a zone, complete area estimates on an acre, square foot, or per item basis to quantify work requirements.
  - Identify and provide staff training for new procedures. If necessary, train special crews for the maintenance of newer, nonstandard facilities.
- Develop and document standards and specifications for each of the quantified tasks.
  - Use design documents and industry standards to develop standards for work requirements.

DEVELOP ESTIMATED TIME AND COST SCHEDULES BASED ON THE AMOUNT OF WORK REQUIRED FOR THE PARK ON A ZONE BY ZONE BASIS

- Type of maintenance
  - Regular maintenance
  - Horticultural care
  - Capital replacement
- Frequency of service
  - Daily or more frequently
  - Weekly
  - Monthly
  - Seasonally
  - Annually
  - Long term
- Size, type, and skills of crews required to perform the work by categories
  - Volunteer
  - Skilled volunteer
  - Seasonal staff
  - Permanent staff
  - Contractor
  - Other city agency
- Equipment required to perform the tasks
  - Tractor
  - Garbage truck
  - Mower
- Estimate the hours required for each task.
- Estimate staff or contractor costs to complete each task.
  - Some tasks are more cost effective to outsource due to specialized skills or equipment that contractors possess.

MONITOR AND ADJUST PERFORMANCE OF MAINTENANCE PLAN OVER TIME

- Track progress by zone, task, and cost.
- Adjust schedules to the park as facilities and landscaping mature and age or use patterns change.
- If the park is maintained by nonagency staff or organization and there is a maintenance bond in place, require an annual review of the maintenance program to ensure the budget and covering bond grow according to escalating costs. Consider tying bond coverage to the Consumer Price Index.

PUBLISH PARK MAINTENANCE PLANS AND ANNUAL EVALUATIONS TO ENHANCE PUBLIC AWARENESS OF MAINTENANCE ACTIVITIES, COSTS, AND PERFORMANCE

- Make park maintenance plans available on the Parks website.
- Publicize annual park inspections and success ratings against the published plans.
- Provide user feedback forms to enhance maintenance activities.

CASE STUDIES

The Seattle Parks and Recreation department requires a Vegetation Maintenance Plan (VMP). A VMP is written to guide the growth, development, and maintenance of parks and open spaces. Each VMP is designed to bring together the diverse interests at work in a park or open space and inform on direct actions of the organizations that manage it. See further: http://www.seattle.gov/parks/horticulture/vmp.htm

In 2003 San Francisco passed a law that requires the city to provide detailed park maintenance standards, park maintenance plans and schedules and to track performance on a park by park basis. The city has established standards for street, sidewalk, and park maintenance. City agencies engaged in street, park, and sidewalk maintenance are required to publish their schedules on the web. The Controller's Office then conducts annual performance audits of the street, sidewalk, and park maintenance and cleaning operations. By 2008, San Francisco had developed draft Park Management Plans for most of San Francisco's neighborhood parks.

For further information see:

- San Francisco Park Management Plans Overview: http://www.ci.sf.ca.us/site/recpark_page.asp?id=92029

- Typical Park Management Plan for John McLaren Park: http://www.parks.sfgov.org/wcm_recpark/PMPlan/JohnMcLarenPark.pdf
- San Francisco Park Maintenance Standards: http://www.parks.sfgov.org/wcm_recpark/Mowing_Schedule/SFParkMSManual.pdf
- San Francisco Park Maintenance Scores: http://www.ci.sf.ca.us/site/recpark_page.asp?id=37737

FOR FURTHER INFORMATION

- City of Oakland, CA, *Lake Merritt Boating Center Maintenance Plan* http://www.oaklandnet.com/community/Chapter6MaintenancePlan.pdf
- Earth Plan Associates, Inc. "Chapter 4 Park Maintenance" in 2006-2010 Parks and Recreation Master Plan, Auburn Indiana Parks and Recreation Department, 2005.http://www.ci.auburn.in.us/departments/parks&recreation/2006_2010_VisionPlan/4-Maintenance.pdf
- Fickes, Michael. "Six Steps to Grounds Maintenance Master Planning." College Planning & Management, v3 n4 p47-50 Apr 2000. http://www2.peterli.com/cpm/resources/articles/archive.php?article_id=49
- Professional Grounds Management Society, Grounds Maintenance Estimating Guidelines, 7th Edition, Hunt Valley, MD: Professional Grounds Management Society, 1995.

M.3 PARTNER WITH PRIVATE SECTOR AND LOCAL COMMUNITY TO ASSIST WITH MAINTENANCE

OBJECTIVE

Work with community groups, nonprofit groups, business improvement districts (BIDs), private investors, and key stakeholders to enhance and maintain parks.

BENEFITS

- Partnerships leverage the assets of both the public and the private sector while increasing the quality or level of service.
- Partnerships foster support from the local community.
- Procurement is simpler and faster if there are in-place agreements with a private sector or local community group.
- A project can be expedited by grouping multiple responsibilities in a single agreement (such as combined design and construction for smaller repair or replacement of inkind projects).
- Partnerships can bring the agency specialized expertise not otherwise available.
- Partnerships can take advantage of new and emerging trends in the parks and recreation field, providing an opportunity for innovation.
- Partnership agreements provide the ability to incentivize improved performance and upkeep.
- A service or project, if spearheaded by a partnership agreement, can often accelerate implementation and improvements sooner than the agency's resources alone would allow.

CONSIDERATIONS

- Disagreement among various stakeholders may prolong the maintenance planning and implementation process.
- It is difficult to maintain equality of access and services if some city residents and neighborhoods are more able to raise private funds.
- Partnership activities must avoid the perception of privatizing public facilities.
- Partnerships must be within the legal authority of the

32 **More than thirty years ago, the National Recreation and Park Association developed formalized levels of service categories to assist park administrators in the development of groundskeeping protocols based on a park facility's visibility, usage, and intended upkeep. This approach to planning anticipated levels of maintenance has been proven to simplify the cost estimating maintenance efforts. It is also an easy way for both designers and staff to understand how various spaces within parks can be aggregated to similar levels of design and care. See further: Feliciani, Simpson, Gratto, Getz, DeStefano, Morrow, O'Donnell, Spengler, Payne, Fournier, Swartzell. Operational Guidelines for Grounds Management. Ashburn, VA: Published jointly by APPA, National Recreation and Park Association, and Professional Grounds Management Society, 2001.**

agency or they may be subject to city or state review and/or control.

- If a partnership involves leases, the use must be legally allowable and may subject the lessee to specific requirements in accordance with city and State laws.

BACKGROUND

A public private partnership is an agreement between the agency and a private sector or nonprofit entity through which the skills, assets, and resources of the agency and the partner are shared in delivering a service or facility for the use of the general public. Parks currently is very successful with the development of its Partnerships for Parks program. There are 57,000 registered park volunteers and 56 percent of all parks have an affiliated group. In 2007, almost 30,000 people participated in 645 cleanup projects.

At the moment, public private partnerships are the most cost effective way to improve park maintenance funding. Understanding how these partnerships work will allow planners and designers to better access opportunities for new ways of doing business to improve the overall sustainability of park facilities.[33]

PRACTICES

PLANNING

UNDERTAKE A COMMUNITY BASED PLANNING PROCESS

- All parks require community input to assure that park design responds to community needs.
  - Evaluate various improvement options and involve community members in decision making whenever possible.
  - Encourage ongoing community stewardship of improvements.
  - Reach out to the Borough Commissioner and staff and Community District managers and park regional managers; use their knowledge of existing community groups, persistent concerns and maintenance issues.
- For larger or higher profile projects, develop or identify a community coalition to increase longterm and high quality engagement.
  - Identify a cross-section of community stakeholders and establish a task force.
  - Develop strategic goals and a shared vision through a plan that outlines expectations of the partnership project.
  - Maintain active participation throughout the planning and design process.
  - Develop partnerships to manage and maintain improvements.

CONSIDER DEVELOPING A PARK IMPROVEMENT DISTRICT (PID)

The Regional Plan Association has recommended use of Park Improvement Districts especially within waterfront park areas where the cost of maintenance and facility upkeep is especially costly. Park districts could provide direct funding for park improvement development corporations and nonprofit partners.

If PIDs were to have a requirement for developers to design and build parks and then turn them over to the city in exchange for zoning or tax incentives, the district could then be set up to fund the maintenance and upkeep of the new facilities in perpetuity. There may also be possibilities for developments to pay for park maintenance as part of zoning or development approval requirements.

CONSIDER BUSINESS IMPROVEMENT DISTRICT (BID) AS A METHOD TO MAINTAIN FACILITIES

Business improvement districts are one way private groups assist with the maintenance of Parks facilities. New York City is home to the nation's largest, most comprehensive network of BIDs in the country. The City's 64 BIDs annually contribute close to $100 million worth of services in neighborhoods across the five boroughs.[34] The Bryant Park Corporation, for example, maintains Bryant Park. BIDs can provide trash removal, tree watering, sidewalk sweeping and a host of other maintenance efforts for streetscapes, bikeways, and plaza parks adjacent to active business areas.

- Develop a project plan among stakeholders to determine if a PID or BID is appropriate.
- Develop a steering committee.
- Conduct public meetings and hold them regularly to maintain an informed constituency.
- Determine boundary of district.
- Survey local businesses and develop a database.
- Determine needed services and improvements and their scope and cost.
- Identify potential funding sources.
- Determine assessment formula and submit it to NYC Department of Small Business Services (SBS) if required under the PID or BID structure.

ENCOURAGE THE FORMATION OF 501(C) (3) NOT-FOR-PROFIT COMMUNITY PARK GROUPS

The implementation of a new capital improvement can serve as a catalyst for the creation of not-for-profit parks groups. Nonprofits are among the most common public private partnerships and their activities provide a variety of benefits. The Project for Public Spaces has outlined nine key areas where nonprofits are a benefit to parks.

- Fundraising is one of the most common activities in which nonprofit organizations get involved.
  - A nonprofit's ability to dedicate funds directly to a park project is particularly attractive to a city with a big vision but lack of funds to implement.
  - Tax-exempt status provides eligibility for funds from foundations and are thus more attractive to individual donors.
  - Fundraising can serve as a park advocacy tool and raise awareness of the work of the nonprofit organization.
  - Generally centers around three types of park needs:
    - To supplement annual operating budgets
    - To implement capital projects
    - To establish an endowment to ensure ongoing park maintenance, restoration, and management
- Volunteers play an important role in all nonprofit organizations, often significantly, building community stewardship, support, and involvement with the park.

- Nonprofits often organize volunteers to participate in maintenance activities, such as weed removal, trail and path upkeep, and park cleanup days.
- Volunteers also commonly help organize and staff public park events, produce and send newsletters and other organizational mailings, and solicit park donations.
- Volunteers can be valuable assets to the park as trained docents, providers of visitor information, education, and outreach, and park security, as well as collectors of park usership information.

- Serve as advisors on the design, planning and construction of capital projects
  - Nonprofits can get involved in any number of activities related to capital projects.
    - Reviewing projects proposed and developed by the parks department
    - Contracting out design and implementation
    - Providing in-house design and construction of minor maintenance or repair projects
- Outreach and Marketing can build usership, educate the public, encourage stewardship, and create support, whether financial, volunteer, or political, for the park and for park issues.
  - Marketing can be used to create new relationships with other institutions through joint publicity and programming, as well as promoting and increasing public involvement in park issues and development.
  - Typical mechanisms include:
    - Direct mail and newsletters
    - Press coverage
    - Greeter programs
    - High visibility events that help draw attention to specific park needs
    - Meetings with local community groups or institutions such as schools and faith based organizations
- Programming activities are often broad in scope, focusing on environmental issues and education, theater and arts festivals, recreation, after school programs, and summer day camps.
  - Programs should be aimed at a variety of ages, cultural backgrounds, etc.
- Advocacy incorporates a wide range of activities.
  - Putting pressure on the city for increased park funding
  - Preserving historical design, improving basic maintenance, and increasing general park safety
- Remedial maintenance
  - Typically, maintenance work is performed in response to a chronic, but critical need such as replanting, path repair, weeding, and erosion control.
  - A seasonal cleanup day with volunteers is also a typical remedial maintenance function.
  - Reclaim neglected areas of the park, through community gardening or replanting, as well as repairs after storms or floods.
- Routine Maintenance
  - Routine maintenance activities include day-to-day tree and lawn care, litter removal, small repairs and painting.
    - Committing to perform the maintenance reduces the additional burden on the parks department.
- Security
  - The relative safety of a public park is more dependent on its use than on any other single factor.
  - Security measures such as hiring rangers to patrol an area can contribute to an overall strategy for bringing people back into a park.
  - Access, visibility, appearance, and use are all important factors.
  - By working on their main mission of encouraging use of a public park, all groups are involved in promoting security.
  - These activities may take the form of volunteer rangers who function very much like a neighborhood watch patrol or professional security staff, and who are responsible for policing the grounds and enforcing regulations themselves.

CONSIDER PUBLIC PRIVATE PARTNERSHIPS THAT INVOLVE SPECIFIC PARK FACILITIES

- Adopt a Field/Playground/Facility: the partner agrees to maintain or upgrade a specified agency-owned field, playground, or facility and for which Parks may grant naming rights or limited advertisement signage for a period of time.
- Operations and Maintenance: the partner operates and maintains a specified agency-owned facility on behalf of Parks.
- Design-Build-Donate: the agency provides access to the land to a Partner, who fully or partially funds the design and construction of the facility and then donates the facility to the agency.
- Concession Agreement: the agency enters into an agreement with a private partner for the design, construction, and, operation of the facility. For example, this is how Parks has constructed seasonal tennis bubbles that are used during the offseason and returned to public use during the warmer summer months.

CASE STUDIES

There are a number of nonprofit and BIDs around the city. Below is a sampling of organizations that provide active programs to support some of New York's premier parks.

- Bryant Park Corporation (BID). http://www.bryantpark.org/park-management/overview.php
- 34th Street Partnership. http://www.34thstreet.org/partnership/index.php
- Central Park Conservancy. http://www.centralparknyc.org/site/PageNavigator/aboutcon_cpc
- Prospect Park Alliance. http://www.prospectpark.org/support
- Randall's Island Sports Foundation. http://www.risf.org/
- Bronx River Alliance. http://www.bronxriver.org/?pg=content&p=aboutus&m1=1

For a complete listing of BIDs currently registered, see the New York City Department of Small Business Services website at: http://www.nyc.gov/html/sbs/html/neighborhood/bid.shtml

The Parks Department partners with conservancy and advocacy groups that can provide additional levels of maintenance and perform specialized tasks. For instance, the Central Park Conservancy provides staff to maintain the fountains in Central Park.

M.4
EXPAND CAPITAL EXPENDITURES TO INCLUDE CRITICAL PRE-MAINTENANCE COSTS

OBJECTIVE

Expand capital expenditures to include funding for planting establishment, equipment, and training needed to properly complete the construction of new parks and facilities.

BENEFITS

- Ensures funding of planting establishment-period maintenance at appropriate levels to ensure the success of landscape installations.
- Provides necessary equipment needed to maintain completed facilities.
- Provides specific staff training needed to properly operate and maintain the park facility.

CONSIDERATION

- Current city policy prevents the use of capital appropriations for purchasing maintenance equipment, training, and services.
- Typically city contracts are not written to provide for multi-year services after substantial completion of work.

PERFORMANCE GOAL

Require establishment care of newly installed vegetation for a minimum of two growing seasons.

PRACTICES

DESIGN

REQUIRE ESTABLISHMENT PERIOD PLANT CARE

Establishment period care for plantings should be included as part of the plant item in the capital project. Establishment period care is in addition to normal park maintenance. All plantings, regardless of how well they are prepared, moved, and installed, require significant time to recover from transplant shock and adapt to their new site. The period of adjustment is known as the "establishment period."

- Plants require greater attention and maintenance during the establishment period than they do three or more years after installation.

FOR FURTHER INFORMATION

- Garvin, Alexander, Berens, Gayle, and Leinberger, Christopher. Urban Parks and Open Space. Washington, DC: The Urban Land Institute, 1997.
- Garvin, Alexander. Parks, Recreation, and Open Space: A Twenty-first Century Agenda. Chicago, IL: American Planning Association, 2000
- Montgomery County Department of Parks, Montgomery County, MD. New Adopted Policy for Public/Private Partnerships. PowerPoint Presentation, September 19, 2007. http://www.mcparkandplanning.org/team/ppp/documents/adopted_ppp_policy_09192007.pdf
- New York City Department of Transportation. *Street Design Manual*. 2009. http://www.nyc.gov/html/dot/html/about/streetdesignmanual.shtml
- Phillips, Leonard. "Chapter 9 Volunteer Programs" in Parks: Design and Management. New York: McGraw-Hill, 1996, pp 79-86.
- Project for Public Spaces, Inc., Public/Private Partnerships, website visited, October 2008. http://www.pps.org/parks_plazas_squares/info/pubpriv/
- Project for Public Spaces, Inc., Public Parks, Private Partners. New York: Project for Public Spaces, 2000.

33 **City of New York Parks & Recreation Biennial Report for 2006-2007, P.19.**

34 **New York City Department of Small Business Services Web site, Accessed August 25, 2009. http://www.nyc.gov/html/sbs/html**

- Establishment period care requires greater skill levels and training for caretakers, greater time and materials to complete, and therefore is more expensive than standard maintenance as provided by agency staff.
- Establishment is well worth the additional cost. Landscapes, unlike buildings, roads, or sewer systems require time and nurturing before they can be left to regular care.
  - Lack of establishment care is one of the leading causes of poor landscape performance over the long term.
  - Good maintenance during the establishment period almost always decreases maintenance needs in future by establishing strong plants from the start.[35]
  - Planting failures are costly, environmentally wasteful, and are often highly visible to the public.
  - It is difficult to explain how money can be spent to install a landscape, but it cannot be spent to ensure landscape survival.
  - Planning and paying for comprehensive establishment care up front as a necessary part of a project's capital appropriation is a logical and cost effective investment in a project's sustainability.
- The landscape contractor who installed and is warranting the landscape work is already familiar with the plantings; it makes sense for the same contractor to continue on the project to ensure the plants' survival during the establishment period.
  - The contractor is still providing a primary service associated with the installation of the plantings.
  - At a minimum, planting contracts should include complete establishment care services for the first two to three growing seasons after the completion of planting (depending upon the size and types of plants installed), coinciding with the completion of a two year planting warrantee.[36] This may need to be coordinated with the contractual specification requirements typically associated with a two year guarantee.

PURCHASE EQUIPMENT AND FACILITIES NECESSARY TO MAINTAIN THE SITE

Project specifications should include the purchase of equipment such as mowers, security vehicles, and lifts, necessary to maintain the site, especially if the project is a new park facility.

- It is risky to construct a new park facility with no guarantee that the equipment necessary to maintain it properly will be available. Without this equipment, the agency's ability to successfully fulfill its mission to maintain the park for the public benefit is compromised.
- It is equally important to build facilities that support maintenance activities.
  - Maintenance operations need space and access enough to allow for maintenance to be conducted on a regular basis.
  - Maintenance staff need room for onsite equipment and materials storage as well as the staging of staff operations.
  - Onsite buildings allow for efficient deployment of staff and also serve to populate the site during the day, allowing park users to feel safe.

INCLUDE STAFF TRAINING IN CAPITAL PROJECTS

Include staff training in the specification of complicated systems included in capital projects. Understanding new systems is crucial in order to improve long term performance.

- Some of the greatest challenges presented by the development of high performance landscapes are that they often include nonstandard materials or systems that are intended to produce parks that are environmentally more responsible and significantly less costly to maintain over the long term.
- If the existing agency staff is not adequately trained in maintaining nonstandard materials or systems, issues will be encountered as the agency transitions over to higher performance parks.

FOR FURTHER INFORMATION

Thompson, J. William, Sorvig, Kim and Farnsworth, Craig D. Sustainable Landscape Construction: A Guide to Green Building Outdoors. Washington, D.C.: Timber Press, 2001.

35 **Thompson, William and Sorvig, Kim. Sustainable Landscape Construction: A Guide to Green Building Outdoors. Washington, D.C.: Timber Press, 2000, p. 128.**

36 **Thompson & Sorvig, p. 128.**

M.5 IMPLEMENT A PUBLIC INFORMATION AND EDUCATION PROGRAM AS PART OF MAINTENANCE & OPERATIONS

OBJECTIVE

Develop and implement a public information and education program for each project to raise awareness of the park and the sustainable practices used in maintenance operations.

BENEFITS

- Increases public awareness of ongoing maintenance and improvement initiatives within parks.
- Provides information about the importance and benefits of park facilities to the local neighborhood.
- Explains the maintenance process and the annual schedule of work, avoiding the perception that park is not being tended, especially when there are meadows and other naturalized areas.

CONSIDERATIONS

- Adds cost to maintenance operations.
- Community participation with maintenance activities requires coordination.

BACKGROUND

Community members often have mixed responses to naturalized areas and new park maintenance operations. Some feel there is not enough being done, while others complain if some areas of a park are closed off to allow for maintenance operations such as lawn aeration, tree pruning, or pavement resurfacing. An effective education program can be used to improve understanding of the needs of a park. When a park has an especially beneficial environmental impact on a neighborhood, it is important to explain the value of sustainability goals. It has long been understood that a pubic that is educated about the values of its open spaces will be more invested in its long term success.

Maintenance is often poorly understood by communities. The public usually wants to know what is going on, or why it's taking so long. For example, they may want to know why sod fields cannot be used after especially heavy rains, why trees have to be removed, or why work needs to take place during peak use periods. An education program also helps publicize the ongoing activities, budgetary constraints, or opportunities for fundraising or volunteering.

PRACTICES

PLANNING

DEVELOP AN INFORMATIONAL SIGNAGE PROGRAM

- Use signs with plan or perspective illustrations of the park features and how they function as well as how maintenance practices promote facility sustainability. This will help the public to visualize the operations and the benefits.
  - If possible, enumerate some of the benefits to the community such as how many gallons of water from spray shower fountains are recirculated or used for landscape irrigation.
  - Describe and explain the nontoxic chemicals that are used.
  - Identify the maintenance budget and funding sources so people see the extent of investment in the local community.
  - Use a dynamic timeline that is updated periodically on signs throughout the seasons.
    - Show work progress by phase or by areas completed.
    - Highlight key sustainable activities such as turf aeration and topdressing, composting, or replacement of worn park furnishings with more sustainable products so people can see sustainable practices in action.
    - Explain actions that may not be obvious, such as tree removal due to disease or decline (and that the trees will be replaced in a subsequent season).
  - Provide phone numbers, websites, or locations where people can get more detailed information on materials or specific practices that can be incorporated into daily routines such as recycling, composting, or insect management.

INITIATE COMMUNITY OUTREACH

Community outreach initiatives can take a number of forms including:

- Flyers: pamphlets outlining the cyclical maintenance operations, budget, timeline, and photos of maintenance work in process
  - Flyers can be made available at local schools, community centers, libraries, houses of worship, and other neighborhood gathering areas.
- Websites: project web sites are an inexpensive way to provide dynamic updates about construction progress
  - A web site can provide links to periodically updated site photos or even time lapse webcams showing seasonal changes in the park.
  - A web site can also serve as a cost effective way to

During neighborhood tree plantings, *PlaNYC*'s Million Tree program distributes information to local residents about how they can help care for their new trees.

provide background information on a site's history and environmental context.

- Community meetings: key staff can periodically speak at gatherings
  - Provide updates on the condition of the park, types of plants in bloom, or animals that may be active.
  - Discuss ongoing maintenance improvements, review schedules, and answer questions.
- Community service days: days where citizens can assist with seasonal maintenance activities such as leaf raking, mulching or annual plantings
  - Coordinate service days with additional recreational programs for children and adults of all ages as a way of activating the park and reminding the public of its resources.
- Conduct site tours: periodic site visits by local members is a good way of maintaining interest and enthusiasm about park facilities
  - Site tour attendees effectively become ambassadors for the community and often can speak about ongoing operations in a less technical way.

M.6 INTEGRATE MAINTENANCE & OPERATIONS STAFF TRAINING INTO THE CONSTRUCTION PROCESS

OBJECTIVE

Specify the training of key maintenance and operations personnel as part of the construction work for projects where new technologies or elements require training. Ensure that staff understand how these features are constructed, operated, and maintained.

BENEFITS

- Allows staff to become familiar with the facility as it is being constructed, facilitating a detailed understanding of how the project was conceived and built.
- Allows staff to understand locations and types of systems used, fostering a greater understanding of maintenance and repair requirements.
- Allows staff adequate time to learn system programming and operations and discuss setup requirements with installing contractors.
- Allows staff to develop a working relationship with contractors or subcontractors who may be used in the future for repairs or expansion of facilities.

CONSIDERATIONS

- Maintenance staff is frequently traveling and seasonal, making it difficult to tie crews to specific park facilities that require specialized training.
- Requires identification of permanent maintenance and operations staff prior to the completion of the facility.
- The investment in staff training is lost when staff members transfer to other facilities or retire.

INTEGRATION

- *M.7 Use Biointensive Integrated Pest Management to Promote Landscape Health*

BACKGROUND

Integrate maintenance and operations staff education into construction processes to better transfer knowledge of utilities, material assemblies, equipment, and systems to staff responsible for future maintenance.

PRACTICES

INVOLVE MAINTENANCE STAFF IN APPROPRIATE CONSTRUCTION AND SITE MEETINGS TO FOSTER UNDERSTANDING OF THE CONTRACTOR'S WORK AS IT IS BEING INSTALLED

- Attendance at site meetings allows staff to see how materials and systems are installed, and to learn contractor techniques for installation and repairs.
- Detailed understanding of construction allows future staff to better follow the layout of the systems and therefore know where elements are located.
- Review of shop drawings allows future staff to participate in decision making about contractor deviations from the original design.

REQUIRE CONTRACTOR OR APPROPRIATE SPECIALIST TO CONDUCT EQUIPMENT DEMONSTRATION, COMMISSIONING, AND TRAINING FOR M&O STAFF UPON COMPLETION OF THE PROJECT

- Include an adequate number of followup sessions where the contractor will be required to provide operation training as well as review staff use and adjustment of systems.
  - For computerized control systems or other specialty items, require the contractor to include an allowance for factory trained representatives of the manufacturer to conduct training and commissioning sessions.
  - For irrigation systems, pools, and other systems that require winterization, require the contractor to return to the site in the late fall to complete winterization training and demonstration for the staff and again in the following spring to assist with startup procedures.
- Include horticultural staff in plant selection, installation and establishment.
  - Encourage future horticultural staff representatives to attend plant tagging trips to understand designer and contractor criteria for plant selection to allow them to be able to replace plants in the future with a greater understanding of the original design intent.
  - For specialty plantings such as meadows, green roofs, or wetland plantings, the design consultant, in-house horticultural staff, or specialty contractor should demonstrate installation techniques and train future maintenance staff on how to make future repairs and replacements.
  - For specialized soil installations such as structural soil, sand-based athletic fields, or green roofs, the design consultant, inhouse horticultural staff, or specialty contractor should demonstrate component mixing, soil layering, under drain system installation, and settlement procedures to train future maintenance staff how to make repairs.
  - For vegetated stormwater management and permanent erosion control systems, the designer, Natural Resources Group staff or ecological consultant should demonstrate construction techniques and train future maintenance staff how to make repairs and adjustments.
  - The contractor should train future staff in plant establishment period maintenance requirements and techniques.

INCLUDE OPERATIONS PERSONNEL IN PUNCH LIST AND USE INSPECTIONS

- Use this as an opportunity to confirm installations are complete and proper, and to confirm staff understanding of the elements.
- Training associated with handover should be scheduled after the punch list session so that adequate time and attention can be paid to the training.

PERFORM A POST OPENING INSPECTION WITH MAINTENANCE PERSONNEL

- Visit the site one month after operation commences to confirm all systems and equipment are working as intended.
- Confirm the operations personnel are familiar with the systems and equipment.

DOCUMENT INSTALLATIONS AND COPY MANUALS

Require construction residents to photograph installations, such as buried valves, so that locations of pipes and valves will be available for future reference. Key the photographs to as built drawings with GPS location references.

- Require the contractor to provide multiple copies of instruction manuals.

M.7 USE BIOINTENSIVE INTEGRATED PEST MANAGEMENT TO PROMOTE LANDSCAPE HEALTH

OBJECTIVE

Include biointensive integrated pest management (IPM) techniques in a maintenance regime to control disease, pests, and invasive plants and manage beneficial organisms in an ecological context.

BENEFITS

- Significantly reduces human health hazards.
- Significantly reduces the use of toxic chemicals that pollute soil, air and water supply.
- Maintains quality habitats for fauna.
- Reduces cost of hazardous waste disposal.
- Reduces cost of chemicals, pesticides, and fertilizers.

CONSIDERATIONS

- Requires close and frequent monitoring of landscape after installation, which can be costly and time consuming.
- Requires education of owner, contractor, and public to understand the process and accept unconventional landscape aesthetics.
- Requires a shift in expectations from public and park maintenance review/evaluation staff.
- Requires training of landscape contractors.

INTEGRATION

- *V.1 Protect Existing Vegetation*
- *V.6 Use an Ecological Approach to Planting Design*

BACKGROUND

Biointensive integrated pest management is a systems approach to pest management based on an understanding of pest ecology. It begins with steps to accurately diagnose the nature and source of pest problems, and then relies on a range of preventive tactics and biological controls to keep pest populations within acceptable limits. Reduced risk pesticides are used if other tactics have not been effective as a last resort, and with care to minimize risks. The primary goal of biointensive IPM is to provide guidelines and options for the effective management of pests and beneficial organisms in an ecological context. The flexibility and environmental compatibility of a biointensive IPM strategy make it useful for public landscapes.

PRACTICES

DESIGN

SPECIFY THE PROPER PLANT FOR THE LOCATION

- Plants that are properly situated in terms of sun/shade exposure, wind resistance, and soil type tend to thrive. Poorly situated plants tend to be stressed and are therefore more susceptible to disease and pest infestation.
- Select plants that are bred for vigorous growth and resistance to disease and pests.
- Rely on locally grown native or naturalized species that are well adapted to the climate. These plants will be accustomed to local cycles of drought, disease, and natural predators.

SPECIFY PLANTS FROM DIVERSITY OF APPROPRIATE SPECIES, GENUS, AND FAMILIES

- Diseases and pests tend to follow the taxonomic categories of host plants at the species, section, series, genus, or family levels. By avoiding monocultural or taxonomic class dominance, there is a better chance that infestation and disease will not be as widespread and devastating. Specifying a more complex, varied planting palate makes the visual impacts of disease and predators less obvious and objectionable.
- Consider soil erosion and desire lines when designing site, projected impact of community use, and maintenance needs.
- Include compost and mulch in the design.

CONSTRUCTION

- Protect planted areas from degradation by construction activities.
  - See *V.1 Protect Existing Vegetation*
- Use healthy planting practices.
  - See *V.6 Use an Ecological Approach to Planting Design*
- Remove invasives.

MAINTENANCE

PLAN CULTURAL PRACTICES (WATERING, MULCHING, PRUNING, ETC) TO MINIMIZE PESTS

- Use compost appropriately to maintain healthy and active soil biology.
  - See *S.4 Use Compost*
- Develop an Invasives Management Plan
  - See *V.2 Manage Invasive Species*

TRAIN STAFF TO IDENTIFY PEST (WEED, INSECT, ETC.) LIFE CYCLES AND WHEN TO IMPLEMENT APPROPRIATE INTERVENTIONS

- Parks' horticultural staff is generally aware, as training is available on many of these topics; inform staff when site specific conditions and plans are unusual or innovative.

- Identify and understand the biology of the plants and key pests involved; recognize the damage that pests inflict and propose appropriate control measures.
- Timing and knowledge of control measures are the keys to successful IPM.
- Develop a monitoring program that includes keeping a record of inspections.

SET REALISTIC ACTION THRESHOLDS THAT TOLERATE SOME DAMAGE

- Establish thresholds of acceptable levels of damage for each landscape type based on aesthetic appearance and pest species. Educate the client, users and public.

SELECT APPROPRIATE METHODS FOR CONTROL

- When pests exceed threshold, hierarchically apply, from least intensive to most intensive, a controlled method with the least nontarget impact. Try cultural, physical, or biological methods first. As a last resort, use spot applications of least toxic chemical.
    - Cultural: control measures based on using best maintenance practices including pruning, sanitation, cultivation, mulching, nutrient management
    - Physical: prune out or remove dead or diseased plants, utilize physical barriers or other means to prevent spread of pests or diseases
    - Biological: control measures based on using natural enemies or beneficial organisms
    - Genetic: control measures based on a plant's or soil fauna's ability to ward off diseases and pests
    - Chemical: nontoxic, nonresidual chemicals or alternatives such as soaps, oils, and bacterial preparations, including spot treatment of regulated pesticide or herbicide products where required
- Only treat when the pest is most vulnerable and its natural enemies are in their least susceptible life stage.
    - Whenever possible, employ methods that preserve, complement, and augment the biological dynamics of the local ecosystem.

MONITORING

- Monitor plants monthly to check for vigor, structure, safety, and the presence of diseases and pests as well as beneficial organisms.
- Keep records of IPM procedures to assist in ongoing proactive management decision.
- Monitor and control invasive species encroachment.

REGULATORY ISSUES

- Comply with city, state and federal codes regarding types, use, application and disposal of chemical controls.

CASE STUDIES

Battery Park City Parks Conservancy (BPCPC) has developed an organic based landscape management program that entails seven targeted approaches that are simultaneously implemented.

SOIL MANAGEMENT

- There are many growing environments in Battery Park City's 30 acres of parks — woodland, coastal, turf, shrub, and flower borders.
- Over the years, BPCPC has worked with various soil scientists and landscape architects to develop a variety of soil mixes to meet the needs of each environment.
- All of the soils in use at Battery Park City are engineered, manufactured soil mixes.

COMPOSTING

- The staff, as part of ongoing refinement of the soils management program, has developed an onsite composting program.
    - Staff adjust the ingredients in the compost products to achieve a balanced biology for each soil type.
    - Leaves and wood chips yield fungal dominant (woody) compost, which is good for trees and shrubs.
    - Annuals and perennials yield bacterially dominant (green) compost, which is good for lawns and flower borders.
    - As part of the annual maintenance program, planting beds and lawn areas are amended and topdressed with specific compost types based on the specific planting community.
    - The compost in the soils provides a growth medium for bacteria, fungi, and mycorrhizae, which enable plants to metabolize beneficial nutrients specific to their plant type.
    - BPCPC also produces a variety of compost teas (compost rendered in liquid form with the addition of biological amendments) and applies them to lawns and plants.

PLANT AND SITE SELECTION

- BPCPC horticulturists consider available sunlight, watering needs, and wind and salt conditions in determining the proper plants for the microclimates of specific site locations.
    - For example, annuals and perennials are located not only to be compatible with their environment but are also grouped according to similar sun and water requirements.

PEST AND DISEASE CONTROL

- BPCPC monitors plantings for pest and disease infestations.
- The BPCPC staff consider the offending organism's life cycle and habitat in the diagnosis and analysis of pests and disease and uses the analysis to develop a course of action.
- BPCPC has successfully managed pest and disease cycles with releases of beneficial insects (e.g., ladybugs, pirate bugs, lacewings, nematodes, and trichogramma or microscopic wasps) and limited applications of horticultural oils and soaps.

IRRIGATION MANAGEMENT

- BPCPC minimizes water evaporation by using inground drip systems wherever possible.
- Compost aids moisture retention in the root zone, playing an important role in water conservation.

PLANTING PRACTICES

- For their numerous installation projects, completed either by in-house staff or by consultants, BPCPC staff horticulturists carefully select plants at nursery sources.
- The staff also closely supervise planting installations to ensure the proper depth (planting too deep can lead to premature plant death), correct planting bed soils preparation and management, and the proper preparation and handling of rootballs as plantings are installed.

PRUNING TECHNIQUES

- The staff is trained to ensure that plants are pruned in a way that encourages natural growth patterns and maintains correct plant structure.

FOR FURTHER INFORMATION

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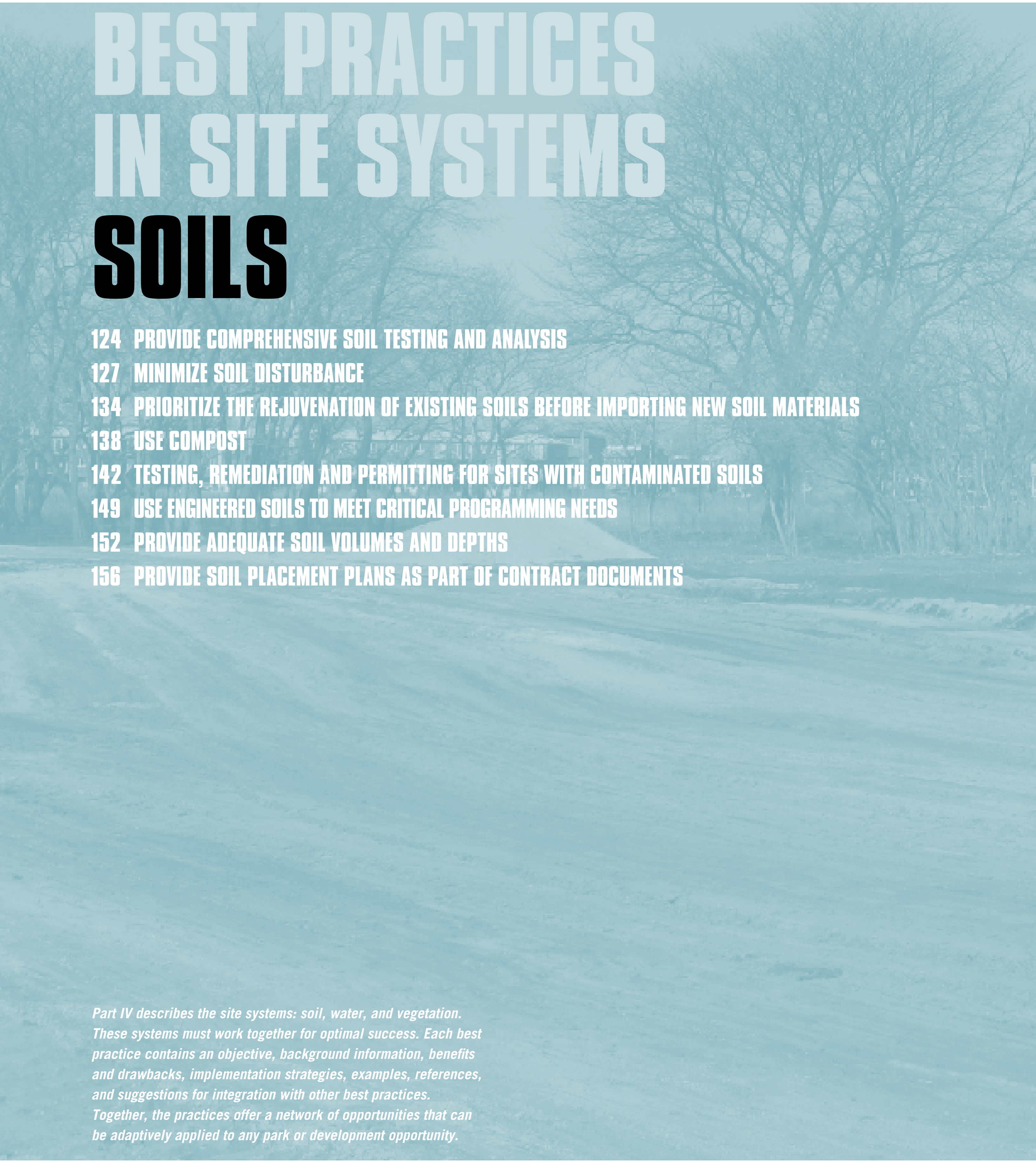
PART IV:



BEST PRACTICES IN SITE SYSTEMS

SOILS

Part IV describes the site systems: soil, water, and vegetation. These systems must work together for optimal success. Each best practice contains an objective, background information, benefits and drawbacks, implementation strategies, examples, references, and suggestions for integration with other best practices. Together, the practices offer a network of opportunities that can be adaptively applied to any park or development opportunity.

INTRODUCTION

Soil is an important but often undervalued component of our urban park infrastructure. Healthy soils have an incredible capacity to capture and clean water, transform pollutants, make nutrients available, and sequester carbon.

Healthy soils are the foundation upon which sustainable parks are built. If soils are not prioritized as a critical resource worthy of care during design, construction, and maintenance cycles, parallel efforts to enhance the vegetative and water ecologies will be compromised.

The Sustainable Sites Initiative has developed an outline of the critical ecological functions of soil systems.[37]

SUPPORT FOR VEGETATION. Soils provide a base to support vegetation by providing rooting area, water storage, and nutrition for growth. Healthy soil also suppresses many plant diseases, and reduces the costs of caring for turf and landscape plantings.

REGULATION OF WATER SUPPLY. Healthy soils allow rainwater to infiltrate, reducing excess runoff, erosion, sedimentation, and flooding. Soils also cleanse and store rainwater, recharge groundwater, and moderate the delivery of water to plants.

TREATMENT AND FILTRATION OF WATER POLLUTANTS. Water and air pollutants are removed or transformed into less harmful materials in the soil. Soil particles and organic matter can filter out pollutants by attracting and holding chemicals and suspended solids. In addition, soil provides habitat for microbes that break down pollutants into more benign substances.

SUPPORT FOR NUTRIENT CYCLING. Soil and its microorganisms play a major role in nutrient cycling, including the carbon and nitrogen cycles. Much of the earth's nitrogen exists in rock, sediment, and soils. The nitrogen cycle depends on soil biota to convert nitrogen in the atmosphere into usable forms in the soil and return nitrogen back to the atmosphere.

SEQUESTRATION OF CARBON. The pool of organic carbon in the soil is approximately twice as large as that of the atmosphere. Soils can contain as much or more carbon than the vegetation they support. Soil carbon storage can help offset release of carbon dioxide, a major greenhouse gas that contributes to global climate change.

PROVISION OF BIOLOGICAL HABITATS. Soils are habitat for such organisms as plants, worms, insects, arthropods, bacteria, fungi, protozoa, and nematodes. The soil food web is responsible for decomposing organic matter, storing and cycling nutrients, maintaining soil structure and stability, and converting or attenuating pollutants. Soils also support healthy vegetation, which supports life above ground.[38]

KEY PRINCIPLES

SOILS ARE FRAGILE NATURAL SYSTEMS. Soils are not inert; they are a dynamic latticework of sand, silt, clay organic matter, air, water, and microorganisms. If handled improperly, a soil's ability to support life is greatly compromised and extremely difficult to restore. Compaction, excessive handling, contamination, and erosion all need to be controlled throughout the construction process in order to ensure a soil environment that will be able to support water quality and vegetative communities over the long term.

GOOD SOIL PRACTICES REQUIRE COMPREHENSIVE STANDARDS, VIGILANCE AND EXPERTISE. Ensuring soil quality on every project and in every park will be challenging but will produce substantial benefits. Soil conditions should be analytically tested and characterized prior to starting design. During design, proposed in situ amendment or new soils practices should be carefully controlled by specification and testing to ensure that the proper texture, organic matter, pH, soluble salts and other parameters are appropriate.

DESIGN PARAMETERS NEED TO BE ENFORCED DURING CONSTRUCTION. Parks staff need to develop a broad range of expertise to be able to direct a variety of soil testing procedures, interpret the results, and develop targeted responses to individual site needs. Designers can consult with the Natural Resources Group, and should also expect to rely on outside soil consultants and testing labs until such time the agency can fund trained dedicated in-house staff soils expertise. Multiple testing laboratory vendors will be required to provide an appropriate range of testing and consulting services to ensure soil material and installation quality. No project should be deemed too small to afford good soil practices.

THERE IS NO SUCH THING AS A ONE SIZE FITS ALL SOIL. A wide variety of soil types is needed in today's diverse range of parks. Soils must provide the appropriate planting medium for the proposed landscape. Soils need to be matched to stormwater design objectives and the anticipated levels of use and compaction. The soil characteristics required by the proposed park programming must be addressed as an integral part of the design process. In order to support goals for plantings and stormwater management over the long term, existing soils must be paired with programming that can realistically be accommodated. Otherwise, soils need to be modified or replaced to meet the specific needs they are intended to support.[39]

37 Hanks, Dallas and Lewandowski, Ann "Protecting Urban Soil Quality: Examples for Landscape Codes and Specifications." December 2003. p. 1. http://soils.usda.gov/sqi/management/files/protect_urban_sq.pdf

38 The Sustainable Sites Initiative,™ Standards & Guidelines: Preliminary Report. November 1, 2007, p. 9.

39 Craul, Phillip and Craul, Timothy. Soil Design Protocols for Landscape Architects and Contractors. Hoboken, NJ: John Wiley & Sons, Inc., 2006, p. 29.

S.1 PROVIDE COMPREHENSIVE SOIL TESTING AND ANALYSIS

OBJECTIVE

Ensure a thorough understanding of the soil quality, contamination, percolation, and bearing capacity early in the design process. Design soil protection with a high degree of technical expertise; monitor construction to ensure proper practices are followed and proper soils are installed. Where appropriate, make it standard practice to obtain soil testing and analysis and the services of a soil scientist.

BENEFITS

- Provides critical information that can guide the design, construction and longterm maintenance of a park project.
- Provides early warning of site contamination, percolation rates, and bearing capacity in order to drive design decisions.
- Ensures success of landscape and minimizes the need for future chemical intervention for fertility, pest, and disease management.
- Identifies fragile soils prior to the start of the design process and enables the design team to set limits on use of heavy equipment and soil disturbance areas.
- Identifies potential design and construction risks including slope failure, erosion and sedimentation, and the need to protect adjacent water bodies.
- Enables soils to fulfill critical onsite stormwater management functions.
- Provides clarity in the permitting process.
- Minimizes environmental impacts and costs associated with removing contaminated soils, and introducing imported topsoil or fill.
- Informs cost estimation associated with soil remediation, amendments, importation, excavation, and drainage improvements.
- Aids in determining the appropriate plantings for revegetation.
- Reduces use of unnecessary soil amendments or topsoil importing.
- Maximizes the potential for soil reuse onsite.
- Identifies costs and requirements for soil disposal, if necessary.
- Quantitatively verifies contractor compliance with project requirements.
- Assists maintenance staff with monitoring planting and stormwater design features post construction.
- Improves soil procurement and installation practices by providing greater level of specificity.

CONSIDERATIONS

- Budgeting the cost of soil analysis during the design phase will be required, as well as the on call services of a soil scientist.
- Park's Capital Projects' Environmental Control Unit can provide assistance for some soil testing and analysis.
- Soil testing for horticultural and stormwater BMP soils typically requires specialized consultant and lab expertise. This may limit the number of entities that can provide qualified services.

INTEGRATION

- *S.3 Prioritize the Rejuvenation of Existing Soils before Importing New Materials*
- *S.5 Testing, Remediation and Permitting for Sites with Contaminated Soils*
- *S.6 Use Engineered Soils to Meet Critical Programming Needs*

BACKGROUND

Geotechnical and analytical soil testing is indispensible to the high performance design process. While an educated designer can glean a great deal of useful information from looking at and touching a soil, it is not possible to determine accurately by eye or feel if an existing soil is safe, how it can be manipulated to ensure longterm success, if the soil delivered to a site is correct, or if it has been properly installed.

Comprehensive soil testing and analysis forms the fundamental basis for the evaluation of existing soil conditions and lays the foundations for the proposed soil, vegetation and onsite stormwater management strategies, allowing for a holistic, ecologically based approach to site design.

Testing should not be a onetime event at the start of a project. It can be used in a variety of ways and at a number of different stages during the design and construction process, as determined by the needs of the site.

- During the site analysis and assessment phase to:
    - Understand existing site conditions and to determine appropriate amendment procedures for reuse of soil if possible.
    - Determine if there are any contamination hazards within existing soils.
    - Determine if there are opportunities for onsite stormwater management.
- During site design phase as required to:
    - Source recommended soil component materials if engineered soils are to be used.
    - Develop mixes and/or amendments for use onsite.
    - Determine the appropriate plant species for installation onsite based on chemical tolerance.
    - Select compatible planting material.
    - Locate onsite stormwater management facilities.

- □ Determine percolation rate.
- □ Determine bearing capacity.

- During construction to:
  - □ Verify acceptable material sources during a contractor's or the agency's procurement process.
  - □ Verify that material delivered to the site is acceptable and complies with specifications.
  - □ Confirm that the final soil installation complies with the construction documents.
- During postconstruction periods to:
  - □ Verify soils are continuing to perform as designed.
  - □ Assist managers in determining the need for supple mental soil nutrients to ensure planting vigor.
  - □ Monitor soil conditions including compaction levels, and infiltration and percolation rates.

PRACTICES

DESIGN

PROVIDE AN ALLOWANCE FOR SOIL TESTING ON EACH PROJECT SEPARATE FROM AND IN ADDITION TO TYPICAL DESIGN BUDGETS

Without accounting for the cost and time required for accurately testing and analyzing soils separately and upfront, this additional cost may be disregarded and eliminated from a project.

ENGAGE A SOIL SCIENTIST

Understanding soil quality requires more than collecting soil samples and sending them to a lab for analysis. A soil scientist working as part of the design team can be useful in several ways beyond the interpretation of test results.

- Provide onsite observations: a soil scientist can provide invaluable insights about existing soil qualities based onsite observations about drainage patterns, condition of existing vegetation, or absence of types of vegetation.
- Optimize onsite resources: a soil scientist can direct the development of site program and physical design that optimizes the use of existing soil resources through careful preservation or reuse.
- Develop soil reuse plans for contaminated sites: there are significant opportunities during the investigation and remediation planning for maximizing soil reuse, thus minimizing importation of soil. Scoping of the remedial investigation should include a soil scientist. Once contaminant results are obtained that delineate contaminated areas (in three dimensions), the soil scientist can optimize the cut and fill required for the project.
- Develop soil specifications: a soil scientist can develop soil specifications aimed at rejuvenating existing site soils or controlling the quality of new soils imported to the site either for mixing with onsite soils or to provide entirely new soil profiles.
- Determine cost effectiveness: a soil scientist can make a critical early determination if there are sufficient soil resources on the site for reuse or if, given the site program, it will be more cost effective and time efficient to import new soils.

CONDUCT SOIL TESTING AS DETERMINED BY SITE RATHER THAN A GENERIC LIST OF STANDARD TESTING PROTOCOLS

- Employ qualified soil professionals as an integral part of the project design team to develop a site specific testing program.
- Specific testing protocols should be developed on a project by project basis by the design team soil professionals, based on a site's unique history and the proposed site program.
- Identify the types of tests, testing locations and labs qualified to complete the testing procedures.
- Discuss soil testing needs with the Natural Resources Group to help lower costs by identifying local soil experts such as those at the Natural Resources Conservation Service or the NYC Soil and Water Conservation District.

CREATE A COMPREHENSIVE SOILS ASSESSMENT REPORT

- See *Part 2: Site Assessment: Soils Assessment Practices*

USE THE COMPREHENSIVE SOILS ASSESSMENT REPORT

The soils assessment report serves as an aid in the following design tasks:

- Determination of suitability of soils for planting
- Selection of plant material
- Selection of soil amendments to produce viable growing medium
- Identification of construction protection zones
- Hydrologic and hydraulic analysis
- Design of stormwater management BMPs
- Selection of an in situ soil remediation strategy
- Design of contamination remediation, soil removal, and soil cover

CONSIDER THE NEED FOR ADDITIONAL TESTING

As the design process continues, it may be necessary to provide additional testing to more specifically design components such as onsite stormwater facilities and building structures.

- Additional tests may include:
  - □ Hazardous contamination percolation or infiltration tests
  - □ Groundwater depths
  - □ Bedrock depths
  - □ Soil bearing capacity
  - □ More detailed soil borings
- Additional tests may be required if material is to be presourced, or if actual mix designs need to be determined in advance of bidding.

USE THE SOIL PROFESSIONALS ON THE DESIGN TEAM TO DEVELOP COMPREHENSIVE SOIL SPECIFICATIONS

- Once the design is near final, specifications can include required testing protocols and frequencies during procurement of materials and onsite construction.
- The extent and frequency of testing will vary depending upon the size and complexity of the proposed site work.

CONSTRUCTION

Testing during the construction phase is critical to ensure that the proper materials are used and installed correctly.

- **Bidding:** Requiring contactors to submit proposed soil supplier test reports is a good way to evaluate the thoroughness of a contractor's bid.
  - Too often contractors simply price their work based on past experience or current market conditions without carefully reading the project specifications.
  - Contractors can easily underestimate a project and, if awarded the contract, can have great difficulty completing the work, leading to delays and complications.
  - The inability of a contractor to demonstrate that they have adequately researched the needs of the project should be a sign of bigger problems in the quality of their bid.
- **Procurement:** Procurement testing is a standard part of construction contracts and should be included in product submittals.
- **Delivery:** All soil materials should be spot tested upon delivery to the construction site before they are installed to ensure compliance with the contract documents.
  - Note that on sites regulated by the NYSDEC, there are testing methods and protocols that should be referenced in the project specifications. All imported soils should be certified clean and delivered onsite with proper documentation.
  - Testing ensures that problems are revealed before materials are placed.
  - Testing of materials such as compost is critical as improperly aged compost can be toxic to plantings.
  - See further *S.4 Use Compost*
  - The sooner a material is tested when it comes onsite, the sooner a contractor can remove and replace non-conforming materials, minimizing construction delays.
- **Installation:** Testing during installation ensures that problems are revealed and corrected before subsequent materials are place over, adjacent to, or in the soil, causing further delays and costs associated with the soil removal and replacement.

  Testing is especially important for stormwater management elements; key testing windows during construction including after completion of rough grading.
  - Inspect subsoil and subgrade areas to ensure they are free of debris or other contaminants.
  - Test for proper penetrability, drainage, and especially subgrade compaction as required by the specifications.
  - During topsoil placement:
    - Inspect soil placement procedures to ensure proper material depths, layering, and transitioning as described in the specifications and shown on the drawings.
    - Test for proper compaction and penetrability.
  - After topsoil placement:

    (1) Test topsoil before planting.

    (2) Amend topsoil as required to correct for organic, nutrient and pH deficiencies.

PLANTING AND STORMWATER MANAGEMENT SOILS

There are a variety of soil tests that provide useful information in the design of planting soils and soils for stormwater management. The specific types of tests required for planting and stormwater management are indicated in Part 2: Site Assessment Practices. At a minimum, new soils should be tested for the following:

- Texture (particle size distribution)
- Organic content
- Reaction (pH)
- Nutrient content (including nitrate, ammonium, phosphorous, potassium, calcium, magnesium, iron, manganese, zinc and copper)
- Soluble salt content
- In-place bulk density
- In-place infiltration

POSTINSTALLATION TESTS

During and after construction the following tests are useful in determining contractor compliance with the design specifications:

- Infiltration
- In situ density
- Percolation or permeability

MAINTENANCE

TEST SOILS ON A REGULAR BASIS TO MONITOR LANDSCAPE PERFORMANCE

Once a project is complete, regular testing should be used to ensure that soils are healthy and functioning properly. Testing allows maintenance crews to apply fertilizers and other amendments at specific levels providing a number of important benefits:

- Provide the nutrients needed for vigorous and health plant growth.
- Buffer plant material from disease and insect predation.
- Minimize runoff or leaching of excess fertilizers into adjacent water systems.
- Minimize excessive plant growth due to over fertilizing.
- Reduction of costs associated with needless or excessive fertilizer and amendment applications

Regular testing of stormwater management soils is also critical to ensure proper infiltration and percolation, as it can determine:

- If soils have become compacted, or are becoming clogged with silt and debris, requiring cleanout or other rejuvenation
- If soil biology is properly balanced to allow for proper nutrient and pollutant absorption and breakdown

The generalized list below identifies some of the more common testing that is used in the assessment of soil during park operation.

- Lawn areas and Planting Beds: Test every two to three years to ensure proper pH and nutrients.
- Sports fields: Due to higher use levels, test annually for pH, nutrients, compaction, and Gmax (rating of impact force for player safety).
- Sand based manufactured soils: Sand based soils, due to their low clay content, do not hold nutrients as well as loam based soils, therefore they require a higher degree of monitoring.
- In the first few years after the completion of construction,

test at least twice per year for proper pH and nutrients.
- Once the soil appears to have stabilized, test for pH and nutrients annually.
- Recommended ranges for test results can be found within the individual BMP descriptions.

SEE FURTHER

- Craul, Phillip and Craul, Timothy. Soil Design Protocols for Landscape Architects and Contractors. Hoboken, NJ: John Wiley & Sons, Inc., 2006.
- Craul, Phillip. Urban Soils: Applications and Practices. New York: John Wiley & Sons, Inc.1999.

S.2 MINIMIZE SOIL DISTURBANCE

OBJECTIVE

To the greatest extent possible, preserve and protect soil resources from damage by limiting the zone of site disturbance and controlling erosion and compaction during construction.

BENEFITS

- Maintains natural soil structure and thus the soil food web, beneficial microorganisms and soil organic content.
- Limits soil compaction and reduces runoff, leading to higher levels of infiltration and water table recharge.
- Maintains vegetation, reducing the need for replanting.
- Maintains habitat.
- Maintains water quality due to contact with vegetation and filtration through soil.
- Prevents future restoration costs.
- Reduces risks of invasive species establishment, which often occurs after disturbance.
- Protects on and offsite streams, rivers, lakes and ponds from sedimentation and turbidity.
- Prevents on and offsite flooding due to poorly controlled construction practices.

CONSIDERATIONS

- Can reduce buildable land area.
- Can increase construction costs and duration due to the fact that the contractor may have to work in a more limited site area with spatial restrictions for site access, staging, stock-piles, and work areas.
- Requires frequent onsite supervision of contractor to ensure compliance with protection measures.
- Requires costs associated with site protection measures.
- Prevention of compaction requires limiting vehicular traffic onsite, limiting contractor site access, storage, and staging area, and requires careful sequencing of work during construction.

INTEGRATION

- *W.1 Protect and Restore Natural Hydrology and Flow Paths*
- *W.3 Create Absorbent Landscapes*
- *V.1 Protect Existing Vegetation*
- *V.3 Protect and Enhance Ecological Connectivity and Habitat*
- *V.4. Design Water Efficient Landscapes*

BACKGROUND

While there are numerous ways to rejuvenate soil functions lost during construction, it is virtually impossible to fully recreate the structure and function of natural soil once it has been disturbed.

Retaining natural soil structure, vegetation, and hydrologic patterns is the foundation for providing a naturally functioning landscape. Disturbing or removing soils and vegetation destroys a site's soil structure and can severely curtail or eliminate its natural capacity for infiltration and evapotranspiration. Compaction and disturbance of soils in the upper horizon will eliminate macropores and significantly reduce air and water movement through soils. Correspondingly, runoff volumes and pollutant loads will increase. The health of both vegetation and fauna will decrease with reduced water and air flow.

Disturbance of soils and vegetation also results in habitat loss, an increased risk of erosion, and dramatic increases in the rate, volume, duration, and frequency of runoff, stormwater pollution, and reduced groundwater quantity and quality. The risk of invasive species establishment is increased from disturbance via seed migration on construction equipment, seed that existed in the soil layers and is brought to the surface, or seed finding available soil areas and lack of competition from existing vegetation.

On all projects, the goal should be to minimize soil disturbance using the following hierarchical approach:

- First, disturb the smallest site area possible by careful design and site planning.
- Second, limit the size of equipment to be as small as is practicable, or specify the type of equipment (i.e., tracked vehicles may be permitted and wheeled vehicles prohibited).
- Third, limit the size of materials and equipment staging and storage areas.
- Fourth, on a daily basis enforce soil erosion and sediment control specification requirements for construction practices that limit soil erosion and compaction and reduce sediment flow.

