Sustainable Open Space: Design, Construction and Maintenance of Teardrop Park, New York City

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1. INTRODUCTION

It is often thought that an open space is by definition sustainable. But sustainability doesn't just happen. A space must be designed, constructed, and maintained with an eye toward sustainability. This paper will discuss aspects of Teardrop Park, a new park in Battery Park City, New York City, that make it uniquely "green."

2. BACKGROUND

Teardrop Park is part of a network of parks within Battery Park City (BPC), a planned, 92-acre project begun in the late 1960s. This multi-use community arose from derelict piers that were filled in with land from the World Trade Center excavation and with sand from the nearby Hudson River. From the start, public parks accounted for a previously unheard-of 30 percent of the total area. Construction, of both buildings and parks, is still ongoing. Most of the buildings in BPC have been built by private entities, while all the parks, and a few of the buildings, have been built by the Battery Park City Authority (BPCA), the New York State authority formed to develop Battery Park City.

From its beginning, BPCA has striven to employ innovative design, construction methods, and maintenance practices. A public agency, BPCA sets design, construction, and other requirements and guidelines that must be followed by any private entity building within the boundaries of BPC. Most relevantly, all private developers in BPC must follow BPCA's environmental guidelines for both residential and commercial buildings.

These environmental guidelines also apply to the design, construction, and maintenance of open space within BPC. Teardrop Park is being designed and created by BPCA based on the environmental guidelines and other sustainable principles specific to open space. Maintenance of Teardrop Park, as with all BPC open space, is carried out by the Battery Park City Parks Conservancy (BPCPC), an arm of BPCA. By leveraging payments from the buildings that have been developed by the private sector, BPCA has been able to maintain BPC parkland at levels unique to New York City. BPCPC has been successful in maintaining parkland in a sustainable manner through the creation of programs they have created for BPC.

3. DESIGN OF TEARDROP PARK

Teardrop Park is a two-acre park designed by the landscape architectural firm of Michael Van Valkenburgh, working closely with environmental artist Ann Hamilton. Van Valkenburgh and Hamilton were chosen by BPCA because of their sensitivity to the essence of a space and their interest in working closely with both BPCA and BPCPC staff to create a sustainable park. The park is scheduled for completion in fall of 2004.

Figure 1 Plan View of Teardrop Park

3.1 Design Intent

The basic design concepts of Teardrop Park, from its earliest consideration, were based on the natural world:

- The park was designed to evoke the Hudson Valley of upstate New York—a wild, dramatic landscape beyond the edges of New York City—in both spirit and form. City dwellers will be able to experience a natural landscape without leaving the city's borders, enjoying the park's serene sights and sounds. Children, instead of clambering on conventional play equipment, can climb and hide in rocks that reach as high as 20 feet in the air, and wade in the water that oozes out from created outcrops. With these and many other features, public park users will experience an environment far removed from the urban world in which it is being created.

- Ann Hamilton has been involved in all aspects of the design, so the park benefited from the eyes and vision of a single artist who is renowned for working passionately to incorporate art into the landscape. In Teardrop Park, her work includes slabs of bluestone stacked in an explosive and rhythmic form throughout the park. In the words of the artist, "The art for Teardrop Park does not stand out as an autonomous object in the landscape, but lies imbedded within the visual and physical structure of rock, water, earth and plant. At the juncture between materiality and image, the artwork animates the surface membrane of the landscape to reveal rhythmic forces, processes and events. In this way the art for Teardrop Park represents a kind of a longing …for nature, for wildness, for absorption into something other and larger than what is human."

3.2 Sustainable Design Elements

Prior to beginning the design of Teardrop Park, BPCA and BPCPC set several specific sustainability requirements. The basis of the requirements was the environmental residential guidelines and the BPCPC's program of organic maintenance. As guidelines for buildings, however, many requirements were not valid (those to do with indoor air quality for instance) and many possibilities and opportunities for *open sp*ace were of course not addressed. The design team and staff therefore researched and analyzed what other measures could be incorporated into the design. The following were those measures that now are part of the design and construction for Teardrop Park.

3.2.1 Local Materials. At least 50% of all materials used in Teardrop Park were obtained from within 500 miles of the site. In fact, all 3,500 tons of stone used were brought from a local quarry and used in rough slabs and boulders that were minimally cut on site. Similarly, the majority of the plant material was located within this distance, and local pavement was used throughout.

3.2.2 Recycled content. At least 50% of all materials has recycled content. The concrete used incorporated fly ash, and concrete forms were reused. Site sand was used where possible and needed, rather than discarded. Composted biosolids, or waste water sludge that has been composted, were the major organic material in the topsoil throughout the park.

3.2.3 VOC levels. Adhesives/paints follow the BPCA's and USGBC's LEED limits for volatile organic compounds.

3.2.4 Water reuse. Water for play and display is filtered and recycled.

3.2.5 Waste Water. Reclaimed black water will be used for drip irrigation of all planting beds. Because of the biological nature of the topsoil, black water will be further treated via a reverse-osmosis system to control salinity levels.

3.2.6 Storm Water. A simple 4 foot wide drainage pipe, capable of holding 10,000-

Gallons of water, has been installed. The water will automatically feed into the irrigation system for the park.

3.2.7 Plant Material Selection. All plant material has been selected for its ability to thrive in the park's microclimate and ability to thrive with minimal water and maintenance, the most crucial criteria. While the majority is either indigenous or native to the Hudson Valley landscape, this was a secondary consideration, since it does not ensure the material is well-suited to the microclimate of the park. In fact, given the location of Teardrop Park, within the shadow of large buildings on all sides and one block from the winds coming off the Hudson River, much indigenous or native plant material would not thrive. For example, a Quercus rubra, or Red Oak, a native tree, would suffer greatly in the park microenvironment. Plant material was all selected through a screen of these local conditions.

3.2.8 Topsoil. The topsoil specified was designed based on the specific microclimate of the planted area within the park and the intended use. Percentage of sand, organics and loam were clearly specified and varied throughout the park, with the greatest percentage of organics in the plant beds, the least in the lawns.

4. CONSTRUCTION OF TEARDROP PARK

4.1 Construction Means and Methods.

Actual construction methodology varies greatly on a project site. To ensure success, the following measures for Teardrop Park were delineated in depth in the specifications as follows.

4.1.1 Diesel Fuel. All equipment used ultra-low-sulfur diesel fuel to cut pollutants.

4.1.2 Construction Waste. Construction waste was brought to recycling facilities rather than to landfills. Concrete washout, usually left to collect and filter into soil, was to be collected in impermeable crates and recycled.

4.1.3 Soil Testing. Critical to the success of the plant material was testing of the topsoil. Not only were topsoil *components* tested continuously for both particle size and chemical and biological content until they all matched the specification, but the final mix was tested in the laboratory as well, ensuring consistency and success of the components in sum in creating the right balance of drainage and nutrients. These measures assured that the correct population and combination of beneficial microorganisms vital to the BPCPC's sustainability soil program—including bacteria, fungi, protozoa, and nematodes—were present in the soil.

4.1.4 Construction Monitoring. Proper monitoring is essential to ensure that carefully designed and specified sustainable measures are not deleted, substituted for less green measures, or otherwise destroyed. Some of the monitoring at Teardrop Park included:

- Lab testing of topsoil *after placement* in the park to detect any inconsistencies to the specification requirements of sieve size and percentage of organics, loam, sand, etc. Because it is often unclear whether the mixing has properly and consistently incorporated each component, testing of placed material is critical. Only in this way, can it be ensured that the soil was properly mixed and that the soil's structure was not damaged during installation.

- Daily testing of topsoil moisture during installation and later sod placement was required. Working topsoil when wet can create permanent damage to the soil structure.

5. MAINTENANCE OF TEARDROP PARK

All BPC parks are maintained organically, meaning no inorganic fertilizers, chemicals or chemical pest control measures are used, a feat it is believed unique to Battery Park City. In 1990, BPCPC started its program of sustainable landscape-management. At that time, no role models existed; research showed that no U.S. parks were managed utilizing completely organic/sustainable methods. By 1997 all BPC parks were truly organic. BPC's organic maintenance program comprises six elements:

- Soil Management and Composting
- Plant Selection and Placement
- Pest and Disease Control
- Irrigation Management
- Proper Planting Techniques
- Proper Pruning Techniques

5.1 Soil Management and Composting

Proper soil management is at the heart of the program. In this critical first step, the correct soil structure for the park is achieved to create an environment in which beneficial soil organisms can thrive. Once the topsoil reaches this critical point, beneficial organisms are introduced through the application of compost and liquid biological amendments ("compost tea").