PRACTICES

PLANNING

SURVEY AND MAP EXISTING FEATURES TO IDENTIFY CRITICAL PROTECTION AREAS BEFORE THE START OF DESIGN WORK

- See *Part 2: Soil Assessment Practices*
- On sites where existing soils are to be preserved, especially at historic fill sites or areas suspected to have been subject to past industrial use, test soils to ensure that they are not contaminated.
- Soils should be sampled and analyzed per 6 NYCC 375 regulations to ensure they are safe.

USE SITE PLANNING STRATEGIES TO PRESERVE AND PROTECT EXISTING HEALTHY VEGETATION

- Design new facilities around preserved areas maintaining as much continuity and connectivity between preserved areas as possible.
- Coordinate proposed building or pavement development areas (places that will require compacted subgrades anyway) with proposed site staging, storage, and stockpiling areas that will generate subgrade compaction.
- Plan linear utility runs in compact corridors through healthy vegetation areas to minimize site disruption.
- Where possible, group utilities in common trenches (maintaining code required separation) to minimize widths of excavation.
- Require pavement removals to be completed with the smallest equipment sizes possible; require that operation of equipment over the base or subbase of pavements removal shall be carefully monitored.
- Carefully consider proposed grading to avoid excessive filling or cutting within critical root zone areas of existing vegetation.
- Carefully consider proposed drainage patterns so as to maintain contributing watersheds to protected root zone areas and avoid the need for irrigation.

DESIGN

PROVIDE ADEQUATE SOIL PROTECTION ZONES AROUND EXISTING VEGETATION

- Protect vegetation in clumps of trees and shrubs rather than individual plants, thereby preserving shared soil volumes and rooting zones.
- See *V.1 Protect Existing Vegetation*

DEVELOP A SOIL PRESERVATION AND PROTECTION PLAN

- As part of the early concept and master planning phase, develop a soil preservation and protection plan diagram that divides the site into five basic zone types:
  - Zones of protection where existing soil and vegetation will not be disturbed.
  - Zones that, based on testing results, will be amended or treated in-place with minimal disturbance.
    - In areas that demand less invasive measures, such as radial trenching, vegetation is to remain.
    - Rototilling and other more invasive techniques generally require removal of vegetation prior to amendment.
  - Zones where construction traffic (both vehicular and pedestrian) will be allowed
    - To the extent possible, these areas should coincide with planned building locations, parking lots, roadways, and walks.
  - Zones for stockpiling site salvaged topsoil and subsoil (in separate piles or areas) and imported soil and soil amendments
- These zones should also be limited to areas where planned building locations, parking lots, roadways, and walks would occur.
  - Zones that require specialized soil treatments (such as removal and replacement of soils or the installation of subdrainage systems) due to existing site degradation, contamination, hardpan layers, or areas that will unavoidably be adversely impacted by site construction activities.
- Develop the first two zones as large as possible to protect them from construction traffic.
- Locate construction activity zones after establishing soil protection zone areas.
- Coordinate with other design consultants, including architects, site utility engineers, and resident engineers, to ensure that protection and preservation zone locations and sizes allow sufficient room for the construction of the proposed site improvements and not just the improvements themselves.

- Unrealistic preservation and protection zones create undue hardship for contractors leading to inflated bids and unenforceable site restrictions during construction.
- Be sure to consider the needs for equipment access and maneuverability in and around buildings, utility trenches, rock outcroppings, stairs, walls, and other new or existing site features when establishing protection and preservation zones.

SHARE DISTURBANCE CORRIDORS

- Construction roads should become final roads, and utilities should run along path corridors.

DEVELOP INCENTIVES AND METHODOLOGY FOR ENSURING SITE PROTECTION

- Tie contractor payments to continued compliance with site protection requirements.
- Site protection specification may be paid out at 25, 50, 75 and 100% complete, with no payments for lack of compliance.
- Design site protections that are adequate and not easily destroyed by general construction activities.
- Maintain basic hydrology of protected areas to ensure their longevity.

DEVELOP A SITEWIDE GRADING AND STORMWATER MANAGEMENT STRATEGY

- Base plan on minimal earth moving.
- Consider construction sequence to minimize site disturbance.

EROSION CONTROL

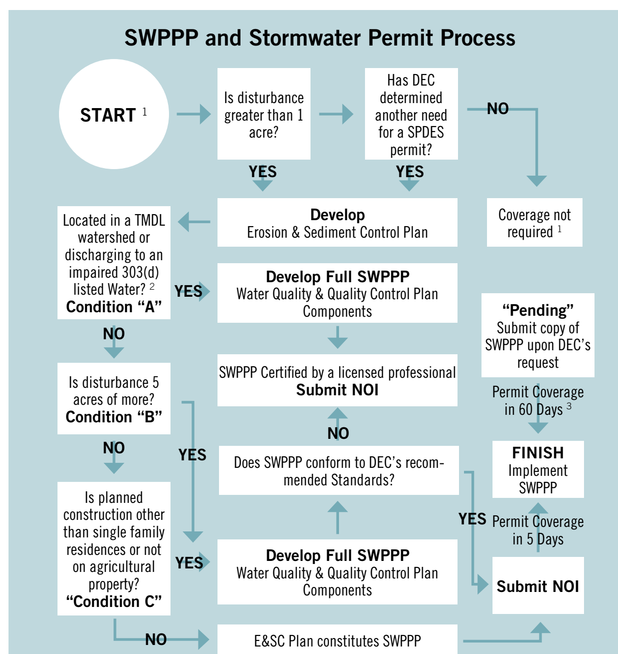
During construction, erosion and sedimentation pose a serious threat to soil and water quality both on and offsite. Erosion removes topsoil and exposes subsoil that is less suitable for plant growth. It reduces soil organic matter levels, making soil more susceptible to compaction and further erosion. Loss of organic matter also reduces nutrient levels and nutrient holding capacity. Erosion disrupts soil structure and soil biological communities that contribute to landscape health. Eroded soil and runoff carries excess nutrients, pollutants, and sediments to surrounding water bodies causing eutrophication and turbidity. Sedimentation clogs drainpipes, swales, and stream channels, oftentimes leading to increased flooding.

These onsite and offsite damages are often expensive or impossible to fix completely, making prevention worthwhile. Due to the seriousness of erosion and sedimentation issues, the NYC Department of Environmental Protection (NYCDEP) and NYS Department of Environmental Conservation (NYSDEC) require projects to obtain approvals and/or permits to specifically control construction operations and changes to both overland and piped stormwater flows.

PRIOR TO THE START OF THE DESIGN PROCESS, DETERMINE AGENCY REQUIREMENTS FOR SOIL AND EROSION CONTROL INCLUDING THE NEED FOR A STORMWATER POLLUTION PREVENTION PLAN (SWPPP), A PLAN FOR CONTROLLING RUNOFF AND POLLUTANTS FROM A SITE DURING AND AFTER CONSTRUCTION ACTIVITIES

- In most cases, soil and erosion control and stormwater permits are required from one or more reviewing agencies if a project disturbance area exceeds one or more acres.
- Consult the Instruction Manual for Stormwater Construction Permit prepared by the NYSDEC.[40]
- See Figure 1: Stormwater Pollution Prevention Plan Component Flow Chart below
- The principle objective of a SWPPP is to comply with the NYSDEC State Pollutant Discharge Elimination System (SPDES) Stormwater Permit for construction activities by planning and implementing the following practices:
  - Reduction or elimination of erosion and sediment loading to waterbodies during construction
  - Control of the impact of stormwater runoff on the water quality of the receiving waters
  - Control of the increased volume and peak rate of runoff during and after construction
  - Maintenance of stormwater controls during and after completion of construction
- A well designed SWPPP requires proper selection, sizing, and citing of stormwater management practices to protect water resources from stormwater impacts; Erosion & Sediment Control (ESC), Water Quantity Control, and Water Quality Controls are interrelated components of a SWPPP.

If a site is required to have a full SWPPP, this plan must be expanded to meet all the requirements of the water quality and quantity sizing criteria outlined in the New York Stormwater Management Design Manual and the New York Standards and Specifications for Erosion and Sediment Controls.



NOTES
1. Under any of the above conditions other environmental permits may be required. DEC may require permit for construction disturbance <1 acre on a case by case basis.
2. **and** the following exists: construction and/or stormwater discharges from the construction or post-construction site contain the pollutant of concern identified in the TMDL or 303(d) listing.
3. After receipt by DEC of completed application.

Figure 1- Stormwater Pollution Prevention Plan Component Flow Chart

Whether or not a formal SWPPP is required for a project, consider these basic site planning principals to reduce soil erosion and sedimentation potential over the life of the project by fitting the proposed design to the existing terrain.

- Avoid the design of excessively steep grading and transitions to existing grade that may become unstable or wear away over time.
- Minimize length and steepness of slopes.
- Maintain sufficient breathing room within the site plan to provide natural buffer areas or pockets that can reduce the velocity of overland flows and provide opportunities for trapping and settlement of debris and sediments.
- Plan for ways to control stormwater velocities within swales, gutters, streams, and other open channels.
- Consider the use of vegetative stabilization methods for hillsides, swales, and stream banks.
- These vegetative stabilization methods offer long term stability and can often be installed as both required erosion control methods during construction and as the permanent design solution.
- Consider temporary seeding for stabilization.

IDENTIFY AREAS OF CONCENTRATED FLOW AND EROSION

Identify areas where existing storm sewers or concentrated flows discharge. Often these areas will create or transform a headwater flow path into an eroded gully. Identify upstream measures to reduce the amount and velocity of flow prior to implementing any restoration or stabilization measures. Caution: stabilizing one area of erosion without addressing the source of erosive flows is likely to transfer the problem downstream.

IDENTIFY PRACTICES THAT ARE CONTRIBUTING TO EROSIVE CONDITIONS IN NATURAL FLOW PATHS AND SMALL STREAMS

- Practices such as vehicle parking on lawns, compaction along the travel paths of maintenance equipment, or a history of compaction by mowing equipment can create flows that will damage natural flow paths and small streams.
- Identify areas impacted by these uses, and implement techniques to restore soils, provide stormwater management, or modify practices.
- See *W.1 Protect and Restore Natural Hydrology and Flow Paths*

COMPACTION PROTECTION AND CONTROL

Healthy soil includes not only the physical particles making up the soil, but also adequate pore space between the particles for the movement and storage of air and water. Pore space in soils is also necessary for root penetration and to provide a favorable environment for soil organisms. Compaction occurs when soil particles are pressed together under vehicular or pedestrian weight loads, destroying a soil's natural structure of fissures and particle aggregation, and reducing the amount and size of pore space within a soil structure. Although desirable under and adjacent to building structures and pavements, compaction is destructive to soils that support vegetation or facilitate stormwater control.

Soil compaction threatens new and existing vegetation due to:

- Restricted root growth
- Reduced plant uptake of water and nutrients
- Reduced air exchange
- Reduced available water capacity
- Reduced soil biological activity

Poor soil quality results in less healthy plants, and higher rates of plant disease and mortality, triggering the need for increased irrigation and fertilization to compensate. Trees are especially sensitive to compaction and low soil oxygen levels. Unfortunately, the impact of compaction on trees, whether caused by construction or post construction use, may not become obvious until years after the compaction occurs.

Excessive levels of soil compaction also lead to wider potential environmental degradation due to:

- Increased stormwater runoff as a result of low infiltration rates of compacted soils
- Increased erosion due to increased stormwater runoff volume and velocity
- Increased water pollution potential in local rivers, streams, lakes, and ponds

Compaction is extremely difficult to ameliorate without drastic and expensive remediation procedures. For open surface areas, traditional agricultural methods of compaction relief can be employed. However, on more developed or vegetated sites compaction relief is especially challenging around the roots of existing plantings, underground utilities, buildings, pavements and other structures.

PLANNING & PROCESS FOR COMPACTION AVOIDANCE

Careful planning during design and before construction can prevent many problems associated with compaction during construction:

- Protect existing uncompacted soils.
- Conduct visual inspection and onsite testing to determine areas where healthy, noncompacted soils are located. Survey these areas and map them for use by the design team in critical decision making.
- Protect uncompacted site areas by designing around them to the extent possible.
- Maintain uncompacted areas in large, contiguous zones rather than as smaller dispersed areas on a site.
- Limit the extent of disturbed area by design.
- Avoid site improvements in areas where there are uncompacted soils.
- Maintain as compact a development footprint as possible to minimize soil compaction.
- Locate new site improvements in areas where existing soils have already been compromised through compaction.
- Restrict onsite construction activities such as access roadways, storage staging, and stockpiling areas to locations where the proposed site development will require compacted soils, such as proposed roadways, parking lots, paved plazas, and sport courts, or future buildings.
- Design site protection measures, such as mulch blankets to prevent soil compaction in areas where heavy equipment is anticipated to be operated.
- Coordinate compaction zones adjacent to structures with the structural engineer, the goal being to limit zones of excessive compaction.

SOIL TEXTURE (USDA)	IDEAL BULK DENSITIES (g/cm3)	BULK DENSITIES THAT MAY AFFECT ROOT GROWTH (g/cm3)	BULK DENSITIES THAT RESTRICT ROOT GROWTH (g/cm3)
Sands, loamy sands	<1.60	1.69	>1.80
Sandy loams, loams	<1.40	1.63	>1.80
Sandy clay loams, loams, clay loams	<1.40	1.60	>1.75
Silts, silt loams	<1.30	1.60	>1.75
Silt loams, silty clay loam	<1.10	1.55	>1.65
Sandy clays, silty clays, some clay loams (35-45% clay)	<1.10	1.49	>1.58
Clays (>45% clay)	<1.10	1.39	>1.47

Figure 2: Bulk Density by Soil Texture (Source: NRCS Soil Quality Institute, 1999)

DEFINE ACCEPTABLE LEVELS OF COMPACTION IN CONTRACT DOCUMENTS

Different soil textures respond differently to compaction.

- Sandy soils are naturally more resistant to compaction.
- Clay soils are highly sensitive to compaction.
- Acceptable compaction levels need to take into account soil type; bulk density is a good proxy measure to understand soil compaction impacts on vegetation.
- By specifying target soil densities and verifying them by onsite testing (using ASTM D2937, for example), the designer can ensure that planting soils will be conducive to plant growth.
- See Figure 2: Bulk Density by Soil Texture (Source: NRCS Soil Quality Institute, 1999).
- Define acceptable equipment to complete work.
- Specifications should encourage the contractor to use the smallest possible equipment sizes to complete the work.
- Define acceptable equipment that will minimize compaction of soils by naming specific models, weights, and wheel or track sizes and tires per axel and wheel loads.
- Create clear levels of accountability for violation.
- Incorporate a system of financial and administrative penalties within the specifications to encourage performance.
- Rate and track contractor performance from contract to contract to provide legally defendable means for disqualifying contractors from bidding if they fail to comply with compaction prevention requirements.
- Require the contractor to remove and replace materials that are over compacted, at the contractor's expense.

CONSTRUCTION

MINIMIZE SITE DISTURBANCE DURING CONSTRUCTION

- Ensure that erosion and sediment control measures are installed and maintained throughout entire construction process.
- Consolidate construction staging area to minimize disturbance.
- Install site protection fencing and maintain throughout entire construction process, including trees and groves, an also any areas within protection and preservation zones.
- Install site protection fencing; monitor and maintain throughout entire construction process.
- Consolidate construction staging area to minimize disturbance.
- Ensure that erosion and sediment control measures are installed and maintained throughout entire construction process.
- Enforce limits of disturbance.

REQUIRE EDUCATION AND ENFORCEMENT

- Contractors as well as construction management and resident engineering staff need to be taught about the importance of good soil practices.
- Most construction professionals easily adapt their methods once they understand the reasoning behind the requirements. However, simply because soil management requirements are on the drawings and in the specifications, it does not mean that they will be followed.
- It is the obligation of the project design team to organize meetings and make periodic site visits throughout the construction phase to ensure that the soil management plan is implemented.
- The message of preservation and reuse needs to be delivered repeatedly to ensure compliance with the stated objectives.

INCORPORATE DISCUSSION OF SITE PROTECTION ZONES AND EROSION CONTROL AND COMPACTION PROTECTION MEASURES INTO CONTRACTOR MEETINGS

- Prebid Meetings:
  - Review and discuss site protection and the importance of soils and vegetation.
  - Review the intent of the construction staging and sequencing plan.
  - Review liquidated damages requirements if appropriate.
- Preconstruction Meetings:
  - Review the requirements of the site protection and

construction staging and sequencing plans.
- □ Discuss in detail the importance of soils and vegetation to the plans.
- □ Review the intent of the construction staging and sequencing plan.
- □ Review liquidated damages requirements if appropriate.

PHASE CONSTRUCTION TO LIMIT SOIL EXPOSURE

- Minimize the length of time that soil is left bare and unprotected.
- Especially avoid bare soil during periods of seasonally high precipitation or wind.
- Provide special protection to critical areas such as steep slopes and stream borders.
- Clear only those areas where construction will begin soon; avoid creating large expanses of cleared areas.
- Land disturbing activities and erosion and sediment control practices should be performed in accordance with a planned schedule to reduce site erosion and offsite sedimentation.
- Construction scheduling should facilitate installation of erosion and sediment control measures prior to construction start, and precede work as construction activities move around the site, by breaking soil disturbing activities into phases.
- Grading activities should be limited to the phase/area that is immediately under construction to decrease soil exposure and its potential for erosion and sedimentation.
- Subsequent phases should begin only when the previous phase is nearing completion and its exposed soil has been stabilized.
- Additional precautions may need to be taken when managing contaminated soil, where runoff may need to be collected separately and disposed of at a licensed facility.
- It may be necessary to discuss dewatering when excavation reaches groundwater.

STABILIZE EXPOSED SOILS

- Exposed soils should be stabilized within two weeks of the onset of exposure.
- Ideally, permanent vegetation should follow each phase of construction; if this is not possible due to seasonal limitations, then mulch, seeding, or other measures of soil coverage can be used.
- Geotextile fabrics offer effective temporary and permanent solutions to erosion and the establishment of permanent vegetation.
- Geotextiles are the best solution when disturbed soils will be exposed for less than six months or where slopes exceed 30%.
- Geotextiles aid plant growth by holding seeds and topsoil in place.
- Some geotextiles are made of biodegradable materials such as mulch matting and netting.
    - □ Mulch mattings are jute or wood fibers that have been formed into sheets and are more stable than normal mulch.
    - □ Netting can be used to hold the mulch and mats to the ground but cannot be used alone to stabilize soils.
    - □ Mulch needs to be tested for potential weed seed content and its use should be limited to wood or straw mulch or other nonseed potential product.
- Nondegradable geotextiles are used to line swales or temporary runoff diversion channels where moving water is likely to wash out either temporary or permanent new plants.
- Seeding is used to control runoff and erosion on disturbed areas by establishing annual or perennial vegetative cover from seed.
- Seeding is economical, adaptable to different site conditions, and allows selection of a variety of plant materials.
- Temporary seeding with annual grass is appropriate in locations where earthwork is not complete, but will not begin again for six months or more and in the spring or fall when seeds can be sown.
    - □ Annual rye grass is the recommended temporary seed cover type for New York City's climate.
    - □ Annual rye grass germinates within 7-10 days and provides reliable soil retention within three weeks.
- Perennial rye grass should be avoided as this is alleopathic to native grasses.
- Depending on the size and slope of the disturbed area, hydroseeding may be more cost effective than hand seeding.
- Compost blankets, a recent technique, have layers of loosely applied compost that typically incorporate seed.
    - □ Proven effective in erosion control
    - □ Applied to a depth of 2-3 inches either by hand or by machine
- On slopes greater than 2:1, netting should be used in conjunction with the blanket.
- The cost of a compost blankets is comparable to straw mat and less expensive than a geotextile blanket.
- Permanent vegetative cover requires more care in soil preparation, finished grading, and maintenance and should be part of the site's overall landscape design.
- Compost berms and blankets can be used to prevent soil movement, and silt and sand fences to capture and filter overland flow.
- Mulch creates temporary erosion control, and can also be a part of the final landscaping plan.

INSTALL PERIMETER STORMWATER RUNOFF CONTROLS

- To control stormwater runoff, silt fences should be properly installed around the perimeter of the construction site.
- As an alternative or in addition to silt fences, use compost berms, which are particularly appropriate on sites with small drainage areas.
- A compost filter berm is trapezoidal in crosssection and provides a three dimensional filter that retains sediment and other pollutants while allowing cleaned water to flow through the berm.
- Catch basin inlets receiving stormwater flows from the construction site must be protected with adequate inlet controls.
- Sediment basins should be created where space is available.

PROTECT STORMWATER FACILITIES UNTIL PROPERLY ESTABLISHED

- Temporarily divert water from disturbed areas until landscaping is fully established, especially lawn areas, vegetated swales, rain gardens, and infiltration basins.

- Controlling concentrated flow and runoff to reduce the volume and velocity of water from work sites prevents formation of rills and gullies.
- Where wind erosion is a concern, install windbreaks.

RESTRICT TRAFFIC AND OTHER COMPACTION GENERATING ACTIVITIES

- To the extent possible, limit the operation of vehicular and foot traffic, parking and equipment, or material storage to predetermined areas where compaction is acceptable or can be mitigated.
- Create "no go" areas with protection zone fencing.
- Use 6' minimum height chain link fencing instead of lower plastic barrier fences to prevent workers from easily removing or damaging fencing and placing material and equipment within protection zones.
- Provide clear protection area signage explaining the purpose of protection zone.
- Signage should indicate fines or other penalties for violation of protection areas.
- Employ ground surface protection measures to minimize soil compaction.
- In areas where compaction is undesirable but unavoidable, employ protection measures and limit area usage to the least damaging activities.
- Provide mitigation for light weight and heavy weight traffic.

PREVENT COMPACTION FROM EQUIPMENT DURING CONSTRUCTION

- Do not operate over or handle soil when it is wet.
- Wet or excessively moist soil is significantly more susceptible to compaction.
- Allow soils to dry out after storm events before resuming construction work.
- Cover stockpiled soils to prevent them from becoming saturated enabling them to be used more quickly after storm events.
- Use specialized equipment for handling soil and grading activities.
- Use the smallest and lightest piece of equipment as possible to complete the work, especially in areas where topsoil is being stripped and stockpiled or planting soils area being installed.
- Use low ground pressure equipment including tracked vehicles or vehicles with low inflated (under inflated) tires, doubles or high flotation balloon tires.
- Use hand rollers and temporary or permanent irrigation systems to settle soil in place at recommended compaction levels.
- If irrigation is used, do not overwater and cause erosion and runoff.
- Sequence soil installation operations to eliminate driving over planting soil during or after installation.
- Stage construction to allow for access roadways over the subgrade through planting soil areas.
- Build up planting soil in layers to either side of the access roadway.
- Back out of the installation area by installing planting soil in layers over the decompacted roadway subgrade.
- Consider the use of conveyors or articulated arm equipment to avoid driving over planting soil areas during installation install.
- Employ specialized construction methods in especially sensitive areas.
- In areas surrounding existing vegetation, complete grading and earthmoving work by hand.
- Provide soil protection measures in areas where there is concentrated foot and wheelbarrow traffic.

MAKE PERIODIC INSPECTIONS DURING CONSTRUCTION PHASE TO ENSURE COMPLIANCE WITH REQUIREMENTS

- Observe if protection fencing and other protections are in place and properly maintained.
- Observe soil placement and amendment operations to ensure sequencing and equipment used is not causing compaction.
- Use spot testing to monitor compaction levels at subgrade, interstitial, and finish grade elevations.
- Recommend corrections to work operations as required to comply with the intent of the contract documents.

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S.3 PRIORITIZE THE REJUVENATION OF EXISTING SOILS BEFORE IMPORTING NEW SOIL MATERIALS

OBJECTIVE

To the greatest extent possible, reuse existing soils on site rather than importing new soil and exporting waste soil.

BENEFITS

- Increases the soil's ability to support healthy vegetation.
- Maintains existing soil flora and fauna that can repopulate and improve adjacent disturbed areas in the future.
- Maintains existing soil health, reducing the need for supplemental irrigation water, fertilizers, and pesticides.
- Increasing macropores will improve the flora and fauna, which will in turn increase macropores and maintain soil porosity.
- Increased soil organisms will increase ecological services, including retaining nutrients in biomass, converting forms of nitrogen, increasing the active organic fraction of soil, and improving biodiversity.
- Increases soil infiltration capacity during large storm events due to conduit flow in macropores.
- Reduces surface runoff and erosion by preserving existing healthy soil functions when vegetation is preserved in situ.
- Reduces air pollution resulting from trucking soils to and from job site.
- Reduces cost by minimizing importation of topsoil and removal of existing soil.
- Reduces potential disruption to existing vegetated areas.
- Reduces risk of importing invasive species or contaminants.
- Reduces stripping of topsoil in other areas by reducing demand for imported topsoil.
- Because the soil substrate supports plant life, these areas can be aesthetically pleasing and highly beneficial for the environment.

CONSIDERATIONS

- Requires testing of onsite soils to determine viability for reuse.
- Rejuvenation of soils onsite can sometimes be costly due to

the amount of amendment and other work required.
- Requires knowledge of soil amendments to successfully rejuvenate soil to meet programming needs.
- Requires coordination and outreach to other divisions, such as the Natural Resources Group, and the Department of Environmental Conservation.

INTEGRATION

- *S.1 Provide Comprehensive Soil Testing and Analysis*
- *S.2 Minimize Soil Disturbance*
- *S.4 Use Compost*

BACKGROUND

One of the greatest challenges in urban park sites is that they often have soil that is compacted, that drains poorly, and has an elevated pH. Earthwork can represent a substantial portion of the budget. There are a number of soil modification strategies that can be used to reduce costs, as well as reduce vehicular emissions, fuel consumption, noise, and project time.

Existing soils do not always need to be replaced with new materials. The most effective tactic is to match the proposed site program with the existing soil character. For example, highly compactable soils would not be appropriate for lawns where you expect high levels of foot traffic, but they may be appropriate for planting beds or reforestation areas. It is important to match soil conditions and proposed uses. Existing soils might also be moved around on the site to clear the way for new buildings or parking areas or areas that require a different soil matrix.

It is best to leave the soil alone and match the proposed plantings to the soil, and to the thriving existing plants.

Understanding the horticultural potential for the existing soil makes it possible to match a proposed planting to the soil condition. This makes it likely the plantings will thrive without amendment or modification. This also avoids damage to existing plants due to extensive reworking or replacement of the soil.

It is important to preserve the existing soil structure by not compacting or modifying the soil if possible. Macropores are formed by soil fauna, plant roots, water movement, and freeze/thaw cycles. Macropores are of significant importance in water management because the macropores can behave like conduits, facilitating the rapid movement of water through the macropores, regardless of overall soil saturation and soil type (clays or loam). Macropores also facilitate the movement of air through soil horizons, supporting a healthy soil organism community from bacteria and fungi to macro arthropods, such as weevils and worms.

Rejuvenation of onsite soil requires cost benefit analysis to determine if it is worthwhile. It does not always pay to reuse existing soils if they are of substantially inferior quality or if the proposed park programming is not well suited to the soil. Substantial modification of existing soil texture is costly. Modification of pH is often only temporary.

PRACTICES

PLANNING AND DESIGN

Use testing and analysis to identify existing onsite soil resources prior to starting design work to determine:

- Soils contamination
- Horticultural value
- Stormwater absorption
- Adequacy of available soil depths and volumes for proposed design
- See *Part 2: Site Assessment*.

ADEQUATELY PLAN FOR STOCKPILING AND REUSE OF HEALTHY SOILS

- Strip and stockpile topsoil from areas where compaction or other disturbance is anticipated.
- Develop a plan for separating topsoil according to depth and soil type as if there are distinct horizons or distinct soil areas that should be preserved.
- Even under the most controlled circumstances, stripping degrades the structure and biology of topsoil; this approach should be used judiciously.
- Evaluate the volumes of soil materials, both topsoil and subsoil, which will be generated from areas to be stripped and stockpiled to ensure adequate space has been planned to accommodate stockpiling, storage of imported amendments, or onsite soil mixing and blending operations.
- Improperly handled topsoil stockpiles can become anaerobic, killing their biological content and making the topsoil toxic to future plantings.
- Topsoil should be stockpiled for as short a period of time as possible.
- Topsoil stockpiles should be limited to six feet in height to minimize crush loading, which destroys structure and cooking from the inside out due to limited oxygen exchange.
- Topsoil stockpiles should be monitored for ammonium buildup and temperature rise.
    - If either of these two indicators is observed, the pile should be broken down or turned to halt the decomposition process.
- Stockpiled topsoil should be covered several weeks prior to reuse to limit additional soil moisture from precipitation.
- If soils become too waterlogged, they will be highly susceptible to compaction during installation, rendering them useless.
- Covering of stockpiled soils also minimizes stormwater runoff and crusting.
- Apply soil erosion and sedimentation control procedures to stockpiled soils.
- Even under the best of conditions, stockpiling will degrade the structure and biology of healthy topsoil.
- Plan to amend reused soils from stockpiles to rejuvenate their health.
- Test soils after placement to determine amendment materials and procedures.
- Often the use of compost is an excellent way to rebuild

structure and reinvigorate biological functioning.
■ See *S.4 Use Compost*

GRADE SUBSOIL NOT TOPSOIL

■ Strip and stockpile healthy topsoil separately from subsoil, which has lower organic content and biological activity and often different structure.
■ Look for design opportunities to balance cut and fill on site through the use of landforms created from excess excavated soils from utility and foundation areas.
■ Shape rough grades from existing subsoil and excess excavated subsoil.
■ Install stockpiled topsoil on top of rough subgrade to achieve finish grades, reestablishing a natural, healthy soil profile.

Existing urban soils at the project site were amended to improve soil quality while minimizing importation of new soils.

CONSIDER SUSTAINABLE ALTERNATIVES TO THE IMPORTATION OF VIRGIN SOIL

Depending on the volumes of soil required, the final intended surface uses, and applicable solid waste regulations, consider alternatives to importing virgin soil from distant locations.

- ■ Recycled concrete aggregate from construction and demolition operations that may otherwise be shipped to a landfill may be used as a substitute for beneath structures or paved areas.
- ■ Processed dredge material (available from NY/NJ Harbor USACE projects) might be considered as fill or as a soil amendment in planted areas, dependent upon quality and levels of certain contaminants.
- ■ For both cases it is necessary to obtain the appropriate Beneficial Use Determination from the NYSDEC.

FOR EXISTING SITE AREAS WHERE COMPACTION IS A PREEXISTING CONDITION, INCORPORATE COMPACTION ALLEVIATION STRATEGIES INTO THE PROPOSED PROJECT PLANNING PROCESS

■ Identify areas of existing soil compaction and test to determine opportunities for alleviation.
■ Test soils to determine existing soil texture, organic content, and bulk density.
■ Use penetration tests and test pits to determine depths of compaction.
■ Use test results to plan compaction remediation work.
■ More often than not, soil removal and replacement or, alternatively, installation of new soils over compacted soils, including subsurface drainage is the most cost effective solution.
■ Placement of new soils over compacted soils requires care to properly interface soil layers.
■ See *S.2 Minimize Soil Disturbance* for acceptable compaction levels in soil of differing textures

CONTRACT DOCUMENTS

■ The contract documents should clearly indicate the extents and requirements of soil preservation, protection, and reuse in order to allow the contractor to easily identify costs and schedule.
■ Clear documents allow for ease of enforcement of the requirements and, ultimately, lead to better long term results.

PREPARE SITE STAGING AND SEQUENCING PLAN AS PART OF THE CONTRACT DOCUMENTS

■ See *C.3 Create Construction Staging & Sequencing Plan*

DO NOT NEEDLESSLY ENRICH EXISTING SOILS

■ Existing soils that have been preserved should be tested to ensure adequate health.
■ Use tests results to determine if amendments would be beneficial and specifically identify which amendments are required.
■ Application of amendments can sometimes degrade existing soil conditions through physical damage caused by workers or their equipment during installation.
■ Excessive fertilization or even subtle pH adjustment can destroy existing soil flora and fauna, altering soil chemistry and disrupting existing vegetative patterns.

DEVELOP COMPREHENSIVE SPECIFICATIONS PERTAINING TO SOIL AMENDMENTS AND MONITORING

■ Specify amendments and procedures associated with the improvement of in-place soils.
■ Specify procedures for monitoring and maintaining stockpile topsoil materials.
■ Specify amendments for stockpiled soils to be reused on site.
■ Specify procedures and standards for onsite soil testing and evaluation.

MITIGATE IMPACTS OF EXISTING OR CONSTRUCTION CREATED COMPACTION

If compaction is encountered on site either as an existing condition or as a result of construction operations, the contract documents should provide specific provisions for amelioration. It is worth noting that after soil structure is destroyed during compaction, simply

digging up the soil or fluffing it will not fix the problem. Rain will reconsolidate the soil after a brief time.

Alleviation methods will vary based on site context; a designer should employ a hierarchical approach to selecting the most appropriate option.

SURFACE COMPACTION TREATMENTS

- Organic Amendment: Blending compost and other amendments into the soil will reduce bulk density, improve drainage, and introduce biological activity, which will assist in the recovery of soil structure.
- See *S.4 Use Compost*
- Organics can be added by a variety of methods including surface rototilling, air tilling, or core aeration and topdressing.
- Significant amounts of well composted organic matter can bring back macroporosity if enough is added.
  - For clayey soils, 50% by volume must be added.
  - For sandy soils 33% by volume must be added.
  - For trees and shrubs somewhere in the range of 18”-24” of soil should be amended.
- Spoon, plug, or spike aeration: loosen soils with rotating toothed equipment that poke holes in the soil surface; usually used to remedy shallow lawn area compaction.
  - Avoid below the dripline of existing trees since this method would damage surface feeding roots.
- Deep jetting or hydro-injection: High water pressure used to bore into the soil at regular intervals to loosen compaction.
  - Can damage nearby roots if done improperly
- Ripping and chisel plowing: Dragging of vertical shafts or plates across the soil surface will breakup and fissure compacted soil.
- Rototilling or disking: Breaks up compaction by churning and rotating soil
  - Can compact the soil just beneath the depth of tillage.
- Soil Replacement: Partial or total replacement of compacted soil with a new soil or soil and compost mix. Soil replacement can include:
  - Complete replacement of soil to below the indicated limit of compaction (as determined by test pits and other testing methods).
  - Radial trenching below the drip line of existing trees and large shrubs.
  - Pneumatic (air spade) replacement: using high pressure air to excavate soil (while preserving surrounding tree roots) which is then replaced by new soil.

SUBSOIL COMPACTION TREATMENTS

- Subsurface ripping: Subgrade treatment before the placement of planting soils involves dragging of vertical shafts or plates across a subsoil to break and fissure compacted soil.
  - Subsoiling can alleviate compaction to depths of 18” to 20”.
  - Subsoiling is only effective if done correctly on adequately dry soil, and if no subsequent traffic recompacts the soil.
  - Subsoiling should only be performed with ripping equipment.
    - Typical agricultural tillage tools such as disks and chisel plows should not be allowed because they are too shallow or are not built to pull through densely compacted layers.

CONSTRUCTION

INCORPORATE DISCUSSION OF EXISTING SOIL PROTECTION AND REUSE INTO CONTRACTOR MEETINGS

- Prebid meetings:
  - Review and discuss protection requirements, off limits areas and areas of limited access, as well as penalties for violation.
    - This may be included within specifications as a liquidated damages clause.
  - Review the intent of the construction staging and sequencing plan.
- Preconstruction meetings:
  - Review the requirements of the site protection and construction staging and sequencing plans.
  - Discuss in detail the establishment of site protection fencing prior to the start of any work.
  - Discuss specific procedures for soil stripping and stockpiling, and reinstallation of soils.
  - Review submittals pertaining to soil amendments and installation equipment requirements.

MAKE PERIODIC INSPECTIONS DURING CONSTRUCTION PHASE TO ENSURE COMPLIANCE WITH REQUIREMENTS

- Observe if protection fencing is in place and properly maintained.
- Check stockpile sizes and conditions including temperature and erosion control measures.
- Observe soil improvement and replacement procedures for compliance with requirements.

SEE FURTHER

→ Craul, Phillip and Craul, Timothy. Soil Design Protocols for Landscape Architects and Contractors. Hoboken, NJ: John Wiley & Sons, Inc., 2006.

S.4 USE COMPOST

OBJECTIVE

Use compost as an amendment for existing soils or as part of imported soil mixes to improve soil functioning.

BENEFITS

- Improves soil structure, porosity, and density, creating a better plant root environment.
- Supplies significant quantities of organic matter.
- Increases infiltration and permeability of heavy soils, reducing erosion and runoff.
- Improves water holding capacity, reducing water loss and leaching in sandy soils.
- Improves cation exchange capacity (CEC) of soils, improving their ability to hold nutrients for plant use.
- Supplies a variety of macro and micronutrients.
- May control or suppress certain soilborne plant pathogens.
- Supplies beneficial microorganisms to soils.
- Improves and stabilizes soil pH.
- Can bind and degrade specific pollutants.
- Reuses organic waste.

CONSIDERATIONS

- Compost should be thoroughly tested prior to use on site.
- Testing biological properties of compost takes approximately four weeks to complete.
- Prior to the use of compost on site, existing soils should be tested to determine compost application rates.
- Compost must be sufficiently mature or it can cause damage to plants.

INTEGRATION

- *S.3 Prioritize the Rejuvenation of Existing Soils before Importing New Soil Materials*
- *S.6 Use Engineered Soils to Meet Critical Programming Needs*
- *W.3 Create Absorbent Landscapes*

BACKGROUND

Compost is aerobically decomposed organic waste; it has a long history of use as an agricultural soil amendment. Over the past two decades, compost has been reassessed as a tool for improving the overall soil quality within urban environments. Compost amended soil has many potential benefits when included with the establishment of turf and landscaping, including:

- Increased water retention
- Improved soil structure
- Increased nutrient retention
- Reduced need for fertilizer and pesticide use
- Improved stormwater retention
- Improved turf and landscape performance and aesthetics
- Long term cost savings due to reduced maintenance needs

As a soil amendment, the numerous benefits of compost exceed the benefits of numerous other soil amendment products available for use.[41] Most importantly, compost is a recycled material, contributing to the longterm sustainability of future landscape projects. In particular compost should be used in place of peat moss, which is not a sustainable product.

PRACTICES

PLANNING

EMPHASIZE SITE ASSESSMENT AND PREPLANNING

Site assessment and preplanning are critical to the proper use of compost as a soil amendment. Soils should be amended only to achieve specific goals. Soil amendment, while usually beneficial, can sometimes lead to unintended detrimental consequences.

- Test existing soils prior to the addition of any soil amendments in order to determine application rates and methods of installation.
- Identify local compost facilities with appropriate materials as a first source, helping to foster local and/or municipal composting systems.
- Consider onsite composting if the project schedule and site logistics allow.
- Identify areas where existing soils exhibit poor drainage; if the cause of poorly draining soil is not addressed, adding compost may exacerbate the compaction problem.
- Avoid onsite amendment on steep slopes (over 3:1) as amendment procedures may destabilize existing soils and contribute to erosion.
- Identify existing vegetation to determine how close to a tree or shrub base, and to what depth, soil amendment can be performed without root damage.
- Compost is typically added to existing soils by site mixing with a rototiller.
  - Rototilling typically penetrates the upper 6 to 8 inches of the existing soil.
  - Rototilling should not be done below the drip line of existing vegetation.
- For incorporation within the drip line of existing vegetation, consider vertical mulching or air tilling to protect shallow feeder roots.

DETERMINE APPROPRIATE COMPOST NEEDS AND APPLICATION METHODS

- The quantity of compost to be incorporated is determined by the final organic content goal for the various soil types desired on site.
- Top dressing is only effective for some aspects of turf management, but is not adequate for planting bed amendments.
  - Addresses low volumes of compost added to the surface of lawn areas as a method of increasing nitrogen and combating thatch and other disease and insect problems

Leaf litter from local residents was added to enrich soils at this stormwater detention basin, helping a diverse range of newly planted vegetation to thrive.

- ◻ Does not add organic content in sufficient volume to significantly increase the percentage within the soil profile
- Annual mulching with compost in planting beds can assist in maintaining organic matter, especially in areas when maintenance removes leaf litter and other sources of organic content.
- For existing soils amended in place, maximize the benefits of compost by blending compost into the top 6-8 inches of soil; deeper amendment will lead to settlement problems.
- Calculations for the various amendment quantities can be kept simple by the following conversion: one inch of material spread over 1000 square feet is equivalent to approximately three cubic yards.
  - ◻ If this one inch is of typical yard debris compost, with an organic content of 50% and bulk density of 1000 pounds per cubic yard, it will increase the organic content of the soil by approximately 2.5 to 3.5 percent when incorporated into the loose eight inch soil depth.
- For onsite blending of stockpiled soils, the organic content of all existing subsoils exposed during site construction is expected to be less than one percent.
- Compost with a 45-60% organic content is used to supply almost all of the organics to the new blended soil profile.
- As a general rule of thumb, a ratio somewhere between 3:1:2 to 1 of existing low organic (subsoil) soil to compost, by loose volume, will achieve the typically desired organics level of 8 to 12 percent.
  - ◻ Lower ratios should be used if blending higher organic existing topsoil with compost.
  - ◻ Testing should be used to more precisely determine specified blending ratios as well as to determine suitability of existing soil materials for reuse.

DESIGN

USE QUALITY COMPOST

- Compost should be a stable, mature, decomposed organic solid waste that is the result of accelerated, aerobic biodegradation and stabilization under controlled conditions.
- Properly prepared compost should have a uniform dark, soil-like appearance with no visible free water or dust and with no foul odors.
- Compost maturity or stability is the point at which the aerobic biodegradation of the compost has slowed and oxygen consumption and carbon dioxide generation has dropped.
- Poorly aged compost or compost that does not meet minimum federal and state safety standards for heavy metals or pathogens can be damaging to the landscape and lead to a number of environmental problems including:
  - ◻ Chemical or biological contamination
  - ◻ Introduction of weed seeds
  - ◻ Plant toxicity due to high ammonium content
  - ◻ Nitrogen leaching from existing soils and plants due to improper aging
- The U.S. Compost Council, the US Environmental Protection Agency, and the New York State Department of Environmental Conservation have developed industry standards and testing protocols that can be used to evaluate the suitability of compost materials.
- Different tests will produce different test results and levels.
- Specifications for compost should clearly indicate the required testing protocol and the testing lab should indicate in the test report which protocol was used to determine compost levels so that comparisons between specifications and materials are compatible.
- The designer should indicate acceptable local suppliers of compost materials, however materials provided by these suppliers should still be subject to testing and approval prior to use.
- Contractors should be allowed to suggest alternative suppliers, but the designer should require a site visit to observe compost production procedures and conditions in addition to requiring testing and approval prior to use.
- A site visit to a compost vendor's site is a critical part of determining if the vendor will be able to supply the quantity and quality of compost materials required for a project.

COMPOST TESTING PROTOCOLS AND RECOMMENDED MINIMUM PERFORMANCE CRITERIA

Compost testing requires specialized skills and experience. Testing required for compost is not the same as testing for soils, though there is some overlap in protocols that may be used. While some testing labs are experienced in testing both soils and composts, it is not unusual that testing labs are unable to complete all of the

necessary testing procedures needed to properly evaluate the suitability of a compost product. Since there will be variability between composts depending upon the source materials of the composts and their maturity, thorough testing is required to determine appropriate mixing rates to achieve particular results within soil mixtures.

- Testing for compost should include:
  - pH
  - Soluble salts
  - Organic content
  - Moisture content
  - Particle size
  - Bulk density
  - Nutrient content
  - Contaminants[42]
    - Heavy metals
    - Pathogens
    - Solids including plastics, metal, glass, and other inert materials
    - Organic chemical compounds including herbicides

USE APPROPRIATE TESTING STANDARDS

While there are both federal (USEPA and USDA) regulations as well as New York State (NYSDEC and NYSDAM) regulations that pertain to compost, there are nationally or state mandated requirements for testing composts. The US Composting Council (USCC) has published a standardized set of methods for compost testing. The program is called Test Methods for the Examination of Composting and Compost (TMECC). The USCC also has a laboratory certification program as part of their Seal of Testing Assurance (STA) Program. Not all qualified labs are enrolled, but these labs may be a good option, since oversight is provided. Consult the USCC website for an updated list of STA certified labs at www.compostingcouncil.org. If you choose not to use an STA certified lab, contact the lab to discuss which testing protocols they typically use.[43] There are other protocols for compost testing that are commonly used by area extension service testing labs including Rutgers University, Penn State University, Cornell University, and the University of Massachusetts. These testing protocols include test methods from:

- ASTM: American Society for Testing and Materials Standards
- Northeastern Regional Publication No. 493: Recommended Soil Testing Procedures for the Northeastern United States, 2nd Edition.. Agricultural Experiment Stations of Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont and West Virginia; Revised,—December 15, 1995.
- ASA: American Society of Agronomy, Methods of Soil Analysis Part 1, 1986.
- AOAC: Analyses by Association of Official Agricultural Chemists, Official Methods of Analysis
- Solvita Procedure, Woods End Laboratories

Regardless of the testing protocols used, provided that the testing lab is qualified and experienced in working with compost, the target ranges indicated in the chart at the end of this BMP section would still apply.

CONSTRUCTION

USE PRECONSTRUCTION TESTING

- If testing has not taken place as part of the design process, the existing soil must be tested prior to soil amendment.
- After testing, the soil scientist can use the soil analyses to determine amendment quantities required, plan the amending process, and proper material volumes can be ordered.

ENSURE PROCUREMENT OF COMPOST COMPLIES WITH SPECIFICATIONS BY CLEARLY LAYING OUT TESTING AND VERIFICATION PROCEDURES IN CONSTRUCTION SPECIFICATIONS

To simplify procedures, the contractor should be responsible for identifying proposed compost sources and that the sources can provide adequate volumes for the project, including providing test data indicating that the compost meets the specification requirements. The contractor should then obtain samples of the material for testing to demonstrate the actual proposed material meets the specifications. Testing for compliance of compost materials should be completed at the source location on a sample of the actual compost to be used prior to delivery to the site. Do not rely on supplier testing data that may be out of date or not representative of the actual material supplied.

- Compost may need to be ordered weeks in advance to ensure availability, especially during the spring season.
- Sufficient quantities of compost are generally available in the fall, but they are frequently delivered before the product has completely decomposed.
- If space is available at the site, having the compost delivered up to eight weeks in advance of use allows the composting process to be completed onsite.
- Testing before use:
  - Require contractor to identify compost source and available volumes before start of any site construction operations.
- Identification of the compost supplier should be a required part of the bid form, requiring the contractor to demonstrate compliance with the work requirements prior to award of the job.

ENSURE COMPOST QUALITY BY REQUIRING TESTING UPON DELIVERY TO THE SITE

Once the compost product is delivered to the site, it is critical to test the material before use to ensure the material is well decomposed.

- If the delivered product is determined not to be sufficiently mature, adjustments to the installation process and schedule will be required.
- Site aging of the compost typically delays subsequent landscape installation operations.

COORDINATE COMPOST TESTING NEEDS WITH CONSTRUCTION SCHEDULE

Soil and soil amendment testing, especially compost testing, is often poorly understood and inadequately planned for within construction schedules. Poor planning leads to needless compromises on longterm quality.

- Require the contractor to include testing and approval

PARAMETERS	UNITS OF MEASURE	TESTING PROTOCOL	RECOMMENDED RANGE
pH		TMECC 04.11-A, “Electrometric pH Determinations for Compost”	5.5-7.5
Soluble Salt Concentration	dS/m (mmhos/cm)	TMECC 04.10-A, “Electrical Conductivity for Compost”	≤2
Nutrient Content (dry weight basis)			N: 1-2.5% P: 1-2% K: 0.5-1.5%
Carbon-to-Nitrogen Ratio			12:1-25:1
Moisture Content	Content %, wet weight basis		40-50%
Water Holding Capacity (dry weight basis)			>100%
Organic Matter Content[44]	% (dry mass)	TMECC 05.07-A, “Loss on Ignition Organic Matter Method”	20-60%
Particle Size	% Passing a selected mesh size dry weight basis	TMECC 02.02-B, “Sample Sieving for Aggregate Size Classification”	<3/8” for soil amendment >1/2” for mulch or topdressing lawn areas
Debris Content			Debris such as metal, glass, plastic, wood (other than residual chips), asphalt, or masonry shall not be visible and shall not exceed one percent (1%) dry weight.
Bulk Density			800-1,000 lbs/yd3
Maturity[45]		Solvita Test	≥6 (mature)
Stability	Carbon Dioxide Evolution Rate mg CO_2-C per g OM per day	TMECC 05.08-B, “Respirometry”	< 8
Maturity	Seed Emergence and %, relative to positive control and Seedling Vigor %, relative to positive control	TMECC 05.05-A, “Biological Assays”	Minimum 80%
Physical Contaminants	mg/kg (ppm)	TMECC 04.06, “Heavy Metals and Hazardous Elements” TMECC 04.13-B, “Atomic Absorption Spectrophotometry”	Meet or exceed US EPA Class A standard, 40 CFR § 503.13, Tables 1 and 3 levels
Biological Contaminants	Fecal Coliform Bacteria, or MPN per gram per dry weight	TMECC 07.01-B, “Fecal Coliforms”	Meet or exceed US EPA Class A standard, 40 CFR § 503.13, Tables 1 and 3 levels

of compost as a specific line item within the construction schedule since testing of compost takes approximately four weeks to complete.

- Plan for at least two complete compost test cycles within the proposed schedule to ensure sufficient time to obtain acceptable compost material.
- The minimum time that should be allotted to compost testing and approvals is two months.
- Three to five months is the preferred schedule allotment to allow for adequate time for disqualification of source materials and the location of acceptable materials verified by testing.

FOR FURTHER INFORMATION

- Chollak, T. and Rosenfeld, R. *Guidelines for Landscaping with Compost-amended Soils*. Prepared for City of Redmond Public Works, Redmond, WA. 1998. http://www.ci.redmond.wa.us/insidecityhall/publicworks/environment/pdfs/compostamendedsoils.pdf
- Compost Fact Sheet #2: *Regulation and Certification of Composts*, Cornell Waste Management Institute, 2005. http://cwmi.css.cornell.edu/compostfs2.pdf
- Guidelines and Resources for Implementing Soil Quality and Depth BMP T5.13 2007 Edition. http://www.soilsforsalmon.org/pdf/SoilBMP_Manual-2007.pdf
- E&A Environmental Consultants, Inc. *Development of Landscape Architect Specification for Compost Utilization*, Seattle, Washington, December 1997. http://www.cwc.org/organics/org972rpt.pdf
- U.S Composting Council (USCC), *Test Methods for the Examination of Composting and Compost (TMECC)*, Holbrook, NY 11741. www.composting-council.org
- United States Environmental Protection Agency, *Compost Specification for Soil Incorporation* http://epa.gov/osw/conserve/rrr/composting/highway/highwy4.pdf
- United States Environmental Protection Agency. *Code of Federal Regulations (USEPA, CFR), Title 40, Part 503 Standards for Class A biosolids.*

41 **E&A Environmental Consultants, Inc. Development of Landscape Architect Specification for Compost Utilization, Seattle, Washington, December, 1997.**

42 **Testing of contaminants is regulated by both the federal and state government, depending upon the type of compost products being used. Organic chemical contaminant and herbicidal testing can be both expensive and time consuming. Typically these tests are done by bioassays. See further Maurice E. Watson, Testing Compost, Ohio State Extension Service Bulletin ANR-15-023. http://ohioline.osu.edu/anr-fact/0015.html**

43 **Cornell Waste Management Institute, Compost Quality Fact Sheet #4, Ithaca, NY: Cornell University, 2004, p.3.**

44 **Compost generated from yard waste and leaf mold is generally lower in organic than compost generated from biosolids. Understanding organic content is critical to determining how much compost to use to alter overall soil mix organic content.**

45 **Compost stability and maturity are critical issues to understand when using compost, The TMCC does have a protocol for testing maturity, and the Solvita test method is perhaps a better measure and generally takes less time. Increasingly, labs are now using this protocol in place of the TMCC 05.08-B, "Respirometry" and TMECC 05.05-A, "Biological Assays" test protocols. For further information see: http://solvita.com/compost_info.html and http://solvita.com/pdf-files/Quick_guideV5.pdf**

S.5 TESTING, REMEDIATION, AND PERMITTING FOR SITES WITH CONTAMINATED SOILS

OBJECTIVE

Improve sites by cleaning up contaminated soils and making them usable as parks.

BENEFITS

- Cleaning up contaminated sites provides new land for park development, and improves the quality of the environment for city residents.
- Remediating contaminated sites reduces health risks.

CONSIDERATIONS

- Sites with contaminated soils require extensive testing, permitting, and remediation due to health concerns and regulatory controls.
- Testing must be conducted early in the process, before or parallel with park design.
- Soil testing and analysis, as well as remediation design, must be budgeted in addition to the normal design costs.
- Considerable experience and expertise is required to properly examine a site for contaminants before the site can be used as parkland.
- Site remediation and soil cover can easily double the cost of a park project.

BACKGROUND

In New York City vacant land is likely to be contaminated to some degree for many reasons, including leaking oil tanks, or unlawful dumping of batteries, oil and building debris, even hazardous materials. Contamination due to illegal dumping is highly likely adjacent to roads in isolated areas or near bridges, railways, waterways, and land filling operations. Some areas were filled with soil and materials regarded as safe when they were installed, but now exceed acceptable limits of contamination. Any site that has a history of manufacturing, industrial, or service establishments such as dry cleaners, printing or photo processing shops are suspect.

One of the great challenges with working on sites within New York City is that there are relatively few areas where there are undisturbed soils, so it is difficult to know for sure what sorts of potentially hazardous conditions may exist below grade. As a matter of course, all sites, including ones assumed to be clean, should be screened for potential contamination. Sites with contaminated or even suspected contaminated soils must be tested early in the design process, as contamination will have a major impact on site planning and the construction budget. If chemical contamination is suspected at a site, the Capital Projects' Environmental Control Unit (ECU) should be consulted.

There are four types of soils that designers may encounter:

- Clean, nonimpacted soils (unclassified soil / fill)
- Historic fill soils, often referred to as urban fill sites (typically nonhazardous, contaminated soil)
- Former municipal landfill waste and cover soil
- Hazardous waste/fuel or chemical spill

Historic fill should be assumed to be contaminated and the soil should be tested even if no environmental permits are anticipated. Historic fill or urban fill material is nonindigenous material historically placed on site in order to raise the topographic elevation and typically contains construction debris. Urban fill typically contains coal ash, PCBs, and heavy metals and should be analyzed/tested accordingly. Urban fills usually require a soil rejuvenation program or soil cover, however sometimes the contamination is sufficient to require disposal or special handling.

A future park's location is a significant factor in the number of permits or approvals needed. The first step is compliance with the City Environmental Quality Review (CEQR) process, where 20 criteria are used to assess whether park development may create impacts to the area. The process could end with a finding of no impact, or it could result in a memorandum of understanding among agencies and Parks on ways to mitigate potential impacts. Other steps in the approval process involve acquiring permits that address soil erosion, tidal wetlands, coastal erosion, and freshwater wetlands.

- If soil is contaminated but not hazardous it may be left in place depending on the anticipated final land use. A geotextile, impermeable cap such as pavement or cement, or clean soil/fill material may be required to be placed over the contaminated soil to provide a barrier against human exposure. A demarcation material or substance (e.g., plastic construction fencing) should be placed on the existing soil before the clean fill in order to delineate the clean fill/soil from contaminated soil and ensure proper handling and disposal procedures. The recommended depth of clean fill/soil should always be maintained to prevent human exposure. This is recommended in those instances where Parks follows New York State regulations most applicable to historic fill sites at 6 NYCRR Part 375-6.8(b).

Former municipal landfill waste, landfill cover soil, and hazardous waste sites are subject to New York State regulations applicable to solid and hazardous waste sites are 6 NYCRR Part 360 and Part 370, respectively. These are likely to require extensive testing, soil removal and soil cover.

The Pennsylvania and Fountain Avenue landfills in Queens, operated as waste disposal sites in the 1950s and 60s, were capped with an impermeable membrane and covered by millions of tons of sand and topsoil brought in by barge. Analysis of regional soils and plant communities provided the blueprint for soil specifications on site.

Despite the challenges of determining the extent of contamination and subsequent remediation requirements, chemically contaminated sites represent substantial opportunities for increasing parklands and, as a result, improving urban ecological functioning and outdoor public access.

PRACTICES

PERMITTING AND TESTING

The primary concern for any contaminated site development is the health and safety of workers and the public. The challenge of accomplishing this is much greater for brownfields and recovered sites. The strategy for success involves a number of steps, including:

- Phase 1 environmental site assessment
- Phase 2 environmental site assessment, which includes soil testing and analysis
- Park design
- Permits and approvals
- Waste disposal
- Fill material importation

It is important that park design, soil testing and analysis, and permits proceed in parallel and not sequentially. Each step is discussed below.

PHASE 1 ENVIRONMENTAL SITE ASSESSMENT

This initial survey of site conditions involves a visual inspection of the site and a review of documents, maps, reports, and other available information that may shed light on potential contamination at a site. The assessment should follow ASTM E1527-05.

- Look for visual cues that the site could be contaminated:
  - Was the site previously used for industrial purposes or waste operations?
  - Is there exposed waste? Are there signs of illegal dumping?

- □ Are there monitoring wells for landfill gas or groundwater on the site?
- □ Is the area covered with invasive plants indicative of site disturbance?

- Perform a document search
  - □ Maps could show land uses that would have been likely sources of contamination.
  - □ Was it used by a business that employed hazardous chemicals, such as dry cleaning fluid, paint thinners, pesticides?
  - □ Was there a gas station or building that would have used underground tanks for oil?
- Perform regulatory database search and records review for petroleum spills, institutional/engineering controls, etc.

PHASE 2 ENVIRONMENTAL SITE ASSESSMENT

This investigation involves soil and groundwater sampling, based on the outcome of the Phase 1 investigation. The assessment should follow ASTM E 1903-97 (2002). Work with the Parks Environmental Remediation unit to determine a proper protocol for testing.

- If the Phase 1 investigation identifies a below ground fuel storage tank, for example, the Phase 2 investigation would include test pits or even technologies, such as ground penetrating radar, to locate buried metal objects, wells to identify contaminated groundwater and/or groundwater flow direction, and soil samples to define the extent of contamination.
- Soil testing locations should be evenly distributed across the entire site with additional focus on locations of suspected contamination. Sample spacing is dependent on the potential contaminant sources and the anticipated use area of the park.
- If buildings are planned, the site should be assessed for soil gas vapors. If present, the building(s) may need to be monitored for the presence of these vapors, and if significant vent them.

PERMITS AND APPROVALS

New park projects usually require one or more permits or special approvals.

City Environmental Quality Review (CEQR)

The first step in the environmental review arena is compliance with the City Environmental Quality Review (CEQR) process that is administered by the NYCDEP. It is New York City policy to limit activities that would have negative impacts on the environment. Park development requires completion of a seven page Environmental Assessment Statement (EAS) that requires information on 20 technical areas, including urban design/visual resources, historic resources, hazardous materials, waterfront revitalization program, and public health. Parks planning office usually leads this process.

The CEQR identifies any potential adverse effects of proposed actions, assesses their significance, and proposes measures to eliminate or mitigate significant impacts. Only certain minor actions (known as Type II actions, see Appendix A below for commentary) are exempt from environmental review.

If the action is judged not significant (see Appendix B below for commentary), a negative declaration is issued, signaling completion of the CEQR process. These notices are sent to all involved or interested agencies, affected community boards, and elected officials. A typical end result of this process is a memorandum of understanding between Parks and other city agencies to address areas of concern that are not covered in specific regulatory programs such as those discussed below.

If the proposed actions are judged to have significant impact, NYCDPR files a positive declaration, requiring the completion of a draft environmental impact statement (EIS). This is a major undertaking, which will not be described here. Once the EIS is complete a notice of completion is filed, a public hearing is held, and a final EIS is filed.

When New York State regulations apply to an action, a regulatory official may request submittals in compliance with State Environmental Quality Review (SEQR) requirements, which is equivalent to the CEQR process. SEQR is not applicable within New York City, as NYCDEP has been authorized to run the CEQR program in lieu of SEQR. In this circumstance, NYCDPR should request NYCDEP guidance on how to proceed.

Examples of permits that may be needed for the development of a park are listed.

- The most common permit requirement is the State Pollutant Discharge Elimination System (SPDES) that requires the preparation of a Storm Water Pollution Prevention Plan (SWPPP) for sites greater than one acre, and for smaller sites under specific conditions.
  - □ The SWPPP commits Parks to take precautions to prevent soil erosion.
- Another common permit (issued separately by the NYSDEC and the US Army Corps of Engineers) is the tidal wetlands permit, as many of the city's parks are located along the 577 miles of coastal lands. Many times this permit is issued concurrently with a navigable waters (excavation and fill) permit and a 401 water quality certification.
- Other permits include ones for freshwater wetlands, solid and hazardous waste management, air pollution control, and coastal erosion hazard areas.
- Projects in coastal areas and some designated inland waterways (where local waterfront revitalization programs have been developed) require a NYS Department of State (NYSDOS) Coastal Consistency Certification.
- In addition to these permits, city agency permits and approvals are needed, including those from the NYC Department of Buildings (NYCDOB), and NYCDEP.

WORK WITH IN-HOUSE EXPERTS, THEN REGULATORS, IN PARTICULAR NYSDEC, TO DETERMINE THE NEED FOR AND METHODS OF REMEDIATION

When working on sites with suspected or confirmed contamination, it is essential to work with the regulating agencies from the start of a project—even prior to the start of soil testing and analysis. Project designers and managers should confer with Capital Projects' Environmental Remediation staff, who may request assistance from the NYC Office of Environmental Remediation that assists city agencies in addressing contaminated site issues.

- Cooperatively develop clear project goals and objectives including specific planned uses of the site and anticipated sampling, testing, remediation, and construction.
  - This allows all parties involved to better understand the project objectives and testing protocols.
- After the sampling and analysis is complete, identify acceptable remediation alternatives.
- Clearly identify the interfaces between remediation work and proposed park construction and maintenance.
- Identify which design elements will need to be coordinated and approved for use with remediation activities.
- Identify protocols for park construction and maintenance subsequent to the completion of remediation, including hazardous material handling, testing, and inspection.
  - It is likely this will require the use of consulting environmental remediation experts and soil scientists to assist with regulating agency coordination, developing remediation plans, and the evaluation of alternative remediation approaches including budgets and schedules.
- Use consulting soil scientists to assist with the evaluation of:
  - Site conditions and opportunities for soil reuse
  - Analysis of proposed soil capping materials and methods
- Regulators and environmental engineers can be focused solely on isolating contaminants from human contact. As a result, soil caps are generically specified without considering the ability to support future plantings.
- Improperly specified capping soils can result in poor drainage and are susceptible to excessive compaction during construction, resulting in limited rooting opportunities not just for trees but for shrubs and grasses. The soil composition must consider the needs of native species as appropriate.
- If impermeable caps are required to prevent the surface infiltration into contaminated soils, a soil scientist can assist with proper specification of cap placement, slopes, and cover materials that will allow for viable plantings above the capping layer.

CONDUCT SOIL TESTING AND ANALYSIS

Before soils or historic fill are excavated, a chemical analysis of contaminants must be made of the material for four reasons. First, construction workers and site personnel have a right to know the nature of soils with which they are working so that they may wear appropriate clothing and protective equipment. Second, the disposal sites require the analysis before the material will be accepted. Third, the analysis will determine whether soils should be excavated and stockpiled, or loaded directly onto trucks for disposal. If contaminated, the soils should not be stockpiled. Fourth, the soil may be clean enough to reuse onsite.

- Work with the Capital Projects' Environmental Remediation staff and the regulator to develop a soil testing grid and protocol based on the examination of the site and its historic uses.
- DEC prefers soil analysis to include hazardous waste characteristics (i.e., TCLP analysis), and chemical analysis for volatiles, semivolatiles, PCBs, pesticides, and metals.
- All activities such as sample collection, transportation, and sample delivery to the analytical laboratory must be performed by a New York State qualified environmental professional, using approved chains of custody.
- The laboratory must be certified by the NYS Department of Health (NYSDOH) under their Environmental Laboratory Approval Program (ELAP).
- NYSDEC prefers a 50 foot by 50 foot grid of tests two feet deep. For large areas, the sampling grid distances may have to be enlarged and the degree of compositing samples may have to be expanded for budgetary purposes.
- A cost benefit analysis should be conducted in terms of grid distances. Additional sampling costs that result in better contaminant delineation and in decreases in soil removal and import may lead to significant cost savings.
- Sampling is not generally required in areas where existing soils will not be excavated and where clean soil cover or an engineered cover (such as buildings, pavement, or impervious synthetic turf) will be placed.
- See *Part 2: Site Assessment*.
- See the Calvert Vaux soil sampling protocol, dated January 27, 2009 (in *Part 6: Case Studies*) for directions on how the first phase of that project is planned to be sampled and the samples analyzed.

DISPOSE OF WASTE AND CONTAMINATED SOIL APPROPRIATELY

The following points provide further guidance on managing waste soils.

- When excess soil must be managed, NYSDEC prefers representative samples be collected, using a 50 foot by 50 foot grid, compositing a single sample from four locations within each grid space, to a depth of two feet below the final design grade.
- In the case where several feet of excavation are required, sampling should be similarly conducted at every two feet of depth.
- Depending on the results, waste soil would be directed for disposal to a hazardous, nonhazardous, or unclassified (i.e., construction and demolition or municipal solid waste) disposal site.
- For a nonhazardous or hazardous waste site, a waste profile form must be completed, certified by a NYCDPR official, and submitted to a representative of the disposal site.
- For hazardous wastes, a special RCRA Subtitle C Site Identification Form (US EPA Form 8700-12 found at http://www.epa.gov/osw/inforesources/data/form8700/8700-12.pdf) must be filled out and sent to the US EPA Region 2 office so that a hazardous waste generator ID number can be assigned.
  - The ID number must be entered on waste profile forms and waste manifests that are carried to hazardous waste disposal sites by waste transporters.

DESIGN

Areas of contamination will control the location of new uses, the soil removal and fill, as well as site access and uses.

INVOLVE THE REMEDIATION DESIGN TEAM IN THE DESIGN OF THE PARK

- Remediation and park development should not be treated as two separate and unrelated activities.
- Close collaboration between the remediation design team and the park design team or, better yet, integration of the remediation and park design as a single project can lead to project efficiencies that are mutually beneficial.
- There are significant opportunities during the investigation and remediation planning for maximizing soil reuse, thus minimizing import of soil.
- Once contaminant results are obtained that sufficiently delineate contaminated areas (in three dimensions), the environmental remediation professional involved in the remediation project can work with the design team to optimize the cut and fill required for the project.

OPTIMIZE USE OF CONTAMINATED SITES

Based on the results of soil sampling and analysis, park programming and facility construction should be matched to levels of contaminants found.

- For soils areas with elevated contaminant concentrations, features such as artificial turf, pavement, or buildings should be considered to serve as appropriate barriers to contamination.
- When placing buildings on contained areas, consideration must be given to the potential for vapor intrusion (i.e., fumes from the subsurface entering built structures through the slab, thus contaminating the indoor air or presenting an explosion hazard).
- The NYSDOH provides guidance on this issue, and often special mitigation measures and engineer controls must be taken to eliminate vapor migration from the subsurface to the indoor air.
- Areas that exceed the restricted residential Soil Cleanup Objectives (SCOs) of NYSDEC but meet commercial SCOs should be selected for passive recreational uses.
  - These areas may require one foot of compliant cover soil.
- Passive recreation areas should be areas "which have public uses with limited potential for soil contact," as per NYS DEC[46]
- Special exemptions for areas with mature trees should be considered regarding the placement of cover soil over critical roots zones, which will kill trees.
- Areas that exceed the commercial SCOs, upon additional assessment, may be reserved for wilderness areas or nature based uses that have restricted human intrusion.
  - The designer should be careful to locate only those activities which meet this definition such as forested areas with restricted access, wetlands, or other forever wild areas.
- Areas meeting the restricted residential SCOs are appropriate for active recreational uses.
  - These areas also include ballfields and soccer fields.
- Traditional open lawn areas, seating areas, and planting bed areas, which are typically considered passive recreation, are considered as active recreation because they have a greater potential for soil contact.
  - These areas may require two feet of compliant cover soils.

CONSIDER PRESERVATION OF EXISTING PLANT COLONIES ESTABLISHED ONSITE

This is extremely difficult because if the site is contaminated, use of vegetated areas will be restricted.

- Existing plant life on a contaminated site serves numerous ecological functions.
- Since many contaminated sites are also located in otherwise industrial or built out areas, existing plant life represents important green space within a neighborhood.

CONSIDER PHYTOREMEDIATION AND BIOREMEDIATION FOR CONTAMINATED SITE CLEANUP

Phytoremediation and bioremediation are sciences that show great potential for use in the remediation of contaminated urban soils. It should be noted that the appropriateness of phyto- and bioremediation is highly contaminant specific. Metals and recalcitrant organic compounds are not biodegraded, and often are simply redistributed by the biological activity of plants or bacteria. In some cases this can mean that the compounds are concentrated in high levels that could become dangerous. When compounds are taken up by the plants, the plant material could cause wildlife and human exposures to the contaminants. Such accumulation scenarios require harvesting and proper disposal, and can be highly labor intensive and costly. Plants have been found to volatilize contaminants in the root zone and leaf stoma, thus creating localized air contamination. Experts in environmental biotechnology, environmental engineering, environmental chemistry, botany, as well as landscape architects should be consulted prior to considering such a strategy. The Parks Environmental Remediation staff can assist you in finding more information.

Phyto- and bioremediation should be judiciously used and the results carefully monitored to determine their efficacy as they are potentially cost effective methods of remediation.

- A number of projects throughout the United States and the world have successfully used these techniques to remediate contaminated soils.
- It may take longer than more conventional approaches, but often at significantly lower cost.
- Careful study is required to determine if this is an option within the project scheduling parameters and regulatory oversight.

SPECIAL CONSIDERATIONS FOR PARKS ON FORMER LANDFILLS

Special regulations will apply to a former landfill as its landfill designation never expires. It is difficult to get NYSDEC approval for introducing trees and other plants within the engineered cap, which has permit specifications to be met now and in the future. It is likely that certain allowable tree species can be planted, but other

volunteer species must be removed. Methane exposures will always be an issue.

CONSIDER SEPARATE CONTRACTS FOR SITE REMEDIATION WORK AND PARK CONSTRUCTION WORK

Remediation work and park construction are two very different types of projects that require divergent contractor skill sets. While some contractors are sufficiently experienced to do both types of work, the pool of potential contractors and, therefore, competitive bidders, is larger if the work is broken into two separate contracts.

Landscaping contractors should be made aware of and follow any site management plans associated with remediation in order to prevent compromising the remedial efforts and unnecessarily exposing workers to potential hazardous materials (i.e., co-mingling of contaminated and clean fill, preserving the integrity of any geotextiles or demarcation barriers) This also applies to future maintenance work.

There are a number of other benefits to separating the contracts.

- Remediation work requires significantly higher bonding requirements, the cost of which would have to be borne over the duration of the park construction if it were issued as a single contract.
- If a site has been successfully remediated, subsequent contract work has a reduced liability and risk, translating into lower bid pricing.
- Separate contracts limit contractor exposure to site contaminants once remediation is complete.
- Isolating traditional site construction from more specialized soil remediation construction work acknowledges that a remediation contractor is not a landscaping subcontractor.

CONSIDER STAGED RESTORATION AND OCCUPATION OF CONTAMINATED SITES

- Complete the identifiable, noncontaminated, nonwetland portions of the project first; these areas may require fewer or no permits. Subsequently complete other, specific projects that are more likely to require regulatory permits.
- For projects where complete restoration of the site and construction of a park program may exceed available funding, consider a staged restoration of the site.
- It may be possible to clean up or contain selected areas to allow limited access or to introduce phyto- or bioremediation installations that may begin the restoration of the site to a more usable state.
- There may be ways to implement significant habitat improvements with staged restoration and occupation of the site of benefit to the surrounding neighborhood.

CONSTRUCTION

FILL MATERIAL IMPORTATION

A typical NYSDEC, NYCDEP, and NYCOER requirement for park development is the importation of soil to fill in areas where waste had been excavated and disposed offsite, to grade a site for new features, and to cover in-place contaminated soils. All agencies require precautions be taken to assure that only approved materials are brought to a project site. All agencies also require that representative samples of the fill be analyzed for the list of parameters listed in NYSDEC's technical and administrative guidance #4046 (TAGM 4046, found at http://www.dec.ny.gov/regulations/2612.html) and require assurance that the fill does not exceed the clean up concentrations listed therein (see Appendix C below for commentary). Parks' challenge is to establish a sampling regime that any agency would approve. Such a regime should include these features:

- Representative samples should be collected and analyzed under the supervision of Parks or its contractors and not by the suppliers of the fill.
- Use of a fill source that is plentiful enough for the entire need of the project, if possible.
- Sampling and analysis at a rate of one per 250 to 1,000 cubic yards of delivered fill, the rate being determined by DEC based on site specifics.
- Both agencies will require more frequent sampling when more than one fill source is required for the project or if the appearance (e.g., light vs. dark colored, sand vs. rock, moist vs. dry) of the fill is variable.
- See Appendix D below for additional details.

APPENDICES

APPENDIX A—TYPE II CEQR ACTIONS

Type II CEQR actions exempt from CEQR (note: these are abridged descriptions) include:

- Maintenance or repair that involve no substantial changes to a structure or facility
- Minor temporary uses of land with negligible or no permanent effect on the environment
- Construction or expansion of single- to three-family residences or nonresidential structures of less than 4,000 square feet
- Replacement or rehabilitation of a structure on the site where it originated
- Maintenance of existing landscaping or native growth
- Expansions of existing educational institutional structures by less than 10,000 square feet of floor area

APPENDIX B — PARK DEVELOPMENT AS POSITIVE ENVIRONMENTAL IMPACT

Nonsignificant environmental impacts should be expected at Park development sites. Park development includes the removal and remediation of contamination, so this can only be considered positive.

APPENDIX C— TAGM #4046

It is questionable whether TAGM #4046 standards (established in 1994) legally apply to historic fill sites (the predominant type of material found at NYC parks sites), given that NYSDEC states the standards apply to Federal Superfund, State Superfund, 1986 EQBA Title 3 and Responsible Party (RP) sites, and when NYSDEC determines that cleanup of such a site to predisposal conditions is not possible or feasible. It is believed that the generally less restrictive standards of 6 NYCRR Part 375-6(b) (established in 2006 and found at http://www.dec.ny.gov/regs/15507.html#15513) actually apply, but until the authority of TAGM #4046 limits are successfully challenged, both Part 375 and TAGM #4046 are to be used.

APPENDIX D — FILL MATERIAL IMPORTATION — ADDITIONAL DETAILS

Fill material quality is a concern that must be addressed in order to provide a safe and healthy soil for the development of a park. The soil must be appropriate for the types of plantings proposed. It should also not be destructive of the place it is removed from. In most instances top soils are removed from construction sites. However, due diligence should be exercised to prevent stripping of green field sites.

Some materials, such as excavated metamorphic rock from subway line extensions, may require reduced testing due to the lack of potential exposure to contaminants only found from human exposure. Other materials, such as excavated soils from beneath paved airport runways, can be uniform and consistently clean and could qualify for reduced testing. This is not the case for fueling or maintenance areas at airports. A common source of material is from a large development project, such as the construction of the parking lots for Yankee Stadium in the Bronx. In these or similar sites, an investigation into the origin and boundary of a targeted material must be completed, using historical maps and other documentation. The current condition and condition at the time of the importation must be known to avoid inadvertent contamination.

Typically, the soil owner collects a representative sample or set of samples in the presence of an independent environmental monitor (IEM), and the samples are then taken, under chain of custody, by the approved laboratory. The IEM may use appropriate field testing equipment such as a photoionization detector (PID) for volatile organics, or x-ray fluorescence (XRF) analyzers for metals in soil. Another control that may be required to prevent noncompliant fill material being imported to a project site involves continuous communication between a NYCDPR contractor at the fill excavation site and a coworker at the receiving park site. Tracking the license numbers of trucks leaving and arriving prevents noncompliant trucks from slipping in.

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- TAGM#4046 — see http://www.dec.ny.gov/regulations/2612.html
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S.6 USE ENGINEERED SOILS TO MEET CRITICAL PROGRAMMING NEEDS

OBJECTIVE

Use engineered soils when needed to withstand urban stresses and conditions where naturally occurring soils are unable to function.

BENEFITS

- The performance of engineered soil is highly predictable due to the inclusion of installation as part of a complete soil system from finished surface down to subgrade.
- Key soil performance criteria can be easily controlled with manufactured soils including compaction resistance, organic content, drainage and infiltration rates, soil weight, bulk density, and filtration of pollutants.
- Engineered soils generally make use of derelict materials, such as sand or stone aggregate and recycled products, making them highly sustainable products.
- Engineered soils may provide a greater range of design and construction opportunities than naturally occurring soils.
- The long term maintenance of landscapes that rely on engineered soils is often less costly than that of naturally occurring soils that may not be well suited to the programmatic use of the site.

CONSIDERATIONS

- Use of manufactured soils requires a specifically designed soil material and implementation oversight by experienced designers or soils scientists to ensure proper installation.
- Manufactured soil procurement costs may be more than natural topsoil due to controlled mixing.
- The procurement of engineered soils is lengthier than procurement of naturally occurring soils due to the need for sourcing and testing of component materials and the development of final mix proportions.
- Manufactured soils may require specialized testing and installation procedures.

INTEGRATION

- *S.7 Provide Adequate Soil Volumes and Depths*
- *S.8 Provide Soil Placement Plans as Part of Contract Documents*
- *W.5 Use Rain Gardens & Bioretention*
- *W.6 Use Stormwater Planter Boxes*
- *W.8 Create Green and Blue Roofs*

BACKGROUND

New York City's parks are unusual in that they are subjected to a wide variety of programming uses at extremely high levels of use and require materials that can function under extreme construction circumstances. Naturally occurring, loam based soils are often too limited in their carrying capacity (due to textural classification, drainage rates, filtration capacity or structural performance) to meet some of the more extreme soil conditions that often needed in the city's parks. Examples of these situations include high use lawns and sports fields, lightweight green roofs, stormwater quality basins and rain gardens, and compactable planting soils located below pavement areas along streets, in plazas and in parking lots.

Engineered soils should be considered as part of a varied soil design palette available to park designers to meet the city's broad open space needs. Because they are designed and manufactured soil systems, engineered soils are highly consistent and predictable in the performance, allowing them to serve long term needs in parks.

Engineered soils have been used for decades around the world on golf courses and green roofs. They have been used extensively on New York City parks including such locations at the Great Lawn in Central Park, Battery Park City, Hudson River Park, Brooklyn Bridge Park, Metrotec Center, on sports fields, for bioretention and stormwater filtration basins, and on numerous street tree applications.

Today, manufactured soils have been recognized as especially useful on highly disturbed urban sites or in locations where basic soil functions cannot be accommodated without wholesale replacement of the soil including:

- Areas of extensive urban fill exhibiting a variety of horticultural challenges such as poor structure, high pH, poor drainage, or heavy compaction
- Areas that have or will become heavily compacted due to construction staging or will be subjected to unavoidable, irreparable compaction due to exposure to repeated heavy vehicle traffic
- Landfill or contaminated sites that require capping or isolation of toxic materials from human contact

Manufactured soils are also commonly used in areas where specialized site programmatic needs cannot be met through the use of naturally occurring, loam based soil mixes including:

- Rooftop or other landscapes over structures that have significant weight restrictions
- Biofiltration and constructed wetland areas for stormwater treatments where soils perform specialized filtration, drainage or detention functions
- Constructed wetlands for sanitary treatment
- Compaction resistant lawn areas that are subjected to

- especially high use or are intended for organized sports
- Stabilized vegetated road beds and parking areas for emergency vehicles or infrequent parking needs
- Steep slope areas where the soils need to exceed their natural angle of repose
- Below pavement areas where soils need to be compacted to support structural loading while still allowing for plant growth and rooting volume

One of the greatest benefits of manufactured soil use, in addition to its responsiveness to specific design requirements, is that it significantly reduces reliance on topsoil that is often stripped from offsite sources to the detriment of other healthy landscape areas and then transported to new sites for reuse. Manufactured soils are largely made up of derelict soil materials such as sands, gravels, expanded clay and shale, and other aggregates as well as recycled materials such as compost. They typically only contain a very small amount of naturally occurring topsoil and, in some cases no soil materials at all. Manufactured soils therefore are generally considered a sustainable product.[47]

PRACTICES

DESIGN

BE AWARE OF WHAT MIGHT TRIGGER USE OF MANUFACTURED SOILS

- Lack of onsite resources or soils that cannot support vegetation
- Programmatic needs such as stormwater management requiring high infiltration and storage rates
- Anticipated high levels of use
- Subsurface constraints such as compaction or lack of percolation are very common on urban sites.

CONSIDER IMPORTANT EARLY PLANNING AND PROCESS REQUIREMENTS

- Testing of existing onsite soils
- Depths and volume requirements
- Subsurface drainage
- Methods of transport and installation
- Staging approaches

ENGAGE THE SERVICES OF AN EXPERIENCED SOIL SCIENTIST

- Use a soil scientist to develop standard specifications for production of engineered soils and to assist with oversight during the construction phase.

CONSIDER A VARIETY OF ENGINEERED SOIL TYPES

There is no one type of engineered soil that meets all high performance needs.

- Develop a range of standard specifications to allow designers to have a variety of options.
  - It should be noted that engineered soils should be used judiciously in city parks as they are often more expensive than traditional loam based soils.
  - Use engineered soils only when other design solutions are not possible or appropriate to programming or levels of use.
- Consider opportunities for recycled materials to be used.
  - NYSDOT has specified recycled crushed glass as underdrain material in bioretention systems.

CONSIDER STRUCTURAL SOIL FOR IMPROVING URBAN TREE ENVIRONMENTS

One of the most pressing needs for engineered soil in parks is the need for planting soils below pavements. These soils, known as structural soils, allow trees to be planted and to survive in paved areas, providing much needed shade and other ecosystem benefits along streets and in parking lots, urban plazas, playgrounds, and other gathering areas. The term structural soil was coined by Cornell University (CU) Urban Horticulture Institute (UHI) to describe their stone-soil mixed product.

- Structural soil creates a supportive environment for trees within compacted soils by designing soil mixes that allow a particle to particle contact (either aggregate or sand grain) that allows for compaction while maintaining sufficient pore space for root penetration, organic matter, and water and air movement.
- The term has become widely used to describe similar systems using a variety of materials.
- Structural soils can be classified into four different types including:[48]
  - Stone and soil mixes (CU Soil is one type of this kind of structural soil)
  - Lightweight mixes based on internally porous aggregates (expanded shale or slate)
  - Sand based mixes
  - Naturally occurring compaction resistant, sandy loams
    - It should be noted that some sand based and naturally occurring sandy loam mixes often achieve compaction rates less than 95% sometimes ranging from 88-95%, making them less suitable for support of vehicular or rigid pavements.
- Each type of structural soil behaves slightly differently and is constructed in somewhat different ways, providing designers a variety of ways in which to solve tree and pavement conflict.
- Work with a soil scientist to determine which type of soil is most applicable.
- It should be noted that structural soils are inherently inferior to loam based soils and should only be used in situations that cannot be accommodated by strategic design methods including planting beds, planters, and other design devices.

DEVELOP A VARIETY OF COMPACTION RESISTANT SOILS TO ACCOMMODATE HIGH LEVELS OF WEAR AND SURFACE COMPACTION

Compaction resistant soils can accommodate heavy foot or vehicular traffic without losing critical structure that allows for plant growth. These soils are generally intended for turfgrass areas and will deform below vehicular traffic, which is why they are not considered structural soils.

- Compaction resistant soils are generally sand or sandy loam based soils used for program needs such as:

- Sports fields and other intensive pedestrian use areas
- Emergency access vehicle routes
- Seasonal and infrequent parking lot areas
  - Sand based soils are used for a variety of reasons — sustainability, compaction resistance, and stormwater quality improvement.

DEVELOP A VARIETY OF OTHER HIGH PERFORMANCE SOILS FOR SPECIALTY USES

There are a number of other engineered soil mixes that are frequently needed to solve specific urban design problems including:

- Steep slope soils with high internal friction to resist sloughing
- Engineered soils often include geofibers
  - Teardrop Park in Battery Park City makes extensive use of geofiber reinforced soil.
- Sand based biofiltration soils for use in stormwater quality areas, including rain gardens and infiltration basins
- Note that not all biofiltration soils need to be manufactured
- See further *W.5 Use Rain Gardens & Biofiltration*
- Wetland soils
- Manufactured wetlands
- Waste water treatment facilities
- Lightweight soils for green roof applications
- See further *W.8 Create Green and Blue Roofs*

MANUFACTURED SOILS NEED TO BE CLEARLY INDICATED AND QUANTIFIED ON SOIL PLACEMENT PLANS, WITH APPROPRIATE DETAILS AND SPECIFICATIONS

- The use of manufactured soils requires detailed drawings and specifications to ensure contractors fully understand soil placement requirements.
- See *S.8 Provide Soil Placement Plans as Part of Contract Documents* for further discussion of soil placement plan requirements.

CONSTRUCTION

DEVELOP A DETAILED CONSTRUCTION SCHEDULE FOR USE BY BIDDERS

- Allow lead time for procurement, testing, and mixing.
- Construction schedule should specifically include time for procurement of acceptable manufactured soil components, testing, and development of acceptable final mix designs.

FACILITATE THE USE AND PROCUREMENT OF MANUFACTURED SOILS

- Manufactured soil specifications require the contractor to source component materials, confirm the material compliance through testing, and develop final mix designs that are also confirmed through testing.
- This process can be lengthy particularly if a contractor is unfamiliar with the use of manufactured soils and where the various component materials can be sourced and tested.
- The procurement and final mix design process can be significantly shortened by providing the contractor with the name and address of testing labs and source material locations within the specifications.
- In some cases, premixed manufactured soils that are generally known to be compliant with the project needs can be sourced and their locations included within the specifications.
  - The use of manufactured soils also requires careful oversight during installation to ensure that the proper material has been delivered, field mixed (if required), and that it has been properly installed.

Engineered soil fiber amendments were added to the topsoil throughout Brooklyn Bridge Park to prevent erosion over the steep slopes. Also visible in this photo is the drip irrigation system, which was later covered with mulch.

AVOID TRANSPORTATION OF MANUFACTURED SOILS OVER LONG DISTANCES

- Manufactured soils should not be transported over long distances as the component materials may segregate during transport.
- If transport distances are a concern, the project requirements may be modified to allow for onsite mixing of soils, assuming there is sufficient space available.

PROTECT MANUFACTURED SOILS ONSITE

- Manufactured soil materials, such as natural soil materials, should be protected from wind and precipitation, which can cause segregation or depletion of component materials, altering the design and performance of the soil mix.
- Manufactured soil materials should also be protected from onsite contamination, which could affect performance.

PROVIDE ONSITE SUPERVISION OF MANUFACTURED SOIL TESTING AND INSTALLATION

- Manufactured soils should be tested upon delivery to the site prior to installation to ensure component materials and mixes are correct.

■ Manufactured soils are often designed to fully replicate natural soil horizons so there are often varying soil mix types and compaction rates installed in successive layers.
■ Confirm manufactured soil performance at the completion of installation through testing to ensure compliance with specifications.

MAINTENANCE

OBTAIN POST-INSTALLATION MONITORING

■ Manufactured soils often have very low actual soil content, specifically low silt and clay content.
■ Since they are so narrowly controlled from a soil texture standpoint, manufactured soils require closer nutrient monitoring than loam based soil mixes.
■ Manufactured soils have a tendency to drain much more rapidly and to have significantly less nutrient buffering capacity.
■ Manufactured soils supporting plant material should be monitored closely for watering needs.
■ Manufactured soils supporting vegetation should also be tested annually for nutrient needs to ensure longterm sustainability of the plants.

FOR FURTHER INFORMATION

Case Studies:

➔ Battery Park City and Hudson River Park are the two largest projects built to date in New York City using entirely engineered soils.

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S.7 PROVIDE ADEQUATE SOIL VOLUMES AND DEPTHS

OBJECTIVE

Provide adequate soil volumes and depths necessary to support vigorous growth to maturity.

BENEFITS

■ Allows trees, shrubs, and plants to achieve mature size.
■ Improves opportunities for structural support for trees, reducing incidence of wind overturn.
■ Reduces the frequency of watering by increasing available soil water storage capacity.
■ Reduces need for fertilization by providing increased nutrient availability.
■ Optimizes soil needs and eliminates unnecessary soil volumes.

CONSIDERATIONS

■ Requires increased coordination with the location of adjacent utilities and structures, if present.
■ Potentially requires greater excavation and soil volumes and costs.

INTEGRATION

■ *S.8 Provide Soil Placement Plans as Part of Contract Documents*

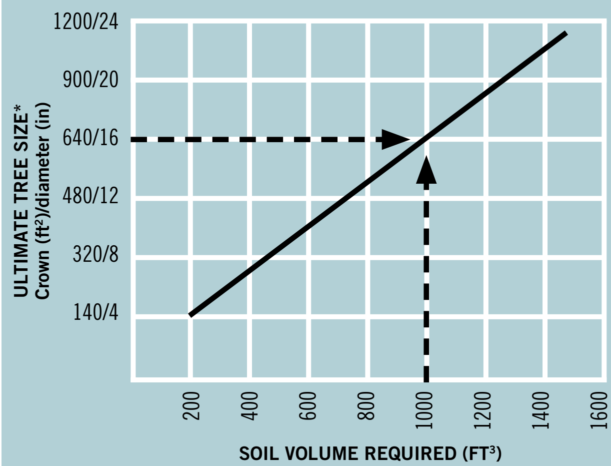
BACKGROUND

While the quality of soils is critical to the success of plantings, it is no less important to provide sufficient depths and volumes of quality horticultural soil. Soil depth is critical to the development of adequate rooting structures which support vegetative growth above ground. Soil volume is critical in that it provides sufficient water storage and nutrient availability for plants. Soil volume is also directly related to the size and area of root mass for plants, ensuring proper structural support and surface area needed to support critical air exchange and water uptake. Adequate soil volumes and depths are also important to stormwater management. Sufficient volumes and depths are required to provide sufficient infiltration, filtration, detention, and retention. Research over the past two decades has revealed that industrywide, the provision of soil volumes has been poorly understood and greatly underestimated.

SAMPLE CALCULATIONS FOR A MATURE TREE WITH A 30' CROWN PROJECTION (30' DIAMETER CANOPY SIZE):

- Assumption: Provide 2 cubic feet of soil available for rooting for each square foot of mature crown projection.
- Calculate crown projection by taking the mature crown spread of the tree in feet, squaring it, and multiplying by 0.7854.
  - Crown projection (30 feet)^2 = 900 x .7854 = 707 and will thus require 707 square foot
- Crown projection x 2 cubic feet of soil per square foot of crown projection = 1,414 cubic feet of soil volume for root growth.
- To calculate the dimensional volume of the soil, divide the total cubic feet of planting soil by an average depth of 3 feet (recommended depth).
  - 1,414 cubic feet ÷ 3' depth = 471 square feet of projected surface area to achieve the necessary

SOIL VOLUME FOR TREES



*The ultimate tree size is defined by the projected size of the crown and the diameter of the tree at breast height.

NOTE: For example, a 16-in. diameter tree requires 1000 cu ft of soil.

PRACTICES

DESIGN

PROVIDE SUFFICIENT SOIL DEPTHS TO SUSTAIN LONGTERM GROWTH AND MATURITY

As soil depths increase, air exchange below these depths is reduced and, as a result, biological activity decreases and the environment is less conducive to feeder roots.

- The vast majority of plant roots exist in the top 8 to 12" depth of soil, especially for most trees.
- Soil depths greater than 12 to 14" are vital to the development of structural roots, water storage, and nutrient uptake.
- Soil depths beyond 36" — especially for trees — are generally a waste of money unless there are extraordinary mitigating circumstances.
- Minimum soil depth by plant type:
  - Turf: 8-12"
  - Annual Flowers and Groundcovers: 10-12"
  - Perennials and Grasses: 12-18"
  - Shrubs: 18" minimum, 24" recommended; larger may be required depending upon plant container or rootball size
  - Trees: 24" minimum, 36" recommended; deeper as required for larger rootballs
  - For green roof plantings, soil depths can be classified three ways:
    - Extensive: 2-6" generally limited to sedums, herbs, and alpines
    - Shallow or Semi-intensive: 6-12" including annuals, perennials, grasses, small woody plants
    - Intensive 12"+ including perennials, grasses, and shrubs
  - For turf grass, large shrubs, and trees and shrubs on green roofs, use volumes listed above.

PROVIDE SUFFICIENT SOIL VOLUMES TO SUSTAIN LONG TERM GROWTH AND MATURITY

There are a variety of ways to calculate required soil volumes for trees including anticipated mature canopy size or anticipated mature trunk caliper. As a minimum, provide individual shades trees with at least 800 cubic feet, 3 feet deep, and cluster trees in a common rooting volume at least 600 cubic feet of soil volume, 3 feet deep. This is the absolute minimum in area, and more total volume is always better.[49] Perhaps a better way to consider soil volume, based on an actual mature tree size basis, is to provide between 1.6 and 2.0 cubic feet of soil for every square foot of mature crown projection.[50] This approach can also be used to better inform soil volume requirements for large shrubs and small trees. Again, more soil volume provides a better rooting environment and structural support, especially for trees. While minimum soil volume has been well studied for trees, it remains poorly studied for shrubs, perennials and groundcovers.

- Landscape architect James Urban has developed a useful chart to quickly calculate anticipated minimum soil volumes:
  - If you have other plantings combined with tree soils, a good rule of thumb is to provide sufficient soil for the trees (closer to 2 cubic feet of soil for the mature crown projection rather than the lower 1.6 cubic foot estimate) and allow the shrubs, perennials, groundcovers or turf grass to inhabit the same soil volume.

Street trees planted in adequate soil volumes are more likely to survive and cause fewer pavement breaks. This tree was not given enough soil, harming both the tree and the surrounding sidewalk.

- ◻ The numerous benefits of contiguous volumes of soil for multiple trees allow for slight reduction in total soil volume for trees, perhaps as much as 25%.[51] Reduction of provided soil volume should be applied judiciously, especially in areas where trees may be under microclimatic stress.
- ■ When using manufactured soils, and in particular skeletal soils, structural soils, green roof soils, or sand based soils that are naturally lean on loam content, soil volumes should be increased to compensate for poor soil quality
  - ◻ For example, with structural soils the actual available soil volume (excluding the stone aggregate matrix) can be as low as 20 to 30% on a volume basis.

ESTABLISH A SITE SOIL BUDGET EARLY IN THE DESIGN PROCESS TO AID IN CRITICAL DESIGN DECISION MAKING

■ Understanding and identifying basic soil volumes and depths allows designer, cost estimator, and construction manager to quickly estimate soil budgets for site.

■ Soil budgeting also identifies if adequate resources are available onsite or if horticultural quality material will need to be imported. It is critical to project scheduling and budgeting, as well as to the ultimate project budget, to understand the time required and costs associated with soil operations to accommodate sufficient quantities of horticultural quality soil.

■ Diagramming of soil for budgeting purposes requires designers to consider how soil volumes are aggregated on site, leading to better coordination with utility corridors, pavement (which may require structural soils) or building structures.

■ Soil budgeting allows designer to develop a plant palate and planting locations that are appropriate to available soil resources. This is especially important when planning projects where there are limited budgets or weight limitations over structures.

■ The preparation of the soil budget will need to include:
- ◻ Finish grades and subgrades
- ◻ Drainage
- ◻ Earthwork calculations
- ◻ Cost estimating

COORDINATE SOIL DEPTHS AND VOLUMES WITH EXISTING AND PROPOSED SITE STORMWATER MANAGEMENT AND EXISTING GROUND WATER CONDITIONS

■ Soil volumes and depths are only of benefit to plantings if the water properly cycles into and out of the soil. Poor subsurface drainage, high ground water (either permanent or seasonal) leads to anaerobic conditions that lead to plant disease, decline and death.

■ Site design strategies should encourage the diversion of surface stormwater runoff to areas that are proposed for plantings to both benefit the health of the plantings and to provide increased storm water quality.

PREPARE A SOIL PLACEMENT PLAN AS PART OF SCHEMATIC AND DESIGN DEVELOPMENT LEVEL DESIGN MILESTONE EFFORTS FOR COORDINATION WITH OTHER MEMBERS OF THE DESIGN TEAM INCLUDING ENGINEERS, CONSTRUCTION MANAGERS, AND COST ESTIMATORS

■ A soil placement plan is a scaled diagrammatic plan that indicates where each type of soil system is installed on the site. Areas of different soil types are indicated by unique hatch patterns and are cross referenced to soil installation details.

■ Soil placement plans show the surface areas requirement of specific soil types (such as lawn areas, planting beds, structural soil, etc.).

■ Provide graphic or text descriptions of the typical soil profiles and interfaces or transitions required to achieve the desired soil depth.

■ See *S.8 Provide Soil Placement Plans as Part of Contract Documents* for further discussions of soil placement plan requirements.

LAYER SOILS TO MIMIC NATURAL SOIL HORIZONS

■ Planting soils should mimic soil structures found in nature to the extent possible to encourage good soil biological functioning and accommodate normal root growth.

■ Horticultural soils should have a high organic layer located at the top 6 to 12" to accommodate soil organisms and surface root feeding, which require frequent air and water exchange.

■ Lower layers within soil horizons serve to store water and nutrients and provide structural support for rooting. High organic content in lower layers is wasted and can lead to settling problems as the organic content breaks down.

CREATE CONTIGUOUS SOIL VOLUMES TO ENCOURAGE HEALTHY ROOTING

■ Plan soil areas to be as contiguous as possible to allow plantings to share rooting space.

■ Large areas of uninterrupted soil areas are preferable to numerous smaller soil areas.

■ Develop clear utility corridors to minimize disruption of soil areas.

■ Consider running utility corridors deeper to allow horticultural soil volumes to span over the tops of the compacted utility backfill areas.

■ If utilities are backfilled with soils that are compacted to 95% density with densely graded materials, roots will not be able to penetrate the utility corridors, thus protecting the utility lines.

■ Where critical volumes are not achievable, create linkages to adjacent areas of soil volume.

■ Consider one of the following methods to allow roots to seek out increased quality soil volumes in other areas:
- ◻ Geocomposite root paths
- ◻ Structural soil root paths
- ◻ Pavement bridging

BE SURE TO UNDERSTAND HOW WATER WILL GET INTO AND OUT OF SOIL AREAS

■ The use of larger uninterrupted soil areas makes the direction and disbursement of site stormwater more efficient.

■ Be sure to understand the contributing runoff volumes, infiltration rate of the proposed soil volumes, and underlying subgrade to ensure that the proposed soil volumes will not be saturated for long periods of time, which may lead to plant decline or death.

- It may be necessary provide:
  - Subsurface drainage for areas that cannot infiltrate quickly enough to support vigorous plant growth
  - High flow bypass to limit inflow to sensitive or confined soil areas
  - Erosion protection at inflow areas during large storm events

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51 **Craul and Craul**

S.8

PROVIDE SOIL PLACEMENT PLANS AS PART OF CONTRACT DOCUMENTS

OBJECTIVE

Prepare a soil placement plan, details, and coordinated specifications as part of the project contract documents.

BENEFITS

- Compels the design team to thoroughly document planting soil requirements and associated material interfaces, improving the quality of the planting soil environment.
- Elevates the importance of soil installation requirements to the contractors working on the project.
- Allows the contractors to accurately estimate scope of work, material quantities, and costs associated with project.
- Allows for more accurate sequencing and scheduling of soil installation.

CONSIDERATIONS

- Requires increased design effort and time to produce contract documents.

INTEGRATION

- *S.7 Provide Adequate Soil Volumes and Depths*

BACKGROUND

The design and quality of planting soil is at least as important to the success of a project as the planting or stormwater design, yet the detail and level of care with which planting soil is given in typical construction document packages is often limited. It is not unusual that the soil requirements are only vaguely shown on the drawings and are poorly coordinated with the specifications. As a result, contractors are often left to infer the intent of the designer as to how soils are to be used and placed across a project site.

A coordinated soil placement plan elevates the importance of planting soils within the contract documents and provides a much higher degree of integration with adjacent materials. The development of soil placement plans during the design process also allows for the development of more accurate earthwork cost estimates, more rapidly revealing project opportunities and constraints. Finally, the development of soil placement plans and supporting details and specifications allows the planting soils to be more fully conceived as an integrated system rather than as the filler between other site elements.

PRACTICES

DESIGN

DETERMINE SITE PROGRAMMING NEEDS IN ORDER TO ACCURATELY DEFINE SOIL QUALITY PARAMETERS

- In order to determine if existing or imported soil will be of sufficient quality for a project, it is important to clearly define the site programming needs before making a final determination of the quality and suitability of existing or new site soils including:
  - Existing or proposed landscape strategies including planting palette
  - Proposed levels of maintenance including whether or not automatic irrigation will be proposed
  - Levels of site use and whether or not compaction resistance would be needed for athletic fields or other high use lawn areas
- Use a zone based approach to soil design.
- It is more than likely that one soil type will not sufficiently address the long term needs of the site's various planting and stormwater site needs. By categorizing soil programming needs onsite into similar programmatic zones, soil quality can more easily be defined, constructed, and maintained. Typical soil zones include:
  - Turf areas with low traffic
  - Turf areas with high traffic (areas subject to large crowds, athletic fields, stabilized vehicle lanes that require compaction resistance, and other special needs)
  - Annual and perennial lawn beds
  - Shrub beds
  - Mixed shrub and tree beds
  - Trees in open lawn areas
  - Trees in paved areas (requiring structural soil or other special needs)
  - Planting areas over subterranean structures
  - Planting areas over roofs including extensive green roof areas, roof planters, and traditional planted roofs

DEVELOP ZONE BASED DIAGRAMMATIC SOIL PLACEMENT PLANS

- Develop zone based diagrams indicating various soil types and their associated depths.
- Develop plans early in the design process to establish realistic soil needs and associated costs, and to identify coordination issues.
- Coordinate soil placement plans with soil preservation and protection plan diagrams.
- Use diagrammatic plan areas to calculate required planting soil volumes and associated excavation to achieve the proposed soil depths. These volumes can be compared to existing soil volumes available on site to determine if there are adequate soil resources or if additional materials will have to be imported.
- Zone based diagrams:
  - Allow the designer to understand excavation depths that are required for rootballs of various plant materials.
  - Enable a designer to begin to make inferences about sub-surface drainage needs within compacted soils or potential conflicts with adjacent and crossing utilities.
  - Are especially important when designers are trying to achieve minimum soil volumes for tree plantings in structural soil areas.
  - Are also important in areas where planting soils are entirely imported as necessary on certain brownfield sites, sites with limited infiltration due to past uses, rooftops or pier structures with weight restrictions, or sports field projects where manufactured compaction resistant soils are required.

DEVELOP TYPICAL CROSS SECTIONS OF PLANTING SOIL AREAS TO UNDERSTAND SOIL DEPTHS, LAYERING REQUIREMENTS AND MATERIAL INTERFACE NEEDS

- Develop typical planting soil cross sections for each type of planting soil need including lawn areas, perennial display beds, tree and shrub beds, constructed wetlands and infiltration basins.
- Use typical cross sections to more accurately estimate soil material and amendment needs on a plan basis.
- Develop cross sections through the site to understand how the various soil profiles interface with one another and adjacent site improvements such as pavements, walls, buildings, and waterbodies.
- Coordinate differing compaction requirements and angles of influence between horticultural areas and areas serving as structural foundations.
- Overlay utility crossings and coordinate anticipated elevation and compaction needs.
- Coordinate the location of surface drainage systems and underdrainage systems for both landscape areas and building areas.
- Develop planting soil termination and interface details based on review of site cross sections, which helps ensure that soils abut each other without creating interface problems that can lead to drainage problems.

USE ZONE BASED SOIL DIAGRAMS TO DEVELOP SUBGRADE GRADING PLANS

- Develop subgrade grading plans to allow the contractor to accurately estimate earthwork calculations (i.e., the difference between the grade of existing soils and the finish grade of proposed planting soils).
- Use subgrade grading plans to locate subdrainage piping systems and to ensure that all planting soils are adequately drained.
- Subgrade grading plans and subdrainage plans are critical for:
  - Any project that makes use of layered or manufactured soil installations requiring coordination of soil depths,

shaping of the subgrade prior to soil placement, and locating underdrainage piping systems
- □ Waterfront development projects where there may be concerns about storm surges, tidal fluctuation, and saltwater contamination of planting soil areas
- □ Brownfield sites in order to coordinate with the elevation of capping layers

PREPARE A SOIL PLACEMENT PLAN

- ■ A soil placement plan is a scaled diagrammatic plan that indicates where each type of soil system is installed on the site.
- ■ Areas of different soil types are indicated by unique hatch patterns, which are cross referenced to soil installation details.
- ■ Soil placement plans show areas of specific soil types, such as lawn areas, planting beds, structural soil, etc.).
- ■ Detail sheets show protection details and typical soil profiles and interfaces or transitions.
- ■ Soil placement notes include specialized equipment requirements, methods of installation, compaction and settlement, as well as protection after installation prior to the start of landscaping operations.
  - □ Alternatively, soil placement notes can be assembled into a single specification section specifically dedicated to planting soil.
- ■ Prepare written specifications as necessary.
- ■ Clearly outline material requirements, performance requirements, and penalties for the contractor for failure to comply with the soil management plan requirements.
- ■ Create a single specification for all soil management requirements, greatly simplifying enforcement of the requirements by resident engineers.
  - □ Numerous references to soil management throughout a specification book can make it difficult for the contractor to immediately grasp the full range of requirements, and make it difficult for a designer to locate and properly coordinate soil management needs across multiple specification sections during construction.
- ■ Coordinate the soil management plan with the requirements of the soil and erosion control plan, soil protection plan, and the site staging and sequencing plan.
- ■ The entire design team should review and assist with the preparation of the soil placement plan, especially on large projects or projects with significant natural features to be preserved or where available site area is limited.
- ■ It is also very helpful to have the plan reviewed by the resident engineer or construction supervisors prior to bidding to ensure that the requirements laid out are reasonable given the total scope of work, budget, and schedule.

DEVELOP A SOIL PLACEMENT PLAN THAT IS COMMENSURATE WITH SCALE OF THE PROJECT

- ■ For less complex projects a soil placement plan, at a minimum, may consist of a single drawing with detailed notes outlining contractor requirements.
- ■ For more complex projects, a soil management plan can consist of a number of drawings including:
  - □ Soil placement notes, soil placement plans, planting soil details and interface details, and subgrading plans

MAINTAIN STANDARDS OF QUALITY THROUGHOUT CONSTRUCTION PROCESS BY COMBINING BOTH DETAIL SPECIFICATIONS AND ONSITE INSPECTIONS

It is not enough to draw plans and specify the proper soil materials for a site; a good deal can go wrong during procurement, delivery, and installation that can compromise the long term success of a project. Soil placement specifications need to specifically detail how soils should be placed, especially with subsoil preparation and planting soil installation and layering.

SPECIFICATIONS FOR TESTING DURING CONSTRUCTION NEED TO BE COUPLED WITH DILIGENT INSPECTION OF THE WORK

- ■ Prior to start of work:
  - □ Verify the proper location and installation of soil and vegetation protection fencing as described in the soil management plan.
  - □ Verify that erosion and sedimentation controls have been properly installed.
  - □ Review with general contractor that topsoil stockpiling and other specified measures are incorporated into the work plan.
  - □ Review procedures for soil material delivery, collection of delivery tickets, and frequency of spot testing for imported soil materials and amendments.
  - □ Review procedures for onsite testing and inspections during installation.
- ■ During grading and earthwork operations:
  - □ Verify that proper erosion and sedimentation control methods are being employed.
  - □ Verify proper excavation and stockpiling of topsoil and subsoil materials.
- ■ After completion of rough grading:
  - □ Inspect subsoil and subgrade areas to ensure they are free of debris or other contaminants.
  - □ Test for proper penetrability, drainage, and compaction as required by the specifications.
  - □ Check that the subgrade is excavated to the proper depth and shaped to provide sufficient slopes to subsurface drains.
  - □ Check that all subsurface drains and irrigation lines, if required, have been properly installed and tested.
- ■ During topsoil placement:
  - □ Inspect soil placement procedures to ensure proper material depths, layering, and transitioning as described in the specifications and shown on the drawings.
  - □ Test for proper compaction and penetrability.
- ■ After topsoil placement:
  - □ Test topsoil before planting and amend topsoil as required to correct for organic, nutrient, and pH deficiencies.
- ■ After completion of planting:
  - □ Verify placement of mulch as described in specifications and as shown on drawings.

SPECIFY THAT SOILS ARE INSTALLED IN LAYERS THAT ARE PROPERLY TRANSITIONED

- Proper soil installation is critical to ensuring soil functioning.
- Soil failures due to poor workmanship are possible even when using the correct soil types.
- Soil placement needs to be detailed and sufficiently specified so that the soils are installed in such a way that they are transitioned or zipped together with the underlying soil so water can flow freely from one layer to the other.
- Soils with abrupt changes in texture, structure, and/or density can significantly reduce the flow of soil water. The abrupt change can result in perched water leading to prolonged saturation of root zones and anaerobic conditions, both of which lead to plant mortality.
- Poor interface of soils can also lead to destabilization and slumping in areas where soil is installed on slopes.
- Transitioning between layers can be accomplished by applying two to three inches of soil, tilling it into the underlying soil, and then applying the remaining soil on top.
- When layering soils, even soils of the same type, it is important to scarify the surface of the soil to be layered on top to break up any crusting or compaction, again minimizing interface problems.
- Prior to placing soils on prepared subgrades, the subgrade soils should be scarified by deep raking or with the teeth of a backhoe rather than by the use of rotary tilling or disc plows to avoid the creation of a compaction layer immediately below the worked surface of the subsoil.

SPECIFY PROTECTION OF SOIL MATERIALS FROM CONTAMINATION DURING CONSTRUCTION

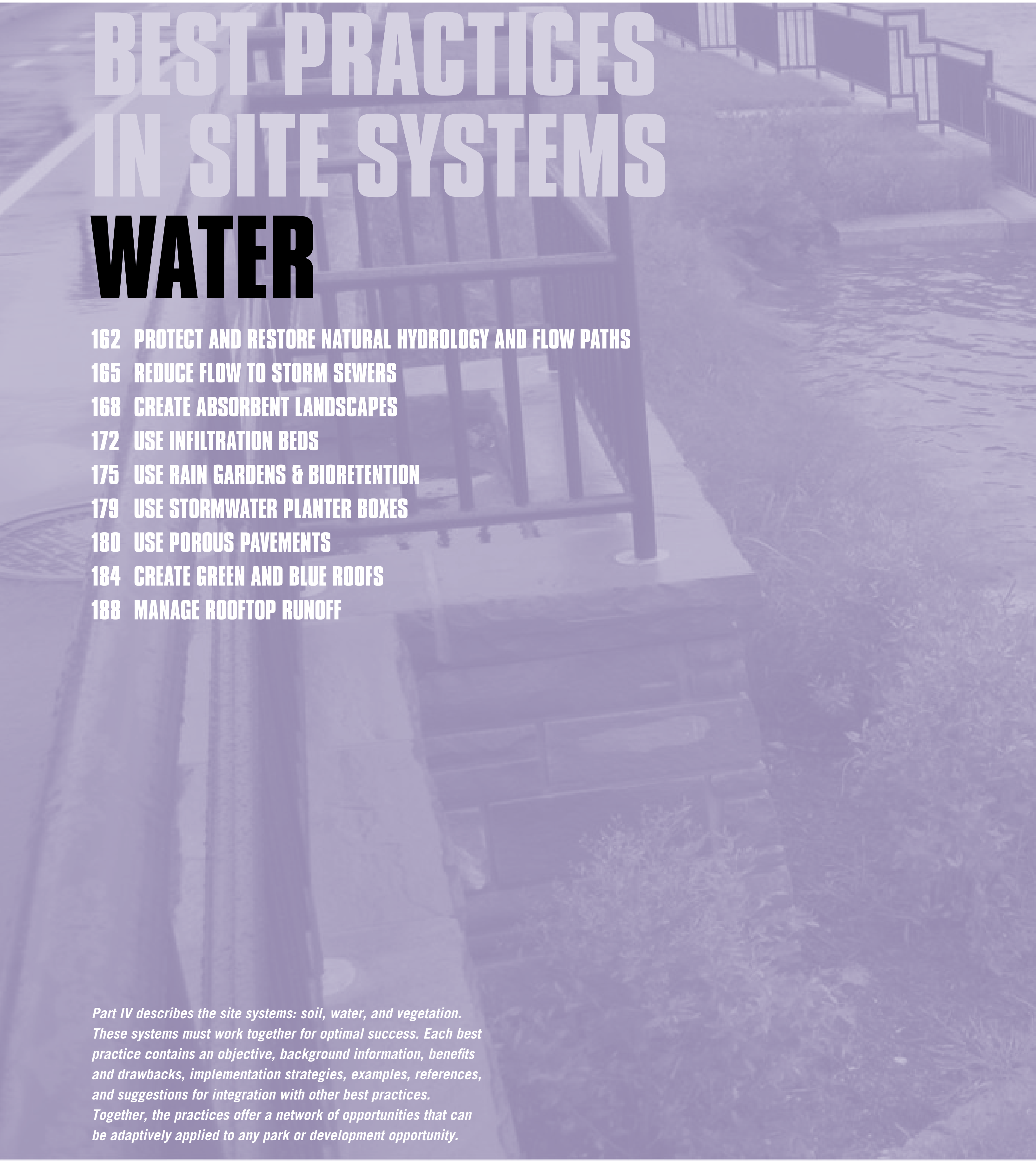
Specifying protection of soil materials from contamination during construction is another important way to ensure soil quality and long term performance.

- Frequently construction activities unrelated to earthwork and planting soil operations create conditions that significantly degrade the horticultural qualities of soils.
- Improper handling or disposal of materials frequently used during construction can contaminate soil.
- Vehicle and generator fuels, asphaltic materials, aggregates, gypsum, plaster, hydraulic fluids, paints, adhesives, cleaning products, acid washes, and waste water produced during construction all have the potential to change soil chemistry or damage the physical properties of soil.
- Cementitious products are among the most common and destructive soil contaminants, clogging soil structure and significantly raise pH.
- Cementitious materials including dry grout and mortar mixes, and washout water from concrete trucks, pumps, and chutes should be carefully handled around soils.
- Prefabricated or onsite fabricated concrete washouts can be used to contain concrete and washout liquids.
    - The washout facilities consolidate solids for easier disposal and prevent runoff of liquids
- Prefabricated concrete washout containers are delivered to the site, and some companies offer maintenance and disposal services.
- See *S.2 Minimize Soil Disturbance* for further discussion of soil erosion and soil compaction, two critical aspects of maintaining soil quality during the construction phase.

FOR FURTHER INFORMATION

Craul, Phillip and Craul, Timothy. Soil Design Protocols for Landscape Architects and Contractors. Hoboken, NJ: John Wiley & Sons, Inc., 2006.

PART IV: BEST PRACTICES IN SITE SYSTEMS



WATER

Part IV describes the site systems: soil, water, and vegetation. These systems must work together for optimal success. Each best practice contains an objective, background information, benefits and drawbacks, implementation strategies, examples, references, and suggestions for integration with other best practices. Together, the practices offer a network of opportunities that can be adaptively applied to any park or development opportunity.

INTRODUCTION

New York City receives approximately 45 inches of rainfall per year, and most of that rainfall (70% of the annual volume) occurs in small rainfall events of one inch or less. In a forest, nearly all rainfall soaks into the soil and ultimately returns to the atmosphere via evapotranspiration from plants and soils; some rainfall infiltrates into deeper soil mantle. On an annual basis, very little water actually runs off in a natural system.

In New York City, virtually all the rain that falls on the impervious surfaces of roofs, streets, and pavement runs off, contributing to flooding, water quality problems, and combined sewer overflows. Watersheds with only 10% impervious surfaces, streams, and other hydrological features are compromised. At 30% impervious, ecosystem functions are compromised; there is significant loss of aquatic habitat diversity, water quality, and species habitat. New York City is generally well beyond these ranges of impermeability.

The city's parks provide an important opportunity to manage water differently: to reduce stormwater runoff and to use soil and vegetation to capture water as a resource for the park system. High performance landscapes begin by intensively managing stormwater. Water from rainfall events should be managed at or near the source, returned to soils and vegetation in a manner that encourages soil absorption and evapotranspiration. Water should be allowed to infiltrate, where feasible. By designing a landscape that can capture the runoff from the small, frequent rainfalls, and allow that runoff to soak into the soil or be absorbed by vegetation, many of the various urban impacts on water quality (such as nonpoint source pollution, combined sewer overflows, flooding, and heat island effects) can be mitigated. *PlaNYC* highlights the importance of New York City's parks and open spaces in capturing and retaining stormwater.

Water should not be wasted. Potable water should be treated as an especially valuable resource because it is water that requires significant energy to clean and deliver that water. Opportunities to reduce potable water use through more efficient designs, and to reuse all available water in general, are critical components of high performance landscapes.

KEY PRINCIPLES

RECOGNIZE THAT RAINFALL IS A RESOURCE THAT SUPPORTS HEALTHY SOILS AND VEGETATION IN PARKS. Water is an important component of a healthy landscape, and healthy soils that absorb rainfall will support healthy vegetation, reducing both stormwater runoff problems and the need for potable water. Rather than considering stormwater as a nuisance to be managed, parks should be designed to value and capture the resource of rainfall, with emphasis on restoring and maintaining healthy soils and vegetation.

RECOGNIZE THAT SMALL FREQUENT RAINFALLS CAN BE CAPTURED BY THE SOILS AND VEGETATION IN NYC PARKS, IMPROVING WATER QUALITY FOR THE CITY. Stormwater systems have traditionally been designed to address flooding concerns during extreme and intense periods of rainfall. The more common small rainfall events have traditionally been overlooked in the design process, but comprise much of the annual volume of rainfall in New York City. Park designs that capture these small frequent rainfalls provide a long term and sustainable approach to managing the resource of rainfall.

DESIGN FOR WATER IN WAYS THAT ARE VISIBLE, CREATIVE, AND THAT RECONNECT PEOPLE TO THE NATURAL SYSTEM. By designing systems that come alive with the movement of water during rainfalls, and allowing water to be visible and active, park designs can increase awareness of water as a resource and its importance to healthy park systems. Water management designs provide an opportunity to educate and reconnect people to water.