There are numerous benefits of using compost in maintaining a balanced soil ecology:

5.1.1 Nutrient Retention. Beneficial organisms keep nutrients in the root zone, where they can be taken up by the plants. For example, natural nitrogen cycling occurs when a good biological balance exists in the soil. Nitrogen, a major resource for plants, is taken up by the bacteria, which are then fed upon by protozoa; the protozoa, in turn, excrete nitrogen that is then available to plants. This makes for an extremely efficient nitrogen cycling system. It also prevents nitrogen from being lost through leaching into the water supply, where it can be detrimental to the water table.

5.1.2 Nutrient Availability. Nitrogen and other nutrients are more available for plants as a result of the action of microorganisms. As a result, organic, low-nitrogen fertilizers can be used. This avoids the need for high nitrogen fertilizers that kill off microorganisms in the soil.

5.1.3 Disease Suppression. Beneficial nematodes protect the roots of plants from harmful organisms. The symbiotic relationship between fungi and plants helps the plant to filter needed micronutrients from the soil.

5.1.4 Water Retention. Organic matter allows water to remain in the soil long enough to be taken up into the plant's roots, rather than being lost as drainage.

5.1.5 Aeration. Beneficial organisms aerate and give structure to the soil by creating air holes and drain pockets**.** This minimizes compaction and maximizes water availability for use by plant roots.

5.1.6 Decomposition of toxins. Bacteria in the soil breakdown toxins and transform them into more benign components.

Compost is an excellent source for these beneficial organisms, including bacteria, fungi, protozoa, and nematodes, that create a balanced soil ecology in topsoil. In BPC parks, all herbaceous and woody material is collected and composted in windrows, worm bins, and in-vessel units. In addition, pre-consumer waste from local grocers is collected and incorporated into the compost; this is a valuable nitrogen source that would otherwise end up as trash or food for vermin.

Composting must be done carefully and systematically. There are three critical elements:

- Temperature: The temperature of the compost is critical for thermal composting done in windrows or in-vessel units (for vermicomposting, or breaking down of organic waste with worms, a non-thermal process occurs). For the windrow or in-vessel processes, the temperature must remain above 131 degrees for a minimum of three days, but never rise above 160 degrees. This is hot enough to kill weed seeds and pathogens, but not so hot as to kill beneficial, cultivated organisms.
- Aeration: This must be done regularly to ensure proper temperature and the creation of a consistent mix. In a windrow, this is done by a front loader; an in-vessel unit requires an agitator or air pump.
- Plant Material: The plants within a landscape will dictate the type of organisms that need to be cultivated. In general, turf, grasses, and perennials require higher bacterial populations, while more complex landscapes (trees and shrubs) require higher fungal populations in the soil. A fungal mix is also used for controlling diseases in all types of plant material.

The following table (Table 1) gives a general description of two basic compost mixes (bacterial and fungal). the three basic components of the compost and some potential sources of the components, and the proportions for both bacterial and fungal mixes.

Compost Components	Source of Components	Proportion for Each Mix	
		Bacterial Mix	**Fungal Mix**
Nitrogen	Legume, manure, glass clippings, vegetable waste	25%	25%
Bacterial - (Green)	Herbaceous materials, hay, weeds	45%	30%
Fungal (Woody)	Sawdust, dry leaves, wood chips, newspaper	30%	45%

Table 1 Bacterial and Fungal Compost Mixes

Compost tea is a liquid biological amendment created from a combination of different composts, specific to the type and needs of the plant material. The process consists of first placing compost in a water medium. Next, oxygen is added via an air pump, which diffuses the compost and encourages beneficial organisms from the compost to enter the water. Finally, both fungal and bacterial foods are added to the water so the organisms can grow and multiply. These foods include fish emulsion, kelp, molasses, soy or wheat flour, and humic acid.

The result is a brew that is full of beneficial soil organisms. During the brewing process, bacterial populations, on average, double every half hour.

Compost tea, when applied properly, helps to correct imbalances that may exist in the soil. Applications are particularly beneficial for trees and lawns for which a high percentage of organic matter is undesirable, but which need the beneficial organisms.

5.2 Plant Selection/Placement. Choosing the right plant for the right place sounds obvious, but it is often overlooked for a myriad of reasons. These include lack of knowledge of the biological needs of the specific material (a science in itself); a lack of knowledge of the microclimate that exists (and, more importantly, will exist upon completion of the project - Teardrop Park, now sunny; will become a very shaded space once the four adjacent buildings are completed) and the unfortunate practice of selecting plant material solely for its aesthetic qualities. For Teardrop Park, cultivars of plants were selected that do not need copious amounts of water or chemical assistance to survive and that can exist in the shady, windy environment of the park.