NATURAL LANDSCAPES SHOULD BE PROTECTED AND ENHANCED TO IMPROVE THE BENEFITS THEY PROVIDE TO THE CITY'S WATER QUALITY. Existing natural systems such as woodlands, meadows, stream buffers, and wetlands provide many ecological and environmental benefits, including the ability to absorb and cleanse runoff. These natural systems provide ecological services by slowing, filtering, and capturing water. Infiltration recharges the groundwater for healthy streams and wetlands, while vegetation returns water to the atmosphere and reduces the urban heat island effect. These services are a resource that should be protected and enhanced within the park system.

URBANIZED LANDSCAPES CAN BE DESIGNED TO MAXIMIZE THEIR ECOLOGICAL PERFORMANCE. Through careful design and consideration, areas such as pavements, roofs, athletic fields, and playgrounds can be designed to capture, clean, and slow stormwater runoff for infiltration, slow release, or reuse. In the urban environment, these park systems can be a model for a more sustainable approach throughout the city.

WATER IS A RESOURCE THAT SHOULD NOT BE WASTED; The availability of potable water represents energy usage in the collection, treatment, and delivery of that water. Any opportunity to reduce the use and demand of potable water, or to reuse any available water (such as rainfall), should be implemented to reduce the energy impact of water within the parks.

W.1 PROTECT AND RESTORE NATURAL HYDROLOGY AND FLOW PATHS

Protect and restore the natural ability of soils, vegetation, and associated topography to absorb rainfall, remove pollutants, evapotranspirate, and recharge groundwater. Protect natural flow paths and small streams from grading, encasement, or the erosive conditions that are created by piped or concentrated flows.

BENEFITS

- Improves water quality for streams, lakes, and shorelines.
- Provides habitat for fish and other organisms
- Supports natural biological activity.
- Increases base flow for streams, improving ecological function of these systems.
- Increases ecosystem services.
- Protects soils and vegetation.
- Increases biodiversity and creates healthier ecosystems.
- Prevents future restoration costs.
- Reduces risks of invasive species or contaminants by leaving soils and vegetation undisturbed.
- Traps sediments and nutrients.
- Keeps sediment out of streams and sewers.
- Promotes infiltration, reducing runoff volumes; slower moving water is more likely to seep into bed and banks.
- Moderates downstream flooding.
- Stores and recycles organic carbon.
- Reduces flow energy, reducing erosion and downstream sedimentation.

CONSIDERATIONS

- Can increase construction costs and duration due to more limited site access, staging, stockpile, and work areas.
- May require greater construction administration.
- Requires defined longterm maintenance.
- Requires education of maintenance staff.

INTEGRATION

- *D.3 Prepare a Site Preservation and Protection Plan*
- *S.2 Minimize Soil Disturbance*
- *W.3 Create Absorbent Landscapes*
- *V.1 Protect Existing Vegetation*
- *V.3 Protect and Enhance Ecological Connectivity and Habitat*

BACKGROUND

Natural flow paths and small streams provide the largest surface area of soil in contact with water. Most biological and physical activity takes place in this area where the water makes contact with the saturated sediments in the channel (the hyporheic zone) or where the water makes contact with the edges of the channel (the riparian zone).

Small headwater streams and natural flow paths are:

- Zero-order streams consisting of swales and hollows that lack natural stream banks but serve as important conduits of and storage sites for water, sediment, nutrients, and other materials during rainfall and snowmelt
- First-order streams, which are the smallest distinct channels that may flow perennially (year-round), intermittently (several months per year), or ephemerally (periodically after a rain or in the spring)
- Second-order streams formed by first- and zero-order streams combining

Small headwater streams and flow paths make up at least 80 percent of the nation's stream network, and in terms of gross area, provide more ecosystem services than any other water feature. They are critically important to the health of larger streams and coastal ecosystems, all of which originate in the smaller stream network. However, most zero- and first-order streams do not appear on maps.

Small headwater streams are rough and bumpy, slowing the passage of water. The friction of gravel, twigs, leaf litter, and woody debris reduces flow rates. Slower moving water seeps into streambeds and banks, providing soil and groundwater recharge and reducing the power of water to cause erosion.

Small headwater streams and natural flow paths are often damaged or lost.

- Piped storm sewer discharge increases flow volume and velocity to create erosive conditions in small streams and natural flow paths, causing the channel to narrow, deepen, and release sediment. As the channel deepens, shallow groundwater and soil moisture will begin to discharge to the channel, ultimately reducing soil moisture conditions in the surrounding area and affecting the health of vegetation, especially woodlands. This is a common problem in urban parks where upstream storm sewers often discharge to parklands, especially along steep slopes.
- The creation of large impervious areas that generate flows in excess of the capacity of the natural channel, lead to erosive conditions.
- The compaction of pervious areas by mowing, parking, and other intense uses collapses the macropore system in the soil and creates more runoff and erosive conditions.
- Grading of pervious areas creates uniform topography, eliminating the natural depressions and flow paths that previously existed.
- Piping of swales and wet areas to eliminate wet conditions beyond the minimum necessary to cross roads and paths will concentrate the discharge further downstream.
- Creation and mowing of lawn and turf affects headwater streams and flow paths. The grass traps sediment and

creates sod, narrowing the channel width. The channel deepens in response, carrying sediment downstream. As the stream narrows, there is less streambed available for microorganisms to process nutrients. Nitrogen and phosphorus travel downstream five to ten times faster, carrying nutrients to streams and coastal waters that can create algal blooms, called eutrophication.

PRACTICES

PLANNING

IDENTIFY NATURAL FLOW PATHS AND SMALL STREAMS

- Most natural flow paths and small streams are too small to appear on maps.
  - Detailed topographic surveys may indicate approximate swale locations, however, visual field confirmation is often required to fully identify the location and extent of small streams and depressions.
  - Consult Natural Resources Group (NRG) historic maps and flow accumulation models to assess hydrologic conditions.
- Conduct field observations during wet periods.
  - Ephemeral pools are more likely to be observed during the wet season of spring.
  - Ephemeral pools are only seasonally wet and provide critical habitat to amphibians, plants, and insects.
- Conduct field observations during periods of rainfall.
  - In the early part of a rainfall, the trickle front can be observed as the leading edge of a stream begins, and often soaks into the soil.
  - Rainfall observation will help to identify areas of recharge to be protected.
  - As flow develops, distinct flow paths can be identified and areas of erosion noted.
- Incorporate the location of natural flow paths and small streams into the site preservation and protection plan.

IDENTIFY NATURAL LANDSCAPE RECHARGE AREAS AND DEPRESSIONS

- Within the existing landscape, identify areas where water naturally forms small puddles that disappear.
- Consult maintenance staff to help identify these areas.
- Consult with environmental scientists and ecologists at NRG to help identify these areas.
- Incorporate the location of natural landscape recharge areas into the site preservation and protection plan.

IDENTIFY AND DELINEATE AREAS OF NATURAL HYDROLOGICAL BENEFIT OR SENSITIVITY

- Maximize preservation of existing undisturbed areas to protect existing intact soils and vegetation.
- Areas of focus include:
  - Steep slopes
  - Mature or valuable vegetation
  - Wetland areas
  - Springs and swales
  - Stream and shoreline buffer areas
  - Areas of natural drainage
- Consult with environmental scientists and ecologists at NRG to help identify sensitive hydrologic areas.
- Incorporate the location of natural hydrological benefit or sensitivity into the site preservation and protection plan.

PLAN FOR LONG TERM PROTECTION OF EXISTING SMALL STREAMS AND FLOW PATHS

- Ensure that protection and preservation zones include small streams and flow paths.
- Identify and manage all offsite sources of runoff into streams and flow paths.
- Require no new stormwater runoff and no new impervious area without complete treatment of those impervious areas for water quality and volume.
- Incorporate the location of existing small streams and flow paths into the site preservation and protection plan.
- See *D.3 Develop a Site Protection and Preservation Plan*

DESIGN

USE SITE DESIGN STRATEGIES TO PRESERVE AND PROTECT BASIC SITE HYDROLOGY

- Design new facilities around preserved areas and basic site hydrology, maintaining as much continuity and connectivity between preserved areas and original drainage patterns as possible.
- See *S.2 Minimize Soil Disturbance*.
- Minimize cut and fill beyond original grades as much as possible.
- Protect soil structure, especially when relying on infiltration for stormwater management.
- Carefully coordinate stormwater management techniques with existing soil conditions.
- Develop planting plans in concert with soil conditions and stormwater management techniques; plants are a major component of the water cycle.
- Consult NRG's NYC-specific native plant lists and plant characteristic data.
- Develop erosion and sedimentation control to protect existing water features and hydrologic patterns.
- Prepare site protection and preservation plans.

IF COMPACTION OCCURS AS PART OF NECESSARY CONSTRUCTION TECHNIQUES, REQUIRE DECOMPACTION PRIOR TO FINAL GRADING

- The contract documents should include a requirement for contractors to pay for decompaction in the case of failure to comply with the site protection plan.
- See *S.3 Prioritize the Rejuvenation of Existing Soils Before Importing New Soil Materials*

PROTECT SMALL STREAM AND FLOW PATHS

- Design buildings, roads, and infrastructure to avoid the removal, grading, or compaction of small streams and flow paths.

- Where crossings are unavoidable, design open bottomed culverts of the minimum required length to allow for passage of aquatic organisms.
- Avoid the use of enclosed pipes.

■ Revisit all grading plans to identify and reduce unnecessary grading.
- Pull grading and contours back to the minimum required for improvements.
- Avoid the unnecessary removal of irregularities in the landscape topography that capture water.
- See *W.3 Create Absorbent Landscapes* and *S.2 Minimize Soil Disturbance*.

■ Design to prevent the discharge of storm sewers directly into small streams and natural flow paths.
- Use berms, level spreaders, and other measures to dissipate water flow upstream of small streams by a distance of not less than 50 feet.

■ Avoid the concentrated discharge of stormwater onto slopes where erosive conditions may develop.

■ Situate built elements or areas of intense activity (such as playfields) with a buffer area that can absorb and slow runoff before it enters small streams and flow paths.

RESTORE EXISTING SMALL STREAMS AND FLOW PATHS

■ Where small streams and flow paths have been damaged by existing conditions, implement upstream measures to reduce flows and volumes.

■ Provide soil stabilization measures as needed.

■ See *W.3 Create Absorbent Landscapes*.

■ Once the source of the excessive flows and erosive conditions have been addressed, use materials and methods to reduce flow velocities and restore sediment deposition, such as woodland berms, low porous check dams, and step pools.

■ Contact NRG for assistance in calculating flow volumes and shear stress and determining design alternatives.

RECREATE SMALL STREAMS AND FLOW PATHS

■ In previously disturbed areas, small streams and flow paths are likely to have been eliminated or encased.

■ Any opportunities to remove piping and "daylight" small buried streams and flow paths should be evaluated for possible restoration.

■ Where possible, storm pipes should be replaced with vegetated swales.

■ In hardscape areas, the use of runnels and surface flow paths add movement and can improve aesthetics.

■ In dense landscapes, small depressions can be created by grading and soil amendments to catch and infiltrate water.

■ Multiple depressions can be linked to create connected water surfaces during periods of heavy rain.

■ Depressions should be limited to no more than four inches in depth, and incorporate soil amendments and plantings.

■ For areas of infiltration, test for infiltration and percolation rates.
- See *W.3 Create Absorbent Landscape*s.

CONSTRUCTION

CONSTRUCTION CONSIDERATIONS AND GUIDELINES

■ Install site protection fencing and maintain it throughout the entire construction process to protect small streams and flow paths.

■ Install upstream measures to reduce flows and erosive conditions prior to any restoration efforts in small streams and flow paths.

■ Ensure that erosion and sediment control measures are installed and maintained throughout entire construction process.

■ Ensure that soil testing is completed immediately before the installation of stormwater measures and at appropriate subgrade and final grade locations to confirm:
- Infiltration rates
- Depth to limiting zones, such as water table and bedrock
- Soil bulk density

■ Take measures to decompact subgrade if required.

■ See *Part 2: Site Assessment* for further details.

■ See *S.2 Minimize Soil Disturbance*.

■ See *S.3 Prioritize the Rejuvenation of Existing Soils Before Importing New Soil Materials*.

INCORPORATE DISCUSSION OF HYDROLOGIC GOALS INTO CONTRACTOR MEETINGS

■ Review and discuss hydrologic goals of the site and the importance of soils and vegetation to the overall stormwater philosophy.

■ Review and discuss the importance of protecting small streams and flow paths.

■ Work with contractors early in the process to stress the importance of keeping equipment and material out of small streams and flow paths.

■ Review the importance of uncompacted soils and erosion control.

■ Review the intent of the construction staging and sequencing plan.

■ Review the requirements of the site protection and construction staging and sequencing plans.

■ Emphasize the need for equipment, storage, and disposal to avoid small streams and flow paths.

PRESERVE AND PROTECT EXISTING SOILS TO ALLOW FOR FUNCTIONING HYDROLOGY

■ See *C.3 Create Construction Staging & Sequencing Plans*

MAKE PERIODIC INSPECTIONS DURING CONSTRUCTION PHASE TO ENSURE COMPLIANCE WITH REQUIREMENTS

MAINTENANCE

PERIODICALLY INSPECT SMALL STREAMS AND NATURAL FLOW PATHS

■ Identify and address erosive conditions before excessive damage occurs.

■ Inspect and repair interim restoration measures such as berms and check dams.

- These measures are not intended to last indefinitely, but to provide soil stability until vegetation and channel stability are established.
- Provide repairs as needed until site stabilization occurs.
- Identify appropriate maintenance measures.
    - For example, small depressions and flow paths that are recreated will require care in mowing to avoid future elimination and compaction.
- Develop brief but detailed maintenance sheets specific to measures and areas that have been protected or restored.

AVOID CREATING NEW PROBLEMS

- Avoid repair measures to paths, roads, and culverts that will create new problems by channelizing excess water.
    - Often a culvert will be installed to repair an eroding path, causing erosive conditions in small streams and flow paths downstream.
- Avoid uncontrolled access of maintenance vehicles.
    - Such vehicles should be directed to specific routes for access needs.
    - Crossing of small streams and flow paths should be avoided.
    - See *W.3 Create Absorbent Landscapes*
- Prevent soil compaction and restore compacted areas
    - See *S.2 Minimize Soil Disturbance*

FOR FURTHER INFORMATION

- Philadelphia Clean and Green Program, which describes where small ephemeral pools were created in reclaimed urban lots: http://www.next-greatcity.com/actions/lots
- American Rivers and Sierra Club. *Where Rivers are Born: The Scientific Imperative for Defending Small Streams and Wetlands*, September 2003.
- Dunne and Leoplold, Water in Environmental Planning. Macmillan. 1978. (Available through Google Docs)
- Gomi, T., R.C. Sidle, and J.S. Richardson. *Understanding Processes and Downstream Linkages of Headwater Systems*. BioScience 52:905-916. 2002.
- Leopold, L.B., A View of the River. Cambridge, Mass. Harvard University Press. 1994.

http://www.epa.gov/OWOW/NPS/urbanize/report.html

W.2
REDUCE FLOW TO STORM SEWERS

OBJECTIVE

Decrease sewer overflows that contribute to stream contamination and flooding. Improve groundwater recharge, evapotranspiration, and water availability for plantings.

BENEFITS

- Reduces runoff, with direct reduction of combined sewer overflows in small storms and local flooding in larger events.
- Increases awareness of stormwater by creating a system that is visible, not buried.
- Reduces irrigation needs if designed to disperse runoff into planting beds and across lawns.
- Increases groundwater recharge.
- Reduces cost of piping and inlets.
- Provides easy access for repairs and changes.
- Requires little maintenance and function for many years if protected and properly used.
- Reduces local erosion by dispersing, rather than concentrating, flows.

CONSIDERATIONS

- Requires occasional weeding and litter removal.
- Detention structures can increase cost of construction.
- May reduce land available for other uses.
- Amount of overflow must be calibrated to the absorptive capacity of the soil.

INTEGRATION

- *S.2 Minimize Soil Disturbance*
- *W.1 Protect and Restore Natural Hydrology and Flow Paths*
- *W.3 Create Absorbent Landscapes*
- *V.4 Design Water Efficient Landscapes*

BACKGROUND

Even in highly urban areas, it is possible to reduce impervious cover and thus reduce combined sewer overflow, one of the chief culprits of water body degradation. Virtually all rainfall that lands on impervious surfaces becomes runoff within moments of falling. Additionally, many urban areas of lawn or playfield can be so compacted that the area is functionally impervious. Even small amounts of rain will create runoff from impervious surfaces. This runoff can overload both separate and combined-sewer systems in urban areas. Disconnecting small impervious areas and downspouts will have a direct and immediate benefit.

Parks provide an opportunity to direct runoff from rainfall events and downspouts into the natural landscape and vegetated areas which will benefit from improved water availability. This will delay the storm flow, thereby reducing the overwhelming flows to the city's taxed storm system and minimizes combined sewer overflows.

PRACTICES

PLANNING

IDENTIFY OPPORTUNITIES WITHIN THE DESIGN PROGRAM

- Identify opportunities for disconnecting roof leaders.
- Identify opportunities to reduce surface flow to piped sewers.

DEVELOP A WATER BUDGET

- See *Part 2: Site Assessment*.

DESIGN

DEVELOP A GRADING AND STORMWATER MANAGEMENT PLAN

- Carefully consider proposed drainage patterns so as to maintain contributing watersheds to protected root zone areas so that plants do not need supplemental watering after the establishment period.
- Small rainfalls make up the bulk of precipitation. Avoid the collection, conveyance, and discharge of small frequent rainfalls from hard surfaces into piped sewers.
- Manage stormwater as close to its source as possible. Rather than collect and concentrate stormwater and pollutants, provide places for stormwater to flow off paved areas into vegetated areas.
- Balance the absorptive capacity of the natural area and the quantity of water expected.
- Runoff from streets, pathways, parking lots, and rooftops should be directed to onsite stormwater management BMPs whenever possible.
- Methods of conveyance can include grading, curb cuts or removal, or through subsurface stormwater pipes.
- Avoid excessive piping of stormwater, which will reduce infrastructure costs.
- For areas where ponding or flooding cannot be tolerated, design a piped system that manages larger storms effectively.
- Design piped storm systems to convey runoff from large storms to detention areas that delay discharge into municipal sewage systems.
- Avoid the use of one large detention basin for stormwater control but rather spread out management strategies throughout the site.
- See *S.2 Minimize Soil Disturbance*
- A grading and stormwater management plan can be a large and technical document.
- Consult with Parks engineers and NRG staff for assistance.

DISCONNECT DOWNSPOUTS FROM EXISTING BUILDINGS

- When disconnecting downspouts from piped sewers, consider the size of the roof area.

Rooftop runoff from the Parks' Maintenance Facility green roof on Randall's Island is directed to cisterns. The water captured by the cisterns is used to water the green roof during periods of drought.

  - Generally, buildings with external existing downspouts serve less than 1,000 square feet of roof area, which includes a vast majority of parks buildings found within park space, such as comfort stations and maintenance buildings.
  - The approximate roof area should be visually confirmed to assure discharged flows to vegetative surfaces are not unmanageable.
  - Flow rate estimates should be made for roof areas greater than 1,000 square feet in area.
- Sufficient area should be available for water dispersion and infiltration.
- While varying by volume, in general, water that is directed to flow across lawns requires a flow path of at least 75 feet.
- Downspouts should be far away enough from the nearest impervious surfaces to discourage reconnection.
- The proximity and nature of existing structures to the disconnection location is important.
  - The surface topography should grade away from the structure.
  - The disconnection should be made ten feet or more from existing basements and drainage should be directed away from structures.
- Disconnected downspouts should not discharge across sidewalks or impervious areas due to the potential for creating icy conditions during freezing weather.
- Do not disconnect downspouts in areas where ponding or basement flooding may occur.
- It may be necessary to extend the downspout to distribute

runoff a safe distance from structures.

- Consult maps from the Mayor's Office of Long Term Planning and Sustainability for areas prone to flooding.
- Maintenance staff can also provide information on ponding areas.
- Take care to avoid compaction of vegetated and lawn areas that receive runoff from downspouts or graded impervious areas.
- Longterm compaction of soils by mowing equipment will reduce soil infiltration.
- See *S.2 Minimize Soil Disturbance*
- See *W.3 Create Absorbent Landscapes*

AVOID DOWNSPOUTS IN NEW BUILDINGS

- Locate buildings such as comfort stations within the landscape so that runoff can be directed to areas of high infiltration.
- Plan for runoff to be managed entirely within the landscape.
  - This is especially important for isolated buildings, where the cost of traditional drainage piping would be prohibitively expensive.
- The site designer should work with the architect to reduce roof size if possible, and to identify potential downspout locations and coordinate drainage, conflicts with path and entrance needs, landscape, and other utility issues.

MAINTENANCE

INSPECT DISCONNECTED ROOF LEADERS AND IMPERVIOUS AREAS REGULARLY

- Confirm that the flow path is still functional and has not been obstructed by mulch, debris, or sediment depositions.
- Restore conditions as necessary for effective runoff dispersion.
- Confirm that erosive conditions or localized flooding problems have not developed.
  - If these conditions have developed, identify the cause of erosion, such as desire lines, trampling, or clogged drains.
  - If erosive conditions have developed, consider methods to prevent further compaction such as fencing desire lines, or implement BMPs such as vegetated swales to direct flow and facilitate infiltration.
  - See *W.1 Protect and Restore Natural Hydrology and Flow Paths*.
- Confirm that compaction has not occurred due to mowing and equipment.
- Refer to *W.3 Create Absorbent Landscapes* for soil conditions.

FOR FURTHER INFORMATION

- City of New York, Department of Design and Construction. *Sustainable Sites Design Manual*. 2009.http://www.nyc.gov/html/ddc/downloads/pdf/ddc_sd-sitedesignmanual.pdf
- City of New York, Department of Design and Construction. *High Performance Infrastructure Guidelines*. 2009. http://www.nyc.gov/html/ddc/downloads/pdf/hpig.pdf
- City of Portland. Stormwater Management Manual, Revision 4. 2008. http://www.portlandonline.com/bes/index.cfm?c=35117
- City of Portland, Bureau of Environmental Services. 2006. Fact Sheets: *Downspout Disconnection*. http://www.portlandonline.com/bes/index.cfm?c=31870
- *Maryland Stormwater Design Manual*, 2000.
- New York State S*tormwater Management Design Manual* (April, 2008); http://www.dec.ny.gov/chemical/29072.html
- Pennsylvania Department of Environmental Protection (PADEP). *Draft Pennsylvania Stormwater Management Manual*. 2005. http://www.dep.state.pa.us/dep/subject/advcoun/stormwater/stormwatercomm.htm

W.3 CREATE ABSORBENT LANDSCAPES

OBJECTIVE

Increase the absorbent capacity of a site by maintaining and restoring a healthy and porous soil matrix that allows water infiltration and by using plants that absorb and evapotranspirate moisture. Remove areas of unnecessary impermeable surface and use pervious alternatives, reducing the amount of stormwater runoff from impervious surfaces increasing infiltration and improving water quality.

BENEFITS

- Applicable at many scales and configurations; ideal for small sites in highly urbanized areas such as medians, planting strips, traffic islands and other leftover spaces.
- Tends to be low maintenance and tolerant of urban conditions if well designed.
- Reduces runoff and combined sewer overflows.
- Reduces peak load of runoff to existing infrastructure during storm events by infiltrating and slowing water flows.
- Significantly reduces chemical and nutrient loading of ground water and surface water bodies.
- Reduces need for expensive hard infrastructure.
- Increases potential for onsite stormwater management including filtering stormwater, ground recharge and water quality improvement.
- Healthy and absorbent soils will facilitate greater evapotranspiration, improving air quality and reducing urban heating.
- Encourages healthy plants by returning water to the soil mantle and providing natural irrigation to areas than may not receive other means of watering.

CONSIDERATIONS

- Requires periodic maintenance to ensure plant health and remove debris.
- Requires plant palette to support extensive root system development.
- May require the use of soil amendments and restoration techniques prior to vegetation installation.
- Not always appropriate for regulated sites such as brownfields, however, absorbent landscapes can be created above caps.
- Requires education and alternative thinking by engineers.
- Can require code changes.
- Soil types may limit infiltration or planting success.

INTEGRATION

- *S.2 Minimize Soil Disturbance*
- *S.4 Use Compost*

BACKGROUND

In urban stormwater management, the simplest approach to reducing stormwater runoff and pollutants is to maintain or restore the ability of soils to absorb rainfall. Biological macropores created by vegetation, especially deep rooted vegetation and fauna, will improve the absorbent characteristics of a soil, thereby reducing runoff, increasing infiltration, and improving water quality. Soil amendments to improve soil health combined with vegetative plantings intended to create extensive root systems, will create, increase, and restore macropores in disturbed soil horizons. Improving the opportunity for macropore development in the upper soil horizon will facilitate deeper macropore development and soil absorptive capability. Areas of lawn that have become compacted are virtually impervious and almost as dense as concrete, generating a considerable amount of stormwater runoff. Absorbent landscapes can control, treat, and gradually release rainfall back into the water cycle through infiltration and evapotranspiration.

It should be noted that impermeable caps, required for the management of contamination, will preclude infiltration to the water table. Such a cap serves to eliminate exposure to the contamination, and the infiltration of water that would mobilize the contamination to the groundwater. The hydrologic holding capacity of the area above the cap is lowered, potentially leading to more runoff. Special attention and engineering to account for this must be included.

PRACTICES

PLANNING

CONDUCT SITE ANALYSIS TO DETERMINE AND OPTIMIZE LANDSCAPE ABSORPTIVE CAPABILITY

- See *Part 2: Site Assessment*.
- See *S.1 Provide Comprehensive Soil Testing and Analysis*.

ASSESS EXISTING IMPERVIOUS SURFACES AND DETERMINE WHERE IT IS FEASIBLE TO REDUCE OR REPLACE WITH A PERVIOUS SURFACE

- See *Part 2: Site Assessment (Water Analysis, Assess Existing Impervious Surfaces)*

EVALUATE PLANNED NEW IMPERVIOUS AREAS AND REDUCE THE AMOUNT OF PAVEMENT WHILE ACCOMMODATING THE DESIRED NEEDS

- Implement pervious surface alternatives in all renovations and new development.

DETERMINE IF THERE ARE IMPERMEABLE LAYERS OR CONTAMINATION BELOW THE SURFACE OF THE SOIL

- Landfill cap

- Transportation or other structure
- Rock
- Contamination

DESIGN

INCORPORATE SITE PROTECTION PLANS

- Keep subgrade from being compacted during construction and decompact previously compacted subgrade.

AMEND EXISTING SOILS TO IMPROVE POROSITY

- Ensure that soil testing, especially in areas of infiltration, is conducted at appropriate areas.
- Test percolation rates in infiltration areas and at appropriate subgrade and final grade locations.
  - Specify measures to decompact existing top soil and subgrade as needed.
- See *S.3 Prioritize the Rejuvenation of Existing Soils Before Importing New Soil*
- Ensure adequate soil depths for healthy vegetation and stormwater storage and infiltration.
- Provide a transition layer between soil horizons to facilitate drainage.
- Maximize vegetation, that is, increase the quality, density, and quantity of vegetation, particularly trees, to increase evapotranspiration.
- Use organic mulch to retain moisture, minimize erosion, and avoid surface sealing.
- Use vertical staking to restore compacted soils.
  - Vertical stakes add soil stability.
  - Rather than disturbing entire compacted areas, which leaves them open to invasive species and erosion, use stakes driven vertically to loosen soil, convey water and air downward.
  - Consult Capital Arborist for further information.
- Use vertical mulching to restore compacted soils.
  - Drill 2" holes 1 foot deep and fill with porous material such as sand and mycorrhiza. The depth and spacing can be varied depending upon the severity of compaction.
- Add compost to increase porosity.
- See *S.4 Use Compost*.

UTILIZE SPECIFIED SOILS OR SUBGRADE METHODS TO INCREASE POROSITY

- Where necessary, utilize soils that are specified and manufactured to increase infiltration and maintain good porosity.
  - Specify soils with very low amounts of USDA texture fines.
    - For example: less than 10% fine and very fine sands and less than 3% silt and clay
  - Specify gap graded soil materials that have a high hydrologic conductivity.
    - Examples include CU Structural soil or Stalite soil mixes
  - Specify the use of gap graded gravel subbases (where fines have been removed) as is commonly done with porous pavement assemblies.
- Consider subgrade remediation to encourage deeper subsurface water infiltration.
  - Ripping of subgrades when space permits, auguring holes to more free draining subsurface layers, and backfilling the holes with porous soil materials

POSITION ABSORBENT LANDSCAPES DELIBERATELY

- Position absorbent landscapes to maximize the disconnection of impervious surfaces from the conventional stormwater system.
- Optimize infiltration opportunities by connecting absorbent landscape areas.
  - The goal is to give rainwater the longest route overland, through the soil strata and past plant leaves and roots before connecting it to the conventional stormwater pipe system.

SELECT PLANTS THAT WILL IMPROVE SOIL STRUCTURE

- Select and manage plants with deep root systems and large amounts of surface or root biomass to increase organic matter, improve soil structure and moisture through better infiltration.
  - Grasses: Big Bluestem, Canada Wild Rye, Little Bluestem, Indian grass, Sideoats Gramma, Canadian Wild Rye, and Switchgrass
  - Forbs: Asters, Indigos, and Coneflowers
  - Shrubs: with deep woody root systems for use in wet areas, such as Cornus and Salix
  - Hardwood trees: oaks and maples are often the pioneers of disturbed sites and can be used in groupings with shrubs to create microclimate.
- Assess feasibility of plant lists to provide stable landscape matrix.
- In large areas of difficult growing condition that will not receive much care, choose plants that don't require very specific soil and microclimate conditions.
  - These plants can tolerate difficult growing conditions and will improve soil porosity and enrich the soil until more sensitive plants can be added.
- Grass and legume cover crops with deep tap roots can reduce existing severe soil compaction and may be needed as a first step in soil restoration.
  - Consider planting noninvasive annual species in conjunction with the desired permanent species.

DEVELOP METHODS TO CAPTURE, TREAT, AND INFILTRATE STORMWATER INTO ALTERNATIVE BMPS

- Tree trenches
- Pervious parking aisles
- Street bump-outs
- Bioswales (See *W.1 Protect and Restore Natural Hydrology and Flow Paths*)
- Rain gardens (See *W.5 Use Rain Gardens and Bioretention*)

USE PERVIOUS SURFACES

- Incorporate pervious surface alternatives at the beginning of the design process of new development.
  - See *W.7 Use Porous Pavements*.
  - Pervious asphalt

The vegetated swale adjacent to this path captures and infiltrates runoff.

- Pervious concrete
- Pervious pavers

- See *D.9 Synthetic Turf*.

USE PERVIOUS SUBGRADE

- Use open graded base course such as stone aggregate or other recycled aggregates including glass, concrete, or recycled glass reservoirs under conventional pavement to spread stormwater over a large surface and allow it to infiltrate slowly.
- This technique requires a method be designed to direct the runoff to this bed.

USE PERVIOUS CURBS AND GUTTERS

- Pervious curbs can be constructed via slotting at intervals, drainage holes, or using a permeable material.
- For areas of higher flows, consider broken stone along the edges of the accepting area to allow for infiltration and minimize erosion.
- DEP is using the technique of a false catch basin or steep top inlet (the curb part of a catch basin).

REDUCE PAVING WITHIN PARKING LOTS

- While they are intended for commercial parking lots, comply with the NYC Department of City Planning's Design Standards for a minimum in street tree and landscaping allowances http://www.nyc.gov/html/dcp/pdf/parking_lots/parking_lot_present.pdf
- See *W.4 Use Infiltration Beds*

ISOLATE AND TREAT HIGH POLLUTANT ACTIVITIES FROM GENERAL RUNOFF

- Collect water from maintenance areas and dumpsters and provide water quality treatment measures.
- Where complete separation is not possible, use pretreatment before runoff areas drain elsewhere.
- See *S.2 Minimize Soil Disturbance*.

INCORPORATE EDUCATION ELEMENTS

- Design to showcase stormwater in rain gardens and other absorbent landscapes.
- Use signage to educate park visitors about stormwater and water conservation.

CONSTRUCTION

CONSTRUCTION GOALS

- Ensure that erosion and sediment control measures are installed and maintained throughout the construction process.
- Avoid soil compaction.
- Minimize runoff from construction and construction activities.

INCORPORATE DISCUSSION OF SOIL PROTECTION INTO CONTRACTOR MEETINGS

- Prebid meetings:
  - Review and discuss hydrologic goals of the site and the importance of soils and vegetation to the overall stormwater philosophy.
  - Review the importance of the plantings to stormwater management.
- Pre-construction meetings:
  - Review the requirements of the site protection and construction staging and sequencing plans.
  - Discuss in detail the importance of soils and vegetation to the plans.
  - Discuss specific procedures for soil protection.
  - Discuss detailing of sustainable stormwater management systems.

ENSURE COMPLIANCE WITH REQUIREMENTS

- Observe installation of stormwater management elements from subgrade preparation to final surface treatment especially if unusual stormwater management systems are used.
- Direct corrections to work operations as required to comply with the contract documents.
- Ensure that stormwater management elements are installed in appropriate weather conditions.
  - Avoid frozen or saturated soils.

CONDUCT SITE VISITS DURING THE ESTABLISHMENT PERIOD

- Make sure vegetation has established.

MAINTENANCE

- Make sure new plantings are cared for during the establishment period, and thereafter.
- Aerate lawns and topdress with compost.
- Confirm standing water soaks into the ground within two days.
- Confirm overflow piping is not clogged.
- Remove litter and weeds from rain gardens.
- Mulch planting beds.
- Develop a management plan that leaves organic matter in place (leaf litter in particular) or adds organic matter on an annual basis to ensure enduring high organic content.

FOR FURTHER INFORMATION

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W.4 USE INFILTRATION BEDS

OBJECTIVE

Retain and infiltrate stormwater in a subsurface layer to reduce the volume of runoff entering storm sewers and increase groundwater recharge.

BENEFITS

- Reduces runoff and combined sewer overflows.
- Improves water quality.
- Uses space efficiently by layering stormwater services below other park uses.
- Reduces need for stormwater conveyance structures such as pipes and inlets.
- Provides a measure to reduce stormwater volume in areas of high erosion or downstream damage.

CONSIDERATIONS

- Design must be considered early in the design phase to account for needs of system in conjunction with surface land use.
- Requires an uncompacted subsurface with well drained soils for infiltration.
- Use may be limited by regulations in landfills or areas of soil contamination.

INTEGRATION

- *W.2 Reduce Flow to Storm Sewer*
- *W.3 Create Absorbent Landscapes*

BACKGROUND

Subsurface infiltration beds are used for the temporary storage and infiltration of stormwater runoff. They consist of a pervious soil layer or porous pavement layer placed above a uniformly graded aggregate bed. Subsurface infiltration beds can be used in a variety of areas to reduce stormwater runoff and improve water quality, but are especially suited for under porous asphalt, porous concrete, tree trenches, and infiltrating synthetic turf.

Subsurface infiltration beds can be used on a slope if the beds are terraced or stepped. Infiltration beds can also be used.

A dry well is a small, subsurface vertical infiltration bed and is especially suitable for roof runoff from the downspouts of buildings. Dry wells can reduce the volume of runoff entering the stormwater infrastructure system by disconnecting roof drainage from the sewer system. The infiltration of this runoff also recharges groundwater. Dry wells are effective in urban parks because they are space efficient and can be located under planting areas, under paths or walkways, or incorporated in other ways into the footprint of project disturbance.

PRACTICES

DESIGN

EVALUATE SITES FOR INFILTRATION BED LOCATION EARLY IN THE SITE PLANNING PROCESS

- Avoid areas of excessive cut if the soil mantle is removed.
- Avoid areas of fill, which require compaction and will not be suitable for infiltration.
- Undertake an integrated design process, with input from different disciplines early in the schematic design phase, to assist in identifying potential areas for subsurface infiltration.

CONDUCT SOIL INVESTIGATION AND INFILTRATION TESTING

- Determine the infiltration rate and verify subsurface conditions suitable for infiltration.
- See *Part 2: Site Assessment*.

DETERMINE WHERE INFILTRATION BEDS WOULD BE USEFUL

- Direct connection of roof leaders
  - Roof leaders and area inlets may be connected to convey runoff water to the bed.
  - Water quality inserts or sump inlets should be used to prevent the conveyance of sediment and debris into the bed.
  - See *W.9 Manage Rooftop Runoff*.
- Direct connection of inlets
  - Catch basins, inlets, and area drains may be directly connected to subsurface infiltration beds.
  - Sediment and debris removal must be provided.
  - Storm structures must include sediment trap areas below the inverts of discharge pipes to trap solids and debris, and screens or snouts to prevent debris and trash from entering beds.
  - In areas of high traffic or excessive generation of sediment, litter, and other similar materials, a sump or a water quality insert may be required (inserts designed to work inside curbs and grates to keep sediment, hydrocarbons, and litter out of the storm water system).
- Under recreational fields
  - Subsurface infiltration is very well suited below playfields and other recreational areas.
  - Work with the specifications department to determine which types of synthetic turf would be appropriate for infiltration.
  - Special consideration should be given to the engineered soil mix in these cases.
  - Additionally, beds can be designed to provide water capture for reuse in irrigation needs.
- Under planting beds and landscaped areas
  - Beds can be constructed with a top layer of 8 to 12 inches of topsoil, allowing for the establishment of vegetation.
- Under parking and pavement areas
  - In areas where porous pavement is not feasible,

subsurface infiltration beds can be placed beneath standard pavement provided a mechanism is installed to convey the runoff to the bed.

- □ Problems to consider:
  - ○ Areas where runoff must receive water quality treatment prior to infiltration
  - ○ Areas where spills or contamination of runoff may occur and a mechanism for spill containment is needed

MEET THE FOLLOWING CRITERIA FOR INFILTRATION SYSTEMS

- ■ Design to capture a 1" storm event as a minimum.
- ■ Size infiltration beds as large as possible considering cost, area available, and site constraints to optimize water capture beyond the minimum.
- ■ Spread the water out rather than concentrating it in a small area.
- ■ Avoid a loading ratio of impervious area to infiltration bed area of more than 5 to 1.
- ■ The loading ratio of total drainage area to infiltration area should not be greater than 8 to1.
- ■ Ensure underlying soils have an infiltration rate of 0.5 inches per hour at the minimum.
- ■ Size the stormwater storage to absorb at least a 1" storm event from the contributing rain fall area.
- ■ Locate infiltration systems so that they pose no threat to subsurface structures.
- ■ Evaluate each situation based on geology, soils, and amount of stormwater.
- ■ Limit the designed depth of water capacity to no more than two feet to reduce compaction and overloading of an infiltration system.
- ■ It is crucial that the base of the bed remains level in all situations to prevent the water from sitting in the low lying area and causing settlement.
- ■ Infiltration beds may be placed on a slope by benching or terracing parking bays.
- ■ Do not compact the bed bottom.
  - □ Place the stone subbase in lifts and lightly roll for minimum required compaction.
- ■ Grading
  - □ Subsurface infiltration beds can be stepped or terraced down sloping terrain provided that the bottom of the bed remains level.
  - □ Stormwater runoff from nearby impervious areas (including rooftops, parking lots, roads, and walkways) can be directly conveyed to the subsurface storage media, where it is then distributed through the bed via a network of perforated piping.
  - □ It is crucial that subsurface infiltration beds not be placed on area of recent or compacted fill and that the bed bottom has a slope no greater than 1%.

DETERMINE INFILTRATION AREA AND VOLUME

- ■ Infiltration area: The infiltration area is the bottom area of the bed, defined as:
  - □ Length of bed x width of bed = infiltration area (if rectangular)
  - □ This is the area to be considered when evaluating the loading rate to the Infiltration bed.
- ■ Volume: The storage volume of the infiltration bed is defined as the area beneath the discharge invert. This is equal to:
  - □ Length x width x depth below invert/drain x void ratio in medium
  - □ The void ratio in AASHTO No. 3 stone is 40%.
  - □ Soil mechanic and physics references are available that provide estimates of pore/void percent associated with different rock/soil grades/textures. Consult NYC engineering department for assistance.
- ■ All infiltration beds should be designed to infiltrate or empty within 48 hours.

CONSIDER SIZE AND DEPTH OF INFILTRATION BED

- ■ The depth of the bed is a function of stormwater storage requirements, grading, and frost depth considerations.
- ■ Infiltration beds may be large in size when located in areas such as beneath athletic fields and pipe fields below pavement areas, or small, such as an area beneath a path or planting bed.
- ■ General rules are to locate systems no closer than 20 feet down gradient or 100 feet up gradient of buildings, but site conditions should be evaluated for each application.
- ■ Maintain at least 2 feet separation between seasonal high water table and the bed bottom.
- ■ Maintain at least 2 feet separation between bedrock and the bed bottom.
- ■ Existing path systems frequently overlap with tree root zones.
- ■ Tree root zones must be avoided when designing infiltration beds.

MATCH INFILTRATION MATERIALS TO THE INTENDED END USE

- ■ The infiltration bed generally consists of an open graded, clean washed stone aggregate, usually 12 to 36 inches in depth.
- ■ The storage media for subsurface infiltration beds typically consists of clean washed, open graded aggregate. Open graded refers a gradation of stone with only a small percentage of aggregate particles in the small range. This results in more voids because there are not enough small particles to fill in the voids between the larger particles.
- ■ Storage alternatives are available, generally variations on plastic cells that can significantly increase the storage capacity of aggregate beds, but often at an increased cost.
- ■ The bed is wrapped in nonwoven geotextile to prevent the movement of soil into the storage bed and clogging of pores.
- ■ Stormwater storage elements may also be used, however, the use of solid pipes for storage is discouraged, as the intent is to promote infiltration and not simply water storage.
- ■ The bed may be covered with:
  - □ A layer of 12-18 inches of permeable soil (see *W.5 Use Rain Gardens & Bioretention*)
  - □ Suitable backfill material for the construction of a natural or artificial athletic field
  - □ Porous pavement (see *W.7 Use Porous Pavements*)

- Standard impervious pavement.
- Inlets and Outlets
  - All infiltration beds must be designed with an overflow outlet so that as the water level rises in large storms, water is safely conveyed to storm sewers or overflows without creating saturated conditions.
  - An outlet control structure is commonly used to provide control in the beds, usually in the form of an inlet box with an internal concrete weir or a low flow orifice.
  - If the design of an infiltration bed is subject to DEP review, an outlet control structure can be required.
  - Cleanouts or inlets should be installed at a few locations within the bed (depending on bed size) and at appropriate intervals to allow access to the perforated piping network.
  - In areas with poorly draining soils, subsurface Infiltration beds may be designed to overflow to adjacent wetlands or bioretention areas.

CONSIDER THE FOLLOWING REQUIREMENTS

- Stone for infiltration beds should be 2 inch to 1 inch uniformly graded coarse aggregate, with a wash loss of no more than 0.5%, AASHTO size number 3 per AASHTO Specifications and should have voids ≥ 35% as measured by ASTM-C29.
- Nonwoven permeable geotextile should consist of needled nonwoven polypropylene fibers and meets the following properties:
  - Grab tensile strength (ASTM-D4632) ≥ 120 lbs
  - Mullen burst strength (ASTM-D3786) ≥ 225 psi
  - Flow rate (ASTM-D4491) ≥ 95 gal/min/ft^2
  - UV resistance after 500 hrs (ASTM-D4355) ≥ 70%
  - Heat-set or heat-calendared fabrics are not permitted.
  - Acceptable types include Mirafi 140N, Amoco 4547, and Geotex 451.
- To provide an even surface for paving, install a 1 inch layer of choker base course of single size, 1/2” crushed stone that stabilizes the open graded asphalt (often AASHTO #57 stone) over the bed aggregate.
- If a vegetated surface layer is planned, then place an approved soil mix over infiltration bed in maximum 6 inch lifts, then stabilize topsoil and conduct seeding or planting.
- If a porous pavement or concrete surface layer is desired, lay it directly over the stone bed course.
- See *W.7 Use Porous Pavement*.

CONSTRUCTION

BE AWARE OF CONSTRUCTION SEQUENCE

- If possible, install subsurface infiltration systems toward the end of the construction period.
- Avoid compacting the existing subgrade or exposing it to construction equipment traffic prior to stone bed placement.
- Remove accumulation of fine materials and/or surface ponding caused by erosion of subgrade using light equipment, and level all bed bottoms.
- Leave earthen berms in place during excavation.
- Immediately place geotextile and bed aggregate after the approval of subgrade preparation.
- Install all necessary upstream and downstream control structures, cleanouts, and perforated piping.
- Keep construction equipment off the bottom of the bed as much as possible while clean (washed) uniformly graded aggregate is placed in the bed in maximum 8 inch lifts.

MAINTENANCE

- Inspect and clean all catch basins and inlets that convey collected runoff to the beds on an annual basis.
- Ensure that upstream measures prevent sediment from entering the bed, or the life of the bed will be reduced and will require frequent maintenance.
- Inspect, clean, and repair water quality measures that treat the runoff before it enters the bed, including catch basins, or vegetative elements such as swales.

FOR FURTHER INFORMATION

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W.5 USE RAIN GARDENS & BIORETENTION

At Mullaly Park in the Bronx, breaks along the curb direct runoff into a planting bed whose engineered soil layers and water-tolerant plants are designed to retain water.

OBJECTIVE

Reduce runoff volume, improve water quality, infiltrate runoff and, where appropriate, provide water for plantings through the use of depressed landscaped areas.

BENEFITS

- Landscaping can be more resilient and maintenance free due to water capture than traditional planting beds requiring frequent watering.
- Reduces runoff and combined sewer overflows.
- Removes pollutants via settling, vegetation, and soils.
- Bioretention can reduce total suspended solids (TSS) by up to 85% and total nitrogen and total phosphorus at ratios of 20:1.
- Landscaping design can be visually appealing as well as functional.
- Landscape provides ecosystem services such as air quality improvement, habitat, and evaporative cooling.
- Offers cost effective detention and treatment.

CONSIDERATIONS

- Poor infiltration rates or clogged overflow pipes lead to standing water and mosquito breeding.
- High velocity flow entering the rain garden could cause erosion.
- Requires education to dispel fears about standing water and insect borne disease.
- Plantings should be appropriate to the function, and can be very naturalized or more formal.
- During rain events, litter will be washed into the rain garden. If it is not intercepted by a screen it will need to be removed from the garden.

INTEGRATION

- *S.1 Provide Comprehensive Soil Testing and Analysis*
- *S.2 Minimize Site Disturbance*
- *W.4 Use Infiltration Beds*
- *W.9 Manage Rooftop Runoff*
- *V.4 Design Water Efficient Landscapes*

BACKGROUND

Rain gardens are shallow planted areas that retain small amounts of stormwater for 12 - 48 hours. Rain gardens typically manage small storm events through both infiltration and evapotranspiration from plants within the garden, but rain gardens can also be designed for temporary storage, known as bioretention. Rain gardens typically consist of the following elements:

- Inflow area(s)
- Shallow planted ponding areas over welldrained, permeable soil media
- A mulch layer, preferably leaf compost
- An optional gravel filter bed and underdrain system
- An overflow mechanism to take larger rainfall events to the stormwater system or other BMPs
- Vegetation

Rain gardens are highly versatile and can be shaped and adapted to fit into a number of constrained surroundings, including playgrounds and court sports, lawn areas, traffic islands and roadway swales. In large parks, they are typically designed as part of a larger stormwater management system. If placed in areas that would be landscaped under a conventional stormwater plan, the additional cost of constructing rain gardens is minimal.

PRACTICES

DESIGN

RAIN GARDEN DESIGN CONSIDERATIONS

- Distribute rain gardens throughout a site near sources of runoff, if possible, to mimic natural drainage patterns and manage water close to the source.
- Place rain gardens on areas of the site with well draining soils if infiltration is a goal.
- Soils should have an infiltration rate of at least 0.5 inches per hour or more to ensure adequate drainage of the system.
- Underdrains or other structures can also be used to manage excess runoff.
- Design to drain all standing water within 48 hours.
- Place rain gardens at natural low points if possible.
- Keep rain gardens 10’ from foundations or provide a method to waterproof foundations.
- Stormwater can be conveyed to a rain garden through sheet flow, an inlet with a flared end section, curb cuts, downspouts, trench drains, swales, or other surface structure.

DESIGN RAIN GARDEN AREA

- Determine design storm volumes and model stormwater flows based on final catchment areas to determine rain garden sizes.
- An ideal drainage area to bioretention area ratio is 5:1.
  - The ratio depends on the underlying soil and the design of the system, particularly the overflow and high flow management system.
- The dimensions (area and depth) of the rain garden should be designed based on the drainage area, desired water depth, soils, and capacity of the overflow structure or underdrain system.
- Avoid side slopes of greater than 3:1.
- Side slopes of 2:1 may be used with a fence or retaining wall in constrained situations.
- Ensure that ponded water drains from the rain garden within 48 hours.
- Provide a soil base for the planting area of at least 2 feet, or more for areas incorporating trees and larger vegetation.
  - Deeper soil can lead to settlement over time and should be accounted for in installed soil volumes.
- Cover with several inches of mulch or compost.
  - Wood mulch that can float is discouraged.
- See *S.7 Provide Adequate Soil Volumes and Depths* for additional information.

PROVIDE FOR OVERFLOW

- Even if rain gardens are not tied directly into the storm system, provide a means of overflow for large storm events, such as a broad weir to disperse flow over a lawn or wooded area.
  - Overflow points can include, but are not limited to, riser pipes or spillways.
  - Domed riser pipes are recommended to prevent surface clogging from debris and vegetation.
- Ensure that soil pH, void space, and organic matter promote vegetation growth and stormwater absorption and drainage.
- Provide a prepared soil mix if onsite soil is not appropriate.
  - Specify 50% sand, 20-30% topsoil with less than 5% clay, and 20-30% leaf compost.
  - Minimize the use of clays.
  - Depth should accommodate the largest rootball as well as the stormwater storage requirements.
  - Provide an underlying 6-10" layer of clean open graded gravel to increase storage and infiltration if necessary.
  - It is essential to wrap stone using nonwoven geotextile fabric to prevent clogging.
- Consider use of an underdrain system in the event of compacted and clay soils to augment drainage.

PERFORM SIZING BASED ON WATER QUALITY VOLUMES

- For sizing, refer to the table compiled from the New York State Stormwater Manual on page 177, and at http://www.dec.ny.gov/chemical/29072.html.
- See also Simple Chart for Rain Garden Sizing on page 178 for sample calculations.

DESIGN APPROPRIATE PLANTINGS

- Use plant designs that include a mix of upland and wetland plants.
- Choose plants with well developed roots.
- Space plantings to facilitate rapid establishment of thick cover and soil stability through dense rooting structure.
- Vary bottom elevations of plant bed to avoid monocultures, as different species thrive in different soil moistures, and to avoid reliance on the survival of one plant type.
- For areas capturing runoff from pavements and sidewalks, do not use for food production without proper filtering precaution to avoid chemical deposition.

CONSTRUCTION

CONSTRUCT RAIN GARDENS WITH CARE

- Construct rain gardens in the last construction phases to prevent damage, compaction and sediment deposition.
- Protect areas planned to become bioretention throughout construction if possible with effective erosion and sediment control measures.
  - Compost socks are highly effective.
- Excavate rain gardens with care to prevent compaction of the bed bottom.
- Slightly overfill the excavated area with the modified soils if the soils are expected to settle somewhat.
- If employing infiltration, follow the guidelines provided in *W.4 Use Infiltration Beds*.

MAINTENANCE

CONDUCT PERIODIC MAINTENANCE AND MONITORING

- Maintain periodically, especially during the first 1 to 2 years of establishment.
- Proper maintenance includes:
  - Weeding
  - Removing litter and excess detritus
  - Replacing mulch or compost
  - Occasional replacement of plants may be required if the rain garden develops gaps in planting.
- Monitor rain gardens, particularly after rainstorms during the establishment period as mulch and smaller plantings can wash out and will need to be replaced

RAIN GARDEN SIZING AND DESIGN GUIDANCE

The following is derived from NYS Stormwater Management Design Manual.

Stormwater quantity reduction in rain gardens occurs via evaporation, transpiration, and infiltration, though only the infiltration capacity of the soil and drainage system is considered for water quality sizing. The storage volume of a rain garden is achieved within the gravel bed, soil medium and ponding area above the bed. The size should be determined using the water quality volume (WQv), where the site area is the area draining to the rain garden. The following sizing criteria should be followed to arrive at the surface area of the rain garden, based on the required WQv.

NEW YORK STATE STORMWATER SIZING CRITERIA

CALCULATION EQUATIONS

WQv = water quality volume, cubic feet of volume of water storage to be filtered

V_{SM} = volume of soil media

A_{RG} = proposed area of the rain garden surface

D_{SM} = depth of soil media, typically 1.0' to 1.5'

P_{SM} = porosity of soil media (assumed to be 0.20)

V_{DL} = volume of drainage layer

D_{DL} = depth of drainage layer, typically 0.5' to 1.0'

P_{DL} = porosity of drainage later (assumed to be 0.40)

D_P = allowable ponding depth about surface, maximum 0.5'

$$\frac{WQv}{(DS_M \times PSM + DDL \times PDL + DP)} = ARG$$

Note: For the equation at left, all units should be in feet, not inches. Be sure to convert inches to feet (i.e., 6" = 0.5') for correct calculations

This equation can be reworked to determine the flexible variables based on a fixed quantity. For instance, if you have a set area for the runoff source and know how deep you want your soil and drainage layers to be, you can determine WQv (volume of storage to filter runoff) first. Adjust the equation to isolate the unknown variable, the necessary size of the rain garden.

STEP 1—CALCULATE WATER QUALITY VOLUME USING

$$WQv = \frac{(P)\,(Rv)\,(A)}{12}$$

Where:

WQv = water quality volume [ft3], as defined in Chapter 4 of the New York Stormwater Management Design Manual

P = 90% rainfall capture = 0.9 in

Note: see Figure 4.1 in Ch. 4 in the NY Stormwater Management Design Manual for more detailed numbers.

I = percentage of runoff from impervious area draining to rain garden

Rv = runoff coefficient

0.05 + 0.009 x (I) where 100% is assumed for paved or rooftop, so 0.05 + 0.009 x 100 = .95

Where measuring "I" is impractical refer to Table 4.2 in the NY Stormwater Management Design Manual.

A = area draining into rain garden

STEP 2—SOLVE FOR DRAINAGE LAYER AND SOIL MEDIA STORAGE VOLUME

Determine the volume of soil media required in the rain garden: $V_{SM} = A_{RG} \times D_{SM} \times P_{SM}$

or Determine area of rain garden: $V_{SM} / (D_{SM} \times P_{SM}) = A_{RG}$

Determine the volume of the drainage layer: $V_{DL} = A_{RG} \times D_{DL} \times P_{DL}$

Determine the volume of water the rain garden can handle: $WQv \leq V_{SM} + V_{DL} + (D_P \times A_{RG})$

EXAMPLE

Assumptions:

A = 1,000 sq. ft. impervious drainage area

P = 90% rainfall capture of a 1" storm = 0.9 in

Note: This does not need to be converted to feet from inches; the division of 12 in the equation accounts for this

Rv = runoff coefficient

0.05 + 0.009 x (I) where 100% is assumed for paved or rooftop, so 0.05 + 0.009 x 100 = .95

A_{RG} = rain garden size of 200 sq. ft.

D_{SM} = soil depth of 1'

P_{SM} = porosity of soil media (assumed to be 0.20)

D_{DL} = drainage layer (below soil) of 0.5'

P_{DL} = porosity of drainage later (assumed to be 0.40)

D_P = allowable ponding depth of 0.25'

Note: This depth would also be the height that a catch basin is raised above the surface.

Step 1:

$$WQv = \frac{(P)\ (Rv)\ (A)}{12}$$

$$WQv = \frac{(0.9")\ (0.95)\ (1000\ ft^2)}{12} = 71.25\ ft^3$$

Step 2:

$V_{SM} = A_{RG} \times D_{SM} \times P_{SM}$

$V_{DL} = A_{RG} \times D_{DL} \times P_{DL}$

$WQv \leq V_{SM} + V_{DL} + (D_p \times A_{RG})$

$V_{SM} = (200\ ft^2)\ (1\ ft)\ (0.20) = 40\ ft^3$

$V_{DL} = (200\ ft^2)\ (0.5\ ft)\ (0.40) = 40\ ft^3$

$WQv \leq 40\ ft^3 + 40\ ft^3 + (0.25\ ft)*(200\ ft^2) = 130\ ft^3$

Because WQv (the volume of storage area needed to achieve water quality) is less (71.25 ft3) than the water storage volume in the rain garden (130 ft3), the rain garden is large enough.

SIMPLE CHART FOR RAIN GARDEN SIZING

Assumes a depth of 2' for soil and 6" for drainage layer, allowable ponding of 2", and that the entire drainage area is impervious.

Table W.2

DRAINAGE AREA (SQ. FT.)	MINIMUM AREA OF RAIN GARDEN (SQ. FT.)	VOLUME OF WATER STORAGE (CU. FT.)
100	7.1	5.4
200	14.3	10.8
300	21.4	16.2
400	28.5	21.7
500	35.6	27.1
1000	71.3	54.2
1500	106.9	81.2
2000	142.5	108.3
3000	213.8	162.5
4000	285.0	216.6
5000	356.3	270.8

FOR FURTHER INFORMATION

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- New York State *Stormwater Management Design Manual*, Chapter 9, April 2008. http://www.dec.ny.gov/chemical/29072.html
- City of Portland. Stormwater Management Manual, Revision 4. 2008. http://www.portlandonline.com/bes/index.cfm?c=35117
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- Center for *Watershed Protection. Watershed Protection Techniques: A Periodic Journal on Urban Watershed Restoration and Protection Tools*, Silver Spring, MD 20910, 301-589-1890. www.cwp.com
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- Native Plant Society of NJ. *Rain Garden Manual*. http://www.npsnj.org/rain_garden_home.htm
- The Rain Garden Network Chicago, Illinois. http://www.raingardennetwork.com/raingardens.htm
- Wisconsin Department of Natural Resources. *Rain Gardens Infiltrating*. http://dnr.wi.gov/org/water/wm/nps/rg/index.htm

W.6 USE STORMWATER PLANTER BOXES

OBJECTIVE

Capture runoff from small storm events, providing water quality treatment, while slowing and reducing discharge.

BENEFITS

- Temporarily stores and reduces runoff.
- Reduces combined sewer discharges.
- Improves water quality through pollutant removal uptake by vegetation, and absorption into soils.
- Provides ideal pretreatment before an infiltration BMP
- Creates visually appealing elements.
- Applicable to small, impervious and constrained sites in urban environments.
- Appropriate for the smaller volumes of runoff from comfort stations.
- Practical in high water tables, such as portions of Queens, Brooklyn and Staten Island.

CONSIDERATIONS

- Applicable only to small drainage areas.
- Must be designed to avoid conflicts with utilities, which could increase costs.
- This approach comes at a relatively high cost compared to other stormwater management practices.

INTEGRATION

- *S.1 Provide Comprehensive Soil Testing and Analysis*
- *S.2 Minimize Soil Disturbance*
- *W.4 Use Infiltration Beds*
- *W.9 Manage Roof Runoff*
- *V.4 Design Water Efficient Landscapes*

BACKGROUND

A planter box is a structure, usually formed from concrete or brick, that is filled with absorbent soils and plants in order to store runoff temporarily and provide treatment. Planter boxes capture runoff from small storm events, usually from roof areas, and are especially useful in the limited spaces of urban areas. They provide some water quality treatment in the process of slowing and reducing the peak discharge of small rainfall events.

Planter boxes may be underdrained for slow discharge to a storm sewer, or open bottomed to serve as infiltration systems depending on location and site conditions.

Runoff from this building is directed to a planter box to allow absorption by plants and soil, helping to reduce stormwater overflow events.

PRACTICES

DESIGN

PLACEMENT

- Consider placing planter boxes against buildings, along walkways and roadways, and in other areas with small, narrow open space available.
- Consider placing planter boxes of various shapes and sizes on top of the existing surface (elevated) or at surface grade (depressed).
- Consider placing planter boxes adjacent to the external downspouts of a building to receive rooftop runoff.
- Roof leaders can be directed to planter boxes.

MATERIALS

- Form planter box structure out of concrete, wood, brick, stone, or other appropriate materials.
- Fill structure with a base layer of gravel covered by soil media and vegetation.
    - The designer should determine proper soil textures to avoid the migration of planting soil into the gravel layer.
- In flowthrough planter boxes, which do not allow infiltration, provide a gravel base that contains waterproofing and an underdrain to allow runoff to flow out of the planter box after it seeps through the vegetation and soil.
- Consider designing planter boxes with open bottoms for infiltration, when there are uncompacted, welldrained soils beneath.
- If roof leaders discharge into planter boxes, design a splash

area to prevent erosion and disperse water through the box.

- Select vegetation for planter boxes based on the plants' ability to tolerate being periodically inundated with water.
  - Give preference to plants that readily assimilate water and pollutants.
- Ensure that the soil media used for planting drains adequately within 48 hours.

INFLOW AND OUTFLOW

- Convey runoff to planter box from roof leaders, storm pipes, or through sheet flow if at grade.
- In elevated planter boxes, allow for a gap up to 12 inches between the soil surface and the top of the box for additional water storage.
- In depressed planter boxes, consider filling the gap above soil surface with gravel or cobbles to avoid creating a tripping hazard.
- Always use an overflow outlet to convey excess runoff from the planter box.
  - Consider conveying overflow to an infiltration BMP if applicable at the site, or to the storm sewer system
  - A domed and perforated cap on the riser will reduce the likelihood that the inlet will become clogged with vegetation and soil.

CONSTRUCTION

- Build planter boxes in the final phase of construction, after adjacent buildings if applicable, to prevent damage.

MAINTENANCE

- Inspect plants periodically for survival and health.
- Regularly inspect and clean all structures and pipes to prevent clogging.
- Regularly remove sediment from planter boxes.

FOR FURTHER INFORMATION

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W.7 USE POROUS PAVEMENTS

OBJECTIVE

Create pervious hardscape surfaces that allow rainfall to drain directly through pavement into a subsurface stormwater storage or infiltration bed.

BENEFITS

- Reduces runoff and combined sewer overflows.
- Applicable to most roads, parking areas, walks, and other paved surfaces.
- Porous asphalt and concrete surfaces provide better traction for walking paths in rain or snow conditions.
- Increases longevity of pavement because freeze-thaw cycles do not adversely affect the structural integrity of the pavement.
- Reduces contaminants such as total suspended solids, if the right base materials are used to act as filters before water gets to the aggregate reservoir,

CONSIDERATIONS

- Porous pavements should never be placed directly on sub-grade, and should only be used with an underlying stormwater bed to receive the water.
- Requires periodic vacuuming twice per year for optimal performance.
- Not applicable to surfaces with steep grades; 5% maximum grades is a good standard.
- Requires uncompacted subsurface with fairly well-drained soils.
- Cost of installation is higher than traditional pavement.
- Use may be limited by existing regulations in brownfield areas or areas of soil contamination.
- Not appropriate in areas prone to spills or contamination, such as refueling stations.
- Salt and sand cannot be used on porous concrete.
- Sand cannot be used on porous asphalt.
- Reinforced grass grids have not worked well in New York City parks in the past.

INTEGRATION

- *S.1 Provide Comprehensive Soil Testing and Analysis*
- *S.2 Minimize Soil Disturbance*
- *W.4 Use Infiltration Beds*
- *W.9 Manage Roof Runoff*

BACKGROUND

Porous pavement consists of a porous (permeable) surface of asphalt, concrete, or pavers overlaying an open graded stone

Stormwater runoff can pool on standard asphalt, as shown above. Porous asphalt allows water to drain directly through it, increasing ground water recharge and reducing icing in the winter.

storage/infiltration bed. These pavements provide stability as they are more stable than gravel or stone screenings. The underlying stone storage bed should have a minimum void space of 40%, which is a critical component.

Stormwater drains through the surface, is temporarily held in the voids of the stone bed, and then slowly drains into the underlying, uncompacted soils. The system is designed with an overflow outlet so that the water level will rise in the stone bed, but at no time will the water level rise to the pavement level. A layer of nonwoven geotextile filter fabric separates the stone aggregate from the underlying soil, preventing the migration of fines into the bed.

Porous bituminous asphalt consists of standard bituminous asphalt without fines in the aggregate. This allows water to pass through small voids. Porous asphalt is placed directly on the stone subbase in a single 3 ½ inch lift that is lightly rolled to a finish depth of 2 ½ inches. It is placed in a single lift, unlike traditional pavement, which has a wearing and a binder course. Because porous asphalt is standard asphalt with reduced fines, it is similar in appearance to standard asphalt. Recent research by the National Asphalt Pavement Association on open graded mixes for highway application has led to additional improvements in porous asphalt through the use of additives and binders such as styrenebutadinestyrene (SBS) or fibers. Porous asphalt is suitable for use in any climate where standard asphalt is appropriate.

Porous concrete similar to porous asphalt, is produced by substantially reducing the number of fines in the mix in order to establish voids for drainage. In northern and Midtlantic climates such as New York, porous concrete should always be underlain by a stone subbase designed for stormwater management and should never be placed directly onto a soil subbase.

Permeable interlocking concrete pavements (PICP) consist of interlocking concrete units that provide some space between the blocks. The voids are permeable or may be filled with a permeable material such as gravel. These units are often very attractive and are especially well suited to plazas, patios, and small parking areas. PICPs are typically built on an open graded, crushed aggregate base. Porous brick pavers that are suitable for traffic loads are also available. There are also products available that provide fully permeable plastic grids filled with gravel, creating a stabile, porous gravel surface.

Reinforced turf consists of interlocking structural units that contain voids or areas for turf grass growth and are suitable for minimal traffic loads and parking. Reinforced turf units may consist of concrete or plastic and are underlain by a stone and/or sand drainage system. Reinforced turf units are good for fire access roads, overflow parking, occasional use parking, or to reduce the standard width of paths and driveways that must occasionally provide for emergency vehicle access. Reinforced turf should not be used in high or frequent traffic areas. Reinforced turf units are suitable for infrequent (event or weekly) use. It should be noted that these systems have had limited success within the Parks Department in the past; consult with maintenance staff when considering the appropriateness of this material for your site. While both plastic and concrete units perform well for stormwater management and traffic needs, plastic units tend to provide better turf establishment and longevity, largely because the plastic will not absorb water and diminish soil moisture conditions. Also plastic systems tend to be cooler and not lead to turf burnout during hot summer months.

PRACTICES

DESIGN

CONDUCT SOIL INVESTIGATION AND INFILTRATION TESTING

- Determine the infiltration rate and verify subsurface conditions are suitable for infiltration.

EVALUATE SITES FOR SUITABILITY EARLY IN PLANNING PROCESS

- See *Part 2: Site Inventory and Analysis*.
- During the site analysis, determine whether and where it is feasible to use pervious pavement.
- Consider using porous pavements in areas where heavy traffic, either pedestrian or vehicular, would compact or compromise a ground treatment with less infrastructure or bearing capacity.
- Do not use porous pavements on steep slopes.
- Use on slopes of 5% or less, although they can be used on slopes up to 8% with careful design.
- Avoid using in areas of excessive cut where the soil mantle is removed.
- Avoid areas of fill that require compaction, which will prevent the use of porous pavement for infiltration.
  - The system must then be designed as a detention system
- The placement of porous pavement systems is less suitable in areas where the threat of spills and groundwater contamination is likely.
  - Pretreatment systems or other alternative infiltration systems may be needed in such a situation.
  - In those areas where the threat of spills and groundwater contamination is quite likely, pretreatment systems, such as filters and wetlands, may be required before any infiltration occurs and porous pavements would not be appropriate.
  - In hot spot areas, such as truck maintenance and fueling

areas, the use of porous pavement is likely not appropriate.
- ☐ Expected use and traffic demands should also be considered in porous pavement placement.

MEET ALL GUIDELINES FOR INFILTRATION SYSTEMS

- Refer to *W.4 Use Infiltration Beds* for specific guidance.

DESIGN FOR INFILTRATION

- Orientation of the parking bays along the existing contours will significantly reduce the need for cut and fill, which negatively impact the performance of porous pavements.
- Consider the placement of porous pavement to reduce the likelihood of sediment deposition, as control of sediment is critical.
- Porous pavement and infiltration beds should not be placed on areas of recent fill or compacted fill.
  - ☐ Any grade adjustment requiring fill should be accomplished using the stone subbase material.
- In areas with poorly draining soils, infiltration beds below porous pavement may be designed to discharge slowly into adjacent wetlands or bioretention areas.
- Infiltration areas should be located within the immediate project area in order to control runoff at its source.
- In extreme cases such as industrial sites with contaminated soils the aggregate bed should be lined to prevent infiltration.
  - ☐ While these areas do not infiltrate, they can provide water storage to reduce peak flows without the use of detention basins.
  - ☐ Water quality can still be improved if there is a filtration layer on top of the reservoir stone that water passes through.
- The underlying infiltration bed is typically 12-36 inches deep and comprised of clean, uniformly graded aggregate with approximately 40% void space.
  - ☐ AASHTO No.3, which ranges between 1.5 inches and 2.5 inches in gradation with no fines, is often used.
  - ☐ Depending on local aggregate availability, both larger and smaller size aggregate has been used.
- While most porous pavement installations are underlain by an aggregate bed, alternative subsurface storage products may also be employed.
  - ☐ These include a variety of proprietary, interlocking plastic units that contain much greater storage capacity than aggregate, at an increased cost.

DESIGN ALL SYSTEMS WITH AN OVERFLOW SYSTEM

- All porous pavement installations must have a backup method for water to enter the stone storage bed in the event that the pavement fails or is altered.
  - ☐ In uncurbed lots, this backup drainage may consist of an unpaved 2 foot wide stone edge drain connected directly to the bed between the wheel stops.
  - ☐ In curbed lots, inlets with 12 inch sediment traps may be required at low spots.
  - ☐ Backup drainage elements will ensure the functionality of the infiltration system even if the porous pavement is compromised.
- Water within the subsurface stone bed should never rise to the level of the pavement surface.
- Inlet boxes can be used for cost effective overflow structures.
- Design and evaluate the subsurface bed and overflow in the same manner as a detention basin to demonstrate the mitigation of peak flow rates.
- Use a weir plate or weir within an inlet or overflow control structure to maximize the water level in the stone bed while providing sufficient cover for overflow pipes.

EVENLY DISTRIBUTE RUNOFF

- Ensure the bed bottoms are level and uncompacted.
  - ☐ Assure that soil infiltration rates are considered when calculating storage area below pavements.
  - ☐ Porous pavement beds designed for infiltration should not be placed on compacted fill material as infiltration will not occur.
  - ☐ Sloping bed bottoms will lead to areas of ponding and reduced distribution.
- If runoff from another area is conveyed to the bed beneath porous pavement, use perforated pipes along the bottom of the bed to evenly distribute runoff over the entire bed bottom.
  - ☐ Continuously perforated pipes should connect structures such as cleanouts and inlet boxes.
  - ☐ Pipes should lay flat along the bed bottom and provide for uniform distribution of water.
  - ☐ Depending on size, these pipes may provide additional storage volume.

EDUCATE SITE STAFF AND USERS

- Employ educational signage at porous pavement systems to prolong life span by communicating maintenance needs.
- Lack of awareness poses a threat to some porous pavement systems in the form of seal coating or paving.

CONSTRUCTION

IMPLEMENT EROSION AND SEDIMENT CONTROL MEASURES

- See *S.2 Minimize Soil Disturbance*.
- Undertake erosion and sediment control measures to prevent sediment deposition on the pavement.
- Remove surface sediment by a vacuum sweeper.
- Do not powerwash sediment into the bed.
- If the porous pavement is compromised, ensure that backup drainage elements (such as a stone edge drain or inlets) maintain the functionality of the infiltration system.

REQUIRE TRAINED INSTALLERS

- Use certified contractors who have been trained in the use and installation of pervious pavements.
- The NRCI and NRMCA provide certification for porous concrete installation.

CONSTRUCT WITH CARE

- Take great care during construction to prevent failure of porous pavement.
- Prevent the following conditions:
  - ☐ Compaction of underlying soil

- ☐ Contamination of stone subbase with sediment and fines
- ☐ Tracking of sediment onto pavement
- ☐ Drainage of sediment laden waters onto porous surface or into constructed bed
- ☐ Clogging during planting soil and mulching operations

STAGE CONSTRUCTION TO MINIMIZE DAMAGE

- Install porous pavement and other infiltration measures toward the end of the construction period, if possible.
- Avoid compacting the existing subgrade or exposing it to excessive construction equipment traffic prior to stone bed placement.
- Allow earthen berms, if used, to remain in place during excavation.
- Place geotextile and bed aggregate Immediately after the approval of subgrade preparation.
- Keep construction equipment off the bottom of the bed as much as possible while installing base materials.
- During construction, consider using the excavated bed as a temporary sediment basin or trap to reduce overall site disturbance.
  - ☐ Excavate the bed to within six inches of the final bed bottom elevation for use as a sediment trap or basin.
  - ☐ Following construction and site stabilization remove sediment and establish final grades.

INSTALL BASE MATERIALS

- If erosion of subgrade has caused accumulation of fine materials and/or surface ponding, remove this material with light equipment and scarify the underlying soils to a minimum depth of 6 inches with a York rake (or equivalent) and light tractor.
- Conduct all fine grading by hand.
- Ensure that all bed bottoms are level grade.
- Install washed, uniformly graded aggregate in the bed in maximum 8 inch lifts.
- To provide an even surface for paving, install a 1 inch layer of choker base course (filling the spacing in the underlying coarser aggregate) over the bed aggregate.
- Install the porous pavement as recommended by the manufacturer or in accordance with industry standards (National Ready Mix Concrete Association for porous concrete or National Asphalt Pavement Association for porous asphalt).
  - ☐ Porous bituminous asphalt is installed in a similar method to the installation of standard bituminous asphalt.
- Lay it directly in one lift over the stone bed course to a thickness of 2.5 inch when compacted.

TEST PERMEABILITY OF PAVED SURFACE

- Test the full permeability of the pavement surface by application of clean water at the rate of at least 5 gallons per minute over the surface, using a hose or other distribution devise.
- Ensure that all applied water infiltrates directly without puddle formation or surface runoff.
- Ensure acceptable performance in the test before accepting pavement from contractor.

MAINTENANCE

PREVENT AND TREAT CLOGGING

- Prevent clogging of pavement surface by vacuuming twice per year.
  - ☐ Parks should purchase this equipment.
- Maintain planted areas adjacent to pavement.
- Immediately clean any soil deposited on pavement.
- Do not allow construction staging, soil, or mulch storage on unprotected pavement surface.
- Clean inlets draining to subsurface bed twice per year.

CAREFULLY PERFORM SNOW AND ICE REMOVAL

- Monitor porous pavement systems, which generally perform better and require less treatment than standard pavements, to determine optimal maintenance during weather events.
- Do not apply abrasives, such as sand or cinders, on or adjacent to porous pavement.
- Give preference to nondamaging deicers.
  - ☐ Salt or preferably calcium chloride may be used on porous asphalt, although salt use may affect quality of groundwater and reduce microbial breakdown beneath pavement water storage area when used excessively.
  - ☐ Salt cannot be used on porous concrete, although some other commercial deicers may be used. Use of salt on porous concrete will cause damage.
- When snow plowing, set blades slightly higher than usual to avoid tearing up asphalt.

REPAIRS

- Ensure that surface is never seal coated.
- Patch damaged areas of less than 50 square feet with porous or standard material.
- Repair larger areas with an approved porous material.

FOR FURTHER INFORMATION

- National Ready Mix Concrete Association, Pervious Concrete. http://www.perviouspavement.org/
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W.8 CREATE GREEN AND BLUE ROOFS

OBJECTIVE

Install vegetation on rooftops to control stormwater, mitigate pollution, reduce urban heat island effect, increase roof membrane longevity, and provide habitat and visual appeal. Rooftop detention, or blue roof, uses engineered controls such as controlled flow roof drains to detain stormwater runoff. Blue roofs can offer similar stormwater benefits to green roofs at a lower cost.

BENEFITS

- Both strategies reduce peak flow runoff during storm events.
- May ameliorate the effects of pollution, trapping dust and breaking down airborne pollutants.
- May extend the service life of the roof by protecting the roof layers from UV degradation and extreme temperature fluctuations.
- Ideal for managing stormwater on buildings in dense areas of the city.
- Blue roofs may be a lower cost option for onsite detention, which slows stormwater runoff from the site.
- Blue roofs do not require any additional maintenance or operational costs compared to typical or standard roofs.
- Green roofs reduce urban heat island effect through evaporative cooling.
- Green roofs can conserve energy by stabilizing indoor temperature and humidity.
- Green roofs create wildlife habitat and biodiversity and can beautify the urban environment.
- Green roofs can provide additional public space for passive recreation and enjoyment.

INTEGRATION

- *W.3 Create Absorbent Landscapes*
- *S.6 Use Engineered Soils to Meet Critical Programming Needs*

CONSIDERATIONS

- Retrofitted roofs are often limited by the loading capacity of existing roof structures; it is highly recommended that a structural analysis be conducted before installing any additional loading on an existing building.
- Other factors such as size, slope, height, and directional orientation of the roof may limit or preclude green or blue roof design options.
- Green roofs require specialized construction and maintenance skills to ensure establishment and long term success.
- While both types of green roofs will likely require some level of irrigation, extensive systems require less due to shallower soil depths and smaller plant size.
- The costs of materials and labor for green roofs are typically greater than for traditional roofs.
- Roofing manufacturers should be made aware of the intended use for green and blue roofs; the manufacturer's warranty should cover such use.

BACKGROUND

In cities, vast areas of rooftops are mostly an untapped resource for stormwater management, pollution mitigation, and habitat. Green roofs fall into two categories:

- Extensive: Thin layers of soil (1"- 6") and lightweight plantings suited to thin media, such as sedums, grasses and other small plants.
- Intensive: Deeper layers of soil (6" +) that can support larger plants including trees and shrubs, which are often irrigated. Intensive roofs can accommodate stormwater management and robust plant life, as well as visually appealing rooftop gardens.

Green roofs can be established on both existing and new roofs, depending mainly on the structural capacity of the building. The large, flat roofs on some shops and recreation centers can be better suited for green roofs, but smaller roofs such as comfort stations offer opportunities as well.

While the savings in energy and roof membrane longevity should be taken into account when comparing the two systems, many of the cost benefits of green roofs are difficult to quantify.

Blue roofs retain stormwater runoff on a rooftop by using controlled flow roof drains with set weirs, which regulate the flow from the roof. Blue roofs delay stormwater entering the sewer system and are a lower cost alternative to green roofs. They should be considered whenever green roof construction or maintenance costs are prohibitive on flat rooftops.

PRACTICES—GREEN ROOFS

PLANNING

INVESTIGATE STRUCTURAL LIMITATIONS OF BUILDING ROOF

- Understand the structural support of the roof system.
- Consider possible growing media depth based on the expected loading and strength of the supporting structure.
- Consider accessibility and intended use of the roof when considering layout and potential loading.
  - Live loads of people accessing the roof require much greater load tolerances than the dead loads of green roof.
- Designers should work with a licensed structural engineer to calculate loads and bearing capacities.
- Account for dead load
  - Approximate weight of green roof materials
    - Extensive roofs: average 14 – 35 lb/sf
    - Intensive roofs: average 59 lb/sf and up
    - Stormwater (dependant on saturated weight of soil media) and/or snow and ice
  - ASTM (Standards E2397 and E2399) has published specific protocols for determining the weight and dead load of green roofs.
- Account for live load

- Maintenance workers (required for all roof types)
- Access by groups of people
- Wind shear effects; note that roofs are most vulnerable along the edges and corners where the green roof media meets a change in materials.

DETERMINE WHETHER AN INTENSIVE OR EXTENSIVE ROOF IS APPROPRIATE

- Consider the expectations of use for the roof as well as anticipated maintenance needs.
- Calculate maximum roof load bearing capacity to determine the upper limits of growing media depth, which often drives green roof design.

DISCUSS HYDROLOGIC GOALS WITH CONTRACTOR AND ARCHITECT

- Prebid meetings:
  - Review and discuss hydrologic goals of green roof and its importance to stormwater management.
  - Review the importance of the plantings and growing media composition to stormwater management.
- Preconstruction meetings:
  - Discuss detailing of green roof.
  - Discuss the importance of the plants.

INVESTIGATE PROPOSED ROOF SLOPES

Green roof slopes:

- 2:12 or 17 percent or 9.5 degrees — maximum slope for typical green roof
- 7:12 or 58 percent or 30 degrees — use horizontal strapping, lathes, battens, meshes or grids or substrate benching to prevent slippage.
- Over 58% — requires specialized mixes, substrate benching and installation techniques.
- The steeper the roof, the more likely it is to experience slippage and erosion.
- Slippage often occurs with materials such as fabric and membrane interface panels.
- Green roofs on slopes often require additional systems to hold soil in place, and are designed with shallower growing media.
- While slope accounts for design limitations at a site, it also reduces the water holding capacity of the system and can impact what plants can survive such a system.

DETERMINE WHETHER IRRIGATION IS NECESSARY OR DESIRED

Typically, extensive green roofs require no irrigation depending on plant selections. But all green roofs will need irrigation in periods of extreme drought. Intensive green roofs generally require irrigation. With careful design, this can be limited to periods of drought.

- Consider irrigating roofs to provide more biodiversity and aesthetic interest.
- Consider capture of stormwater in cisterns to supply irrigation water.
- Consider the following factors in using grey water systems to irrigate green roofs:
  - Water supply volumes
  - Ability to modify building plumbing
  - Space within the building to store water
  - Ability to control types of soap and other materials than can enter drain water
  - Compliance with codes and regulations
- Consider using the following irrigation methods:
  - Drip and tube irrigation located at the surface or the substrate
  - Substrate systems are the most efficient for water delivery as they minimize evaporative losses and the substrate location also minimizes damage and maintenance.
  - Capillary systems such as porous mats that feed the base of the substrate
  - Standing-water systems: these add to dead load
- If weight limits allow, consider using layers of mulch to hold in moisture and reduce irrigation needs.

DESIGN

SURVEY LATEST DEVELOPMENTS IN GREEN ROOF TECHNOLOGY

- Designers should monitor new developments in green roof technology when planning a project, as the technology is rapidly evolving.
- Consider proprietary systems.
- Evaluate costs, benefits, and implementation experiences of various roof options.
- Specify roof systems by their qualities, such as design depth and materials used.
  - Often, growing media is proprietary and is difficult to specify.

WEATHERPROOF THE ROOF SURFACE

- Provide a membrane layer to protect the building from water penetration.
  - In general, because green roofs protect the membrane layer from ultra-violet degradation and extreme temperature fluctuations, green roofs last longer than conventional roofs.
- Protect the roof surface from root penetration.
  - PVC sheets placed atop the roof membrane are often used as root penetration barriers, however, designers should keep abreast of research on the environmental impacts of PVC and pursue alternatives if available.
- Design drainage elements, such as drains, scuppers, and drainage conduits specifically for green roof systems, accounting for sediment capture.
  - This protects the underlying roof from damage, prevents oversaturation of the planting medium, and reduces weight on the structure.

DESIGN GREEN ROOFS FOR STORMWATER MANAGEMENT

- If possible, design green roof to manage the most frequent small storms which will in turn manage the bulk of regional rainfall.
- Avoid overdesigning a green roof for storage capacities beyond typical storm events, as this will reduce the roof's cost effectiveness.
- See the next section for discussion of growing media and the section on blue roofs for green roof systems that maximize runoff detention.

The green roof at St. Simon Stock School was designed with a recycled Styrofoam growing media thick enough to support native plants grown and cared for by students.

DESIGN THE GROWING MEDIUM OR SUBSTRATE

- Ensure efficient absorption and drainage.
  - Design for proper aeration of the medium to avoid anaerobic conditions.
  - Ensure that water drains to the bottom of the system and has overflow/relief points to avoid supersaturated mediums.
  - Ensure that ponding does not occur unless the system was specifically designed to handle ponding.
  - Consider flooding tolerance if plants are selected for extreme drought.
- Factor in the density of the growing media. Lighter media allow for greater depths and water storage.
- Consider media depth and its relation to diversity of plant material and stormwater capture objectives.
- Consider the composition of a growing medium in similar fashion to selecting any other material.
  - From a renewable resource
  - Contains recycled material
  - Embodied energy and resources required for its production
- Reduce costs by using growing media components that are simple to obtain and mix.
- Consider cost and control implications of using proprietary mixes when selecting media and roof system.

DESIGN THE PLANTED LAYER

- Design plant palettes for climate extremes especially hot, dry and windy conditions, unless the design of the green roof allows for greater vegetation support.
- Consider desired benefits of the green roof in choosing green roof systems and the types of plants that they support.
  - Deeper media allow for a wider variety of plants to grow successfully, and can also capture larger volumes of stormwater.
  - Greater plant diversity increases habitat benefits.
  - Increased vegetation increases evaporative cooling.
- Research plant communities that mimic green roof conditions.
  - Consider mountain climates and coastal, free draining and dry communities based on thin soil layers.
  - Consider the following plant forms, which are particularly successful:
    - Succulents
    - Low mat and cushion forming
    - Shallow rooting
    - Compact twiggy growth
- Use plants that can establish themselves fairly quickly, infill gaps in the planted areas, store water, survive the extremes of rooftop microclimates and have the ability to reestablish.
- Consider various means of establishing plants:
  - Seed or cuttings — inexpensive initial costs, longer establishment period
  - Plug or small containers — more cost effective depending on density of planting
  - Pregrown vegetative mats — quick establishment, higher initial costs
- Consider cost implications inherent with each method, as well as expectations for appearance at installation and during establishment period.
- Avoid overfertilizing green roofs, since it may lead to contamination of runoff with phosphorous and nitrogen.
- Consider aesthetic preferences in selecting plant material, keeping in mind that the success of plantings is tied to growing media depth and maintenance.
- Set realistic expectations for plant growth and performance based on site constraints.

IF POSSIBLE, INTEGRATE GREEN ROOF WITH BUILDING DESIGN

- Design the building to provide access to the roof for construction and maintenance.
- Design for proper offsets from roof penetrations, parapets, and utility structures.
- Design water supply to the roof for establishment period watering and watering during extended drought periods.
- Carefully coordinate roofing materials and installation specifications and warrantees with subsequent green roof assemblies and construction so as to avoid contractor disputes and invalidation of warrantees.
- Consider the cost benefits of using a pregrown green roof plant installation versus a plug installed plant installation to aid in construction scheduling and eliminate costly establishment period requirements.

CONSIDER PUBLIC ACCESS

- Guard rails are required on accessible green roofs.
- Use signage to take advantage of educational opportunities, such as the Five Borough Administration Building green roof on Randall's Island.

CONSTRUCTION

Constructing a green roof requires a level of specialized skill that may require qualified contractors and roofers to be involved in installation. This is especially true for the installation of the base layers prior to media being installed. Work with roofing installers to assure that warrantees remain intact with the installation of a green roof. If using a modular or proprietary system, most manufactures provide detailed installation guidelines. If these systems are not being used, consider installation by a professional experienced with green roofs.

Parks' Five Borough staff and the Green Apple Corps have installed green roofs throughout the city. This includes a test green roof at the Five Borough Administration Building that demonstrates installation and costs for 12 green roof systems, with more planned for the future. Contact these in-house experts if green roofs are being considered.

PERFORM PERIODIC INSPECTIONS DURING CONSTRUCTION TO ENSURE COMPLIANCE WITH DRAWINGS AND SPECIFICATIONS

- Observe installation of green roofs from rooftop waterproofing to final planting.
- Assure that establishment irrigation is provided.
  - This is especially important for vegetation that is not preestablished upon installment, such as cuttings.
- Recommend corrections as required to comply with the intent of the contract documents and warrantee requirements.

CONSIDER CONSTRUCTION SEQUENCING AND ACCESS NEEDS AND CONSTRAINTS

- Determine best approach for installation of specialized roofing materials, soils and plantings, such as:
  - Crane access as part of building construction
  - Elevator access after completion of building
  - Constructed roof access
- Consider need for storage and staging areas since large volumes of materials cannot be concentrated on a roof without exceeding weight limits.

MAINTENANCE

CONDUCT APPROPRIATE LONG TERM MAINTENANCE

- Extensive
- After plant establishment, weed twice per year and monitor for infill if necessary.
  - As with any planted area, time weeding to prevent weeds from seeding.
  - Conduct periodic feeding to compensate for nutrient loss and to enhance vegetation quality and appearance.
  - Use compost as an amendment to slowly release nutrients without adding nutrients to runoff.
- Intensive
  - Depending upon complexity, maintenance is similar to that of groundbased gardens.
  - See *W.4 Design Water Efficient Landscapes*

ESTABLISH SPECIALIZED CREWS TO MAINTAIN GREEN ROOFS

- In the future, Parks may also form designated green roof maintenance crews to attend to the agency's growing list of green roofs.
- More information can be obtained from the agency's Director of Horticulture.

PRACTICES: BLUE ROOFS

PLANNING

INVESTIGATE STRUCTURAL LIMITATION OF BUILDING ROOF

- Understand the structural support of the roof system.
- Designers should work with a licensed structural engineer to calculate the load bearing capacity.
- Analysis for deflection, or the degree to which a structural element is displaced under a load, is particularly important for roof areas where ponding instability may occur.
- See appropriate codes:
  - NYC Building Codes 2008, Sections 15, 16, and 17
  - NYC Plumbing Code 2008, Section 1101, 1107, and 1110
- Determine if onsite detention is required for connection to the sewer system pursuant to Title 24 of the Administrative Code and DEP rules and criteria and if a blue roof is appropriate for meeting this requirement.

DISCUSS HYDROLOGIC GOALS WITH CONTRACTOR

- Prebid meetings:
  - Review and discuss hydrologic goals of blue roof and its importance to stormwater management.
- Preconstruction meetings:
  - Discuss detailing of blue roof.
  - Discuss the desired release rate.

INVESTIGATE PROPOSED ROOF SLOPES

Roof slopes are an important consideration for roof top detention and can greatly affect the amount of water that can be detained. A slope analysis would be appropriate to determine its affect on the detention system and to ensure that the loads associated with ponded water on the entire roof surface are consistent with NYC Construction Codes.

DESIGN

SURVEY LATEST DEVELOPMENTS IN BLUE ROOF TECHNOLOGY

- Designers should monitor new developments in blue roof technology when planning a project.
- Consider proprietary systems.
- Evaluate costs, benefits, and implementation experiences of various blue roof options, such as controlled flow roof drains or retrofit options to account for roof slopes e.g., intermediate weirs.

DESIGN BLUE ROOFS

- Create a weir structure at rooftop drains that detains water on the rooftop and releases at a specific rate.
- Assure that all water will drain within 24 hours.
- Consult with the building's engineer for loadbearing capacity.
- Ensure depth of ponding is consistent with NYC Construction Codes.

WEATHERPROOF THE ROOF SURFACE

- Dependent on the roofing system to be applied, an additional waterproofing membrane may be needed to protect the building from water penetration and extend the life of the roof.

INTEGRATE BLUE ROOF WITH BUILDING DESIGN ON NEW BUILDINGS

- Design the building to provide access to the roof for construction and maintenance.
- Design for proper offsets from roof penetrations, parapets,

and utility structures.
- Carefully coordinate roofing materials, installation specifications, and roof system warrantees.
- Consider reusing the water captured on the roof surface within the building or for landscaping purposes.

CONSIDER PUBLIC ACCESS
- Guard rails are required on accessible roofs.
- Use signage to take advantage of educational opportunities and to indicate that the roof is being used as a stormwater detention system.

CONSTRUCTION

PERFORM PERIODIC INSPECTIONS DURING CONSTRUCTION TO ENSURE COMPLIANCE WITH DRAWINGS AND SPECIFICATIONS
- Observe installation of roofing system.
- Ensure the correct slope will be achieved.
- Recommend corrections to work operations as required to comply with the intent of the contract documents and warrantee requirements.

CONSIDER CONSTRUCTION SEQUENCING AND ACCESS NEEDS AND CONSTRAINTS
- Determine best approach for installation of specialized roofing materials such as:
    - Crane access as part of building construction
    - Elevator access after completion of building
    - Constructed roof access
- Consider need for storage and staging areas since large volumes of materials cannot be concentrated on a roof without exceeding weight limits.

MAINTENANCE

CONDUCT APPROPRIATE LONG TERM MAINTENANCE
- Maintenance for blue roof should require checking for clogged drains, removing debris, and breaking up ice formation around drain inlets.
- See *W.4 Design Water Efficient Landscapes*.

FOR FURTHER INFORMATION

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- The Gaia Institute. http://www.gaiainstituteny.org/
- Green Roofs for Healthy Cities. http://www.greenroofs.org/
- Roofscapes, Inc. http://www.roofmeadow.com
- Green Roof Construction Standards: Forschungsgesellschaft Landschaftsentwicklung Landschaftsbau. e.V. (FLL). (An English translation is available from FLL or through Roofscapes, Inc.). http://www.fll.de/
- American Standard Testing Methods (ASTM). Green Roof Task Force. http://www.astm.org

W.9 MANAGE ROOFTOP RUNOFF

OBJECTIVE

Use tanks, cisterns, rain barrels, and other vertical containers located above or below ground to capture and store runoff from buildings during rain events. Reuse stormwater for irrigation, toilet flushing, or washing cars. Disconnect impervious roof surfaces and use dry wells to temporarily store and slowly infiltrate stormwater runoff.

BENEFITS

- Reduces runoff and combined sewer overflows.
- Well suited for urban parks since containers are small and can be placed underground.
- Reduces potable water consumption.
- Placing storage elements up gradient of reuse areas may reduce or eliminate pumping needs.
- Potential to educate the public through visible water recycling.
- Dry wells do not require a large surface area, making them highly applicable in urban areas.
- Removes pollutants through filtration and infiltration.
- Recharges groundwater.
- Captures small frequent rainfalls.

CONSIDERATIONS

- Water must be used or discharged before next storm event to minimize storage needs.
- Design measures and monitoring required to prevent breeding of mosquitoes and other insects.
- In New York City, runoff is not permitted for reuse as potable water or for pressurized unless treatment is provided to potable standards.
- Soils must infiltrate at a sufficient rate for many technologies to be effective.
- Overflow system is required to manage large storms.
- Space required to site system an adequate distance from building foundation.
- May be limited by existing regulations in brownfield areas or areas of soil contamination.
- May be costly.

INTEGRATION

- *W.2 Reduce Flow to Storm Sewers*
- *W.3 Create Absorbent Landscapes*
- *W.4 Use Infiltration Beds*
- *V.4 Design Water Efficient Landscapes*

BACKGROUND

The purpose of cisterns and other vertical structures is to capture and store precipitation draining from a building during a storm. Unlike dry wells, which slowly infiltrate water, these structures hold water for extended periods of time, enabling reuse for passive irrigation, fire protection, or building services. These systems are especially useful in detaining stormwater for reuse in urban areas where there is little room for runoff management and storage or in combined sewer areas.

CISTERNS AND TANKS

Cisterns and tanks are large — typically 250 to 500 gallons — storage units designed to capture runoff from the rooftops of large buildings or other large impervious areas. Cisterns can be placed above or below ground and are readily available in many sizes to accommodate capacity needs. Cistern tanks are constructed from a variety of materials, including steel, concrete, fiberglass, or plastic. Underground cisterns can also be plastic modular units. Using an underground cistern hides the system from view and avoids interference with above ground activities. It also provides flexibility in design configuration and depth, allowing the cistern to be customized to the project needs. However, care must be taken to design for or prevent heavy equipment from driving over and damaging underground systems.

RAIN BARRELS

Small barrels or boxes — 100-130 gallons — aroused for capturing limited amounts of stormwater for reuse. Downspouts from rooftops enter the top of the barrel where water can be stored for later reuse, typically for plant watering. Before water enters a rain barrel, it should pass through a screen to minimize the amount of leaf litter and other debris entering the container. A lid or screen should also cover the rain barrel so that standing water does not serve as a breeding ground for mosquitoes and other insects. Materials used to make rain barrels include wood, plastics, and ceramic; some commercial models include features such as planter box tops. A hose, spigot, or another method of distributing stored rainwater should be in place, as well as an overflow outlet for large storm events. Rain barrels are inexpensive but have a minimal impact on stormwater runoff reduction.

VERTICAL STORAGE

Vertical storage units perform the same function as rain barrels and cisterns, but they are used for very large buildings, such as apartment and office buildings. They can be large towers or pipes that connect to or are located adjacent to a building, allowing water to be stored during storm events and then slowly released into the storm sewer system after the storm or reused for building services or site uses.

DRY WELLS

A dry well is a small, subsurface infiltration pit or chamber that is used to collect roof runoff from the downspouts of individual buildings. Dry wells can reduce the volume of runoff entering the stormwater infrastructure system by disconnecting impervious roof surfaces. The infiltration of this runoff also recharges groundwater. Dry wells are effective for use in urban parks and landscapes because they are space efficient and can be located under planting areas, under paths or walkways, or incorporated in other ways into the footprint of project disturbance.

PRACTICES

DESIGN

PLAN FOR WATER REUSE

- Plan storage devices to capture a large portion of the runoff from small, frequent storms.
- When possible, plan storage devices to meet a specific water reuse need.
- Seek to reduce the amount of potable water used for irrigation, plant watering, fire protection, and toilet flushing by reusing stormwater for those purposes.
- Do not reuse stormwater captured in rain barrels and cisterns for potable water uses such as sprinkler irrigation unless treatment is provided.

APPROPRIATELY SITE DRY WELLS

- Ensure that dry well sites meet the following criteria:
  - Soils provide a sufficient infiltration rate and suitable subsurface conditions
  - Adequate depth above groundwater
  - Adequate space to place the dry well away from structure foundations
  - Install dry wells below the frost line.
- Avoid dry wells in areas with high pollutant and sediment loads, since runoff will discharge into groundwater.

ENSURE ADEQUATE INFILTRATION RATES AND RATIOS

- Perform soil testing — See *Part 2: Site Assessment.*
- See *W.4 Use Infiltration Beds*
- Ensure that dry well will completely drain within 48 hours of a rainfall event.

ENSURE SUITABLE SUBSURFACE CONDITIONS

- See *W.4 Use Infiltration Beds*

DETERMINE CATCHMENT AREA

- Determine usage requirements and expected rainfall volume and frequency to calculate the volume of water needed for reuse purposes.
- Evaluate the size and layout of the catchment area, which is typically rooftop surface area, to aid in determining the amount of water to be captured.

CONSIDER CONVEYANCE OPTIONS FROM BUILDINGS

- In most cases, roof leaders from buildings tie directly into the seepage pit, thus, reducing the contribution of roof runoff to stormwater flows.
- Runoff from nearby roofs can be directly conveyed to subsurface beds via roof leader connections that distribute water through the bed via perforated piping.
- Roof runoff generally has relatively low sediment levels, making it ideally suited for direct discharge to an infiltration bed.
- Cleanout(s) with a sediment sump are recommended between the building and infiltration bed.
- It is also possible to convey drainage to dry wells with stormwater pipes or swales when a roof does not have gutters or downspouts.
- Dry wells are often part of a larger stormwater system and are designed to overflow in large events.

PREVENT AND PROVIDE FOR OVERFLOW

- To prevent overflow, use or release stored water between storm events.
  - This process is known as drawdown.
  - Use floats and gauges to monitor the water level in the storage unit.
- Make provisions for overflow or bypass of large storms.
- Allow for slow discharge between storm events if water is not reused.

PROVIDE FOR WATER QUALITY

- Filter runoff before entering the storage system via screens or a first flush filter or diverter.
- Micropollutant removal will likely not be 100% efficient, potentially leaving residual contamination and should be considered prior to dedicating captured water to a specific type of reuse.
- Limit light exposure in order to minimize algae growth within the system storage.
  - Position structure in the landscape to limit light.
  - Bury cisterns to limit algal growth problems.
- Use lids or covers to keep out light, surface water, animals, and dust, and to prevent mosquito breeding.
- Clearly mark the system: Caution: Reclaimed Water, Do Not Drink.
- Do not connect the conveyance system, which is generally pipes conveying water from the roof to the storage unit, to any potable water system.
- Use different color piping to indicate that the water is from a reuse source. Purple is the international standard.

USE PRETREATMENT

- Consider using screens or other debris filters at the end of roof leaders to catch leaves and other litter before it enters the system.
  - Regularly inspect and maintain filters to ensure that the system functions properly.
- If some sediment loading is expected, consider passing runoff through a sediment trap structure, or intermediate sump box, which would allow sediments to settle before discharging to the dry well.
- Consider using dry wells for pretreatment of runoff before discharging to a downstream stormwater BMP.

CONSIDER KEY DESIGN CRITERIA FOR DRY WELLS

- Consider various options for seepage pit construction:
  - Uniformly graded aggregate wrapped in nonwoven geotextile
  - Prefabricated storage chamber
  - Perforated pipe segment
- Provide approximately 40% void space through the use of evenly graded stone.
- Cover with approximately one foot of soil.
- Provide access covers for inspection and cleanout.
- Ensure that structural design supports top loading of soils, pedestrians, and vehicular traffic.
- Seek to limit the size and area of excavation.
- Provide an overflow mechanism, such as a surcharge pipe or other outlet, to protect the system from being overloaded during large storms.
- Design an observation well and/or clean out in order to conduct maintenance.

ENSURE CORRECT SIZING OF DRY WELLS

- Size dry wells to temporarily store and then infiltrate the small frequent rainfall events (1-inch or less).
- Estimate the required volume of a dry well for a 1inch rainfall as follows:
  - 1"/12 x Depth of Dry well x Area of Dry Well x 7.48 = Volume in Gallons
  - If the dry well is filled with open graded aggregate, reduce the volume estimate by multiplying by 0.40
  - If the dry well is constructed of stormwater units (i.e., Rainstore units), adjust the volume according to manufacturer's recommendations.

CONSIDER CONSTRUCTION SEQUENCING AND SITE PROTECTION MEASURES DURING DESIGN PHASE

- Consider the duration of various construction phases, including site preparation, utility installation, rough grading, building construction, interface with public utilities, and final contract closeout.
- Incorporate dry well site protection into the construction sequencing and site management plan.
- See *C.3 Create Construction Staging & Sequencing Plans*.

CONSIDER OTHER DESIGN ALTERNATIVES

- Design rain barrels and cisterns to be easily and safely drained during winter to avoid damage from freezing.
- A pump system may be necessary if the storage unit is located down gradient of the intended area of reuse.
  - Open impeller wastewater pumps are effective for use in cisterns as they are designed to pass small debris and sediment without damage to the pump.

PROPERLY SITE STORAGE STRUCTURE ABOVE GRADE

- Place aboveground rain barrels and cisterns close to the building that is providing the catchment area.
- Place aboveground storage systems on a sturdy foundation, such as compacted earth or a concrete pad.
- Consider disconnecting aboveground rain barrel and cistern systems during the winter to prevent freezing.

PROPERLY SITE STORAGE STRUCTURE BELOW GRADE

- Place underground storage systems below the frost line.
- Line storage systems and account for building foundations.
- Place underground storage systems away from areas experiencing vehicular traffic, unless designed to be covered with structurally suitable materials.
- Consider the use of prefabricated polyethylene or concrete vault structures with access manholes for below grade storage.
- Alternatively, design pipe field systems if a shallower storage strategy is needed due to subsurface conditions such as bed rock or high ground water.
- Install all storage systems per the manufacturer's instructions.

CONSTRUCTION

PROTECT DRYWELL SITE DURING CONSTRUCTION

- Prevent compaction of soils with heavy equipment in the dry well area.
    - Incorporate dry well off limits area into construction sequencing and site management plan.
- If possible, install dry wells in the final stages of site construction to prevent compaction from equipment, clogging with sediment, or other types of damage.
    - If earlier installation is necessary, undertake erosion and sedimentation control measures.

MAINTENANCE

PERFORM PERIODIC MAINTENANCE OF INFILTRATION SYSTEMS

- Check the system, especially seams, for leaks.
    - Clean storage tank to remove sediment and debris.
    - Check the distribution system for clogging to and from the storage tank.

UNDERTAKE PERIODIC INSPECTION AND MAINTENANCE OF DRY WELLS

- Periodically inspect dry well to ensure drainage within 48 hours of a storm event.
    - In case of a longer drainage period, check the system for clogging.
- Periodically clean screens, filters, and the seepage pit to ensure proper functioning.

FOR FURTHER INFORMATION

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PART IV: BEST PRACTICES IN SITE SYSTEMS

VEGETATION

Part IV describes the site systems: soil, water, and vegetation. These systems must work together for optimal success. Each best practice contains an objective, background information, benefits and drawbacks, implementation strategies, examples, references, and suggestions for integration with other best practices. Together, the practices offer a network of opportunities that can be adaptively applied to any park or development opportunity.

INTRODUCTION

New York City is an amalgam of plant communities that have evolved for millennia in response to specific geology, soils, climate, and other environmental influences particular to our geographic location. Even with centuries of urbanization and industrialization, and despite of severe fragmentation of the natural landscape, 23 distinct plant communities can still be found within the five boroughs, mostly on parkland.

Vegetation is critical to the users' experience of a park and a park's ecological and climatological value. Vegetation absorbs and transpires rainwater, prevents soil erosion, creates habitat from the ground to the treetops, and is integral to healthy air and a stable climate.

For every project, the fundamental questions to ask are: what are the existing plant communities on and around the site, and what plant communities are currently thriving. All By analyzing and assessing these variables, Parks staff will be able to nurture existing plant communities, coax the highest level of biological function from a given site, and design plantings that will have the best chance to thrive far into the future.

This focus on plant survival helps provide the proper context for one other critical issue: the use of native or non-native plants. Although park advocates and experts continue to debate this issue vigorously, many urban sites — with their altered microclimate, compacted soils, high intensity uses, and numerous environmental stresses including climate change — are difficult for native species to thrive in. At the same time, some nonnative species can become invasive, overwhelming other species and ultimately eradicating plant diversity.

KEY PRINCIPLES

CONTROL INVASIVE VEGETATION: Tame or eradicate existing invasive vegetation. Invasive vegetation is not the same as nonnative vegetation. Invasive vegetation dominates an area or habitat. Although there is vigorous discussion within many segments of the design and environmental professions about the value of native vs. nonnative vegetation, the first principle of designing with vegetation is to do no harm. When introducing nonnative plants, do not introduce any species that may dominate native species, create a monoculture, or reduce plant biodiversity.

SUSTAIN NATIVE VEGETATION COMMUNITIES: Often native plants are among the existing plant communities on a given site. In these cases, Parks should conserve, manage, and enhance their sustainability, and plant native species communities where it has been determined they can thrive.

CONSIDER VEGETATION, SOIL, AND WATER AS AN INTEGRATED SYSTEM: Vegetation needs living soil and appropriate amounts of water to survive. Designers and Parks staff must understand the existing and anticipated soil and water conditions and develop plant palettes that will respond favorably to available or newly engineered conditions. Designers must understand what soils are needed to sustain a desired plant community.

CREATE MULTITIERED VEGETATION COMMUNITIES: Plant communities should include a balance of upper, middle, and lower story vegetation. Woodland and forest plant communities, for example, provide greater habitat value, diversity, aesthetics, resiliency, erosion control, and water resources protection if they include multiple tiers of trees, shrubs, grasses, and herbs. In contrast, other vegetation communities such as grasslands provide specific habitat and ecological functions with a more homogeneous vegetation structure.

VEGETATION TIMELINES ARE LONG: Always consider maturity when making decisions about plant selection. After determining what a given site will support, designers and Parks staff must also consider what the long term goals of a mature park are. For example, a timeframe could be decades long. Planting must be designed to support overall programmatic, scenic, and habitat goals. Careful consideration should be given to the sun needs of vegetation and activity, and scenic views, as well as the need for vegetation buffers.

ENCOURAGE A BROAD RANGE OF AESTHETIC CHOICES IN VEGETATION DESIGN: Successful parks can contain a variety of formal and informal landscapes. Aesthetic choices have ramifications for ecological diversity and overall sustainability. The general public and the Parks Department should be encouraged to imagine, create, and embrace many different kinds of landscapes that have high ecological values and can be sustained over time. The traditional park landscape of lawn and trees is of relatively low ecological value, providing little habitat for insects, birds, and other creatures. There are many examples of ways to increase sustainability, such as featuring meadows instead of lawns, and planting multiple species of trees to avoid the plight of monocultural disease vulnerability.

PRIORITIZE PLANT COMMUNITY EXPANSION AND HABITAT ENHANCEMENT: Efforts should be made restore existing plant communities and connect to surrounding plant communities. If restoration is not feasible, efforts should be made to maximize biological functionality and connectivity to neighboring sites.

CONSIDER ESTABLISHMENT AND MAINTENANCE OF PLANTINGS: It is critical to design plantings for the level of maintenance that can be expected at a site, and to provide a source of water for the establishment period. Without this level of foresight, plantings likely will not survive.

V.1 PROTECT EXISTING VEGETATION

OBJECTIVE

Identify, assess, and protect existing vegetation of aesthetic, historic, and ecological value. Preserve existing onsite vegetation and its stormwater management, air quality, and microclimate benefits.

BENEFITS

- Reduces overall site disturbance including soil compaction and erosion.
- Maintains ability of the site to manage stormwater flows and treat stormwater.
- Minimizes costs by reducing need for soil amendments and new plantings.
- Reduces long term maintenance needs and costs.
- Protects desirable plants from becoming crowded or shaded out.
- Improves biodiversity and animal habitat.
- Preserves mature ecosystems and habitat.
- Provides insight into site-appropriate ecosystems that can inform landscape design.
- Reduces urban heat island effect.
- Reduces energy use by minimizing new plantings and transport.

CONSIDERATIONS

- Protection zones may limit contractor maneuverability onsite
- May add cost if protection fence needs to be relocated and reinstalled during construction to provide temporary access.

INTEGRATION

- *V.2 Manage Invasive Species*
- *V.3 Protect and Enhance Ecological Connectivity and Habitat*
- *V.7 Increase Quantity, Density and Diversity of Plantings*

BACKGROUND

Preservation of healthy and appropriate site vegetation promotes the ecological viability of a site. Existing trees and shrubs provide important stormwater management functions such as absorption and cleansing. Vegetation improves air quality and microclimate. Mature vegetation provides habitat and aesthetic value. Mature trees improve environmental quality by decreasing air pollution, reducing and treating stormwater runoff, and reducing urban heat island effect.

PRACTICES

DESIGN

UNDERSTAND EXISTING PLANT COMMUNITIES ON AND OFF SITE

- Include native, nonnative, and noninvasive plants in analysis.
- Engage a botanist or ecologist as part of the planting design team to review context and make recommendations.
- Identify a reference plant community for comparison to past and future site conditions.
  - Compare soils from the reference community to site conditions and amend if necessary.
  - Whether the desired plant community is native or horticultural and noninvasive, choosing a successful reference community will boost the success rate of the installation.
  - Set goals for the plant community such as growth rate, species diversity, maximum tolerated invasive plant cover, indicator plants or animals desired.
  - Set a desired timeline for goals and supply to site manager.
- Review site with Parks Natural Resources Group (NRG) if adjacent to any Forever Wild sites or forested or wetland areas.
- NRG can provide a site assessment and background data on native plants and invasive plants of concern in these areas.
- Consult with Parks' Native Plant Center (NPC) to determine if there are opportunities for utilizing NPC nursery stock in construction, or engaging NPC expertise in native plant preservation or proliferation onsite.
- Early notification of plant needs helps the nursery to plan ahead.

ENGAGE A CERTIFIED ARBORIST AS PART OF THE DESIGN TEAM

- Engage a certified arborist or registered consulting arborist to prepare an existing vegetation report.
- The arborist should assist the design team with:
  - Determining long term site goals so that plant palettes can be designed to build on and enhance existing vegetative ecosystems and respond to desired performance of plants on site
  - Recommendations about vegetation preservation, transplanting and removals, and recommended pruning or support system installations required during construction
  - Reviewing the soil tests and soil scientist recommendations completed beforehand and offering additional comments or recommendations as required, including fertilizing or other compensatory actions required during construction
  - Determining critical root zones based on tree species' tolerance to construction impacts, condition, age class and growing conditions
  - Developing existing vegetation protection measures
  - Developing an invasive species management program
  - Developing an existing vegetation maintenance program to be used by the contractor during the construction phase
  - Monitoring existing and new vegetation during the construction and establishment period phases

USE SITE PLANNING STRATEGIES TO PRESERVE AND PROTECT EXISTING HEALTHY VEGETATION

- See *S.2 Minimize Soil Disturbance*
- Number the trees in accordance with the vegetation report.
- Where possible, protect vegetation as clumps of trees and shrubs rather than individual plants, thereby preserving shared soil volumes and rooting zones.
- Ideally, protection zones should be as large as possible to preserve adequate critical rooting zone areas.
  - Protection zones should be as symmetrical as possible around large plant material, especially trees, so as to not create structural instability.
  - The critical root zone (CRZ) is calculated by the DBH, species, tolerance to construction impacts, and age class, where tree species known to be tolerant of typical construction stress and young (less than 20% of their life expectancy) have a CRZ radius of ½ foot per inch DBH and tree species known to be sensitive to construction stress, overmature (greater than 80% of their life expectancy) have a CRZ radius of 1 ½ foot per inch DBH.
  - Reference the Tree Protection Zones of Healthy, Structurally Sound Trees[52] tables for more species and condition-specific standards.
- Illustrate the CRZ for each tree on all design plans that include excavation and grading.
- Carefully consider proposed grading to avoid excessive filling or cutting within critical root zone areas of existing vegetation.
  - When construction activity is to take place around a group of trees or other vegetation, the cumulative critical root zones of the massing should be determined to reduce or eliminate any impacts to those areas.
- Consider removing trees that have sustained CRZ loss in excess of 30%.
  - Tree species, health, structural integrity, soil type, vegetation competition, structure proximity, future planned impacts, and planned maintenance and management regimes contribute to the determination of which trees should be removed.
- Carefully consider areas adjacent to project site but not within contract limit lines to protect important vegetation.
- Carefully consider proposed drainage patterns so as to maintain contributing watersheds to protected root zone areas.
  - Grade changes, cuts and fills can alter the hydrology of the site and the water and nutrients available to the tree impacting root system vitality.
  - Develop specifications that clearly identify requirements pertaining to work adjacent to and below the dripline of existing trees and vegetation.

DEVELOP TREE AND VEGETATION PROTECTION PLANS

- Prepare a tree protection plan and necessary details showing:
  - A summary of the tree inventory (tree protection schedule) prepared by an arborist, including:
    - Tree number keyed to plans
    - Tree species
    - DBH

Protecting groves rather than individual trees leaves larger areas of soil within the critical root zone undisturbed during construction.

    - CRZ measurements
    - Council of Tree and Landscape Appraisers (CTLA) condition rating at time of design
    - Means of tree protection throughout project, i.e., tree fencing, root protection
    - ANSI 300 pruning needs
    - Indication of tree removal/transplant
    - Special comments/notes
  - Clear and concise notes outlining standards of tree protection and contractual responsibilities of protecting and preserving existing vegetation
  - Protection of critical root zone areas, including fencing and reference fencing or other protection details
  - Fencing that can withstand vehicular impact
  - Special means of excavation to minimize impacts to trees
- Coordinate tree and vegetation protection plan with other contract documents including:
  - Soil protection plans
  - Construction staging and sequencing plans
  - Soil placement plans
  - Soil erosion and sedimentation control plans
  - Grading and drainage plans
  - Site utility plans
  - Planting plans
- Include designated stockpile location(s) and truck access route(s).
- Indicate on plans and in specifications that protection barriers may have to be relocated and reinstalled during construction to provide temporary access.
- Require contractor to maintain protection barrier in good condition throughout the life of the contract.

DEVELOP A PLAN FOR TREE AND VEGETATION REMOVAL AND TRANSPLANTATION

- Identify individual trees and shrubs for removal.
  - All trees greater than 6 inches in DBH to be removed must be approved by the Borough Forestry Office and mitigated based on the NYC tree valuation formula.
  - All trees less than 6 inches in DBH to be removed under

the clear and grub specification must be approved by the Borough Forestry Office.

- Select species for removal based on their structural integrity, relative invasiveness (as defined by NYSDEC or local experience), state of health/viability for survival, and conflict with proposed construction.
- Specify top down tree cutting rather than felling to protect surrounding viable trees/vegetation.
- Avoid tree cutting during migration and nesting periods.
- Identify species for transplant and show new locations; identify root pruning and transplant procedures and advance timing in specifications.
- Require two year guarantee on transplants.
- If appropriate, develop a plan for invasive species removal or in place control to minimize disturbance, and consult with NRG to identify appropriate techniques.

PLAN FOR VEGETATION IN CONSTRUCTION STAGING AND SEQUENCING PLANS

- See *C.3 Create Construction Staging & Access Plans.*

DEVELOP SPECIFICATIONS THAT CAREFULLY INDICATE WORK REQUIREMENTS AND RESTRICTIONS

- Indicate specific scheduling and coordination requirements associated with plant material transplanting, including procurement root pruning, protections, and aftercare.
- For large quantities or specific sizes of native plants, contract growing may be required to ensure healthy plants for installation.
- Indicate seasonal limitations associated with vegetation work.
- Require that work adjacent to and within critical root zone areas be supervised full time by a certified arborist.
- Require all work within the critical root zone to be completed by hand or with pneumatic (air spade) equipment.
    - Clearly indicate if trenching is to be required and what methods the contractor must employ.
    - Show approximate trenching requirements on the plans so that the contractor can readily quantify costs.
- Require pavement removals to be completed with the smallest equipment sizes possible; operation of equipment over the base or subbase of pavements removed shall be carefully monitored.
- Clearly indicate who shall be responsible for directing and approving work operations in and around protected vegetation to remain.
- Clearly specify that work and corrective actions shall be directed by the design team's consulting arborist or another dedicated noncontractor party.
    - Assign a realistic construction allowance within the contract documents when it is anticipated that there may need to be adjustments to work operations based on unforeseen site conditions such as buried tree roots or the necessary removal of trees that are structurally compromised by construction operations through no malice of the contractor.
        - The use of the allowance avoids lengthy disagreements and delays to the work.
    - Clearly indicate vegetation assessment and replacement formulas such as the NYC tree valuation process that shall be used to determine the value of replacement plant materials damaged by construction operations, as outlined in Article 14 of all Parks capital contracts.
    - Tree inventories and tree impact mitigation plans are required as part of any infrastructure project that may adversely impact existing vegetation.

IMPROVE ENFORCEMENT OF CONTRACTOR COMPLIANCE THROUGH THE DEVELOPMENT OF A SYSTEM TO IMPOSE LIQUIDATED DAMAGES ON CONTRACTORS WHO FAIL TO FOLLOW HIGH PERFORMANCE GUIDELINES

- Many contractors will build the cost of liquidated damages and replacement vegetation into their bid pricing reasoning that it is far cheaper and quicker to simply remove and replace existing vegetation rather than to work around it.
    - Liquidated damages for existing vegetation destruction should be realistic in their value as determined within industry standard vegetation appraisal guidelines.
    - In order to be truly effective, the incurrence of liquidated damages on a project should also have consequences regarding the ability of the contractor to bid future work with the agency.

CONSTRUCTION

CREATE A SCHEDULE

- Review scheduling requirements for installation of vegetation protections, transplants, and other related work at the preconstruction meeting.

MONITOR MAINTENANCE AND HANDLING

- Maintain vegetation protections throughout the duration of construction.
- Inspect vegetation protection areas daily and promptly correct deviations from the requirements.
- Use the design team's consulting arborist to monitor existing vegetation health throughout construction
- For large and/or specialized installations, consider requiring a restoration ecologist or other specialist to oversee soil placement and planting, paid for as a contract item.
- Require the contractor to take corrective actions immediately as determined by the consulting arborist.
    - Mulch areas where existing vegetation has been protected to provide additional moisture retention.
    - Maintain water to areas of protected vegetation. Contributing water may have to be temporarily interrupted during construction operations.
    - Wash plantings to minimize build up of dust.
    - In areas where excavation may expose roots of existing plants to be preserved, minimize damage to roots, properly prune roots, and ensure that they are covered with sufficient soil and/or moisture maintaining mats to prevent the roots from drying out.
    - Monitor and enforce vegetation protection requirements by immediately giving a warning when the contractor

violates the protection zones and then imposing damages at next occurrence.

TRAINING

- Provide additional training for construction staff about the use of liquidated damages and appraising and evaluating tree and plant damage according to International Society for Arboriculture standards.

FOR FURTHER INFORMATION

- The Natural Resources Group of the Parks Department has a number of applicable publications available on their website. They include resource guides to habitat locations and plant selection, forest restoration, and assessments of individual parks: http://www.nycgovparks.org/sub_about/parks_divisions/nrg/nrg_stats.html
- Ecological Management Plan for the Bronx River http://www.bronxriver.org/puma/images/usersubmitted/greenway_plan/
- Gargiullo, Margaret B. Native Plants of New York City and Vicinity for Natural Habitat Restorations. Rutgers University Press, New Brunswick, New Jersey and London. 2008.
- The New York Invasive Species Clearinghouse. *New York Invasive Species*. Cornell University Cooperative Extension.
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- USDA National Plant Materials Center http://plant-materials.nrcs.usda.gov/
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INDUSTRY ASSOCIATIONS

- American National Standards Institute (ANSI), Washington, DC. (202) 293-8020. www.ansi.org
- International Society of Arboriculture (ISA), P.O. Box 3129, Champaign, IL 61826 (217) 355-9411. http://www.isa-arbor.com/home.aspx
- American Society of Consulting Arborists (ASCA), 9707 Key West Avenue Suite 100, Rockville, MD, 20850 (301) 947 — 0483. http:/www.asca-consultants.org

STANDARDS

- American National Standards Institute, ANSI A300 (Part 1) Pruning Standards.
- American National Standards Institute, ANSI A300 (Part 2) Fertilization Standards.
- American National Standards Institute, ANSI A300 (Part 3) Support Systems Standards — Cabling, Bracing & Guying Established Trees.
- American National Standards Institute, ANSI A300 (Part 5) — 2005 Management - Tree, Shrub and Other Woody Plant Maintenance — Std. Practices for Management of Trees and Shrubs During Site Planning, Site Development and Construction.
- American National Standards Institute, ANSI A300 (Part 6) — 2005 Transplanting — Tree, Shrub and Other Woody Plant Maintenance — Std. Practices for Transplanting.
- American National Standards Institute, ANSI Z60.1 — 2004 American Standards for Nursery Stock.
- American National Standards Institute, ANSI ZI33.1 2000 - Tree Care Operation Standards for Pruning, Repairing, Maintaining & Removing Trees and Cutting Brush — Safety Requirements.

52 **Matheny, N., and Clark, J., Trees and Development: A Technical Guide to Preservation of Trees During Land Development, International Society of Arboriculture, Champaign, IL, 1998.**

V.2 MANAGE INVASIVE SPECIES

OBJECTIVE

- Prevent the introduction of invasive species and control existing invasive species to allow desired vegetation to regain an ecological majority. Effectively prepare sites for successful reintroduction of complex ecosystems that are horticulturally sustainable.

BENEFITS

- Restores habitat conditions that have been altered by the presence of invasive species.
- Benefits native species and increases the likelihood of establishing a more diverse, self sustaining vegetation community.
- Allows the redevelopment of complex ecological relationships.
- Begins the process of restoring long term ecosystem resiliency.
- Improves potential habitat value for local fauna through increased biodiversity.

CONSIDERATIONS

- Invasive species control often takes extended periods of time.
- It may require the use of herbicides, which require certified applicators.

INTEGRATION

- *V.3 Protect and Enhance Ecological Connectivity and Habitat*

PERFORMANCE GOAL

For new construction projects within sites exhibiting invasive vegetation, NYCDPR has developed standard specifications for invasive species eradication. However, the field of invasive management is rapidly evolving and research on latest best management practices should be conducted on highly invaded sites. Consult with NRG on the best options to develop management practices for invasive management. The practices should start with Parks standard specifications for invasive species eradication, but should also include the research of local universities, plant societies, and plant conservation organizations to develop the database. These include Society for Ecological Restoration International, New York Invasive Species Information, the New York Invasive Species Clearinghouse, Cornell University Cooperative Extension, and the USDA. Finally,research on latest best management practices should be conducted on sites, and documented to add to the database.

PRACTICES

DESIGN

PREVENT THE INTRODUCTION OF INVASIVE SPECIES

- Do not use any plants listed on state and federal lists of invasive species, many of which are still available in the nursery trade, except in highly isolated urban areas where spread of these plants is not possible.
- Review sourcing of site materials to prevent accidental introduction of invasive species.
  - This can be coordinated with USDA screening methods.
- If the use of hay is required onsite, salt hay bales may be used to prevent the introduction of unwanted species.
- If invasive species are present on nearby properties, plantings that crowd out seed establishment should be incorporated into the planting design.
- Limit fertilizer usage; many invasive plants will outcompete native plants in a high nutrient environment.

FOCUS ON INVASIVE SPECIES THAT ARE HARMFUL RATHER THAN NONNATIVE SPECIES

- Identify and target top invaders that are displacing diverse ecosystems, altering ecosystem processes or impeding the establishment of goal ecosystems.

DEVELOP A CONTROL AND MANAGEMENT PLAN BASED ON LATEST BEST MANAGEMENT PRACTICES

- Identify species to be eradicated.
- Understand invasive species' growth habits and identify optimal season(s) for eradication by mechanical or chemical means.
- Research local, state, and federal control methods for individual species as not one control method works for all invasive plants.
- Control measures should provide an advantage for desired species to establish and compete with invasive species; control measures can include:
  - Herbicide
  - Hand removal
  - Mowing
  - Cutting, which is usually associated with an herbicide treatment; roots can be removed or left in place depending upon the allowable amount of soil disturbance
  - Fire management if allowable
  - Shading out invasive species with larger tree plantings
  - Covering soil with weed barrier during construction phase
  - Using a black tarp to bake out weed seeds over a summer during construction
- Cover soil with filter fabric and plant in strips between filter fabric or in holes cut in filter fabric.
- Identify if permanent root barriers are required for long term protection of site.
  - For complicated projects that utilize unconventional construction practices, consider specifying a contractor with experience through prequalification requirements in the contract and fulltime supervisory personnel as contract items.
- Specify appropriate soil sterilant or nonresidual systemic herbicide as applicable to the particular species to be eradicated

Large areas of Randall's Island that had been overrun with invasive species underwent extensive restoration, creating freshwater and saltwater marshes.

and the surrounding vegetation and hydrologic conditions.
- Require a certified applicator for all chemical applications and review regulatory requirements of DEC and other governing agencies.
- Request material safety data sheet on chemical treatment, if used.
- Specify that surrounding areas are to be protected from migration of chemical applications.
- Exercise caution when using chemical treatment adjacent to aquifer, high quality water, or high water table.
- Protect water sources during construction.
- Specify that all parts of invasive plants are to be removed from the site and disposed of legally, and in a manner that prevents spread to other sites.

SET GOALS FOR ECOSYSTEM RECOVERY AND ASSESSMENT

- Set goals for restoration of site including restoration at multiple scales, for example, after removal of invasive species replace non-vegetated areas with native plants consistent with surrounding species.
- See *V.3 Protect and Enhance Ecological Connectivity and Habitat*.

CONSTRUCTION

CLEAN CONSTRUCTION EQUIPMENT TIRES WHEN ENTERING THE SITE TO AVOID IMPORTATION OF INVASIVE SPECIES

- Earthmoving equipment brought to the site from other areas can bring unwanted invasive plants and seeds on to the site with unpredictable consequences.
- Require contractors to clean equipment prior to entering site.

MAINTENANCE

DEVELOP METHODS FOR EARLY DETECTION AND RAPID MANAGEMENT

- Provide training for site managers to recognize invasive plants as they emerge as removal is much easier when plants are few, young, and vulnerable.
- Maintain a schedule for monitoring and removal of invasive species.

FOR FURTHER INFORMATION

- For new construction projects within sites exhibiting invasive vegetation, NYCDPR has developed standard specifications for invasive species eradication.
- Roesch, R.G. *Instructional Manual for the Removal of Invasive Species Along the Bronx River*.NYSDOT May 18, 2005.
- National Invasive Species Management Plan. http://www.invasivespeciesinfo.gov/council/nmp.shtml
- Society for Ecological Restoration International. www.ser.org
- New York Invasive Species Information. http://nyis.info/
- The New York Invasive Species Clearinghouse. http://nyis.info/
- Cornell University Cooperative Extension. www.cce.cornell.edu/
- USDA National Invasive Species Information Center. http://www.invasivespeciesinfo.gov/
- USDA National Plant Materials Center. http://plant-materials.nrcs.usda.gov/

V.3 PROTECT AND ENHANCE ECOLOGICAL CONNECTIVITY AND HABITAT

OBJECTIVE

Maintain and enhance landscape biodiversity and ecological connectivity within the site, neighborhood, and region. Increase areas of multitiered vegetation and ecological value.

BENEFITS

- Protects and enhances existing plant and animal communities, prevents species extinction, and helps maintain genetic diversity.
- Protects riparian ecosystems and potable water supply from contamination by herbicides, pesticides, and fertilizers.
- Protects site soils.
- Encourages biodiversity.
- Protects nutrients held in the biomass of native vegetation.
- Absorbs and cleanses stormwater runoff.
- Stable vegetative systems that are linked to surrounding systems require less maintenance, fertilizer, water, and herbicides than stand alone islands.
- Stable vegetative systems are far less susceptible to invasive species, pests, and disease.

CONSIDERATIONS

- Multitiered landscapes and the preservation of vegetation remnants necessary to build connectivity may not meet community expectations of manicured appearance.

INTEGRATION

- *D.2 Plan for Connectivity and Synergy*
- *V.7 Increase Quantity, Density and Diversity of Plantings*
- *S.2 Minimize Soil Disturbance*

PRACTICES

PLANNING

- Analyze soil characteristics, hydrologic conditions, and local flora and fauna species prior to design to understand the site and its neighborhood context as an integrated ecosystem.
- Identify critical or unique habitats based on topography, water, or vegetation.
- Link land use mapping and development plans to the

As part of a larger restoration effort along the Bronx River, Spartina species were planted at the salt marsh at Concrete Plant Park. Nearby stands of Spartina were referenced in order to place them in their appropriate habitat.

preservation and enhancement of environmentally sensitive areas.

- Engage local stakeholders to learn about historic knowledge, nesting, and unusual sightings, including them in the planning process.

RESEARCH INDIGENOUS PLANT COMMUNITIES TO UNDERSTAND THE ECOLOGICAL DEVELOPMENT OF THE REGION

- Analyze the site to understand current climate and micro-climate constraints, including soils, contaminants, adjacent uses, sun and shade, and hydrology.
- Historical plant communities can provide insight and guidance to define target ecological restoration goals
- See *Part 2: Site Analysis: Water Analysis*.
- See *S.1 Provide Comprehensive Soil Testing and Analysis*.
- See *V.1 Protect Existing Vegetation*.

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MAP EXISTING VEGETATION TYPES AND COMMUNITIES PRESENT ON SITE

- Consult with Parks' Natural Resources Group to assess existing vegetation communities and develop vegetation plans.
- Assess vegetative health and complexity to begin to develop a sense of realistic future plant palettes that preserve and add to the richness of site.
- On highly disturbed sites, a vegetation map will serve as a base map for future comparison rather than reveal historic patterns.
    - This should include canopy, shrub and ground layers.

DESIGN

EVALUATE SENSITIVE ADJACENT PLANT COMMUNITIES TO AVOID ACCIDENTAL INTRODUCTION OF SPECIES DETRIMENTAL TO THOSE COMMUNITIES

- Consult with NRG and the NPC to avoid plantings that foster globally homogeneous plant communities.
- Reinforce local and regional plant communities.
- Refer to New York City Parks Forestry Department's survey of street trees:
    - Top species are listed by borough district.
    - Avoid those species most common in park's district to increase diversity.
- Design for species diversity at all scales, within a site as well as within a region.
- Planting homogenous communities jeopardizes the integrity of the site to disease or infestation.
- If desired, select plants with similar forms but different taxonomy for visual uniformity but genetic diversity.

CREATE CONTIGUOUS NETWORKS OF NATURAL SYSTEMS

- Develop overarching goals for reconnection of fragmented landscapes.
    - May include consideration of desired wildlife or indicator species representing overall ecosystem health.
- Design landscaped areas to reconnect fragmented vegetation and establish contiguous networks with other natural systems both within the site and beyond its boundaries.
- Where space permits, design redundancy of multiple habitat movement corridors to adapt to the dynamic nature of landscape processes.
- Design habitat corridors of sufficient width to allow for good vegetation layering and a diversity of species that comprise both interior and edge conditions.

MINIMIZE SITE DISTURBANCE

- Minimize edge conditions that degrade habitat, encourage invasive species, and alter ecological communities.
- Avoid major alterations to sensitive topography, vegetation, and wildlife habitat.
- See *S.2 Minimize Soil Disturbance*.
- See *V.8 Avoid Utility Conflicts with Planting Areas*

CREATE AND PRESERVE HABITAT

- Preserve ecologically significant and/or sensitive vegetation, wildlife habitat, and topography.
- Use a diversity of ecotypes to repair or restore existing site systems.
- Use plant associations found locally that will enhance biodiversity and habitat.
- Use plants to help stabilize slopes, shores, and stream banks to prevent erosion and increase sites for refuge and cover.

PRESERVE AND PROTECT THE GENETICS OF THE LOCAL LANDSCAPE BY USING LOCAL SPECIES

- Develop methods for procuring plant material that go beyond the usual specification from a plant catalog.
    - This allows for careful consideration of local ecotypes, plant availability, and alternative procurement methods.
- Consult with the Native Plant Center for advice and availability.

MATCH PLANT SELECTIONS TO PROTECTION AND PRESERVATION GOALS

- Woodland preservation
- Canopy development
- Wildlife protection and attraction

DESIGN FOR WATER QUALITY

- Design riparian corridors with adequate dimension to offer optimal protection of waterways by filtering contaminants.
- Integrate stormwater management BMPs to manage and treat runoff and to minimize water pollution.

DESIGN FOR PLANT SUCCESS

- Consider the likely vegetation evolution at the site given the longevity and form of the plants in the design and adjacent plants, and likely maintenance and management scenarios at the site.
- Set 5, 10, 15, 25 and 50 year landscape goals in order to create rich habitats that can evolve and adapt to time rather than maintain a look indefinitely.

MAINTENANCE

MONITOR THE SITE WITHIN ITS LARGER CONTEXT

- Consult with NRG about other forest and natural areas management in the vicinity of a site.
- Ecological systems rarely relate to property boundaries; working on a site by site basis can make it difficult to see the larger landscape and ecological patterns within the landscape.
  - Use GIS mapping and link records to other land use mapping and decision systems.
  - Maintain records of plant and animal species to monitor changes over time.
- Perform annual assessment of landscape conditions and ecological features to inform landscape management.
  - While this may currently be a long term goal, Parks must begin to build a database of information on plant performance to successfully assess the quality of installations and learn for future work.

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V.4 DESIGN WATER EFFICIENT LANDSCAPES

OBJECTIVE

Promote plant survival through plant selection and placement, associating plant needs with available water resources, using zones, appropriate soils, and mulch. Use stormwater as a resource by directing stormwater runoff from impervious areas to plant beds where infiltration, limited ponding, detention, evapotranspiration, and pollutant filtering can occur.

BENEFITS

- Promotes planting success.
- Conserves local water supply.
- Reduces construction costs.
- Protects downstream water bodies by reducing impervious surfaces and the stormwater runoff they create.
- Reduces combined sewer overflows.
- Protects water resources from contaminants associated with landscape maintenance.

CONSIDERATIONS

- Requires monitoring to ensure optimal water efficiency, minimal plant loss, and performance quantification.
- May raise operations and maintenance concerns, depending on source and quantity of the stormwater runoff.

INTEGRATION

- *W.1 Protect and Restore Natural Hydrology and Flow Paths*
- *W.9 Manage Rooftop Runoff*
- *V.1 Protect Existing Vegetation*
- *V.5 Design Low Impact Irrigation Systems*

PERFORMANCE GOAL

- After establishment, apply no more than 1 inch of irrigation water per week, including rainwater, to turfgrass areas.
- Set a goal of no irrigation of plants except during initial installation and establishment period.

PRACTICES

DESIGN

DEVELOP WATER BUDGET GOALS

- See *Part 2: Water Assessment Practices*.
- Identify water capture opportunities onsite.

- Develop goals.
- Consult with Parks Greenstreets Division to learn from their stormwater capture experience.
- Look for opportunities to contribute to NYC BMP database for stormwater capture.

GROUP PLANTS ACCORDING TO THEIR WATER NEEDS

- Establish landscapes with full vegetation cover to create microclimates and reduce watering needs, as opposed to large mulch beds with few plants.
- Use a hydrozone approach to the landscape design where plantings are grouped in beds with similar water requirements.
- Establish zones based on:
  - High use (regular supplemental watering)
  - Medium use (occasional supplemental watering)
  - Low use (natural rainfall only, no supplemental watering)
- Coordinate zones with the site's aesthetic and programming requirements.
  - Concentrate high use areas in the most visually prominent locations or where highest levels of site uses will occur.
  - Try to maximize low use areas not only to conserve water but to also to minimize the need for irrigation systems.
- Determine if the proposed grading and drainage design could be adjusted such that any high or medium use areas could be designed to accept stormwater runoff.
- This is often the case for planting areas near buildings with large roof areas or adjacent to large paved areas.

USE DROUGHT TOLERANT NATIVE AND LOW WATER-USE PLANTS

- Select plants to minimize watering needs.
- In rain garden and infiltration areas, be careful to select plants that can tolerate both inundation and droughty conditions.
- Review soil mix designs in planting beds to determine if soil types can further minimize the need for supplemental watering.

LIMIT TURF AREAS TO THOSE NEEDED FOR PRACTICAL PURPOSES

- See *V.9 Reduce Turfgrass*

PROVIDE HEALTHY SOIL

- Engage a soils scientist to evaluate the water capacity of soils as well as water movement within soils.
- Improve soil conditions to maximize water efficiency.
- The use of compost and other amendments greatly improves water infiltration and plant holding water capacities.
- See *S.4 Use Compost*.

MULCH OVER SOIL AND AROUND PLANTS TO REDUCE EVAPORATION

- Provide between 2 and 4 inches of organic mulch to prevent evaporation of soil moisture
  - Inorganic mulches such as rocks, gravel, marble or glass are good soil insulators, but they are not typically good choices for urban landscapes and especially landscapes surrounded by large areas of paving or buildings because inorganic mulches absorb and re-radiate heat in the planting bed, increasing water loss from plants.
- Determine a plan for mulch reduction as plants establish.

USE EFFICIENT IRRIGATION SYSTEMS

- See *V.5 Design Low Impact Irrigation Systems*.

CONSTRUCTION

WATER PLANTS REGULARLY DURING ESTABLISHMENT

- Develop incentives and penalties to ensure compliance.
- Use tree gator bags or similar to reduce labor cost and frequency of watering.

MAINTENANCE

WATER WISELY

- Plant water requirements will vary by season and weather conditions; watering, whether manual or automatic, should be adjusted according to plant needs.
- If an irrigation system is used, operate the system at times of low evaporation; watering in the early morning hours from 12AM to 7AM is generally best because evaporation rates are low and the public is generally not onsite.
  - Drip or subsurface irrigation systems, due to their very low volume flows, often operate outside of this schedule.
  - Monitor and repair irrigation system leaks or malfunctioning components immediately to prevent water loss and plant injury.
- Avoid overwatering trees to conserve water and prevent root rot.
- Maintain mulch cover to recommended depths; replenish annually.
- Do not shear shrubs; shearing promotes water demanding new growth.
- Consider hand watering for medium zones during low rainfall/drought periods after establishment.
- Remove competitive weeds regularly.

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V.5 DESIGN LOW IMPACT IRRIGATION SYSTEMS

OBJECTIVE

Reduce irrigation to the minimum, for establishment periods and high use turf areas. Prioritize use of systems that reuse stormwater and greywater.

BENEFITS

- Conserves local water supply.
- Keeps stormwater onsite.
- Can reuse available greywater to reduce loads to the combined sewer system.

CONSIDERATIONS

- May require monitoring to ensure optimal water efficiency.
- Existing regulations require treatment of stormwater before it can be used in an irrigation system.
- Greywater will require treatment before reuse.
- May require outside agency coordination including the health department.
- Cost, maintenance, and regulations are often cited as reasons for reverting to conventional designs over stormwater or greywater systems.

INTEGRATION

- *W.1 Protect and Restore Natural Hydrology and Flow Paths*
- *W.9 Manage Rooftop Runoff*

PRACTICES

PLANNING

CREATE A SITE WATER BUDGET

- See *Part 2: Water Assessment Practices*.

USE EFFICIENT IRRIGATION SYSTEMS

- Harvest, store, and reuse stormwater for irrigation where possible.
    - Coordinate greywater harvesting and reuse with associated design professionals including civil engineers, architects, plumbing engineers, and irrigation consultants.
    - Consider greywater harvested from other sources

including sinks and showers, which necessitates coordination with health department, but should be examined in overall water budget balance.
  - Research past greywater systems that have been installed in parks to determine which systems have been more successful.
- If an irrigation system is to be used, engage an independent Irrigation Association certified irrigation designer (CID) as part of the project design team to design the system.
  - Design an irrigation system to maximize water efficiency and uniformity of distribution; design in accordance with soils, slope, plant species, microclimate, water source, and local weather conditions.
  - Consult with maintenance staff when designing a durable system that avoids past failures in popup sprinkler heads and PVC piping.
- Keep irrigation systems simple.
- Use low volume drip systems in planting beds and around trees.
- Continue to research durable systems within Parks and beyond to ensure success.
- Consider the use of a subsurface capillary irrigation system for rooftop and lawn area applications.
- Assess whether temporary or permanent irrigation systems are more appropriate.
- Develop an irrigation system that will be abandoned after the plants' establishment.
  - This could be an inexpensive underground system or soaker hoses.
  - This would probably be less costly than providing temporary water such as hand watering from a truck, hydrants or hose bibs.
- Design irrigation systems or efficient spray systems (turfgrass areas only) to reduce evaporation loss and to avoid applying unnecessary water on pavements.
- Specify water conserving irrigation management methods such as check valves, pressure regulators, and a weather-based irrigation controller (WBIC) that can monitor soil moisture levels, rain events, and wind velocities; also, specify a system that can be timed to irrigate at appropriate times.
- Determine available onsite water pressure and volume and provide a booster pump, if necessary.
- Carefully consider irrigation system water sources.
  - Test water supplies to ensure water will not cause long term injury to plantings.
  - If grey water is used, it is likely that code requirements will require a decontamination system.
  - Consider installation of a filtration system if water supply is known to be frequently dirty.
  - Refer to existing water reduction programs such as EPA's Water Sense program to develop sites that remain within the specified water budget.
- EPA approved low flow irrigation fixtures are listed on the agency's website.

CONSTRUCTION

IRRIGATION SYSTEM INSTALLATION

- Use an Irrigation Association certified irrigation contractor or equivalent to install irrigation system in accordance with specifications, system design criteria, and water supply source (harvested rainwater, cistern, filtered greywater, or potable water supply).
- Prior to beginning installation, verify that the point of connection, flow rate, and static and dynamic pressures meet design criteria.
- Install the irrigation system according to the design drawings and specifications and manufacturer's published performance standards.
- Review planting plans prior to installation to minimize conflicts between larger plants and irrigation equipment.
  - Review construction plans for conflicts between hardscape and irrigation system elements.
  - Install sleeves for irrigation piping and wiring, including spare sleeves for future renovations, below pavements and through foundations and building walls as required.
- Document the actual installation and prepare an as built record set of drawings.
- Within the record set of drawings, describe the system layout and components including all changes from the original design.

IRRIGATION SYSTEM STARTUP AND TESTING

- Test the irrigation system to verify that it meets the design criteria.
- After installation, perform an irrigation audit using a procedure approved by the Irrigation Association.
- Program the weather based irrigation controller (WBIC) as required.

MAINTENANCE

IRRIGATION SYSTEM TRAINING

- Explain to the maintenance staff the location and operation of all components of the system.
- Provide the staff with recommendations for operation of the system for maximum water conservation and the importance of maintaining system components according to the original design.
- Provide the staff with keys, tools, warranties, and operating instructions for all equipment.
- At the end of the growing season, require that the installation contractor return to the site to review system winterization and shutdown procedures with the staff as the system is actually shut down.
- Require that the installation contractor to return to the site to review the system startup procedures with the staff as the system is turned back on.

WATER PLANTS REGULARLY DURING ESTABLISHMENT

- Use soaker hoses to reduce labor costs of watering.
- Use tree gator bags or similar to reduce labor cost.

WATER WISELY

- See *V.4 Design Water Efficient Landscapes*

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V.6 USE AN ECOLOGICAL APPROACH TO PLANTING

OBJECTIVE

Preserve local plants and plant communities, specify plants that are appropriate to site conditions, recreate multitiered plant communities that are noninvasive. Choose plants appropriate for the soil, climate, and level of care.

BENEFITS

- Increases probability of plant success.
- Helps preserve and increase genetic diversity.
- Helps preserve local pollinators, insects, birds, and mammals.
- Preserves a sense of place.
- Reduces maintenance needs including weeding, fertilizing, watering, and insect and disease management.
- Increases soil health.
- Protects water quality by reducing need for fertilizers, herbicides, and pesticides.

CONSIDERATIONS

- Designers will have to adjust standard plant palettes to comply, and become more aware of local conditions to specify correct planting procedures.
- Finding suppliers for native species or local sources of species can be difficult and may increase costs.
- Plant availability may be different at time of purchase than at time of design.
- Establishment period maintenance and budgeting is typically poorly understood and therefore not provided for on most projects, however, without establishment care there will be greater plant mortality.
- Public expectation of planting area appearance may not be congruent with certain plant communities; outreach may be necessary for acceptance.
- Current maintenance methods and Park Inspection Program may not appropriately address this method of planting or these plant types; outreach, training and education may be necessary, as well as reevaluating how park vegetation is rated.

INTEGRATION

- *S.1 Provide Comprehensive Soil Testing and Analysis*

BACKGROUND

Healthy plants are essential to the functional, ecological, and aesthetic success of a high performance landscape. Plantings that are properly selected for their location and nurtured during their establishment period are more successful and have significantly reduced long term maintenance and replacement costs.

Multitiered plantings have enormous environmental benefits and significantly reduced long term costs due to microclimate creation and total plant cover. These landscapes are not reconstructions of a false place in time, but rather are put back on an appropriate ecological trajectory and succeed over time. They do not remain static. Each level of succession relies on certain conditions to develop before they can succeed to the next stage. For instance, meadows succeed to shrublands if there is little disturbance; organic matter will accumulate, and insects, birds, and animals will move seeds from nearby ecologies onto the site.

PRACTICES

DESIGN

STUDY SOIL TO DETERMINE WHAT COMMUNITIES WILL SURVIVE OR WHAT AMENDMENTS ARE NECESSARY TO FOSTER APPROPRIATE PLANT COMMUNITIES

- Avoid soil amendments that require long term applications; aim for soils replenished by the vegetation.
- Soil microbes are integral to the success of herbaceous plant layers and are especially important in areas of created or heavily disturbed soils.
- Consult with NRG about the soils and to assess the need to conduct soil faunal tests.
- Engage a soil microbiologist to help assess soil fauna development.

RECOGNIZE AND PLAN FOR CLIMATE CHANGE AND PLANT SPECIES MIGRATION

- *See D.7 Mitigate and Adapt to Climate Change*
- Plan for warmer temperatures.
- Plan for higher sea levels, especially for waterfront parks.

DEVELOP GOALS OF PLANT MATERIAL FOR STORMWATER MANAGEMENT AND MICROCLIMATE MITIGATION

- *W.3 Create Absorbent Landscapes*
- *W.4 Use Infiltration Beds*
- *W.5 Use Rain Gardens and Bioretention*
- *W.6 Use Stormwater Planter Boxes*
- *W.8 Create Green and Blue Roofs*

DEVELOP PLANT PALETTES BASED ON DOING NO HARM

Even Frederick Law Olmsted, the great American landscape architect, made plant choices based solely on aesthetic desires and thus introduced one of the most invasive trees on the east coast (*Ailanthius altissima*, Tree of Heaven). It is imperative that we learn from mistakes like these.

- When using nonnative plants, conduct sufficient research to ensure that invasive plants are not released into the ecosystem.
- *See V.2 Manage Invasive Species*

SELECT PLANTS APPROPRIATE FOR LOCAL ECOLOGY AND SITE CONDITIONS

- It is important to select plants adapted to and appropriate for the ecology at the installed location.
- Native plants are best suited to undisturbed local conditions, yet in urban applications, especially where radically altered soils and climate situations exist, success is contingent upon selecting the proper plant palette for the site and its unique conditions rather than simply using native or nonnative provenance as a selection criterion.
- Evaluate environmental conditions to determine proper selection such as:
  - Soil
  - Water
  - Anticipated precipitation or irrigation
  - Anticipated climate change, which can include a warmer and wetter New York
  - Migrating pests and known pest problems; consult with NRG and Forestry on pest policies.
  - Elevation, especially relative to stormwater management areas, rivers, streams or marine coasts where stormwater surges with flooding, both brackish and fresh, can be reasonably expected.
  - Deicing areas
  - Solar orientation
  - Wind exposure
  - Air pollution
  - Sun/shade resulting from adjacent habitats or structures
- Consider both installed and future plant material size and locations in relation to design requirements.
- Apply hierarchical approach to species selection striving to protect, maintain, and restore local ecosystem types and their associated plant palettes first and then moving to more horticultural responses:
  - Native
  - Locally adapted (naturalized), noninvasive
  - Nonnative, noninvasive
- Select plants as part of ecosystem groupings to encourage multiple types of landscape cover and canopy cover each well suited to specific program and ecological needs, including but not limited to wetlands, grasslands, old fields, managed forests, and unmanaged forests.

LEARN FROM OTHER SITES

- Plant in patterns observed onsite or in analogous habitats.
- Research local ecotypes and develop methods to preserve these species.
- Research past restoration efforts in parks and visit those sites.
- Contact designers and learn from past successes to replicate and failures to avoid repeating.

At Pugsley Creek Park in the Bronx, retaining walls incorporate willow braches that will continue to grow, providing greater soil stabilization and habitat.

CHOOSE PLANTS TO RESPOND TO EXPECTED SITE CONDITIONS AND SURROUNDINGS

- Avoid species that require extensive site remediation and long term care such as watering and fertilizing.
- Weigh the environmental cost of plant selections.
- Weigh the maintenance costs of plant selections.
- Weigh the codependency need of individual plants.
  - For example, trillium needs a very specific set of climatic, soil, and moisture conditions to grow; can the site sustain those conditions?
- Select salt tolerant species for plants located in areas susceptible to deicing salt runoff, tidal surges, or sea level rise.
- Selects plants according to their ability to accommodate the following challenges as necessary:
  - Flooding
  - Compaction resistance due to soil conditions, existing or proposed site uses or adjacent traffic vibration
  - Pollution resistance
  - Resistance to extreme climatic conditions such as wind, reflected heat or shade due to adjacent building conditions
  - Sun/shade resulting from maturity of adjacent plantings
- Select plant species that are resistant to local pest or disease problems.
  - Select species, varieties, and cultivars of plantings that are known to be naturally resistant.
- Avoid Asian longhorned beetle host plants in quarantine zones.
- Carefully consider plants that are currently known to be susceptible to nearly uncontrollable infestation such as Fraxinus species and emerald ash borer or Tsuga canadensis and wooly adelgid.
  - Understand that plant diseases morph over time and assess the ramifications of eliminating species due to current problems.
- Avoid combinations of plants that serve as the host species for organisms that attack other plants.
  - For example, junipers are the host plant for a fungus that attacks crab apples, roses, and a variety of other plants in the Rosacea plant family.
- Coordinate construction schedule with plant availability and success rate at time of planting.

SPECIFY THE PROPER PLANT FOR THE PROPER LOCATION

- Plants that are properly situated in terms of sun/shade exposure, wind resistance, and soil type tend to thrive.
- Poorly situated plans tend to be stressed and are therefore more susceptible to disease and pest infestation.
- Select plants (nonnative, native, and naturalized) that are bred for vigorous growth and resistance to disease and pest resistance in difficult sites.
- Strongly rely on locally grown native or naturalized species that are well adapted to our climate; these plants will be accustomed to our cycles of drought, disease and natural predators.
- Marge Garguillo has compiled extensive lists of NYC native plants for NYC Parks' Natural Resources Group. Contact NRG for copies of these lists.

DEVELOP METHODS FOR PROCURING PLANT MATERIAL THAT GO BEYOND THE USUAL SPECIFICATION FROM A PLANT CATALOG

- Develop cooperative propagation programs with another agency, organization, or interested nursery.
  - In New York, the Greenbelt Native Plant Center is a 10 acre greenhouse and nursery complex owned and operated by Parks.
  - The Nursery's mission is to provide locally derived native plants for city sponsored natural area restoration and management projects.
- Hire a local naturalist or botanist.
  - Have this local specialist provide a technical review of planting plans, collect seeds from local seed banks, review plant palettes for ecosystem appropriateness, and check for invasive plants.
- Investigate and use local nurseries growing indigenous plants.
  - It is often useful to contract with these local experts to monitor projects during the first several years of establishment to fine tune the planting plan especially when planting for restoration.
  - Collect local seeds or cuttings and find a nursery to grow the plants until the site is ready for planting.
    - This requires more coordination on the planting plan earlier in the project and alternative procurement procedures, but often yields stronger, better adapted plants and preserves local ecotypes that would otherwise be lost to development.
- To the extent possible, specify seedling stock, not clonal stock, cultivars or horticulturally enhanced trees to avoid limiting genetic variation, although some disease resistant varieties maybe worth including.
- Avoid substitutions.
  - Coordinate tree species selection with locally available growers to avoid undesirable substitutions during construction.
    - Poor planning and improper scheduling should not be an acceptable excuse for compromising the design of a planting palette that is designed for specific plantings suited to their site and at the same time achieve a specified diversity either on site or within the park's neighborhood.
  - Require landscape contractor to identify nursery sources at time of bid to reduce likelihood of substitutions.

COORDINATE PLANT SIZE AND AVAILABILITY WITH WHAT IS AVAILABLE IN THE LOCAL OR REGIONAL MARKET PLACE

- Consider contract growing, on an advanced or separate project schedule, for required plant material that is otherwise not available.
- Require growing conditions similar to site conditions to reduce risks associated with acclimatization.

RECOGNIZE THAT LANDSCAPES ARE BASED ON GROWTH AND CHANGE OVER TIME

- Develop plant community goals for set periods of time (5 years, 10 years, 25 years, 100 years).

- ◻ For example, a site may succeed from young deciduous, wooded groves into mature deciduous groves with an ericaceous understory, ground cover and leaf litter.
- Develop long term management plans that require monitoring of landscape over time and anticipate changes to the plan.
- ◻ For example, successional landscapes that move from field to forest may require selective removal of woody invasive species and the introduction of deciduous tree seedlings of types not found in surrounding remnant forests.
- Plan for succession based on remaining adjacent ecosystems or a planned additive planting approach.
- Consult with a landscape ecologist to set performance goals.

DEVELOP A LONG TERM MAINTENANCE PLAN WITH THE MAINTENANCE DIVISION

- See *M.3 Provide Maintenance Plans for New Parks*
- Develop management plans with which to reinforce the short and long term landscape goals.
- Develop budget projections of funds necessary to manage the landscape and amend it or thin it according to the plan.
- Develop management strategies and plans to foster the ecosystem goals.
- Develop maintenance plans that account for years one and two, such as watering, weeding and invasive management, then layout goals for year three and beyond.
- Educate the maintenance crews during the design phase.
  - ◻ Develop maintenance plans adapted to the maintenance crews' methods of working and available equipment.
  - ◻ Where this is not possible, work with maintenance crews to develop alternative maintenance techniques and to plan for the purchase of new maintenance equipment.
  - ◻ Quantify the amount of work required.
  - ◻ Prioritize tasks to deal with staff and budget deficiencies, and provide priorities based on area as well as season.
- Develop methods for ongoing site monitoring.
- ◻ Review baseline plant ecosystems.
  - ◻ Review ongoing maintenance activities including time and budget.
  - ◻ Create a site journal with photos.

CONSTRUCTION

- Conduct a prebid meeting to inform contractors of any contract grown materials, specific local ecotype requirements, and the importance of the plantings to the success of the high performance landscape.
- Brief the construction team on any alternative planting patterns, techniques, and specifications.
- Insure contractors have demonstrated expertise.
- Do not accept plant substitutions that compromise the ecological integrity of the overall design.
- Review substitutions with the team biologist if possible and/or applicable.
- Monitor importation and installation of plant material.

MAINTENANCE

DESIGNATE A SITE MANAGER AND GAIN FAMILIARITY WITH THE PLANTINGS AND MANAGEMENT PLAN

- Review the management plan.
- Review the maintenance plan every few years to account for and to adapt to site and use changes.
- Keep photo records and written logs to document the successes and failures of all planting and management techniques.
- The anticipated future agency site manager (after the completion of establishment) should participate in quarterly review during construction to learn the specific needs of the site.
  - ◻ Maintenance managers and staff should attend at least monthly site meetings with the designer, construction inspector, and establishment period contractor to learn the requirements of the planting areas and any special maintenance procedures that might be required including nontraditional, plantings including:
    - Grass and wildflower meadows
    - Perennial plantings
    - Native planting areas
    - Wetlands
    - Rain gardens
    - Green roofs

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V.7 INCREASE QUANTITY, DENSITY, AND DIVERSITY OF PLANTINGS

OBJECTIVE

Increase the quantity, density, diversity, and distribution of canopy, understory, shrub and herbaceous layers in planting areas. This may not necessarily mean expanding the plant palette, but ratherplant to create a greater diversity of landscape types; expanding the palette of landscape types beyond lawn and trees has enormous environmental benefits and significantly reduced long term costs.

BENEFITS

- Reduces air pollution, noise pollution, and soil erosion.
- Reduces and treats stormwater runoff via water uptake and evapotranspiration.
- Reduces the urban heat island effect by shading pavements and lowering local ambient temperatures.
- Assists in stabilizing local microclimates and moderating weather extremes.
- Provides shading and insulation, reducing energy required to heat and cool buildings.
- Trees and plants clustered in groups are better protected and healthier, and damage and natural degradation of infrastructure is reduced by providing shelter from harsh weather.
- Diversity of tree species protects against spread of disease and pests that can devastate monoculture plantings.
- Improves public health and quality of life.
- Provides habitat diversity for wildlife.

CONSIDERATIONS

- Grouped plantings consume greater area than individual tree pits.
- Requires expansion of planting palette and sourcing of wider variety of plant material than is typically used on a large scale within the public realm.
- Increased planting densities are often an issue in communities concerned about public visibility and the perception of crime, and may not be appropriate for all areas.
- Change in planting palette, arrangements, and aesthetics within the public realm may require education and explanation.

At Canarsie Park in Brooklyn, approximately 90 tree and shrub species and 100 wildflower species were used throughout the hills, forested wetlands, and mown meadow areas.

INTEGRATION

- *W.3 Create Absorbent Landscapes*
- *V.3 Protect and Enhance Ecological Connectivity and Habitat*
- *V.9 Reduce Turfgrass*

BACKGROUND

By improving both the quantitative and qualitative aspects of the urban landscape it is possible to both improve ecological functioning and urban livability. Increased areas of landscape density also encourage greater ecological connectivity and habitat. The design of a greater number of landscapes beyond the traditional 19th century notion of public parks consisting trees, lawns, and ornamental planting beds not only contributes to greater ecological function, but it also provides the setting for more diverse collections of plants and the attendant flora and fauna they support.

PRACTICES

PLANNING

CONSIDER BIODIVERSITY ON MANY SCALES: SITE, NEIGHBORHOOD, AND REGION

- A broader diversity of trees, shrubs, and groundcovers is needed in our urban landscapes to guard against the possibility of large scale devastation by both native and introduced insect and disease pests. Strips or blocks of uniformity, while desirable from an aesthetic standpoint, should be scattered throughout the city to achieve spatial as well as biological diversity.
    - Define the urban forest area you are serving and within that area follow the 10-20-30 rule for maximum protection against the ravages of new pests or outbreaks of old pests.
    - To the greatest extent possible, urban forest should contain:
        - No more than 10% of any single tree species
        - No more than 20% of species in any tree genus
        - No more than 30% of species in any tree family

      This means that although your particular park may have more or less diversity, overall you are meeting the forest or meadow or shrubland goals of the overall ecological area.
- Increased planting complexity provides an opportunity to preserve genetic biodiversity among plantings.

DESIGN

DEVELOP COMPLEX PLANT PATTERNS AND PALETTES

- Avoid monoculture plantings.
- Ensure that multiple habitat opportunities are presented.
- Plant in tiered layers — trees, shrubs, and ground covers as found in nature; set the stage for plants to form communities to become self sustaining.
- Use plants to create and manage microclimates.
- Understand the symbiotic relationships of plants and capitalize on them.
    - Begin construction with invasive species control and removal, which continues until the end of a contract when new plantings are installed.
- Look not only at species, but also ages of plants, to create parks that have the ability to regenerate over time.
    - Often younger plant material has higher survival rates and exhibits faster growth.

PLANT TO CREATE A GREATER DIVERSITY OF LANDSCAPE TYPES

- Look for opportunities to create a greater variety of landscape types including:
  - Fresh water and salt water wetlands
  - Marshes
  - Grass and wildflower meadows, both wet and dry
  - Woodlands
  - Forests
- Look for opportunities to expand people's ideas of appropriate garden types including:
  - Butterfly gardens
  - Fragrance gardens
  - Rain gardens
  - Shade gardens
  - Green roofs
  - Alpine gardens

SPECIFY PLANTS FROM A DIVERSITY OF APPROPRIATE SPECIES, GENUS, FAMILY, AND CULTIVAR

- Diseases and pests tend to follow the taxonomic categories of host plants at the species, section, series, genus, or family levels. By avoiding monocultural or taxonomic class dominance, there is a better chance that infestation and disease will not be as widespread and devastating. Specifying a more complex, varied planting palette makes the visual impacts of disease and predators the less obvious and objectionable.

CREATE MORE AND DENSER LANDSCAPES

- Increased landscaping and especially increased landscape density improves urban environments.

CREATE LAYERED LANDSCAPES

- Layered landscapes improve urban environments by:
  - Mimicking natural habitats
  - Increasing available natural habitats and promoting species migration between habitat fragments throughout the city
  - Improving the health of plantings by:
    - Protecting each other from wind throw and leaf scorch
    - Allowing for the development of better root systems, which strengthens plants against disease and drought
    - Promoting better rooting, which also protects trees from wind throw
    - Increasing leaf mass of clustered plants helps protect against erosion caused by drip splash
    - Reducing peak runoff velocities, allowing for better absorption of stormwater
  - Offering greater spatial definition and scale in the environment, mitigating between human scaled spaces and the scale of larger trees and buildings
  - Providing increased therapeutic and restorative value to people's outdoor experience through the development of landscapes that present a variety of colors, textures, and seasonality

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V.8 AVOID UTILITY CONFLICTS WITH PLANTING AREAS

OBJECTIVE

Plan and coordinate utility locations and installation requirements with proposed planting and soil designs to avoid construction compromises and long term maintenance conflicts.

BENEFITS

- Protects existing trees and vegetation.
- Preserves critical soil resources and rooting areas for plantings.
- Allows for ease of maintenance access in the future.

CONSIDERATIONS

- Requires the design team to coordinate utility and planting plans.
- Specialized excavation and tunneling operations to preserve existing trees increases installation costs.
- Longer meandering utility runs increase costs.

INTEGRATION

- *S.2 Minimize Soil Disturbance*
- *V.1 Protect Existing Vegetation*

PRACTICES

DESIGN

PROTECT EXISTING TREES AND VEGETATION FROM INTRUSION BY SITE UTILITIES

- The primary course of action should be to locate all proposed utility runs outside of the critical root zone of existing trees and vegetation.
- Where utilities need to pass through areas of existing vegetation, plan for specialized construction requirements such as hand digging, air spade, or mechanically tunneling under the roots with a horizontal directional drill and hydraulic or pneumatic air excavation technology.

LAYOUT THE SITE UTILITIES IN CLEARLY DEFINED CORRIDORS

- Coordinate the proposed locations of site utility structures and utility runs with the existing and proposed site planting.
    - Poor coordination inevitably results in compromised planting since most often planting takes place after the installation of the site utilities when it is too expensive to dig up the utilities and move them and reinstall the planting soils.
- Draw coordinated utility corridors on site utility and planting plans; locate corridors dimensionally or with coordinates so that locations can be determined and verified by contractors and the construction manager.

COORDINATE THE DESIGN OF UTILITIES IN PLANTING BEDS

- Carefully plan out differential soil density (compaction) requirements between planting bed requirements (typically 80 to 85%) and utility requirements (typically 95% or higher).
    - Install utility structures in planting beds with sufficient foundations to prevent settlement or displacement during normal operations.
- Plan utility manholes, hand holes, and vaults in planting beds with clear access points and adequate room for maintenance equipment and vehicles.
- Locate utilities at sufficient depth to avoid primary rooting areas and provide detectable warning tape over all utility runs to allow for future detection.
- Do not place tree rootballs directly over subdrainage lines where rootballs could crush lines or cause future damage.
- Avoid aggressive rooting trees and plants in proximity to utility corridors to avoid root penetration and damage.
- Use root barrier technologies to protect sensitive utility structures from root penetration and damage.
- Provide adequate subsurface drainage for wet utility valves and structures so as to not saturate surrounding planting soils.
- Provide adequate separation between plants and mechanical units that exhaust air or generate excessive heat.
- Avoid planting near thermal utilities such as steam lines or buried high voltage conduits since heat from these utilities will damage the roots of new plantings.

FOR FURTHER INFORMATION

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V.9 REDUCE TURFGRASS

OBJECTIVE

Reduce the use of turfgrass in new or existing areas. Establish a meadow or use native ground covers in lieu of turfgrass wherever possible. Use lower maintenance turfgrass species where recreational activities warrant the need for mown grass.

BENEFITS

- Reduces water consumption.
- Minimizes the need for pesticides, fertilizer, and fumigants, substantially reducing maintenance costs and environmental impact.
- Significantly reduces chemical and nutrient loading of groundwater and surface water bodies.
- Reduces the need for supplemental irrigation and conserves potable water.
- Eliminates the need for regular mowing, reducing maintenance costs, energy consumption, and air and noise pollution.
- Reduces damage to trees from mowing.
- Strengthens native plant communities, habitat, and local ecosystems.
- Encourages healthy soil.
- Reduces erosion due to deeper root systems of turfgrass alternatives.
- Increases potential for onsite stormwater management including ground recharge and water quality improvement.

CONSIDERATIONS

- Requires education and adaptation of landscape aesthetic expectations.
- Plantings other than turfgrass may have higher initial installation costs than conventional turfgrass.
- Establishing weed free meadows requires a longer establishment period than traditional turfgrass.
- Some alternative turfgrass and ornamental grass species can be invasive.
- Can require management training.

PERFORMANCE GOAL

- Reduce turfgrass areas and introduce both turf grass alternatives and alternative landscape types wherever possible.
- Remove all turfgrass within a 4 foot diameter (minimum) of tree trunks.

INTEGRATION

- *V.4 Design Water Efficient Landscapes*
- *V.6 Use an Ecological Approach to Planting Design*
- *V.7 Increase Quantity, Density and Diversity of Plantings*

BACKGROUND

Concerns about energy consumption, air and noise pollution, drought, water shortages, and the health effects of lawn chemicals give good reason to reconsider the ubiquity of lawn areas in parks. New York's climate and soils are generally suitable for many turfgrass choices, but during warm summer months and during drought conditions lawns become stressed.

As a result, regular irrigation and fertilizing is often required to maintain a plush green lawn look and for turfgrass to survive extensive use.

From a maintenance standpoint, lawns require a large amount of time and resources to maintain. Lawn maintenance equipment also produces air and noise pollution and may damages trees.

From a stormwater management perspective, lawns absorb much less stormwater than forests or meadows. Heavily compacted turf soils or turf with substantial thatch build up are virtually impermeable, contributing to stormwater runoff volumes. Turfgrass is shallow rooted and is not able to stabilize stream banks.

From an ecological standpoint, traditional mowed turfgrass offers little biodiversity to support beneficial insects, songbirds or other elements of our natural environment.

PRACTICES

DESIGN

- Reduce use of turf especially in shaded, steeply sloped, natural or hard to maintain areas.
- Wherever possible, replace turf with mulch, ground covers, naturalized vegetation, or low maintenance grasses.
- Coordinate selection of nonturfgrass areas with drainage patterns, located to optimize stormwater infiltration.
- Select native or well adapted species requiring minimal or no maintenance over time.
- Specify a combination of pioneer and successional species.
- Use turfgrass only for specific functions (sports, passive recreation). Specify drought resistant, lower maintenance turfgrass species.
- See *V.4 Design Water Efficient Landscapes*

LIMIT TURF AREAS TO THOSE NEEDED FOR PRACTICAL PURPOSES

- Do not use turfgrass within 4 foot diameter (minimum) of tree trunks.
- Reduce turf areas to the greatest extent possible.
- Consider planting alternatives to traditional turfgrass species.

CONSIDER ALTERNATIVE PRACTICES FOR MAINTAINING TURF GRASS

- Mow less frequently to leave longer turf heights and coordinate such designated areas with Parks Inspection Program

SUBSTITUTE THE USE OF TRADITIONAL TURFGRASS WITH LOW MEADOW AND WETLAND GRASSES, ORNAMENTAL GRASSES, GRASS-LIKE GROUNDCOVERS, AND MOSSES INCLUDING:

- *Agrostis perennans*, Autumn Bentgrass
- *Agrostis stolonifera*, Creeping Bentgrass
- Andropogon gerardii, Big Bluestem
- *Aristida stricta*, Wiregrass
- *Bouteloua gracilis*, Blue Grama
- *Buchloe dactyloides*, Buffalo Grass
- *Carex flacca*, Blue Sedge
- *Carex appalachia*, Appalachian Sedge
- *Carex pennsylvanica*, Wood Sedge
- *Carex plantaginea*, Plaintain-leafed Sedge
- *Carex stricta*, Tussock Sedge
- *Carex vulpinoidea*, Fox Sedge
- *Dicranum scoparium*, Rock Cap Moss
- *Eragrostis spectabilis,* Purple Love Grass
- *Leucobryum glaucum*, Large White Moss
- *Luzula acuminate*, Hairy Wood-Rush
- *Muhlengergia cuspidate*, Plains Muhly
- *Panicum virgatum*, Switchgrass
- *Poacompressa*, Canada Bluegrass
- *Polytrichum juniperinum*, Juniper Haircap Moss
- *Puccinellia distans*, Alkali Grass
- *Sorghastrum nutans*, Indian Grass
- *Spartina patens*, Salt Meadow Cordgrass
- *Sporobolus heterolepsis*, PrarieDropseed
- *Sisyrinchium angustifolium*, Blue-eyed Grass
- *Schizachyrium scoparium*, Little Bluestem
- *Thuidium delicatulum*, Fernleaf Moss

Note: This list is not exhaustive, and individual designers need to coordinate the list with their actual site conditions.

to assure that this does not result in inspection failure once the park is completed.

- Use drought tolerant plants instead of turfgrass along pavements and other areas where there is likely to be significant radiant heat gain

CONSIDER LOWER MAINTENANCE AND LESS NUTRIENT INTENSIVE FESCUE TURFGRASS

TYPES INCLUDE:

- Festucarubra, Creeping Red Fescue
- Festucarubra ssp. commutate, Chewings Fescue
- Festucaovina, Sheep Fescue
- Festucalongifolia, Hard Fescue
- Festucabrevipila, Hard Fescue
- Festucaarundinacea, Tall Fescue
- Low maintenance types
  - Kentucky 31, Fawn, Alta, Chesapeake, Clemfine
- Original turf types:
  - Rebel, Falcon, Olympic,Mustang, Falcon
- Improved second generation turf types:
  - Rebel II, Apache, Bonanza, Jaguar II
- Moderately low growing turf types:
  - Rebel Jr., Hubbard 87
- Ultra dwarf turf types:
  - Bonsai, Shortstop, Mini Mustang

CONSTRUCTION

- Follow recommended procedures for protecting planted areas.
- Prepare soil prior to native grass/meadow/turfgrass installation to minimize use of fertilizer and pesticide. Consider differences in fertility needs when specifying soil amendments.
- Many native grass species may require lower nutrient levels to survive thus eliminating the need for fertilizers and reducing the risk of invasive species.

MAINTENANCE

- Where turf is used, mow grass higher than conventional mowing height to conserve water and energy.
- Leave grass clippings on turf to reduce moisture loss; a mulching mower can be used.
- Reduce use of fertilizer and pesticides in conjunction with selected lower maintenance species.
- Where no mow grass is used, mow once per month to once per year.
  - Where meadow grass/wildflowers are used, mow every 1-2 years.
- Choose mowing time to avoid disturbing wildlife and prevent spread of weed seed.
  - Fall mowing can create food for insects and invertebrates.
  - Spring mowing, when timed poorly, can disturb ground nesting birds.
- Follow biointensive integrated pest management recommendations.
- See *M.7 Use Biointensive Integrated Pest Management to Promote Landscape Health*

MONITORING

- Monitor meadows for encroachment of invasive species.
- Reseed immediately after removal of invasive species.

FOR FURTHER INFORMATION

- The State of New Jersey has developed the Municipal Environmental Resource Inventory that provides maps and data to facilitate sensitive site design in municipalities. The State's Municipal Land Use Law extends this recognition to requiring alternatives to turfgrass to protect stormwater runoff from carrying pollutants emanating from turfgrass.
- The Audubon Cooperative Sanctuary System for golf courses (endorsed by the U.S. Golf Association) promotes landscaping that benefits wildlife. *Audubon Cooperative Sanctuary System for Golf Courses*. http://acspgolf.auduboninternational.org/
- The National Park Service and General Services Administration (which

In this meadow, only a narrow path is mowed, allowing access while limiting maintenance and water needs.

administers 100 government facilities in D. C.) have both adopted integrated pest management (IPM), a move that has resulted in a 90% reduction in pesticide use, a 33% reduction in fertilizer use and a 10% reduction in emissions.

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V.10 IMPROVE STREET TREE HEALTH

OBJECTIVE

Street trees provide myriad benefits to urban landscapes, but the health of street trees is often compromised by constraints to their growth. Street trees should be planted whenever space and regulations allow. Each tree pit should be designed to optimize the future health of the tree, allowing it to reach its full potential.

BENEFITS

- Captures stormwater in leaves of trees as well as within pervious tree pits.
- Reduces urban heat island effect through shading.
- Street tree longevity reduces replacement rates and provides healthier trees.
- Species selection for tolerance of site specific conditions can improve success rates.
- Street tree diversity reduces risk of species specific disease impacts.
- Connected tree pits improve tree health and stormwater capture.
- Creates shade and reduces energy use.

CONSIDERATIONS

- Higher initial cost to create larger pits.
- Engineered soils used to expand root growth area may require more expensive materials, proprietary products, or increased contractor education.
- Larger pits may not be feasible in heavily congested areas.
- Drainage from pits can be impacted by surrounding utilities, subways, and poorly draining soils.

PERFORMANCE GOAL

- Increase tree pit size to largest allowable size and connect tree pits whenever possible.
- Create tree pits that allow water and air both into and out of the tree pit. Combine tree pits with stormwater goals wherever possible.

BACKGROUND

Different tree pits are appropriate for different sites, but tree pits should always be sized as large as possible to allow for root growth. This improves the longevity and size of trees, both of which impact the benefits trees can provide. A mature tree offers carbon sequestration, shading and cooling, stormwater capture, noise reduction, and higher property values far beyond a smaller and less mature tree. Fostering tree growth reduces replacement rates and their subsequent costs.

Concerns over saturated soils and tree toppling should be addressed and solved through under drainage and other methods. The NYC Green Codes Task Force is currently reviewing a comprehensive sidewalk specification that will provide protocols for how to treat this complicated but important design approach.

Many factors impact tree pit size and tree growth. Within urban areas, conflicts of use in congested spaces make locating tree pits and sizing them appropriately very difficult. Bus shelters, lighting, bike racks, hydrants, and driveways all share the same space with street trees. Sight lines cannot be blocked by trees, and overhead wires can lead to heavy pruning as trees grow. Below ground, utilities and poorly drained, compacted soils negatively impact tree growth capacity. However, making a determination about the long term goals of trees in tree pits can have profound impact on New York's ecosystem. Designers should decide, preferably on a city wide scale, the goal of street trees. Are we designing for trees that achieve 100 year status or for a young, healthy urban forest of lesser age that requires more frequent replacement?

PRACTICES

PLANNING

Considering all street tree placement options at an earlier stage in planning provides for better tree pit design in the future. Consider the needs of trees at the beginning of planning stages and account for them in proposals.

OUTLINE ALL TREE PIT LIMITATIONS

- Consider all regulations, setbacks, and requirements for street tree pits; contact the forestry division for information.
- Outline tree pit locations and consider possible sizes and possibilities of connecting with other areas of soil.

DESIGN

Street tree plantings can be designed to optimize health in a variety of ways. The size of the tree pit has the most direct impact on growth capacity, but protection of the tree above ground is also very important.

INCREASE TREE PIT SIZE

- Generally a minimum size for tree pits is complicated, relying on species and desired final size.
  - Smaller tree pits prevent large shade trees from ever reaching their maximum size.
  - If larger trees or shade is desired, design tree pits that account for the final desired tree pit size.
  - For example, a 120 cubic foot tree pit only allows for a 10' crown, while a 1000 cubic foot tree pit allows for a 30' crown.
- A depth of 3' is generally recommended, as most tree roots grow above this depth.
- The tree pit length and width can vary widely, and the two measurements do not need to be the same.
- Often, longer rectangular tree pits allow for more space for the tree on narrow sidewalks.
- Retrofit existing pits and increase their size.
- Empty pits often indicate that the pit size was not successful before and improving the pit will increase the likelihood of successful tree establishment.
- In areas where tree pit sizes are limited, plant appropriate species. Large shade trees should not be placed in tree pits too small to allow for maturity. Match feasible pit size with tree species most likely to succeed.

ALLOW FOR PERVIOUS COVER OF TREE PITS WHENEVER POSSIBLE

- Direct stormwater into tree pits whenever possible. Consider designing tree pits to accept larger volumes of stormwater, but factor in underdrainage needs in its design.
- In lower trafficked areas, leave tree pits open or vegetated. Understory plant growth can often serve as an indicator of water stress before the tree shows signs, encouraging adjacent property owners to water trees.
- In areas of higher traffic, pervious pavers allow for walking over pits while reducing soil compaction.
- Use paver spacing that allows for water to move through without causing tripping or ADA concerns.
- Consider fencing or guards around the perimeter of the tree pit — not around the tree itself.
- Consider means of protecting the tree from injury from pets, car doors, and other urban tree perils.
- If possible, locate tree pits on the building side of the sidewalk rather than the street side.
- In heavily trafficked areas, more substantial pavement may be necessary.
- Use engineered soils or other technologies than allow for root growth underneath pavements.
  - Ideally, these areas should connect with larger blocks of green space, as many engineered solutions limit the void space available for root growth.

CONNECT TREE PITS

- Connecting tree pits opens up additional space for root growth and lateral water flow. Increasing the area available for trees improves their health and survival rates.
- Tree pits can be connected below ground, with pervious or impervious pavements separating the trees, allowing for pedestrian access across the continuous pit.
- Connect street trees adjacent to park areas with interior green space. Roots can benefit and increase growth, nutrient and water availability for street trees.

PLANT MEDIANS AND OTHER AREAS ADJACENT TO LARGE PAVED AREAS

- Medians are often areas of low pedestrian traffic, allowing greater amounts of space to be allotted for street trees.
- Create large and/or continuous tree pits with large shade trees to increase shading and cooling benefits.
- Allow for adequate space for large shade trees to become

Porous paving over a portion of this tree pit allows for increased soil volume and infiltration without limiting pedestrian traffic.

established in any area lacking in shade.

- Large planting beds adjacent to paved sports areas and playgrounds improve the user experience by keeping active use areas shaded.

INCREASE STREET TREE DIVERSITY

- Select a variety of tree species.
  - This reduces the spread of species based diseases and the potential impact of a citywide loss of a species type.
- Contact the Forestry division for the most common species in the district in which your site is located.

INSTALL GREENSTREET AREAS WHEREVER POSSIBLE

- Install greenstreet areas in remnant sites where pavements are not necessary.
  - These areas can increase vegetation, capture stormwater, reduce urban heat island effect, and provide a more aesthetically pleasing pedestrian experience.
- Remove existing pavements and subgrade to possible depths.
- In greenstreets, where stormwater will be directed, provide drainage layers of broken stone beneath topsoil.
- Select plants for their tolerance of urban conditions; tolerance of both dry and wet conditions, salt and compacted soils are all necessary characteristics.
- Successful designs must be site specific; consult the Greenstreets division for additional case studies and further information.

CONSTRUCTION

Proper construction is crucial to tree survival. Not only the tree pits, but their associated soil mixes, stormwater interventions, and air introduction systems must be carefully designed.

- Trees must be monitored and watered during establishment periods to promote vitality and success rates.
- Trees must be protected during their lifetimes from adjacent construction.
  - This includes proper protection and pruning of branches, trunk protection, and root system protection.

FOR FURTHER INFORMATION

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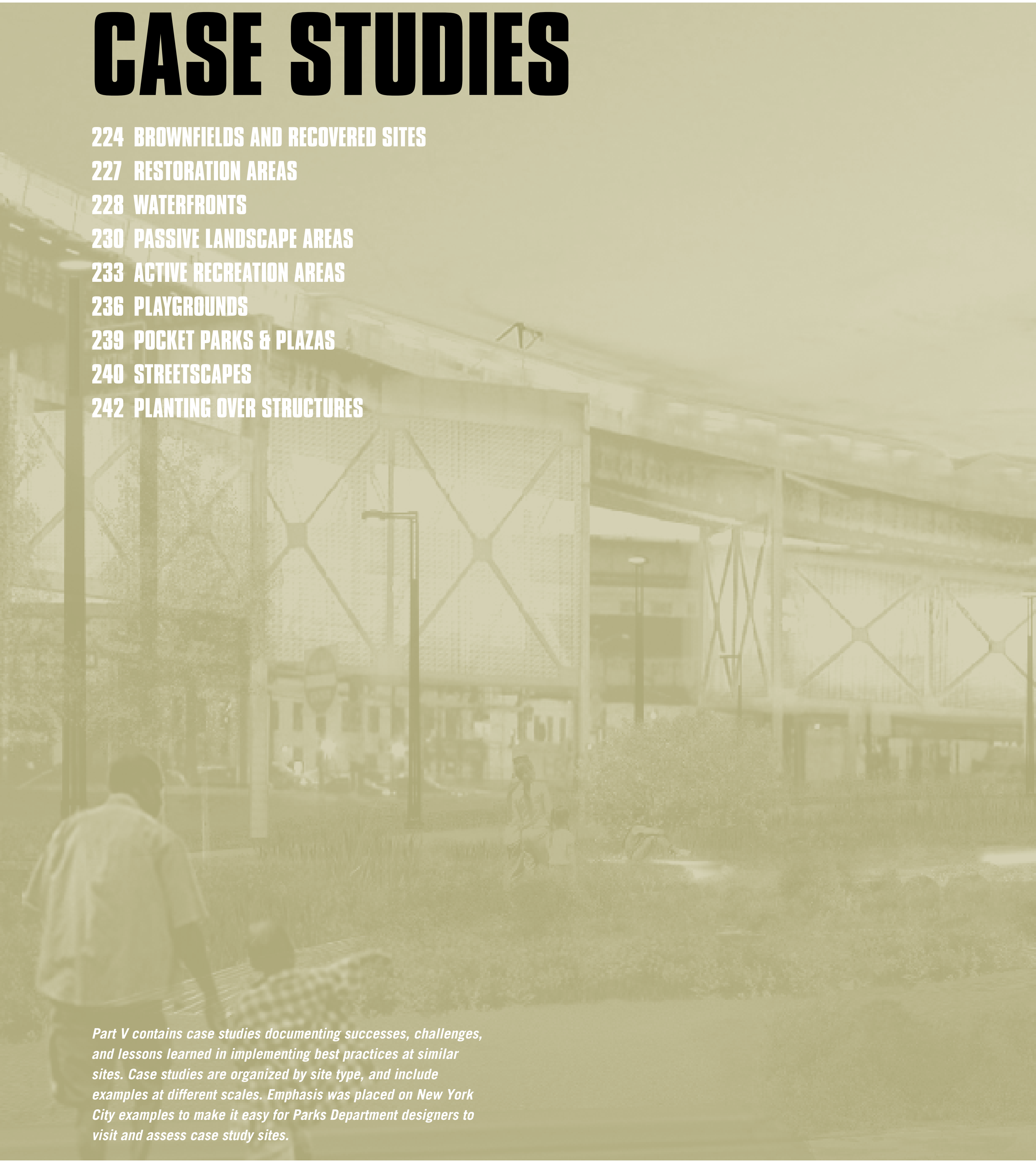
PART V: CASE STUDIES



Part V contains case studies documenting successes, challenges, and lessons learned in implementing best practices at similar sites. Case studies are organized by site type, and include examples at different scales. Emphasis was placed on New York City examples to make it easy for Parks Department designers to visit and assess case study sites.

BROWNFIELDS AND RECOVERED SITES

ECOLOGICAL RESTORATION OF PENNSYLVANIA AND FOUNTAIN LANDFILLS

The New York City Department of Sanitation operated the Pennsylvania and Fountain Avenue Landfills as waste disposal sites in the 1950s and 60s. Located on the shores of Jamaica Bay, within the Gateway National Recreation Area, both landfills are within a sensitive and regionally important environmental area. Highly contaminated with PCBs and heavy metals, the sites have been remediated and closed under the New York State Superfund Program. The landfills were capped with an impermeable membrane and covered by millions of tons of sand and topsoil brought in by barge.

In 2006, NYCDEP began ecological restoration efforts including planting native trees, shrubs, and wildflower species. When the ecological restoration project is complete, the sites will be ceded to the National Park Service to become part of the Gateway National Park system.

DESIGNERS: NYCDEP, New York State Department of Environmental Conservation, National Park Service, and local community stakeholder groups
CLIENT: National Park Service, U.S. Department of the Interior
COMPLETED: The first planting at Pennsylvania Landfill was in Spring 2006 and at Fountain Landfill in Spring 2007.

PROJECT SIGNIFICANCE

The restoration of the Pennsylvania and Fountain Avenue Landfills is a model of adaptive reuse that enhances existing ecological features while following the principles of sustainable environmental design. The project accomplished the following:

- Developed a restoration plan that goes beyond conventional methods of placing a thin layer of soil with cool season grasses, and instead performs a wide range of ecological functions (creates diverse habitat, retains stormwater, etc.).
- Designed related plant community associative plantings and appropriate soil types within the maritime setting that provide maximum environmental benefits today while reducing future maintenance requirements and the need for supplemental interventions.
- Increased and promoted the local genetic diversity of indigenous plants.
- Improved and protected wildlife habitat, shelter, and food sources.
- Eliminated or substantially reduced the need for supplemental watering, fertilizers, herbicides, and insecticides.
- Reduced soil erosion and sediment loading to Jamaica Bay.
- Provided pollutant attenuation through effective site stormwater management via plant evapotranspiration.

DESIGN FEATURES

SOILS

- Soil preparation was the keystone of this restoration. All soil types and plant community associations are not created equal. However, all too often, the development and use of appropriate soil specifications, along with the monitoring of implementation in the field is considered low value and warrants little attention. The use of appropriate agricultural soil testing laboratories, soil testing methodologies, testing parameters of soil quality, frequency of testing, and measurements of bulk density after placement was vital to the project's success.
- A sample collection program was developed for soil analysis from existing plant communities within the region to develop plant community specific soil specifications that closely mimic natural soil conditions of proposed plant communities.
- Mycorrhizal soil inoculation treatments were specified to help restore and maintain soil biological diversity and activity and to increase health of ecosystem.

VEGETATION

- Initiated multiple nursery contract growing programs for nearly 40,000 plants, maximizing the use of seed grown plants, and limiting use of cuttings.
- Specified smaller plant material to acclimate better to the site and allow more vigorous growth over the long term.
- Specified varying sizes of plant species to mimic a more natural and uneven aged stand.
- Specified exclusive use of low maintenance, warm season grasses with high wildlife value, over conventional cool seasoned lawn grasses that have low wildlife value and high maintenance requirements (except for nonpersistent nurse crops).
- Selected appropriate plant material for maritime conditions (aesthetic qualities of plant material were considered least).
- Specified and enforced tight seasonal planting windows.
- Limited provenance of plant material to within a 150 mile radius of the planting site to ensure local genotypes and diversity.
- Specified landscape subcontractor minimum qualifications and hired a Restoration Specialist to oversee implementation of restoration.
- Conducted an extensive literature study and researched applications of root growth patterns to persuade regulators to permit trees and shrubs with modest soil cover of 3' over landfill cap.
- Developed specific proportions of individual plants within each plant community type based on literature.
- To produce a more random field layout, located plant material through computer generated design software.
- To help with monitoring efforts and evaluate growth, each plant was field located with a global positioning system (GPS) device. Each plant has been labeled with encoded bar code

New trees were planted at significantly higher densities than typical park installations to better compete against invasive species.

tags that include information on species, nursery supplier, plant provenance, date of planting, and size at time of planting. Editable fields allow annual update of growth measurements. This enables an accurate monitoring of individual plants to aid in identifying specific issues related to plant origin and environmental conditions after planting that may affect the growth and health of the plant.

LESSONS LEARNED

SCHEDULE DELAYS CAN BE PROBLEMATIC WITH CONTRACT GROWING

AS SPECIFIC SIZES AND TIME FRAMES ARE PREARRANGED WITH NURSERIES, ANY DELAYS CAN CREATE ISSUES WITH PLANT MATERIAL HEALTH (E.G., CONTAINER SIZE, OVERCROWDING, ETC.) AND NURSERY OPERATIONS. CAREFUL COORDINATION AND EARLY NOTICE OF DELAYS WILL HELP MINIMIZE IMPACTS.

SITE SPECIFIC EDUCATION IS IMPORTANT FOR ALL INVOLVED

All involved parties should be educated about the specific site and its ecological context, regardless of work on other projects.

FINDING EASY REFERENCE POINTS FOR PLANT LOCATIONS IS CHALLENGING IN LARGE RESTORATION AREAS

Additional monitoring and field protocols will be established for greater ease in locating specific coded and labeled species.

TREE ROOTS ARE SHALLOW, BUT CAN EXTEND FAR LATERALLY

The perception from traditional renderings of tree roots shows them to be very deep but not very wide. Today we know the opposite to be true — tree roots are relatively shallow but can extend laterally nearly three to five times the width of the canopy. As the trees at Penn and Fountain mature, the project will provide valuable data on the viability of planting trees on landfills.

DESIGNING AND INSTALLING AN EXTENSIVE ECOLOGICAL SYSTEM, RATHER THAN JUST A BAREBONES SYSTEM OF GRASSES WITH THIN SOIL, PAYS OFF

Long term ecological functions implemented as part of the restoration, along with the reduction in supplemental watering and chemical use, substantially reduce future maintenance needs.

WIND AND BIRD DISPERSED INVASIVE SPECIES CAN BE DIFFICULT TO MANAGE

Early intensive management and controls are necessary to give the site time to mature and begin to buffer more of these plants on their own as density and shading increase. Although site conditions were designed to favor the growth of maritime indigenous plant communities, opportunistic invasive vegetation will always find its way to the site. Substantial control measures are required and must be sustained over time.

WEATHER PLAYS AN IMPORTANT ROLE IN PROJECT ESTABLISHMENT AND FUTURE SUCCESS

Allowing soil placement, planting, or seeding when the soil is either too moist or dry will substantially increase soil compaction and loss of soil structure. The adherence to seasonal windows and specifications prohibiting activity under adverse weather conditions needs to be strictly enforced.

FOR MORE INFORMATION

- New York City Department of Environmental Conservation http://www.dec.ny.gov/chemical/53590.html
- NYCDEP. “A Forest Grows on a Brooklyn Landfill.” WNYC Radio interview of John McLaughlin, http://www.wnyc.org/news/articles/73332

RESTORATION AREAS

BRONX RIVER TIDAL MARSH VEGETATION RESTORATIONS

The mission of the NYC Parks Department Natural Resources Group (NRG) is to conserve New York City's natural resources for the benefit of ecosystem and public health through acquisition, management, restoration, and advocacy using scientifically supported and sustainable research. For this project, NRG wanted to establish a salt/brackish marsh in the tidal zone of the Bronx River as well as restore degraded upland edge habitat and demonstrate opportunities for restoration in a historically industrial region.

LOCATION: Bronx, New York
DESIGNERS: NYC Department of Parks & Recreation Natural Resources Group with the Bronx River Alliance, Hunt's Point Development Corporation, National Atmospheric and Oceanic Administration, Partnerships for Parks, Sustainable South Bronx, Youth Ministries for Peace and Justice
CLIENT: The City of New York

PROJECT SIGNIFICANCE

- Design parameters:
  - Upland slope: soil specifications and soil stabilization techniques
  - Plant community: species, size, placement, distribution, density and installation form
- Evaluation strategies:
  - Low nutrient soils were chosen for the slope to minimize competition with invasive exotic species that thrive under high nutrient conditions.
  - Soil stabilization techniques were dictated by site constraints, excavation costs, and planting soil depth requirements.
  - Soil horticultural, textural, and mechanic characteristics were evaluated to assess plant species suitability, size requirements, and plant installation options.
  - Scour conditions, ease of construction, and cost determined slope stability.
  - Native plant communities in other local estuarine maritime uplands guided plant selections.
- Design elements used for the first time in NYC:
  - A nursery built on site by NRG staff and community partners was established to grow Spartina alterniflora in wet beds.
    - 50 volunteers helped construct over 8,000 square feet of wetland planting beds.
  - Biodegradable coir fabric mattresses used as a growing medium.
    - 2 inch plugs were installed in the coir fiber mattresses so roots could grow into the coir matrix.
    - Prevegetated coir mats are easy to use on low energy tidal or freshwater shorelines where there is low scour, some deposition, and a relatively predictable water height or flow regime.
    - Coir mats were rolled up and carried onto the site by volunteers and anchored with metal staples or loose rock.
  - A cellular confinement system (Geogrid) was installed on the slope to retain clean, nutrient-poor sand, which supports maritime grassland and shrub species.
    - This system is an effective option for steep, relatively dry embankments where there is little room for other stabilization measures and no concentrated overland stormwater runoff.

Spartina was raised in a constructed nursery onsite prior to planting along the shoreline. Netting above prevented birds from destroying the young seedlings.

LESSONS LEARNED

The relative ease and success of this project created an illusion that it could be easily replicated elsewhere. However, the low scour site conditions were very specific to this particular planting location, and in fact less than one third of the original planted area survived and showed robust growth over time. This was not entirely unexpected, since the wide original planting area was designed to ensure that the planting would cover the full potential possible areas for *Spartina alterniflora* to survive.

- Community involvement is enjoyable and provides an opportunity for education.
- The design used soils and plants that would thrive in nutrient poor location and compete with invasive exotic species, minimizing the need for invasive plant maintenance.
- The use of prevegetated coir mats simplified installation in the unconsolidated soils of the mud flat.
- The cellular confinement system allowed construction of the slope with minimal excavation and relative ease.
- The project would have benefited from more attention to stormwater runoff and soil erosion at the top of the bank.
- More monitoring and documentation during construction would have provided important information on replicating and improving upon the design.
- Soil contamination levels and appropriate protection practices should be considered when volunteers work on old industrial sites.
- Designs should be site specific and driven by an understanding of physical processes.

HUGO NEU METAL MANAGEMENT RECYCLING FACILITY STORMWATER CAPTURE SYSTEM

The Gaia Institute developed a zero discharge stormwater treatment system for the Hugo Neu (formerly Sims) Metal Management Recycling Facility on the Bronx River waterfront in Hunts Point. Soil buffers, constructed wet meadows, and a 300 foot green wall constructed from recycled materials were integrated into the fully functioning waterfront workspace, where thousands of tons of metal, glass, and plastics are handled each month.

LOCATION: Hunts Point, Bronx, NY
SIZE: 6.5 Acres
DESIGNER: The Gaia Institute
ENGINEERING AND LANDSCAPE DESIGN: WSP Sells, RRT Design & Construction, Kosuri Engineering & Consulting PC, Young Environmental LLC
DESIGN IMPLEMENTATION AND CONSTRUCTION: The Dawson Corporation
RECYCLED MATERIAL SUPPLY: NYC Department of Sanitation, Bureau of Waste Prevention, Reuse, and Recycling (compost), Sims Metal Management (recycled glass for sand substitute for green wall mortar, and chain link fence supply)
REGULATORY GUIDANCE AND INPUT: NYC Department of Environmental Protection, New York State Department of Environmental Conservation
PLANTING, FINE GRADING, MULCHING, AND WEED CONTROL: NYC Department of Parks & Recreation Green Apple Corps, Rocking the Boat, Youth Ministries for Peace and Justice, Sustainable South Bronx
CLIENT: Hugo Neu/Sims Metal Management
COMPLETED: Spring 2009

PROJECT SIGNIFICANCE

The main goal of the project was to demonstrate how a natural stormwater purification system could be minimally invasive on an active truck to barge material handling site, while utterly changing its appearance and ambience and allowing for participation in nature in the busy day of workers handling scrap metal and curbside metal, glass and plastic (MGP) recyclables.

DESIGN FEATURES

A photovoltaic solar power system runs eight water pumps for a native wet meadow as well as a green wall.

- Below grade stormwater storage consisting of 240 StormChambers™ as well as stone fill allows for high volume inputs to underground storage.
- Parking lot swales interdigitated with gravel beds created a mosaic of industrial usage and ecosystem service. Consideration was given to the use of grasses on the parking beds, but even without the soil based infiltration galleries of the swales fully planted and mulched, runoff from even the largest storms has infiltrated into the below grade environment.
- Use of local recycled materials in construction of the green wall included:
  - Humus in the form of compost supplied by the NYC Department of Sanitation provided capillary water holding and infiltration capacity.
  - Crushed recycled glass from the NYC waste stream was used both as a wet meadow soil component and as a sand substitute in the green wall mortar, lowering material and transport costs.
  - A small fraction of chain link fence (3,000 square feet) was diverted from the tons of scrap chain link moved through the Sims Metal Management site, and provided the base for the mortar. It provided a strong tensile structural element to which the green wall mortar could be adhered.
  - Wood chips and branches from a local tree maintenance crew were embedded in the surface of the wall to provide texture and a low pH habitat for mosses, amidst the high pH concrete surface.
- For water distribution on the green wall, although standard pressurized pumps and spray or drip irrigation were considered, a slotted pipe manifold running the length of the wall was installed. Because slots are forgiving structures both in terms of flow rate and potential for clogging, two inch PVC was installed across the top of the 300' wall. As a distribution curtain and for aesthetic purposes, the PVC was wrapped in burlap to broaden the distribution of each slot, and as mosses grow they will greatly enhance this tendency.

LESSONS LEARNED

WATER FEATURES MUST BE DESIGNED WITH ADEQUATE DEPTH

The linear swale at the westernmost edge of the property presented the typical challenge involved in building smaller water bodies: how to keep the water deep enough in the footprint provided to ensure fish, frog, and invertebrate survival through frigid winter seasons. While terracing with gabions or like structures could have been used to step down a steep meadow edge to the bottom level, the added expense and time to incorporate such structures became a significant burden on this first of its kind construction. Instead, continuous grading was used to move the deepest sections towards a 24" to 30" depth. Given the shallow depth of groundwater, it is expected that this large heat source will limit deep freezes of the wet meadow bottom habitat.

ANTICIPATING AND INTEGRATING NEIGHBORING CONSTRUCTION ZONES AND EFFORTS IS CRUCIAL

The team assembled to work on the Hugo Neu/Sims Metal Management site had never worked together on any prior project, nor had any similar project of such a scale ever been constructed. It was therefore essential to maintain a high level of communication across the team, especially regarding sequencing of work and construction time lines.

SUBSTANTIAL DIFFERENCES EXIST BETWEEN SURFACE AND SUBSURFACE CONDITIONS, AND BETWEEN ANTICIPATED AND ACTUAL SOIL STRUCTURE AND BEHAVIOR

Varying conditions in the work area and wet meadow led to significant unexpected increases in water storage capacity. The removal of compressible silt and claybased soils under the material handling area and replacement with structural materials to support the large loads greatly increased pore or void volume by a conservatively estimated factor of two, at least doubling water holding capacity below grade.

ENSURING INTEGRATION OF PARTS IS CRITICAL IN COUPLING INFRASTRUCTURE WITH ECOLOGICAL SYSTEMS

Numerous minor dislocations provided reminders that it is necessary to identify, in advance where possible, the interacting design, construction, and regulatory responsibilities. Early in the project, the design and construction teams did not coordinate their work adequately. Eventually, the participants instituted regular, timely meetings to coordinate activities, including daily monitoring of work efforts.

PROPER SEQUENCING OF STORMWATER MANAGEMENT SYSTEMS IS ESSENTIAL

An array of 240 StormChambers, together with the below grade connections to the solar pumps west of the scale road, had to be installed prior to the pouring of the concrete scale road and the material handling area to the east. Construction thus proceeded from east to west, with the underground StormChambers installed as the construction crews prepared work on the 200,000 square foot work area and the scale road on its western edge, and then an additional 100,000 square feet to the north, under the new curbside MGP recycling zone.

OVERSIGHT OF CONSTRUCTION IS KEY

There was no one person who had, on a daily basis, an overview of each of the parts as well as how they fit together. An oversight process to review the integration of design and construction would have helped to avoid mistakes and facilitate construction. Fortunately, a just-in-time technology has emerged that appears to be uniquely suited to address this problem. This is none other than the cell phone, and the willingness to use it.

FIRST OF THEIR KIND PROJECTS WILL HAVE FIRST OF THEIR KIND PROBLEMS

As of the date of filing, the city's specific stormwater regulations required discharge to the combined sewer system, and it was necessary to show how this industrial landscape, at the periphery of the Bronx, built on fill over tidal marsh, and hydrologically decoupled from the mainland by the CSX rail line, could handle the entire volume of runoff discharged during large storms.

FOR MORE INFORMATION

- Hugo Neu Metal Management
Tom Outerbridge, General Manager
Hugo Neu Municipal Recycling
tom.outerbridge@simsmm.com
www.hugoneu.com
- The Gaia Institute
Paul S. Mankiewicz paul@gaiainstituteny.org
John Halenar, john.halenar@thegaiainstitute.org
Eric Dalski, eric@thegaiainstitute.org
www.gaiainstituteny.org
www.gaiasoil.com

PASSIVE LANDSCAPE AREAS

CANARSIE PARK

The eastern portion of Canarsie Park West was first constructed in 1896, and is comprised mostly of paths lined with trees through sports fields. The land that is now the western part of the park was originally the northern edge of Jamaica Bay, which was filled in with Rockaway Beach dredge sands in order to construct the Belt Parkway in the 1930s. This flat land remained unused until the 1950s, when a portion of it was used as a launch pad for antiaircraft missiles. In the 1990s, another portion of the site was taken over by the Department of Sanitation (DOS) for use as a composting facility. When DOS left the site, 15,000 cubic yards of compost and 7,000 cubic yards of asphalt millings remained, which were used in the construction of the new park.

LOCATION: South Shore, Brooklyn, New York
SIZE: 53 acres
DESIGNERS: Katherine Bridges, RLA, and DPR Natural Resources Group
CLIENT: The City of New York
COMPLETED: Phase 1 (36 acres) was completed in June 2009, Phase 2 (17 acres) is scheduled for completion in 2010

PROJECT SIGNIFICANCE

COMMUNITY ENGAGEMENT

- The Community, the DPR Borough Office, and Elected Officials participated in several meetings to determine the scope of the project, compile a wish list, and review and comment on the conceptual plan. Their requests included:
  - A natural area with lighting, walking paths, and a cricket field, all of which were provided
  - Minimal active recreation in the form of additional fields
  - Picnic tables and a maintenance facility
  - An additional comfort station to provide bathroom amenities to park users in the newly developed portion of the park
- A conceptual plan for the whole site lays out other wish list items that were not possible in the first two phases.
- Undulating landforms were built to provide visual diversity, encourage passive use, and provide more challenging walking paths for exercise.

CREATE NATURAL FORESTED WETLANDS, A HILL, AND MOWN MEADOW AREAS

- Due to high shell content in the dredge sands that make up much of the forested wetland site's soil, the pH was stable at around 7-8, requiring the plants selected to be tolerant of these conditions.
- Approximately 90 tree and shrub species and 100 wildflower species were used throughout the project.
- The forest was planted with smaller size plants (#1 and #2 container size), while trees had an approximate height of 3 feet.
- Nurse crops and plants were used to help suppress weeds and facilitate establishment.
  - Annual rye was mostly used for wildflower establishment, along with annual oats, barley, and buckwheat.
  - Fast growing sumac and willow were used in the shrub and tree areas.
  - No soil amendments or topsoil were used across the entire restoration area to minimize weed establishment.
  - Fertilizer and hydrogel was installed directly into plant pits.
  - Mycorrhizal inoculants were used for both plant pits and seed mixes.
- Stock and custom seed mixes were provided by Ernst Conservation Seeds.
- Planting started at the far end of the park and was completed at the near edge, at Seaview Avenue.
  - As all areas were a mix of different species, this required approximately 85-95% of all of the plants to be onsite before planting could begin. A temporary nursery was set up with irrigation onsite.
  - To complete the project, the contractor wanted to plant outside of the planting season, beginning in June. It was allowed on the contingency that an onsite temporary irrigation system was installed for all of the plants during this time.

USE ONSITE MATERIALS

- Compost provided by NYCDOS was used in the mown meadow area.
  - Higher nutrients were required in the mown meadow and athletic fields to replenish nutrients lost through mowing.
- Asphalt millings were used 12-18" deep below pathways to stabilize.
  - Sand close to the water table was very unstable, but the millings counteracted this as well as being a free resource.

ENGAGE THE NECESSARY PROFESSIONALS TO SUCCESSFULLY COMPLETE THE PROJECT

- The Parks Natural Resources Group (NRG) aided in plant selection for the meadow and wetland species, as well as in the design of the water bodies.
- The designer and NRG members visited Connetquot State Park, an undisturbed fishing preserve, on the South Shore of Long Island, to help provide a vision of a mature forested wetland.
- A prequalified landscaping subcontractor with prior natural landscape installation experience was required in the contract.
- A restoration specialist was included as a contract item, required to supervise grading, erosion control and planting.
  - The contractor was very pleased with this process, as it resulted in a very successful establishment of plant species. The restoration specialist oversaw all erosion control measures in compliance with State Pollutant Discharge Elimination System (SPDES), even though compliance was not required by law.

The restoration area shown here is interwoven with walking trails, meadows, and cricket fields

RETAIN ALL STORMWATER ON SITE

- No hookups to outside sewer systems were necessary.
- Grading with high and low points collected water.
  - Three of the largest low points had 5'-3" of aggregate buried between the surface and the water table to retain stormwater until the plant species establish and are able to uptake water.
  - An error in grading during construction produced an additional low point, which required an aggregate reservoir draining to two dry wells.
- The problem of having the high water table at elevation 5 while some low points were at elevation 7 was overcome by flattening the retention areas rather than building deeper.

ESTABLISH A MAINTENANCE SCHEDULE

- Maintenance circulation and access were considered in designing the pathway system.
- The mown meadow portion of the park is scheduled to be mowed at half of the frequency as the athletic fields.
- To distinguish the different areas, with different maintenance schedules:
  - The asphalt paths act as an edge between the athletic fields and the mown meadow, and the unmown restoration areas.
  - The restoration areas are bounded by range fence to separate areas that are not to be mown at all.
- The designer met with Park Inspection Program (PIP) members to relay the desired maintenance approaches and determine how to evaluate maintenance success.
  - While lawns are typically limited in height, the designated mown meadow area is allowed maximum 12" of growth.
- Wildflowers began to sow into the asphalt paths, so a smaller (32" wide) mower was purchased as restoration equipment to allow M&O to mow a 3' edge along the unmown restoration sides of the pathway.

LESSONS LEARNED

- This was the first restoration project of its scale for the Parks Department, and as a result, in-house expertise beyond NRG was difficult to find.
  - The designer met with a restoration specialist during the design phase, clarifying that due to the contract structure, hiring in construction was not controlled by the designer.
  - Having a restoration specialist on site to oversee all soil and planting activity greatly improved the quality of the installations and took pressure off of the boroughwide landscape construction team for such a large project.
- Asphalt millings can be used as subgrade for a low cost, and are readily available within the city, especially along the Brooklyn shoreline.
- Compost from the Department of Sanitation can be used as a lowcost soil amendment, and is particularly useful for large scale mown fields or mown meadow projects.
- The mown meadow on compost and clean fill established much better than the athletic field areas where the topsoil was brought in through a change order. The organics in the topsoil were not aged properly and required nitrogen in order to decompose. Three clover species in the mown meadow mix provided extra nitrogen. One clover species in the athletic field helped to compensate for the soil, however extra fertilizer was required to establish grass on the topsoil.
- Designing natural restoration projects requires many custom items and a flexible installation schedule.
  - Plant palettes can be complicated and must be tailored to an individual site.
  - Construction, especially planting schedules, cannot be rushed beyond what is optimal conditions for the plants.
  - Phase 1 began in May 2006 with a scheduled completion date of November 2007, but was not finished until June 2009 due to plant installation schedules and confirmation of germination prior to accepting the construction work.
  - The considerations towards planting led to an extremely low loss rate for plant material.

CONTACT

NYC Department of Parks and Recreation, Capital Projects Division
Katherine Bridges
http://www.nycgovparks.org/sub_about/parks_divisions/capital/pd_capital.html

ACTIVE RECREATION AREAS

CALVERT VAUX PARK

This park, on the southern edge of Brooklyn, is named for Calvert Vaux, an English architect who spent 40 years in New York City, mostly working alongside Frederick Law Olmsted on projects including Central and Prospect Parks. Largely bounded by Gravesend Bay, Calvert Vaux Park offers water views, bird watching opportunities, a playground, basketball courts, bocce courts, six baseball diamonds, and a soccer field.

LOCATION: Brooklyn, NY
SIZE: 78 acres
DESIGNERS: Emmanuel Thingue, RLA
CLIENT: New York City Department of Parks and Recreation

PROJECT SIGNIFICANCE

Parks' goals for the park renovation included:

- Maintain the recreational resources in the park while attracting a broader group of users to the park and enhancing the experience of the park's natural features.
- Preserve the pastoral feel of this secluded site.
- Improve the ecological performance of the site.
- Restore wetlands to improve stormwater management.
- Reduce future maintenance costs.

DESIGN FEATURES

- To accommodate the possibility for more flexible program and passive uses, the number of soccer fields was reduced from eleven to six. The fields were concentrated in the portion of the site closest to the highway. This allowed the remainder of the site, which afforded the best water views, to be dedicated to more passive activities (picnicking, strolling, sunbathing, etc.).
- A wide swath of the site's edges was restored as coastal wetlands; further inland, rain gardens and wetlands were created. Portions of the site were regraded to maximize infiltration and to guide water to these new rain gardens and wetlands.
- Designers worked closely with Parks' Maintenance and Operations division to reduce maintenance requirements and impacts on the park. Paths were established to accommodate maintenance vehicles and designated maintenance access points were designed to minimize conflicts with pedestrian and bicycle circulation. A maintenance and operations building was constructed to provide a permanent onsite presence. Synthetic turf fields were introduced, replacing the old grass fields.

LESSONS LEARNED

INTRODUCING SYNTHETIC TURF HAS ADVANTAGES AND DISADVANTAGES AND CAN CONTRIBUTE TO PROJECT DELAYS

The New York State Department of Environmental Conservation required the construction of a subdrainage system, additional studies of water quality issues related to stormwater discharge

The masterplan for this park integrates a site-wide stormwater strategy with a dense concentration of athletic fields to serve the borough's recreational needs.

from turf to existing water bodies, and heightened soil remediation standards that would not have been required for a grass field. Opposition to the use of synthetic turf by some local community groups also caused delays in the permitting process.

PARK PERMITTING PROCESSES ARE OFTEN UNPREDICTABLE AND CAN INVOLVE LENGTHY DELAYS
Even projects that seem straightforward to the designers may encounter unexpected delays in permitting. All agencies and consultants should understand the permitting issues related to a project early on to avoid delays.

NEW SYSTEMS MAY REQUIRE NEW MAINTENANCE TECHNIQUES
Although not necessarily more difficult, new maintenance techniques should be acknowledged and accepted prior to moving forward with designs.

FOR MORE INFORMATION

→ NYC Department of Parks and Recreation, Capital Projects Division
Emmanuel Thingue, RLA
http://www.nycgovparks.org/sub_about/parks_divisions/capital/pd_capital.html

Below is the Soil Sampling Protocol used for Calvert Vaux Park. Please contact Marty Rowland or Emmanuel Thingue for additional information and referenced attachments.

CALVERT VAUX SOIL SAMPLING PROTOCOL — HISTORIC FILL SITE

This New York City Department of Parks and Recreation (NYCDPR) soil sampling protocol is specific for the Calvert Vaux Park Site and is not for general use, or for other specific sites. It is based on a draft New York State Department of Environmental Conservation (NYSDEC) guideline, dated July 2, 2007, entitled “DEC Guidelines for Submissions, Excavation, and Fill for Historic Fill Sites.” The definition of the word “subsample” in the text below is “the media collected at a specific point that is subsequently composited (mixed) with other subsamples into a single sample that is then analyzed for a single set of parameters.”

INTRODUCTION

The project is located in the Bensonhurst/Gravesend/Coney Island communities of Kings County, New York. It includes the renovation of existing recreational fields, the addition of new amenities such as bleachers and lighting for one of the soccer fields, the creation of a formalized parking lot, great lawn, dedicated model helicopter area, picnic area, amphitheater, playground, comfort station, field house, and nature pedestrian and bicycle pathway network. The sampling protocol applies only to the Phase I portion of the project.

VICINITY PLAN: See attachment A.

SITE PLAN: See attachment B.

TYPE OF SOIL MANAGEMENT PLAN: Cut/fill/cover plan

ESTIMATE OF VOLUME OF EACH: See attachment C.

SAMPLING AND ANALYTICAL PLAN: See attachment D; the NYSDOH ELAP lab will be used for all sample analysis.

SAMPLING PLAN LOCATIONS AND NUMBER OF SAMPLES:
Samples will be collected on a composite 50’ x 50’ grid (within the contract limit line) for RCRA metals list (i.e., no nutrient metals), and the target compound list (TCL) for organic chemicals. The TCL includes volatile organic compounds (VOCs), semivolatiles (SVOCs, also known as polynuclear aromatic hydrocarbons, or PAHs), pesticides, and polychlorinated biphenyls (PCBs). Sampling of site soils will occur only in 1) those areas of proposed excavation into existing soils, and 2) areas where existing cover soils are proposed as the final top cover. Sampling will not generally occur in areas where existing soils are not excavated and where the addition of a clean soil cover or an engineered cover type such as buildings, pavement, or synthetic turf is proposed.

COMPOSITE SAMPLING METHODOLOGY: Four grab subsamples shall be collected at the nodes of the 50' x 50' grid, mixed together in a bowl or sealed bag. All sampling and mixing equipment will be decontaminated between composite samples or dedicated for each composite (or disposable, single use equipment may be used). Soil shall be collected within the top two feet or to the depth of the excavation in those locations where the excavation is deeper than two feet. In those locations where excavation is deeper than two feet and the subgrade will be the final grade, an additional two feet shall be added to the soil collection depth. In the areas of storm drain trenching, a vertical composite soil sample will be collected from ground surface to the depth of excavation, along the length of the drain line, at 50 foot intervals.

CONTAMINANT LIST: RCRA metals and the TCL of VOCs, SVOCs, pesticides, and PCBs

DATA PACKAGE: DEC Analytical Services Protocol (DECASP) Category B will be the format/media for the data. This data will be compressed onto a CD for submittal to the DEC. The NYCDPR will keep all necessary records of field sampling and sample custody.

SAMPLE DETECTION LIMITS: Sample analysis shall follow the contract required quantitation limits (CRQL) of the DECASP.

ANALYTICAL METHODS TO BE USED: DECASP shall be used for the sample analyses. The laboratory shall be DOH ELAP-certified. If there is any ambiguity in the methods to be used, EPA SW-846 shall be used. The laboratory, in any case, shall conduct these analyses in accordance with DECASP:

- VOCs: EPA Method 8260B
- SVOCs: EPA Method 8270C
- Pesticides: EPA Method 8081A
- PCBs: EPA Method 8082
- Metals: EPA Method 6010B

CRITERIA FOR USE AND REUSE OF SITE SOIL: It is the intent of the protocol to safely reuse site soil whenever possible. In the Phase I area of the Calvert Vaux site, two categories of site soils regarding use and reuse are anticipated. The first category includes soils clean enough to be moved and managed anywhere on the nonwetland portion of the proposed park site. The second category refers to soils that exceed the soil cleanup objectives (SCOs) for residential use and protection of groundwater.

- Soils demonstrated to be below the concentration limits of the residential and protection of groundwater SCOs of New York Codes, Rules and Regulations (NYCRR) Part 375-6.8(b) (and TAGM 4046 limits where there are no Part 375 limits) may be left in place or moved to any other nonwetland part of the site without restriction. Compliant soils at the proposed final surface grade in a layer of at least two feet shall qualify as final soil cover at the park, and will not require further testing to demonstrate that level of quality.
- Excavated soil demonstrated to be above those concentration limits would be disposed offsite. Soil demonstrated to be above those concentration limits but that will not be excavated, will be covered by at least two feet of soil that meets the residential use and protection of groundwater contaminant limits of Part 375 Section 6.8(b), per Part 375 Section 3.8(e)(1)(i), or TAGM 4046 where there are no Part 375 limits, or by other methods of acceptable cover such as synthetic turf, impervious pavements, or vegetative barriers.

SUBMITTAL OF SITE PLAN DRAWING: See attachment E for a cut and fill drawing.

SUBMITTAL OF TEST PIT AND SAMPLING LOCATIONS: Contact the agency Environmental Remediation Specialist, Marty Rowland, for test pit locations and sampling locations, illustrating those locations where there are exceedances of the Part 375-6.8(b) contaminant limits for residential use and protection of groundwater (as well as TAGM 4046 where there are no Part 375 limits), and the volume of material for cut in cells by sampling location.

FORMAT OF DATA: All data shall be in PDF format and shall be searchable in Excel format.

FORMAT OF SUMMARY DATA: The summary of data shall be submitted in a printer table and searchable in Excel format, illustrating where exceedances of the Part 375-6.8(b) residential use and protection of groundwater contaminant limits (as well as TAGM 4046 where there are no Part 375 limits) were found.

COVER SOIL PLAN: See attachment F for an illustration of the location of impervious surfaces and soil.

CHEMICAL AND PHYSICAL SPECIFICATION FOR IMPORTED SOIL COVER: Soil cover imported from offsite shall not exceed the contaminant concentration limits of Part 375-6.8(b) for residential use and protection of groundwater, per Part 375-3.8 (e)(1)(i), (as well as TAGM 4046 where there are no Part 375 limits). The acceptability of cover soil is a contract condition between NYCDPR and the agency's contractor. Contract shall specify that all imported cover soil from offsite shall not exceed the Part 375-6.8(b) residential use and protection of groundwater soil contaminant limits (as well as TAGM 4046 where there are no Part 375 limits). The number of tests for acceptance shall be one (from a grab sample) per 500 delivered cubic yards of cover soil (approximately one sample for every 20 truck loads). All noncompliant soils shall be removed by the contractor and replaced with compliant soils as per the contract. Also, contract specifications shall describe acceptable permeability characteristics, and will be verified in the field by visual means by the project field monitor, i.e., silty and clayey soils would be minimized in favor of sandy soils.

DATE OF THIS PROTOCOL: March 16, 2009

PLAYGROUNDS

PRINTERS PARK

Printers Park Playground had been closed since the 1980s due to severely unstable conditions caused by the subsidence of construction fill. The new playground design was needed to remediate the subsidence, handle stormwater more effectively, and use sustainable best practices, while meeting the community's needs for a family friendly play space. The park needed to accommodate younger children (2-5 years old) and their families, and also visually relate to both existing and future phases of the park.

LOCATION: Bronx, New York
SIZE: 1.3 Acres
DESIGNERS: Stephen J. Koren
CLIENT: City of New York Department of Parks & Recreation
COMPLETED: Completed Spring 2010

PROJECT SIGNIFICANCE

The reconstruction of Printers Park not only incorporated stormwater management best practices, but also made the practices visible and relevant to park users and the surrounding architectural context.

DESIGN FEATURES

- Specification of 94% postindustrial recycled pavers that possess the feel and familiarity of standard Parks hexagonal asphalt pavers but have a lighter environmental footprint.
- The hand activated spray shower uses less water than standard Parks spray showers. After leaving the shower, water flows through scuppers in the concrete seating wall, irrigating the surrounding planting beds designed with plants that are adapted to an additional water load.
- The existing soils were removed to 3' below final grade and rebuilt using stabilization geotextile, clean fill, and topsoil specifically designed for increased permeability. Once established, the plants should be drought tolerant and require little maintenance.
- The hydrology of the site is visibly demonstrated to visitors. Water that does not infiltrate the play surface flows across a swale topped with local/recycled granite cobbles and infiltrates a continuous ring of topsoil planted with a grove of very durable Gingko trees.
- The history of the site, which was once the estate of Richard March Hoe (1812-1886), the inventor of the rotary printing press, is evoked in the park design. The play structure in the center of the park recalls and playfully abstracts this history as a sculptural event.

LESSONS LEARNED

SPRAY SHOWER WATER (GREYWATER) MUST BE PRETREATED BEFORE USING FOR IRRIGATION

To comply with water regulations, surface runoff from spray showers (greywater) should be routed through an underground drainage layer or other pretreatment before reuse for planting bed irrigation.

EDUCATION OF THE CONTRACTOR IS HELPFUL TO OVERCOMING RESISTANCE TO NEW TECHNIQUES

Education and real life demonstrations are the best way to satisfy criticisms of unconventional products and techniques that deviate from maintenance workers' experience. This project serves as an important pilot to showcase these techniques.

Spray shower runoff is minimized by the use of low-flow spray heads and a push button that runs the spray shower for three minutes at a time. Runoff is directed to underground gravel trenches that water the surrounding planting beds.

CONSTRUCTION DETAILS MUST BE TWEAKED ON SITE TO BE SUCCESSFUL

Partnering with the contractor and listening to his experience was the best way to navigate such field conditions.For example, the stone drainage/geotextile sandwich layers which receive the spray shower water needed to extend further. It was the contractor who suggested creating an entire layer of stone sandwiched inside the drainage fabric instead of little fingers of stone/fabric, which increased volume of retention and also allowed for easier installation.

THE COMPLICATIONS OF INSTALLING INFILTRATION PAVERS CAN BE OVERCOME

Setting infiltration pavers on a permeable base has been criticized because of concerns about tripping hazards, differential settlement, and theft. These potential problems can be prevented through constant supervision and education. Such conditions can be remedied more easily if caught early. As a preventative measure, a double layer of stabilization fabric and sand is provided under the hex pavers so that if there is settling, the fabric will disperse the load.

CONTRACTORS MAY EXPRESS CONCERN THAT SOIL DRAINS TOO QUICKLY

More stone or recycled glass cullet wrapped in geotextile could be added to the perimeter planting beds to ensure positive drainage, and more compost could be added to the topsoil mixture to mitigate water retention in the soil and increase plant success.

THE SITE NEEDS TO FUNCTION HOLISTICALLY

The scope, layout, grading, hydrology, and planting plan inform one another and need to be considered, designed, and implemented at the same time to ensure success. Working with an engineer from the beginning is also crucial.

A CIVIL ENGINEER TRAINED IN THE CONSTRUCTION OF CURRENT INFILTRATION STRATEGIES IS ESSENTIAL

TIGHTLY WRITTEN SPECIFICATIONS ARE A CRUCIAL ASSET

Specifications need to identify sources for local materials, recycled content, and performance intentions so the contractor is legally bound to provide this quality of materials. Submittals documenting the source should be a part of the specification.

FOR MORE INFORMATION

→ NYC Department of Parks and Recreation, Capital Projects Division
Stephen Koren, RLA
http://www.nycgovparks.org/sub_about/parks_divisions/capital/pd_capital.html

HESTER STREET PLAYGROUND

When Sara Delano Roosevelt Park was slated for capital improvement, the Hester Street Collaborative and the SDR Park Coalition organized an input gathering process involving over 1,000 local park users. The purpose of the process was to determine local needs and desires for the playground's renovation. The resulting community wish list was handed over to the NYC Parks Department, and is shaping the playground's new design. By fostering this collaboration between the Parks Department and community residents, Hester Street Collaborative was able to advance the design of a park that will serve neighborhood needs while also cultivating local commitment to the site's long term success and maintenance.

LOCATION: Lower East Side, Manhattan
SIZE: 7.8 Acres
DESIGNERS: Allan Scholl and NYC Department of Parks & Recreation (Parks)
CLIENT: Hester Street Collaborative (HSC), Sara Delano Roosevelt (SDR) Park Coalition and partnering neighborhood community organizations
COMPLETED: Completed Summer 2010

PROJECT SIGNIFICANCE

The Hester Street Playground is a model for community participation in design. The community was not only asked its opinion, but was able to work closely with Parks designers during input gathering and visioning activities. During the process, HSC and Parks' staff gained a deep understanding of the existing park's current uses and limitations, for example, how community members use playground equipment and space unconventionally:

- Seniors use the play equipment for stretching and exercise in the morning.
- Teenagers hang out on the play equipment after school.
- Young children, who cannot get playtime at the local handball court, use the back of a large concrete slide as an alternative court.

The process of community input, visioning, and reconciling multiple viewpoints, while unique, can be replicated in other community spaces, as can the incorporation of a variety of play surfaces and age appropriate equipment into one space.

DESIGN FEATURES

- The new park design itself is unique and includes several elements of innovative playground design, meeting Parks equipment standards while sustaining the feeling of variety, adventure, and a multifunctional neighborhood gathering space.
- The playground incorporates:
  - Grade changes into a play area
  - Several play features into a small area without overcrowding the space

The successful participatory process of Hester Street Playground has helped inspire the creation of People Make Parks guidelines to be used throughout the city.

- Alternatives to post and platform play equipment that allow for creative play
- Sand, water, plantings, and other natural materials
- Increased green space
- Loose play objects with a play attendant
- Regular and bucket swing sets
- Spaces for creative and free play as well as physical recreation
- Vertical surfaces that can informally be appropriated for handball

■ Community specific elements were used to reflect the history and culture of the Chinatown/Lower East Side neighborhood:

- Public bulletin board at the park building on Hester Street
- Basketball courts retained as an open community space
- Community led installation to express cultural identity facilitated by HSC and the SDR Coalition

LESSONS LEARNED

COMMUNITY PARTICIPATION IS MOST EFFECTIVE AT THE BEGINNING OF THE DESIGN PROCESS

Gathering meaningful community input requires a significant amount of lead time, so coordination with Parks' internal timeline was essential to ensure that this input could be effectively analyzed and incorporated into the design process. Hester Street Collaborative, the Sara Delano Roosevelt Park Coalition and other community stakeholders benefited from working with Parks from the beginning of the design process.

CLARITY AND HONESTY ABOUT FEASIBILITY CONSTRAINTS LEADS TO INFORMED COMMUNITY INPUT

Community groups often request unconventional (not preapproved) play equipment that is not easily serviced. The Parks designer conveyed to the local community early on which of their ideas might be difficult to approve from a construction and maintenance perspective. This informed the scope of the community's final recommendations and made them as effective and feasible as possible. Ultimately, the community's request for sand and water areas, climbing nets, spray showers, and increased green spaces were included in the design.

COMPROMISE IS IMPORTANT

Although all community wishes would ideally be incorporated into a neighborhood space, the expertise of Parks ultimately made the design more feasible and maintainable. Encouraging compromise is an important part of the community visioning process.

FOR MORE INFORMATION

Anne Frederick, Executive Director
Hester Street Collaborative
113 Hester Street
New York, NY 10002
info@hesterstreet.org
http://www.hesterstreet.org

POCKET PARKS & PLAZAS

WORLDWIDE PLAZA

The redesign of Worldwide Plaza in Midtown Manhattan was precipitated by a combination of waterproofing failures that caused leaks in to the below grade theaters, and violations of the Department of City Planning's privately owned public space regulations. Over the years, successive numbers of trees had been removed and not replaced, while the plaza's public realm was increasingly encroached upon by concessions.

The 27,000 square foot plaza is a bonus plaza per the Department of City Planning which has strict guidelines for public amenities. Therefore, the basic premise of the plaza was predetermined. The role of the landscape architect was to work within those parameters and adapt them to contemporary conditions, correct past failures, and foster new ways in which the plaza could serve as a destination.

LOCATION: West Side, Midtown Manhattan
SIZE: 27,000 sf
DESIGNERS: Mathews Nielsen Landscape Architects, Desman Associates (for waterproofing and structural)
CLIENT: Time Equities Inc.
Completed: 2003

After its reconstruction, Worldwide Plaza became a neighborhood asset through successful collaboration and community engagement.

PROJECT SIGNIFICANCE

The primary innovations of this redesign are subtle but important. When constructing on a deck there are many unseen conditions that make maintenance of plantings, wiring and plumbing of light fixtures, fountains, and pavement extremely difficult. The designer needs to understand the reasons for prior failures and address these as part of the overall aesthetic and technical project goals.

DESIGN FEATURES

ROOF DECK PLANTING INNOVATION

Prior to starting the design renovation, the landscape architects conducted a forensic investigation as to the reasons for tree failure. The combination of inadequate root zone volume, poor soil, faulty irrigation, and poor drainage appeared to be the problem. Working with structural engineers, the landscape architects created large, below grade egg crates that increased the soil volume. Tree pits were redesigned to have removable panels for future maintenance, and if needed, tree replacement. The irrigation system included moisture sensors to detect problems in tree watering.

COLLABORATION WITH DEPARTMENT OF CITY PLANNING

Worldwide Plaza set a new standard for collaboration with the Department of City Planning. The property owner's relationship with the agency had become adversarial due to heavy fines imposed for violations. The landscape architects met regularly with the agency to discuss aesthetic and functional modifications to the plaza that retained the public amenities of the original plaza permit of 1989, yet were adapted to site conditions and other changes to use patterns. The landscape architects demonstrated weaknesses of the original design in terms of seating, fountain overspray, and plant selection. A number of aspects of the original design were modified to make the plaza more inviting to the public, while preserving the same number seats and trees, and offering the same accessible square footage.

COMMUNITY PARTICIPATION

Over the years as the plaza deteriorated, local stakeholders found the plaza to be more of a liability than an asset. At initial meetings, community participants viewed the redesign as a land grab for more privately operated concession space and not a true restoration of the original amenities. Gradually, with the support of the Department of City Planning and the property owner, the landscape architects were able to demonstrate that the physical and aesthetic modifications would enhance both the usage and ongoing maintenance of the plaza. In the end, the project received unanimous approval from the community board.

LESSONS LEARNED

CAREFUL DESIGN OF BELOW GRADE ROOT ZONE IS CRITICAL

To ensure ongoing health and successful maintenance of trees, the designer must work collaboratively with the structural and waterproofing engineers to undertake proper measures from the outset. It is essential to evaluate both the structural limitations and the required soil volume for trees in order to arrive at a satisfactory solution.

VIGILANT CONSTRUCTION OVERSIGHT IS CRITICAL TO SUCCESSFUL BELOW GRADE SYSTEMS

Much of the effort spent during the design phases to promote design excellence can be lost if the project is not implemented correctly. This is particularly true in below grade construction where faulty workmanship or materials can be installed and quickly covered up before proper inspection and testing.

DEVELOPING STRONG PARTNERSHIPS IS ESSENTIAL TO REALIZING THE DESIGN

Landscape architects are often in a precarious position as their work is built towards the end of a project when construction financing and patience have begun to wear thin. Having the strong backing of city agencies and engaged civic organizations helps ensure that a project will be realized and maintained as designed. This will help to dissuade owners from value engineering site components out of a project.

FOR MORE INFORMATION

Mathews Nielsen Landscape Architects
120 Broadway, Suite 1040
New York, NY 10271
snielsen@mnlandscape.com
www.mnlandscape.com

STREETSCAPES

QUEENS PLAZA

This project intends to transform the tangle of urban infrastructure cutting through Long Island City from a harsh, disorienting industrial maze into a lush, navigable landscape. The design team reconceived the gateway landscape to Long Island City for the NYC Department of City Planning and NYC Economic Development Corporation's Queens Plaza Bicycle and Pedestrian Landscape Improvement Project. The design reconnects the surrounding neighborhoods and restores the connection between the city and the river, a one mile stretch from JFK Park to the river's edge below the Queensboro Bridge.

LOCATION: Long Island City, New York
DESIGNERS: Wallace Roberts & Todd, Margie Ruddick, Marpillero Pollack Architects, Michael Singer and Leni Schwendinger Light Projects, Langan Engineers and Environmental Services
CLIENT: New York City Economic Development Corporation
COMPLETED: ongoing; anticipated 2011

PROJECT SIGNIFICANCE

The project addresses an urban condition common in New York and around the world: the intersection of multiple infrastructure systems that create a forbidding and sometimes hazardous environment for people. At Queens Plaza, the infrastructure elements are the Queensboro Bridge, elevated subway lines (for the N, W, and 7 trains), an elevated subway station, and heavy traffic and parking below. The designers sought to integrate these systems with art and ecology, transforming what was residual or leftover space into public space that people will want to occupy and maneuver through, and a place that performs ecological functions. At the same time, the designers' interventions use lighting, custom paving patterns, and contemporary materials to reveal the essence of the existing structure and to heighten visitors' perceptions of the space.

DESIGN FEATURES

- The structure of the elevated train track, currently appearing as a tangle of steel, will be transformed by Marpillero Pollak Architects into a lantern-like series of sculptural spaces suspended above the flow of people and traffic.
- A system of permeable pavers, designed by artist Michael Singer, will manage and filter stormwater through plantings, and serve as hard walking surfaces.
- A broad swath of ironwood trees will arc along the elevated train track at JFK Park, enfolding the refuge-like park landscape.
- A river of understory trees will meander within the park, then along the medians to the river.
- All site stormwater will filter through subsurface wetlands and median plantings, challenging the conventional notion of an urban park and streetscape as hardscape.

This rendering depicts the planned open space, plantings, water management and highlighted infrastructure that will transform Queens Plaza.

LESSONS LEARNED

Interagency coordination will need to evolve to achieve truly sustainable design

Thanks to the involvement of the Mayor's office, a good measure of coordination was achieved between agencies (DCP, EDC, DOT, MTA, and DEP). Nevertheless, there are still some areas where the design had to be scaled back, such as the stormwater management system, because the agencies involved were not prepared to maintain certain structures.

ADMINISTRATIVE CHALLENGES TO INNOVATION IN STORMWATER MANAGEMENT MUST BE OVERCOME

The project attempted to filter street runoff in more sustainable and innovative ways (using hydrodynamic separators, detention tanks, permeable pavement, rain gardens, etc.), which each agency was supportive of throughout the design process. However, when the question of maintenance arose, no agency was willing to take on maintaining the stormwater filtration system.

AGENCIES MAY RESIST MAINTENANCE OF UNCONVENTIONAL TREE SPECIES OR LIGHTING FIXTURES

Parks would only accept and maintain certain tree species in the project. As far as lighting is concerned, only DOT standard fixtures were allowed and no new types of lighting fixtures could be used.

FOR MORE INFORMATION

WRT / Wallace Roberts & Todd, LLC
247 W. 35th Street, 11th Floor, New York, NY 10001
www.wrtdesign.com

PLANTING OVER STRUCTURES

FIVE BOROUGH GREEN ROOFS

On the roof of a nondescript building on Randall's Island, the NYC Department of Parks and Recreation has launched an ambitious pilot program for sustainability. Parks' Technical Services Division has installed 16 different green roof systems at the Five Borough Administrative building on Randall's Island, totaling over 15,000 square feet. The green roof systems vary in planting material, soil composition, weight, and cost, and will be regularly maintained and monitored to determine their suitability for various applications in New York City.

LOCATION: Randall's Island, NYC
SIZE: approximately 15,000 sf
DESIGNERS: NYC Department of Parks and Recreation
CLIENT: City of New York

PROJECT SIGNIFICANCE

The Five Borough green roof systems provide many economic and ecological benefits while offering additional green space for passive recreation. These benefits include reducing stormwater runoff, mitigating the urban heat island effect, conserving energy, reducing air pollutants, creating wildlife habitats, and extending the service life of the existing roofs.

This project is Parks' first attempt to install green roofs, so a key objective is to experiment with and compare several, distinct, small scale systems, rather than install one large green roof system. With each system differing from the next in growing medium, plant selection, and/or installation model, the Five Borough green roof serves as an experimental station where lessons learned can be applied to future installations around the city. Technical Services has been involved in all stages of development, including planning, design, selection and procurement of materials, actual installation, and post monitoring of the systems.

With 11 traditional and five nontraditional green roofs and one green wall system completed to date, the Five Borough rooftop has become one of the few in the nation where so many different types of systems can be viewed and studied. As a result, it has attracted many groups of people within the Parks Department, other municipalities in and outside New York, universities and high schools, as well as professionals and researchers involved in sustainability and green roofs. Based on the success of the Five Borough building, Parks plans to implement green roofs on 10 recreation centers throughout the city in the near future.

According to Green Roofs for Healthy Cities, in summer, depending on the plants and depth of medium, 70-90% of the precipitation that falls is retained on the green roofs. Between the months of May and October, New York City receives on average of 24.1 inches of rainfall. If Five Borough's green roof can retain 70-90% of this rain, it will be capable of absorbing about 64,000 to 84,000 gallons of stormwater between May and October.

DESIGN FEATURES

EXPERIMENTATION WITH MODULAR PLANTING SYSTEMS

- One modular system used, known as Green Paks, consists of 195 woven polyethylene bags prefilled with a mineral based growing medium that consists largely of heat treated shale. The bags were placed side by side atop a rolled out root barrier and drainage mat layer. Then slits were cut into the black knit surface and sedum plugs were inserted into the growing medium.
- Another modular system is made up of 400 aluminum trays that cover 1,600 square feet of rooftop with plants. It offers flexibility in that each 2' x 2' tray can be removed, if necessary, to provide access to the roof below.
- Another installed system at Five Borough is made from 100 biodegradable planting trays that will soon decay, contributing organic material to the growing medium, and ultimately providing a monolithic system.
- Another system, known as Xero-flor, is an ultra-extensive system that is unique because of itslight weight and shallow depth (3.5 inches). Unlike all the other systems placed on the roof, Xero-flor is pregrown in a field and harvested in a similar fashion to grass sod.

USE OF A GREEN ROOF MONITORING SYSTEM

Technical Services is in the process of installing a green roof monitoring system that will quantify and measure several environmental factors that are related to green roofs. This data will be made available in an online database, and will enable clear comparisons between the varied green roof systems at Five Boroughs and future projects.

LESSONS LEARNED

CONDUCTING RESEARCH, DESIGN AND CONSTRUCTION IN-HOUSE HAS MANY ADVANTAGES

Technical Services Division staff took on all tasks from designing each green roof system, to ordering all materials, to construction (including hauling equipment up flights of stairs to the roof). Throughout this process, in-house staff developed a comprehensive understanding of green roof systems and details, and can now assess the benefits and drawbacks of each system. The in-house process also enabled quick and relatively inexpensive completion of the project.

ONE SIZE DOES NOT FIT ALL

Depending on the goals and constraints of a given green roof project (e.g., cost, stormwater retention, aesthetics), some systems may be more appropriate than others. With 16 various green systems atop the roof, side by side, Technical Services staff have noted the advantages and disadvantages of the components in each system. Certain observations have included how the growing medium affects the growth of the plants, how

Most recently, the Five-Borough green roof has expanded to adjacent rooftops and incorporated more vegetables such as tomatoes and peppers.

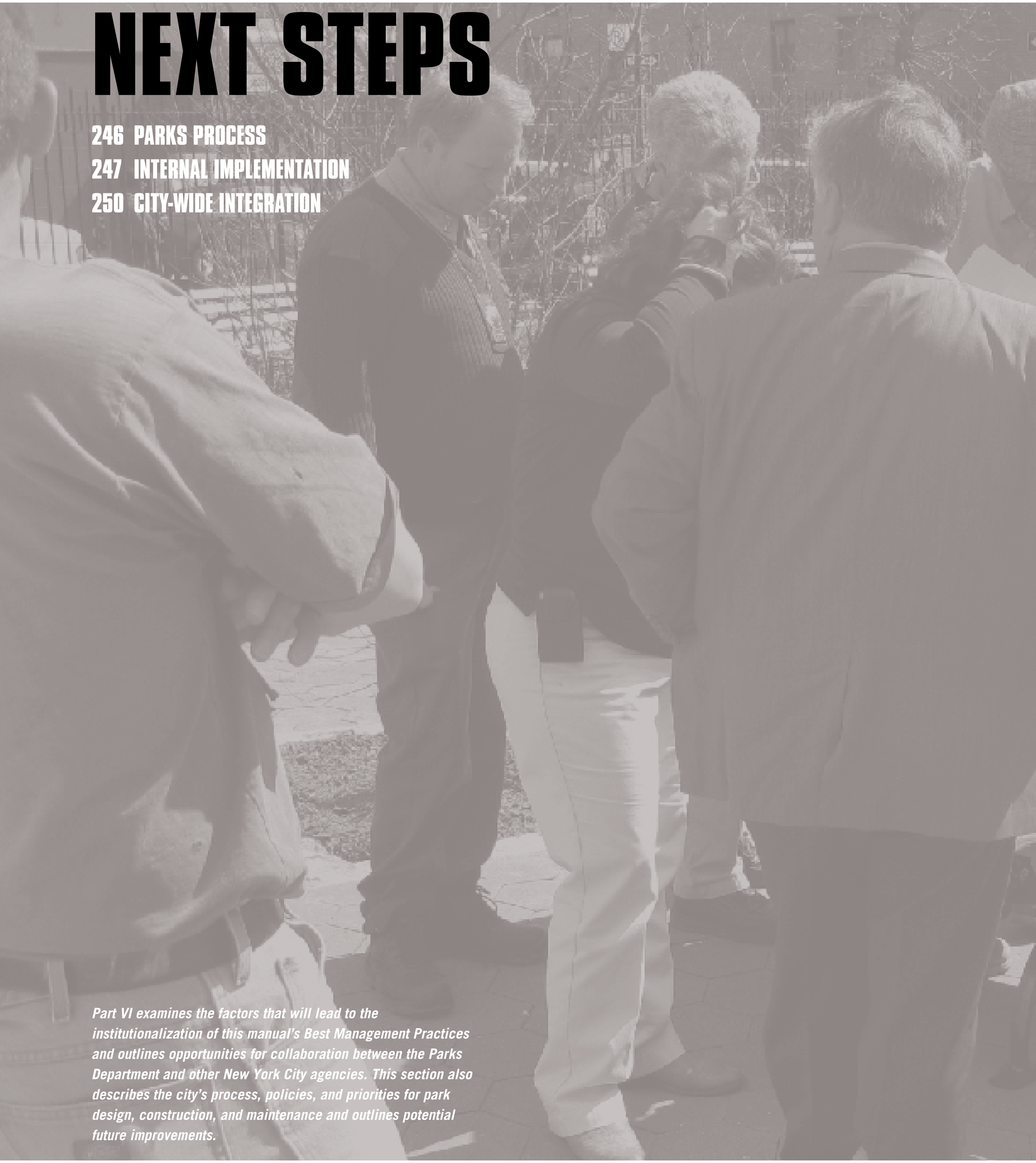
well the plant's weight is supported, how much water is being retained, along with how much maintenance is required for each systems.

FOR MORE INFORMATION

NYC Department of Parks and Recreation
Artie Rollins, Five Borough Chief of Technical Services
http://www.nycgovparks.org/sub_about/go_greener/green_roofs.html

NYC Department of Parks and Recreation
John Robilotti, Senior Project Manager
http://www.nycgovparks.org/sub_about/go_greener/green_roofs.html

PART VI: NEXT STEPS



Part VI examines the factors that will lead to the institutionalization of this manual's Best Management Practices and outlines opportunities for collaboration between the Parks Department and other New York City agencies. This section also describes the city's process, policies, and priorities for park design, construction, and maintenance and outlines potential future improvements.

PARKS PROCESS

The success of any park design is contingent on more than the work of the designer. Many people influence the outcome and success of a design, including the contractor who builds it, the operational staff who nurture and maintain it, and the people who ultimately will use it. The design process should be a logical sequence of decisions based on mutually accepted criteria and goals among all of these stakeholders and many others as well.

This section recommends changes to key elements in the Parks Department's internal process for creating new parks. These changes may take time to establish, but they will lead to shorter design times, more client satisfaction, and fewer change orders.

PRESCOPING

Prescoping is critical to the timely and successful completion of the project and should be the first step of the process. Prescoping includes identifying project goals and critical site issues,as well as aligning the scope with the carrying capacity of the site, the construction budget, and the future operating budget. It is critical to adjust the scope and size to the construction budget at the beginning of the project to avoid later redesign to meet cost requirements.

SHARED PROJECT GOALS

At the beginning of the design process, the Parks Department's staff, including Planning, Capital Design, Construction, and Operations divisions, should evaluate designs based on shared criteria, rather than on separately held and often contradictory convictions.

PROJECT REVIEW

Project reviews should bring together all evaluators into meetings at the same time. The linear sequence of reviews creates conflict between divisions when every evaluator's criteria are not considered simultaneously.

CONSTRUCTABILITY AND QUANTITY REVIEW

It is critical for the construction and specification staff to review the drawings and specifications in order to confirm that the project can be built as designed and that there is proper coordination between the drawings and the specifications. In particular, staff should confirm that materials quantities are properly estimated.

POSTCONSTRUCTION EVALUATION, CORRECTION, AND FEEDBACK

Projects should be evaluated soon after construction and periodically thereafter until it can be assured that they were constructed properly and are operating according to project goals. This will require site visits by the designer, who will need to stay engaged until problems are resolved. Reviews from other Parks Department experts, such as staff from the departments of Natural Resources, Forestry and Five-Borough Shops, would also be helpful.

Evaluation and feedback is crucial as the Parks Department experiments with new techniques and materials and coordinates with maintenance staff. Each analysis should include how and why a design element succeeded or failed. Feedback allows the agency to learn what works and what doesn't, allowing for continued improvement and tracking to refine efforts in the future.

During the evaluation and correction process, all parties involved need to have complete information about problems discovered and corrective actions taken, who is responsible, and what are the specified time frames. In addition the designs and specifications of other projects in design will need to be altered so problems are not repeated. This continual feedback and analysis of how the Parks Department builds parks will lead to constantly improving park design.

INTERNAL IMPLEMENTATION

A critical part of implementing high performance landscapes is to establish clear steps for implementation so that everyone in the Parks Department knows how to proceed. Everyone, including consultants, needs to join the effort.

New initiatives need to be monitored and evaluated before they are adopted as standards. When the Parks Department tries new materials and equipment, or implements the Best Management Practices contained in this manual, it's crucial to: test them, track their locations, evaluate their performance systematically, and correct problems quickly. The Parks Department should communicate lessons learned to project teams; new processes should be incorporated in this manual for easy reference. These responsibilities need to be vested with a single entity; research, testing and evaluation, all need to be rigorous and consistent.

It is important for design, construction, and operations to develop a set of shared goals and objectives. Frequent discussion by managers, designers, and construction and operations staff about goals, objectives, and progress will begin to foster the cooperation needed to implement the paradigm shift envisioned by these guidelines.

Below is a list of the efforts that will be needed to institutionalize the Best Management Practices described in this manual and to lead to continuous innovation.

IMPLEMENTING THE GUIDELINES

EMPOWER AN OFFICE OF INNOVATION

VEST THE RESPONSIBILITY FOR RESEARCH, TESTING, TRACKING, EVALUATION, COMMUNICATION, AND ADOPTION WITH A SINGLE OFFICE

The lead responsibility for research, testing, tracking, evaluation, communication, and adoption needs to be vested with a specific office or staff person. For instance, the New York City Department of Design & Construction (DDC) has an Office of Sustainable Design that performs these functions for that agency. For the Parks Department, these responsibilities should be incorporated into the Specifications Office. The Specifications Office acts as the gatekeeper to determine what materials and methods are incorporated into construction documents and standard specifications. A new office or position would keep abreast of innovative design in the profession and assure that these guidelines become a living document, complete with updates.

SUPPORT RESEARCH AND TESTING

RESEARCH NEW MATERIALS, EQUIPMENT, AND CONSTRUCTION TECHNIQUES, EVALUATE THEIR PERFORMANCE, AND DEVELOP SPECIFICATIONS

Emerging concern for sustainability and global warming, as well as operational and design problems, necessitate new materials, equipment, and methods. Requests to solve operational and design problems can be generated by designers, field personnel, or the supervisors of mechanics, either informally or formally. Every request for improvement should be formally investigated and discussed with the requestor. If a new element has promise, it should be included in a pilot project.

EMPLOY PILOT PROJECTS

DEVELOP A PILOT PROJECT PROCESS TO TEST NEW APPROACHES, MATERIALS, AND DESIGN PROCESSES

Pilot projects can encompass a whole project, a portion of a project (such as a new material), or a discrete system such as a rain garden or greywater capture from a spray shower. Pilot projects can be used to develop details, specifications, calculation worksheets, or other forms that may become agency standards.

The specific design objectives of a pilot project should be established at the predesign stage and subsequently evaluated, first for feasibility and then after construction, to identify goals met and/or implementation difficulties, and then periodically to document success (or failure). The goals of pilot projects should be made clear to construction, maintenance, and inspection staff, as well as to contractors who are implementing or servicing designs. The objectives must be measurable in order to learn from successes.

Further, locations for pilot projects should be selected strategically, with a priority on sites where there is interest from stakeholders and the Operations division of the Parks Department. Pilot sites should also have sufficient schedule and budget flexibility to accommodate thorough evaluation.

Pilot projects should be well documented, and the results — both good and bad — should be recorded and circulated so that learning is shared. As pilot projects advance specific high performance goals on a project by project basis, the Parks Department can begin to formulate more broadbased project goals and metrics for similar project types that have been demonstrated as possible by the successes of pilot projects.

TRACK AND EVALUATE PROGRESS

THE SUCCESS OF THIS DOCUMENT DEPENDS ON THE SYSTEMATIC TESTING, EVALUATION, AND UPDATING OF ITS RECOMMENDATIONS

The use of new materials, methods, and equipment must be tracked at multiple points in time: during construction, upon completion of construction, after a brief period of operation, and then before the guarantee period is up (typically, one year later). Designers should participate in this evaluation. There should also be annual assessments of landscape conditions and ecological features to determine if techniques were successful and to fine tune design and management practices.

STREAMLINE PROBLEM CORRECTION

IF A PROBLEM IS DISCOVERED, IT SHOULD BE CORRECTED QUICKLY

Designers should participate in problem solving and communicate with operations personnel until a given problem is resolved. Any changes should be documented and communicated internally.

UPDATE STANDARDS

UPDATE DESIGN PROCESS, STANDARD DETAILS, AND SPECIFICATIONS AS NEW DESIGN APPROACHES AND MATERIALS ARE PROVEN SUCCESSFUL

As new projects are completed, the Parks Department can incorporate different materials and methods into its standards. For example, more comprehensive tree protection is a practice called for within the guidelines that has already been adopted. In some cases, innovations will replace old standards, while other new approaches and materials will exist as alternatives for designers to use when appropriate.

FACILITATE BETTER COMMUNICATION

FREQUENT DISCUSSION BY MANAGERS, DESIGNERS, AND CONSTRUCTION AND OPERATIONS STAFF ABOUT PROGRESS, PROBLEMS, AND SOLUTIONS WILL HELP TO IMPLEMENT THE GUIDELINES

Operations personnel need to share their concerns about current designs and their observations about new projects in a risk free environment. Designers need a forum for sharing information with other designers about what they have learned about new elements, in design, construction, and operation.

The Parks Department should also assemble a collection of in-house case studies, complete with specifications and drawings. By promoting discussion among designers, this collection could foster collaboration.

The agency's Specifications Office should act as the clearinghouse for this information, as well as the implementer of change and the recorder of new methods. The office could communicate via email blasts, bulletins, training programs, and updated versions of this manual, standard details, and other specifications.

PUBLISH AND UPDATE THESE GUIDELINES

UPDATE THESE GUIDELINES AS EXPERIENCE AND KNOWLEDGE IS GAINED

A variety of options for updating exist, largely dependent on the time and the availability of staff for the task. Ideally, the print document will be transformed into an online resource, easily permitting changes and updates. The cross referencing used in the document lends itself to an online format. Other approaches for updating the document include printed supplements.

ESTABLISH METRICS

ESTABLISH METRICS THAT QUANTIFY PROGRESS IN IMPLEMENTING THE GOALS OF *PLANYC*

Initiatives and achievements to be measured should include extended bike routes, habitat expansion, wetland expansions, tree plantings, rain garden areas, reduction in paved surfaces, and the introduction of porous pavement.

PROVIDE WORKSHOPS AND TRAINING

DEVELOP AN ORIENTATION TO THE HIGH PERFORMANCE LANDSCAPE METHODOLOGY AND SET CRITERIA FOR EVERY PROJECT'S IMPLEMENTATION

It would be very useful to develop a workshop that orients designers to these guidelines and outlines a process for implementation. This workshop could also introduce minimum implementation standards, such as integrated analysis of the soil, water, and vegetation, and standards for stormwater infiltration and recycled product use.

PUBLISH GUIDELINES ONLINE

THE MANUAL SHOULD BE EASILY AVAILABLE FOR REFERENCE AND FEEDBACK

The manual should be available on the Parks Department's website, as well as on the NYC government internal intranet. It should be searchable by key word, and there should be a feedback loop for comments on the guidelines and observations about the constructability and functionality of recommendations and guidance.

CONSIDERATIONS

DEVELOPING SHARED GOALS

IT IS IMPORTANT FOR DESIGN, CONSTRUCTION, AND OPERATIONS TO DEVELOP A SET OF SHARED GOALS AND OBJECTIVES

The Parks Department should resolve conflicts between the goals of different Parks divisions. For instance, the Five Borough Shops and Maintenance divisions should be consulted during the design phase, as they will become the stewards of parks once a design project is complete. Borough Commissioners should be included as well, since they have a detailed understanding of community and operational difficulties. This collaboration can lead to a better understanding of problems and solutions.

PARKS INSPECTION PROGRAM

REVISE INSPECTION CRITERIA TO ACCEPT THE CHANGES REQUIRED BY BEST MANAGEMENT PRACTICES, SUCH AS RAIN GARDENS, VINE-COVERED STRUCTURES, AND MEADOWS

The Parks inspection program (PIP) has proven to be one of the most effective management tools employed by the Parks Department. It was established to monitor and evaluate the conditions of parks, as experienced by the public. Parks are inspected at random according to a detailed list of criteria. The three categories of evaluation are cleanliness, landscape, and structures. There are factors within each group, some weighted more strongly than others. The PIP has provided the Parks Department with a thorough assessment tool for the quality of parks and park maintenance. The factors that are evaluated have become points of focus for Maintenance and Operations and can drive allocations of staff and funds to meet the standards of the inspection process.

Some of the best practices described in this manual will require changes in how parks are maintained. For instance, a rain garden designed to slow and hold water over a 48 hour period may appear to be a flooded area that does not require routine maintenance. A meadow could be construed as unmown lawn.

To avoid these misunderstandings, Parks Department designers and maintenance staff will need to work with the PIP division to keep abreast of new types of landscapes and their maintenance schedules. This will eliminate potential conflicts between sustainable park designs and park rating criteria. Ideally, areas of sustainable landscape would have detailed criteria that rated appearance in an appropriate manner, and operations personnel would be trained in recognizing that standard.

COLLABORATION BETWEEN DIVISIONS

WORK ACROSS AGENCIES TO DEVELOP CREATIVE AND PRACTICAL SOLUTIONS TO PROBLEMS

Sharing experiences and working together will expedite problem solving as well as the distribution of knowledge. Specialized divisions — such as Planning, Natural Resources Group, Forestry, including Horticulture, Street Trees, and Greenstreets — should be included in problem solving.

TRAINING OF OPERATIONS PERSONNEL

EVERY EFFORT SHOULD BE MADE TO ENSURE THAT PERSONNEL KNOW HOW TO MAINTAIN NEW FEATURES, THAT THEY HAVE MANUALS AND SPARE PARTS, AND THAT THEY ARE INVESTED IN SUCCESS

It is difficult to hire and train specialized maintenance staff, and this workforce is often stretched over large areas. The Parks Department must treat the labor of park workers as a resource to be conserved and give utmost regard to their concerns.

Many of the day to day workers in parks do not stay at a particular park long enough to learn about unique features or maintenance needs. Protocol for material care, equipment operations, and planting maintenance should be simplified and thoroughly documented so there will be a clear record of the requirements. Maintenance plans, with operational costs, should be developed for each project.

NEED FOR SPECIALISTS

HIRE SPECIALISTS AND SERVICE PROVIDERS TO HELP PERFORM TESTING AND TO UNDERSTAND COMPLEX ISSUES SUCH AS BROWNFIELDS AND REMEDIATION

Specialists will greatly assist the agency in achieving goals within complicated urban sites with histories of demolition, dumping, or industrial use. Some services, such as soil remediation and tree preservation, can be provided by in-house staff or by other agencies and partner groups, such as the Central Park Conservancy. However, areas that could benefit from outside assistance include the following:

- Soil testing and soil design
- Borings and percolation testing
- Soil contamination testing and remediation
- Marine engineering for waterfront design and restoration
- Energy modeling
- Maintenance planning
- Alternative stormwater design, modeling, and permitting
- Greenroof design and maintenance
- Plant material sourcing and propagation
- Construction planning and management
- Materials lifecycle analysis and evaluation

Subconsultant specialists have already been used on a number of consultant projects with great success. These services should be readily available to in-house designers so they design solutions can be better calibrated to the specific needs of a site.

CITYWIDE INTEGRATION

This document sets forth specific actions that implement the goals and recommendations of *PlaNYC*, as well as several other initiatives. Some of this manual's recommendations will require close coordination with other agencies, and some best practices (BPs) will require a reevaluation and assessment of current regulations, as the city's Green Codes Taskforce has begun to do. For these guidelines to succeed, the Parks Department will need to work with sister agencies and the Mayor's Office of Long Term Planning & Sustainability (MOLTPS) to establish common goals and to revise current regulations.

Compliance with citywide policy initiatives will also affect maintenance requirements for the Parks Department and other agencies. Many of these mandates will require changes in expense budget purchases of supplies, services, and equipment. The Parks Department and other agencies will need to identify associated costs and justify new requests for funding.

In addition, to implement new regulatory, operational, and maintenance programs, the Parks Department will need to explain its high performance goals and actions. Residents, approval bodies, elected officials, developers, advocacy groups, and all of the other stakeholders who are invested in how city infrastructure and resources are allocated, designed, and maintained should be treated as partners in the Parks Department's efforts.

As part of the necessary effort to integrate Parks Department functions with other agencies and stakeholders, this section describes relevant city policies, examples of how the Parks Department has responded, and provides examples of problems of implementation.

RELEVANT CITYWIDE POLICIES

PLANYC

Mayor Bloomberg's *PlaNYC* charged every city agency with specific goals to steer the city towards greater environmental responsibility and to improve New York City's urban environment and quality of life over the next 25 years. This manual is a direct response to the goals of *PlaNYC*, and the Parks Department will play a critical role in accomplishing them.

Among many environmental, social, and economic initiatives, *PlaNYC* calls for the improvement of underdeveloped park sites in all five boroughs. The plan articulates significant and broad goals for the development of the city's parks and general landscape, including a target of reducing carbon emissions by over 30 percent, the expansion of park access for all New Yorkers, the need for better stormwater management throughout the city, and improvement of air and water quality. In response to these goals, the Parks Department has established a number of programs, including the Million Trees Initiative, Schoolyards to Playgrounds, and construction of new regional parks.

The Mayor's Office of Long Term Planning & Sustainability was established to further the goals of *PlaNYC*. The release of such plans as the *Sustainable Stormwater Management Plan* and *New York City Wetlands: Regulatory Gaps and Other Threats* are examples of detailed policy inspired by *PlaNYC* that will continue to influence the goals and approaches within the Parks Department and New York City as a whole. This process is continuous and will yield more advanced and influential policies and analysis in the future.

GREEN CODES TASK FORCE

The Green Codes Task Force was established in July 2008 by Mayor Bloomberg and City Council Speaker Quinn. The task force is charged with encouraging green building and removing policy and code barriers to green design. Divided into groups focused on a range of topics, the task force is a partnership of accomplished experts from the public and private sectors. Topics include climate adaptation, construction practices, energy and ventilation, homes, lighting and daylighting, materials and VOCs, site and site stormwater runoff, and water efficiency and building stormwater.

Since its inception, the task force has been involved in examining construction codes and proposing changes and additions to facilitate green building within New York City. A report of their proposals and guidance was released on February 1, 2010. Changes stemming from this document should be significant and far-reaching within the Parks Department over the coming years.

ENVIRONMENTALLY PREFERRED PURCHASING

The Parks Department is a large consumer of concrete, asphalt, soil, mulch, compost, recycled aggregates, low sulfur fuel, and low VOC building materials, such as paint. Many of these items are required by other agencies, such as the New York City Departments of Design & Construction (DDC) and Transportation (DOT), for new construction and ongoing maintenance.

The City should harness the enormous purchasing power of capital projects and maintenance needs to encourage the marketplace to provide more environmentally sustainable and locally produced materials and products. The development of uniform material standards and sustainability goals would create an alignment of materials needs that would allow for economies of scale. The Parks Department needs to work with New York City Office of Management & Budget (OMB), DOT, DDC, and other agencies to develop a process for coordinated requirements and purchasing.

POTENTIAL OPPORTUNITIES FOR COLLABORATION

ENCOURAGING ACTIVITY

DEPARTMENT OF HEALTH & MENTAL HYGIENE

The Parks Department's agenda should be melded with the health agenda for more traction. The NYCDOH is promoting physical activity to counteract obesity, and the Parks Department can play an important part in that effort. See New York City Active Design Guidelines: Promoting Physical Activity and Health in Design, which was released in 2010.

For example, parks should provide drinking fountains to offset the consumption of sugary drinks.

IMPROVING LIGHTING

DEPARTMENT OF TRANSPORTATION

Currently, the Parks Department has an agreement with the Department of Transportation for maintenance of lighting features within parks. However, there are limitations, based on DOT standards. This requirement, while efficient, limits innovation in lighting. The Parks Department should partner with the DOT to determine how to move forward with new lighting fixtures that use less energy and reduce or prevent light pollution while modernizing the palette of materials. In remote areas where wiring for lighting is cost prohibitive, new types of lighting using solar and wind energy should be considered. Pilot projects with the DOT on these types of lights can be informative and helpful for both agencies.

ADOPTING STORMWATER CREDITS AND PERMITTING

DEPARTMENT OF ENVIRONMENTAL PROTECTION

The New York City Department of Environmental Protection (DEP) is currently changing the sewer codes for new development within the city to adopt performance standards that will advance the Mayor's Sustainable Stormwater Management Plan of 2008. The Parks Department should encourage stormwater management systems that reduce constituents of concern and suspended solids from stormwater runoff in new developments.

Currently many alternative stormwater management techniques are not recognized or factored into stormwater evaluations prepared by DEP. These include green roofs for detention and water quality, rain gardens, infiltration basins, and wetland detention and treatment facilities, even though the U.S. Environmental Protection Agency has instituted a number of programs aimed at promoting these technologies and design strategies. In addition, DEP will not maintain alternative drainage structures such as swales and inline stormwater cleaning mechanisms.

RECYCLING AND REUSING GREYWATER AND BLACK WATER

DEPARTMENT OF HEALTH & MENTAL HYGIENE

Currently the DOH has a number of restrictions on grey water use, and prohibits black water use. There are a number of alternative solutions that are widely used across the country and that would be applicable to the Parks Department. In particular, use of drinking fountain water, fountain water, and spray play area water could be valuable for planting irrigation and groundwater recharge.

EXPANDING GREENSTREETS

DEPARTMENT OF TRANSPORTATION AND DEPARTMENT OF ENVIRONMENTAL PROTECTION

The Parks Department should continue collaboration with DOT and DEP to refine Greenstreets guidelines and opportunities for alternative stormwater management, street greening (including trees and other types of plantings), bikeways, and sidewalk narrowing and other pedestrian improvements. Further funding sources for both capital improvements and maintenance should be identified.

RECYCLING IN PARKS

DEPARTMENT OF SANITATION

New York City is encouraging recycling in public facilities. Recycling bins for bottles and paper are provided in hightraffic parks, in subways, and at facilities or venues where events take place. However, much more can be done.[53]

Parks can contribute to increasing recycling. Active recreation facilities that have a higher usage, such as those that accommodate substantial intramural and league play or that have large numbers of fields, could be prioritized due to the greater recyclable waste generated. If coordinated properly, recycling programs for small scale items such as cell phone batteries, where collectors are compensated by recycling companies, might provide a small revenue stream for smaller parks and community gardening groups. The success of this initiative hinges on working with the Department of Sanitation to facilitate pick up and coordination.

SUPPORT COMPOSTING

DEPARTMENT OF ENVIRONMENTAL PROTECTION, DEPARTMENT OF SANITATION, AND NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL COORDINATION

Parks are a natural location for composting. The Parks Department should encourage composting at parks and community gardens throughout the city and provide support through education and cooperative distribution of compost. Already, local groups have compost drop off stations, such as the Lower East Side Ecology Center at Union Square.

The development of compost use can include commercial food byproducts from restaurants, breweries, produce markets, and green markets, as well as locally collected yard waste. There may be opportunities to work with New York City Department of Sanitation (DSNY) to develop collection points and composting facilities for use within city parks, highways, or other facilities or for redistribution back to the public. There may also be opportunities for the development of a commercially viable facility that generates compost for sale to private contractors and other local municipalities, similar to the development of the Town of Islip composting facility.

53 **"According to the American Plastics Council, only 50% of #1 and #2 plastics were recovered for recycling in 2001 because a large percentage of plastic bottles are consumed at public venues where recycling is unavailable." (See http://www.recycleworks.org/business/event_planning.html.)**

RELEVANT NEW YORK CITY POLICIES AND GUIDELINES

There are a number of city guidelines that can be used by Parks Department designers to inform their approach. While some of these guidelines do not directly regulate the Parks Department, the thorough approach and research that has gone into these documents provides a great deal of useful of information.

High Performance Building Guidelines (DDC & Design Trust for Public Space) — 1999
Construction and Demolition Waste Manual (DDC) — 2003
High Performance Infrastructure Guidelines (DDC & Design Trust for Public Space) — 2005
Mitigating NYC's Heat Island with Urban Forestry, Living Roofs & Light Surfaces (NYSERDA) — 2006
***PlaNYC* (Mayor's Office) — 2007**
Cool and Green Roofing Manual (DDC) — 2007
Jamaica Bay Watershed Protection Plan (DEP) — 2007
Sustainable Urban Site Design Manual (DDC) — 2008
Sustainable Streets: DOT Strategic Plan for 2008 & Beyond (DOT) - 2008
Sustainable Stormwater Management Plan (Mayor's Office) — 2008
Climate Change Program Assessment and Action Plan (DEP) — 2008
New York City Wetlands: Regulatory Gaps and Other Threats (Mayor's Office) — 2009
Street Design Manual (DOT) — 2009
Sustainable Urban Site Design Manual (DDC) — 2009
Active Design Guidelines (DOHMH & DDC) — 2010

A team of designers, maintenance staff, and contractors review plans on site. Collaboration between these groups and other agencies can create sustainable and functional parks, such as Printers Park shown here.

GLOSSARY

Alleopathic: Plants that inhibit the growth of other plants chemically through their roots or through shedding leaves that transfer chemicals to the soil that stop other plants from growing. These biochemicals are known as allelochemicals and can have beneficial (positive allelopathy) or detrimental (negative allelopathy) effects on the target organisms.

Albedo: The ratio of reflected light to the total amount falling on a surface. A high albedo indicates high reflectance properties.

Allee: A walkway lined with trees or tall shrubs.

Berm: A constructed, vegetated or paved embankment used for enclosure, separation or protective purposes.

Best Practice (BP): A technique, method, or process that is most effective at delivering a particular outcome. The idea is that with proper processes, checks, and testing, a desired outcome can be delivered with fewer problems and unforeseen complications. Best practices can also be defined as the most efficient and effective way of accomplishing a task, based on repeatable procedures that can be proven over time.

Best Management Practice (BMP): *(See Best Practice.)*

Biodiversity: The tendency in ecosystems, when undisturbed, to have a large number and wide range of species of animals, plants, fungi, and microorganisms. Human population pressure and resource consumption tend to reduce biodiversity.

Biofiltration: A pollution control technique using living material to capture and biologically degrade process pollutants. Common uses include capturing harmful chemicals or silt from surface runoff. Examples of biofiltration include Bioswales, Constructed Wetlands and Natural Wetlands.

Bioremediation: A biotechnology that uses biological processes such as bacteria or plants to overcome environmental problems by removing or neutralizing contaminants or pollutants.

Bioretention Areas: Landscaping features adapted to treat stormwater runoff on the development site. Surface runoff is directed into shallow, landscaped depressions that are designed to incorporate many of the pollutant removal mechanisms that operate in forested ecosystems. During storms, runoff ponds above soil in the system. Runoff from larger storms is generally diverted past the facility to the storm drain system. The remaining runoff filters through the prepared soil mix.

Bioswale: A strategically placed earthen depression that captures stormwater and filters it using native wetland plants.

Bluebelt: A program initiated by New York City's Department of Environmental Protection and one of the Northeast's most ambitious stormwater management efforts. The bluebelt uses a series of carefully placed BMPs at the storm sewer/wetland interface to reduce flooding and improve water quality. BMPs used in the bluebelt include stormwater wetlands, stream restoration, outlet stilling basins, and sand filters.

Blue roof: A roof design that is explicitly intended to store water, typically rainfall. Blue roofs can provide a number of benefits depending on design, including temporary storage of rainfall to mitigate runoff impacts, storage for reuse such as irrigation or cooling water makeup, or recreational opportunities. Blue roofs can include open water surfaces, storage within or beneath a porous media or modular surface, or below a raised decking surface or cover.

Brownfields: Abandoned, idled, or under-used industrial and commercial facilities/sites where expansion or redevelopment is complicated by real or perceived environmental contamination.

Buffer: A strip of heavily vegetated land that absorbs and filters runoff water.

Carbon dioxide (CO_2): A naturally occurring greenhouse gas in the atmosphere, concentrations of which have increased (from 280 parts per million in pre-industrial times to over 350 parts per million today) as a result of humans' burning of coal, oil, natural gas and organic matter (e.g., wood and crop wastes).

Cistern: An artificial reservoir (such as an underground tank) for storing water (such as rainwater). Cisterns can be either above or below ground, and they come in a range of sizes and shapes, with varying features. Several companies sell ready-made cisterns, and others will custom build a cistern to exact specifications.

Climate Change: A regional change in temperature and weather patterns. Current science indicates a discernible link between climate change over the last century and human activity, specifically the burning of fossil fuels.

Combined Sewer Overflow (CSO): Combined sewers are designed to collect rainwater runoff, domestic sewage, and industrial wastewater in the same pipe. Most of the time, combined sewer systems transport all of their wastewater to a sewage treatment plant, where it is treated and then discharged to a water body. Caused by a storm event overwhelming the sewer treatment system, combined sewer overflows contain stormwater but also untreated human and industrial waste, toxic materials, and debris. This overflow is a major water pollution concern.

Composting: A process whereby organic wastes, including food wastes, paper, and yard wastes, decompose naturally, resulting in a product rich in nutrients and ideal for gardening and farming as a soil conditioner, mulch, resurfacing material, or landfill cover.

Constructed Wetlands: Engineered wetlands that simulate natural wetland in processes and/or form and utilize natural and biological processes for wastewater treatment. Includes surface and subsurface flow constructed wetlands.

Critical Root Zone (CRZ): An imaginary circle on the ground that corresponds with the dripline of the tree, sometimes called the tree protection zone. This zone is used in determining allowable disturbance to the area around an existing tree during construction. Since the dripline is very irregular, the trunk diameter is often referred to for calculating CRZ. To determine a CRZ, measure the tree diameter at 4.5 feet above grade and multiply by 12 inches. While this is a generally accepted method for measuring CRZ, root systems will vary in depth and spread based on size of tree, soil quality, water table, species, and other related factors.

Curb Cuts: Ramps built into a sidewalk to facilitate pedestrian or wheel chair travel between sidewalk and street elevations. In accordance to the American with Disabilities Act Standards for Accessible Design curb ramps shall be provided wherever an accessible route crosses a curb.

Design Charrette: A focused workshop that takes place in the early phase of the design process. All project team members meet together to exchange ideas, encouraging the generation of integrated design solutions.

Dry Well: An underground structure that disposes of unwanted water, most commonly stormwater runoff, by dissipating it into the ground, where it merges with the local groundwater. A dry well receives water from one or more entry pipes or channels at its top and discharges the same water through a number of small exit openings distributed over a larger surface area, the side(s) and bottom of the dry well.

Ecological Connectivity: The maintenance of a connected system of open space throughout an *ecosystem*. Not only is a contiguous line of open space maintained, but also specific natural systems are kept intact. Ecological connectivity relies on maintaining *ecotones*, the linkages between different ecological regions.

Ecotones: A habitat created by the juxtaposition of distinctly different habitats; an edge habitat; or an ecological zone or boundary where two or more ecosystems meet.

Ecosystems: An interactive system that includes the organisms of a natural community association together with their abiotic physical, chemical and geochemical environment.

Environmentally Preferable: Products or services that have a lesser or reduced effect on human health and the environment when compared with competing products or services that serve the same purpose. This comparison may consider raw materials acquisition, production, manufacturing, packaging, distribution, reuse, operation, maintenance, or disposal of the product or service. Often used in reference to New York City's Environmentally Preferred Purchasing (EPP) laws.

Erosion: The wearing away of the land surface by running water, wind, ice or other geological agents including such processes as gravitational creep.

Eutrophication: A natural process that occurs in an aging lake or pond as that body of water gradually builds up its concentration of plant nutrients. Cultural or artificial eutrophication occurs when human activity introduces increased amounts of these nutrients, which speed up plant growth and eventually choke the lake of all of its animal life.

Evapotranspiration: A combined process of both evaporation from soil and plant surfaces and transpiration through plant canopies. Water is transferred from the soil and plant surfaces into the atmosphere in the form of water vapor.

Fill: Material used to make up the percentage of missing earth or other material so as to produce a stable site.

Global Warming: Increase in the average temperature of the earth's surface. *(See Greenhouse Effect.)*

Grading: Initial clearing, brushing or grubbing, subsequent excavating or filling of earth, stockpiling, terracing, road building, leveling and bulldozing on any property.

Green Roof: Vegetated roof covers, with growing media and plants taking the place of bare membrane, gravel ballast, shingles or tiles. The number of layers and the layer placement vary from system to system and green roof type, but include a waterproofing layer, drainage, growing media and plants.

Greenstreets: A citywide program to convert paved, vacant traffic islands and medians into green spaces filled with shade trees, flowering trees, shrubs, and groundcover.

Greywater: Wastewater that does not contain sewage or fecal contamination and can usually be reused for irrigation after filtration.

Greenhouse Effect: The process that raises the temperature of air in the lower atmosphere due to heat trapped by greenhouse gases, such as carbon dioxide, methane, nitrous oxide, chlorofluorocarbons, and tropospheric (ground level) ozone.

Habitat: The place where a population (e.g., human, animal, plant, microorganisms) lives and its surroundings, both living and non-living.

Herbaceous Species: Non-woody plants, typically herbs and grasses that occupy the understory as a vegetative ground cover.

Hydrology: The science dealing with the properties, distribution, and circulation of water.

Hyporheic Zone: A subsurface volume of sediment and porous space adjacent to a stream through which stream water readily exchanges. The hyporheic zone is an important component of stream ecosystems**.** (*See Riparian Corridor.*)

Impervious Surface: Constructed surfaces, such as rooftops, sidewalks, roads, and parking lots, covered by impenetrable materials such as asphalt, concrete, brick, and stone. These materials seal surfaces, repel water, and prevent precipitation and melt-water from infiltrating soils. The term impermeable may also be used.

Infiltration: The passage of water through a myriad of voids in the receiving ground.

Infiltration Bed: An area used for the temporary storage and infiltration of stormwater runoff. Subsurface infiltration beds consist of a pervious soil layer or porous pavement layer placed above a uniformly graded aggregate bed and can be used in a variety of areas to reduce stormwater runoff and improve water quality, but are especially suited for under porous asphalt, porous concrete, tree trenches, and infiltrating synthetic turf.

Integrated Pest Management: A coordinated approach to pest control that is intended to prevent unacceptable levels of pests by the most cost-effective means with the least possible hazard to building occupants, workers, and the environment. Also called Biointensive Integrated Pest Management.

Invasive Species: Plants that are 1) non-native to the ecosystem under consideration and 2) whose introduction causes or is likely to cause economic or environmental harm by competing for space and resources. The spread of invasive species results in monoculture and hence a decrease in habitat diversity.

Life Cycle: The life cycle of a product refers to all stages of a product's development, from extraction of fuel for power to production, marketing, use, and disposal.

Life Cycle Assessment: The comprehensive examination of a product's environmental and economic aspects and potential impacts throughout its lifetime, including raw material extraction, transportation, manufacturing, use, and disposal.

Life Cycle Cost: The amortized annual cost of a product, including capital costs, installation costs, operating costs, maintenance costs, and disposal costs discounted over the lifetime of a product.

Light Pollution: Excess brightness in the sky resulting from direct and indirect lighting above urban areas that has a negative impact on the urban ecology, disrupting biological cycles in plants and animals. It has also been hypothesized that human health requires a certain amount of exposure to darkness. The amount of energy wasted in lighting the sky or outdoor and indoor spaces, which do not need it, has been estimated conservatively to reach approximately $2 billion per year in the US.

Liquidated Damages: Damages whose amount the parties designate during the formation of a contract for the injured party to collect as compensation upon a specific breach (e.g., late performance).

Locally Manufactured Material: Building materials manufactured locally, the use of which reduces the environmental impacts resulting from their transportation and support the local economy. Typically, the material or product must be manufactured within 500 miles of the project.

Monoculture: The planting of one species of tree or plants. Single species plantings are more vulnerable when infected with a pathogen, or are attacked by insects, and by adverse environmental conditions.

Mulch: An organic or inorganic material which is spread or allowed to remain on the soil surface to conserve soil moisture and shield soil particles from the erosive forces of raindrops and runoff. Mulch also serves to moderate soil temperature, discourage weeds and, if a good, organic mulch, will introduce nutrients into the soil as it decomposes.

Native Species: Plant species that have evolved or are indigenous to a specific geographical area. The strict definition is a species that has not been introduced by humans either accidentally or intentionally. Because native species are a part of an ecosystem where everything is interdependent, these plants are adapted to local soil and weather conditions as well as pests and diseases.

Nitrogen Oxide (NO_x): A product of combustion from transportation and stationary sources such as power plants. NO_x is a major contributor to acid rain and to ground level ozone (the primary component of smog).

Operations & Maintenance: *Operations* refers to how equipment or systems are run, e.g., when a system should be turned on, temperature ranges, set points for boiler pressures and temperatures, thermostat set points, etc. *Maintenance* refers to servicing or repair of equipment and systems. Preventive maintenance performed on a periodic or schedule basis to ensure optimum life and performance is designed to prevent breakdown and unanticipated loss of production or performance. Corrective or unscheduled maintenance refers to repairs on a system to bring it back online. Predictive maintenance is performed on equipment to monitor for signs of wear or degradation, e.g., through thermography, oil analysis, vibration analysis, maintenance history evaluation.

Permeable Interlocking Concrete Pavements (PICP) consist of interlocking concrete units that provide some portion of surface area that is permeable itself or may be filled with a permeable material such as gravel. PICPs are typically built on an open-graded, crushed aggregate base.

Pervious Paving: (*See porous pavement.*)

Phytoremediation: The treatment of environmental problems (*see also bioremediation*) through the use of plants without the need to excavate the contaminant material and dispose of it elsewhere. Phytoremediation consists in mitigating pollutant concentrations in contaminated soils, water, or air, with plants able to contain, degrade, or eliminate pollutants and various other contaminants.

Planter Box: A structure, usually formed from concrete or brick that is filled with absorbent soils and plants in order to store runoff temporarily and provide treatment. Planter boxes capture runoff from small storm events, usually from roof areas, and are especially useful in the limited spaces of urban areas. They provide some water quality treatment in the process of slowing and reducing the peak discharge of small rainfall events.

Post-Consumer Recycled Content: Post-consumer material is a material or finished product that has served its intended use and has been discarded for disposal or recovery, having completed its life as a consumer item.

Porous Pavement: Paving specifically designed and constructed to encourage rapid infiltration and percolation of rainfall and stormwater through the entire pavement cross-section, and maintain this function over many decades, while directly supporting traffic loads. A permeable pavement surface with an underlying stone reservoir that temporarily stores surface runoff before infiltrating into the subsoil.

Pre-Consumer Recycled Content: Pre-consumer material is material diverted from the waste stream following an industrial process, excluding reutilization of materials such as rework, regrind or scrap generated in a process and capable of being reclaimed within the same process. Synonyms include post-industrial and secondary material.

Porous Bituminous Asphalt: Standard bituminous asphalt in which the fines have been screened and reduced, allowing water to pass through very small voids. Porous asphalt is placed directly on the stone sub-base in a single 3 ½ inch single lift that is lightly rolled to a finish depth of 2 ½ inches, unlike traditional pavement which has a wearing and a binder course.

Porous Concrete: The substantially reduced number of fines in the concrete mix establishes voids for drainage. In northern and mid-Atlantic climates such as New York, porous concrete should always be underlain by a stone sub-base designed for stormwater management and should never be placed directly onto a soil sub-base.

Public Private Partnership: An agreement between an agency and a private sector or nonprofit entity through which the skills, assets, and resources of the agency and the partner are shared in delivering a service or facility for the use of the general public. Parks currently is very successful with the development of its Partnerships for Parks program. Public private partnerships can provide a cost effective way to improve park maintenance funding.

Rain Garden: A planted depression that allows rainwater runoff from impervious urban areas like roofs, driveways, walkways, parking lots, and compacted lawn areas the opportunity to be absorbed. This reduces rain runoff by allowing stormwater to soak into the ground.

Recycling: The series of activities, including collection, separation, and processing, by which products or other materials are recovered from the solid waste stream for use in the form of raw materials in the manufacture of new products other than fuel for producing heat or power by combustion.

Reinforced Turf: Interlocking structural units that contain voids or areas for turf grass growth and are suitable for minimal traffic loads and parking. Reinforced turf units may consist of concrete or plastic and are underlain by a stone and/or sand drainage system.

Riparian Corridors: The zone between a river or stream, and an upland area. Both areas are home to many specialized plants and animals that respond to changes in aquatic and terrestrial influences, and which actually depend on this rapidly changing environment to function and survive.

Root Path: A narrow zone of growing medium that permits plant roots to reach a larger surrounding soil mass to draw minerals and water.

Runoff: Runoff from a rainstorm or melting snow

Sedimentation: The (unwanted) settling and depositing of loose dirt in a given area.

Shade: A term used to describe some degree of relief from the sun. There are basically four classes: light shade, partial shade, full shade, and deep shade. These are based on the duration of time without sun, coupled with shade density.

Soil Particles: Particles have void spaces between them and the more densely compacted the soil particles are (the higher the bulk density) the less pore space will be available for the movement of water and air. Interconnected pore spaces form continuous and irregular spaces known as macropores (larger than 0.1 mm in diameter), mesopores (0.1 to 0.01 mm) and micropores (smaller than 0.01 mm). The interconnected nature of macropores is critically important in the movement of water and air.

Soil Placement Plan: A scaled diagrammatic plan that indicates where each type of soil system is installed on the site. Areas of different soil types are indicated by unique hatch patterns and are cross referenced to soil installation details. Soil placement plans show the surface areas requirement of specific soil types (such as lawn areas, planting beds, etc.).

Storm Water Pollution Prevention Plan (SWPPP): A plan for controlling runoff and pollutants from a site during and after construction activities regulated by New York State Department of Environmental Coordination.

Stormwater Management Best Management Practices: Programs to maintain quality and quantity of storm water runoff to pre-development levels. Best Management Practices (BMPs) are structural or non-structural devices designed to temporarily store or treat urban storm water runoff in order to mitigate flooding, reduce pollution, and provide other amenities.

Sulfur dioxide (SO_2): An air pollutant formed primarily by coal and oil burning power plants. SO_2 combines with other pollutants to form acid rain.

Sustainable Forest Products: Wood products originating from a forest certified for sustainable forest management through various agencies and verified through an independent chain of custody audit. This creates an opportunity for both suppliers and buyers of forest products to demonstrate and communicate their commitment to sustainable forest management. It creates market incentives for producers to responsibly manage forests and harvest timber, gives consumers the power to positively 'vote' for conservation when they buy certified wood products, and contributes to the preservation of forests and forest wildlife worldwide.

Total Suspended Solids (TSS): A water quality measurement that refers to the identical measurement: the dry-weight of particles trapped by a filter, typically of a specified pore size.

Trenchless Technology: Underground construction methods that eliminate or minimize surface disruption. Trenchless methods include auger boring, directional drilling, robotic fiber-optic installation, manhole rehabilitation, micro tunneling, pipe bursting/splitting, pipe jacking, pipe fusion, pipe ramming, pipe relining, pipe inspection and cleaning systems, pipe jacking, robotic sewer repair methods, rock drilling, utility tunneling, and vacuum excavation.

Turbidity: An actual weight of the particulate material present in the water sample.

Urban Heat Island Effect: The additional heating of the air over a city as the result of the replacement of vegetated surfaces with those composed of asphalt, concrete, roofing (excluding vegetated roofs) and other man-made materials. These materials store much of the sun's energy, producing a dome of elevated air temperatures up to 10^{o}F greater over a city compared to air temperatures over adjacent rural areas. Light colored rooftops and lighter colored pavement can help to dissipate heat by reflecting sunlight, and tree planting can further help modify the city's temperature through shading.

Utility Infrastructure: All the physical elements that comprise the utilities, i.e. water, electricity, gas, sewage disposal, etc., and that provide for their delivery to citizens of a community.

Volatile Organic Compounds: Volatile organic compounds (VOCs) are chemicals that contain carbon molecules and are volatile enough to evaporate from material surfaces into indoor air at normal room temperatures (referred to as off-gassing). Examples of building materials that may contain VOCs include, but are not limited to: solvents, paints adhesives, carpeting and particleboard. Signs and symptoms of VOC exposure may include eye and upper respiratory irritation, nasal congestion, headache, and dizziness.

Watershed: All the land area that drains to a given body of water.

Wetlands: Environment characterized by shallow or fluctuating water levels and abundant aquatic and marsh plants, including marches, swamps, bayous, bogs, fens, sloughs, and ponds.

Xeriscape: Landscape that uses drought-tolerant vegetation instead of turf to reduce the amount of water required to maintain a lawn.

ACKNOWLEDGMENTS

PRIMARY AUTHORS

Design Trust For Public Space Fellows

Michele Adams
Meliora Environmental Design

Steven A. Caputo, Jr.
Policy Advisor, NYC Mayor's Office of Long Term Planning and Sustainability

Jeannette Compton
NYC Department of Parks & Recreation

Tavis Dockwiller
Viridian Landscape Studio

Andrew Lavallee
AECOM Design + Planning

NYC Department of Parks & Recreation

Charles McKinney
Former Chief of Design, Capital Projects

Design Trust for Public Space

Jerome Chou
Director of Programs

Deborah Marton
Executive Director

Stephanie Elson
Former Director of Programs

TEXT CONTRIBUTORS

Jeremy Barrick
Capital Projects Arborist,
NYC Department of Parks & Recreation

Angelyn Chandler
Fresh Kills Program Manager,
NYC Department of Parks & Recreation

Jennifer Greenfeld
Director of Street Tree Planting,
NYC Department of Parks & Recreation

Chris Kannen
Design Trust for Public Space

Stephen Koren
Landscape Architect,
NYC Department of Parks & Recreation

Marit Larson
Natural Resources Group,
NYC Department of Parks & Recreation

Erik Linsalata
Construction Division,
NYC Department of Parks & Recreation

Kate Louis
Technical Assistance Coordinator,
Partnerships for Parks

Bryan Quinn
Planning Division, NYC Department of Parks & Recreation

Marty Rowland
Environmental Compliance Manager,
NYC Department of Parks & Recreation

Charles Rudesill
ADA Liaison, NYC Department of Parks & Recreation

MANAGING EDITORS

Design Trust for Public Space

Deborah Marton
Executive Director

Jerome Chou
Director of Programs

Stephanie Elson
Former Director of Programs

NYC Department of Parks & Recreation

Charles McKinney
Former Chief of Design, Capital Projects

Jeannette Compton
Senior Project Manager for Design

TECHNICAL EDITOR

Cynthia Gardstein
Director, SWADC
Steven Winter Associates, Inc.

INDEXER

Do Mi Stauber

DESIGN & GRAPHICS

Claudia Brandenburg
Publication Design, Language Arts

Shaun O'Rourke
Graphics, AECOM Design + Planning

DESIGN TRUST FOR PUBLIC SPACE STAFF

Megan Canning
Deputy Director

Jerome Chou
Director of Programs

Chris Kannen
Production Associate

Kristin LaBuz
Development and Communications Associate

Deborah Marton
Executive Director

Stephanie Elson
Former Director of Programs

PARKS DEPARTMENT PARTICIPANTS

Commissioners

Thérèse Braddick
Deputy Commissioner, Capital Design

Liam Kavanagh
First Deputy Commissioner

Capital Design

Jeremy Barrick
Capital Projects Arborist

Katherine Bridges
Landscape Architect

David Carlson
Director of Landscape Architecture

Angelyn Chandler
Fresh Kills Program Manager

Ricardo Hinkle
Landscape Architect

Kathleen de Monicault
Schoolyards to Playgrounds

Marcha Johnson
Landscape Architect

Hope Kaufman
Ferry Point Project Manager

Stephen Koren
Landscape Architect

Celia Petersen
Director of Specifications

Marty Rowland
Environmental Compliance Manager

Paul Rube
Design Supervisor

Charles Rudesill
ADA Liaison

Forestry

Ronnit Bendavidval
Director of Citywide Horticulture

Bram Gunther
Chief of Forestry, Horticulture, & NRG

Minona Heaviland
PlaNYC Program Manager

Matt Stephens
Senior Forester

Fiona Watt
Assistant Commissioner for Forestry and Horticulture

Greenstreets

Barbara Barnes
Landscape Architect'

Adriana Jacykewycz
Greenstreets Manager

Jeff Keiter
Landscape Architect

Construction

Erik Linsalata
Construction Division

John Natoli
Chief Engineer

Maintenance & Operations

Bennett Agnello
Supervisor of Mechanics

Omer Cabuk
Energy Liaison

Martin Maher
Chief of Staff, Office of the Brooklyn Borough Commissioner

John Robilotti
Construction Project Manager

Artie Rollins
Chief of Technical Services

Namshik Yoon
Chief of Manhattan Operations

Planning

Christina Davis
Planning Division

Nora Libertun de Duren
Former Director of Planning

Jose Lopez
Deputy Director of Parklands,
NYC Department of Parks & Recreation

Bryan Quinn
Planning Division

Natural Resources Group

Marjorie Ely
Natural Resources Group

Michael Feller
Chief Naturalist, Natural Resources Group

Marit Larson
Senior Project Manager

Kelley Mahoney
Natural Resources Group

NYC PARKS PARTNERS

Rob Crauderueff
Policy Director, Sustainable South Bronx

Erica Johnson
Active Living by Design Coordinator,
Sustainable South Bronx

Kate Louis
Technical Assistance Coordinator,
Partnerships for Parks

Karen Overton
Catalyst Project, Partnerships for Parks

PEER REVIEWERS

Nina Bassuk
Cornell University

Stephen Benz
Principal Civil Engineer, Sasaki Associates

Chris Boyd
NYC Department of Health & Mental Hygiene

Matthew Brown
Central Park Conservancy

Kerry Carnahan
NYC Department of Design & Construction

Rob Crauderueff
Policy Director, Sustainable South Bronx

Susannah Drake
ASLA New York Chapter and dlandstudio

Teresa Durkin
Senior Planner, HOK Planning Group

Mike Flynn
Planning and Sustainability,
NYC Department of Transportation

Alexander Garvin
Alexander Garvin Associates

Deon Glaser
Manager of LEED Technical Development,
U.S. Green Building Council

Maggie Greenfield
Greenway Coordinator, Bronx River Alliance

Deb Guenther
Mithun

Bram Gunther
Deputy Chief of Forestry & Horticulture,
NYC Department of Parks & Recreation

Nina Haiman
NYC Department of Transportation

Minona Heaviland
PlaNYC Program Manager,
NYC Department of Parks & Recreation

Bruce Hendler
NYC Department of Design & Construction

Ricardo Hinkle
Landscape Architect,
NYC Department of Parks & Recreation

Denise Hoffman Brandt
Professor of Landscape Architecture,
CUNY Architecture

Cheryl Huber
New Yorkers for Parks

Tessa Huxley
Executive Director, Battery Park City
Parks Conservancy

Ethan Kent
Project for Public Spaces

Laurie Kerr
Senior Policy Advisor on Sustainability,
Mayor's Office of Long Term Planning
& Sustainability

Aaron Koch
Policy Advisor, Mayor's Office of Long Term
Planning & Sustainability

Joan Krevlin
BKSK Architects

Robin Kriesberg
Ecology Director, Bronx River Alliance

Katie Lechelt
National Association of County & City Health Officials

Paul Mankiewicz
Executive Director, Gaia Institute

John McLaughlin
Dir. of Ecological Services,
NYC Department of Environmental Protection

Dino Ng
NYC Department of Design & Construction

Signe Nielsen
Principal, Mathews Nielsen

Karen R. Nikolai
National Association of County & City Health Officials

John Orcutt
Senior Policy Advisor, NYC Department of Transportation

Linda Pollak
Principal, MP Architects

Joyce Rosenthal
Columbia University, GSAPP

Eric Rothstein
eDesign Dynamics

Margie Ruddick
Wallace Roberts & Todd LLC

Charles Rudesill
ADA Liaison, NYC Department of Parks & Recreation

Zach Schreiber
NYC Office of Environmental Remediation

Howard Slatkin
NYC Department of City Planning

Laura Starr
Partner, Starr Whitehouse

Frederick Steiner
Dean, School of Architecture,
University of Texas at Austin,
Center for Sustainable Development

Andy Stone
Trust for Public Land

Carter Strickland
Deputy Commissioner for Sustainability,
NYC Department of Environmental Protection

Margot Walker
Office of Stormwater Management Planning, NYC Department of Environmental Protection

Claire Weisz
Weisz + Yoes

Clark Wilson
US Environmental Protection Agency,
Smart Growth Program

Steven Yavanian
Wallace Roberts & Todd LLC

IMAGE CONTRIBUTORS

AECOM

Hester Street Collaborative

Meliora Environmental Design

New York City Department of Parks & Recreation

Matthews Nielsen

Viridian Landscape Studio

Wallace Roberts & Todd

INDEX

Q

R

S

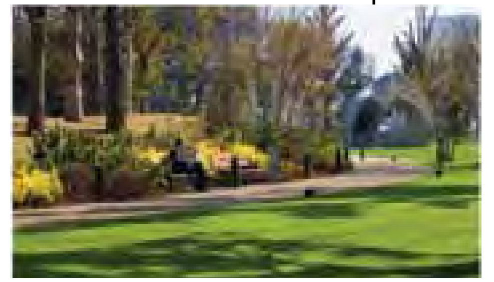
T

U

COMPOSITE SECTION SITE TYPES FOR NYC PARKS

New York City's urban landscape includes a complex network of open spaces, each characterized by different site conditions, uses, and surrounding contexts. *High Performance Landscape Guidelines* defines nine types of open spaces, highlighted in the composite section below. From waterfronts to playgrounds, active recreation areas to passive landscapes, this section illustrates prominent features, opportunities, and constraints that everyone designing, building, and maintaining the city's 21st century parks should understand.

STREETSCAPES



PASSIVE LANDSCAPES

POCKET PARKS & PLAZAS

BROWNFIELDS & RECOVERED SITES

WATERFRONTS

PARKS OVER STRUCTURES

PLAYGROUNDS

ACTIVE RECREATION AREAS

RESTORATION AREAS