While the words “native” and “indigenous” are often used when describing plant material, these terms become meaningless when the microclimate is not considered first and foremost.

Plant adjacencies are also critical. In Teardrop Park for example, moss, an acid-loving plant, was specified for installation next to non-acid-loving plants like Amelanchier and ferns. Upon review, it was determined that the proposed locations would mean a shared bed and shared topsoil. Selection was changed so that plants with similar pH were used instead.

5.3 Pest and Disease Control. BPCPC staff has been trained to detect early signs of insect pest and plant disease. This early detection is crucial when using non-toxic means of pest control. The problems must be identified early, and action must be taken quickly. As with all new procedures, creating a sustainable approach to pest control, and all other areas of landscape maintenance, requires constant staff education, even to those who have had extensive experience in horticulture and maintenance. As a result, staff is informed and able to scout the landscape on a regular basis, both within BPC and in neighboring areas to avoid infestation.

A non-toxic approach to pest and disease control will be used in Teardrop Park, as it is in all BPC parks. Soap, horticultural oils and beneficial predatory insects such as ladybird beetles, pirate bugs, and trichogramma are used instead of environmentally persistent pesticides.

Using the correct materials and products is critical. The fact that a product is labeled "organic" or "non-toxic" does not mean that it is necessarily safe or effective. It is important to do the research to pick the best products.

5.4 Irrigation Management. Irrigation is an important aspect of sustainable landscape management. Every effort must be made to utilize water efficiently. By creating and monitoring ground-irrigation lines and specific irrigation schedules for each microclimate, transpiration, evaporation, and disease are minimized. Also, the use of reclaimed waste-water brings another level of efficiency. At Teardrop Park, waste water will be taken from a green residential building, The Solaire, that is adjacent to the park. This waste water will be monitored continuously to ensure the correct levels of salinity that, in excess, would kill off the beneficial organisms we work so hard to cultivate.

5.5 Proper Planting Techniques. At Teardrop Park, many common mistakes made in planting—mistakes that can kill plant material—will be carefully avoided:

- Depth of Planting: One of the biggest landscape-management problems today is plants that have been planted too deeply. When a plant is too deep in the soil, neither water nor air can properly circulate to the roots. Also, moisture in the soil causes decay in the plant's fragile cambium layer. This compromises the periderm and renders the plant susceptible to infection. Instead, plants are planted at a height where the flair of the stem is clearly above grade. This seemingly small change has an incredible effect on the long-term success of the plant material.

- Excess Soil: Many nurseries fail to remove excess soil from the root crown. This has become more prevalent with the tree spades that are used extensively today. At Teardrop Park, this excess soil will be removed before digging.

- Use of Detrimental Materials: Wire baskets, synthetic burlap, and twine are used extensively. If they are not removed completely at the time of planting, the plants will not survive over time. At Teardrop Park, all will be completely removed prior to final planting. Tree wrap, once thought to be useful for protection, actually impedes photosynthesis and also acts as a reservoir for harmful substances such as dog urine.

5.6 Proper Pruning Techniques. Well-pruned plant material will thrive by encouraging incremental growth. It also reduces wind resistance, and allows light to reach understory plantings. The anatomy of the plant must be understood. For example, deciduous trees and shrubs actually have three levels of canopies, each of which is important at different times of year. These different canopies must be pruned discriminatingly to ensure protection for the plant material throughout the year.

6. CONCLUSION

The long-term sustainability of Teardrop Park has been considered from the project's onset. Without the early involvement of the construction, horticultural, and maintenance staffs during both the conceptual design and actual construction, the original sustainability concepts would have been either greatly compromised or never fully realized. For example, early designs for Teardrop Park showed the predominant use of just one type of stone. But with further study and a desire to remain true to the essence of the Hudson Valley landscape, the palette was changed to a mix of several types of stones.

Also, the involvement of the horticultural and maintenance staffs at the project's beginning ensured that decisions were fixed before the park was completed. For example, the original design included paths that would not allow maintenance carts along them. This was corrected during construction. Another example of the need for constant vigilance came during construction, when soil monitoring identified topsoil material that differed from what was originally tested. This allowed BPCA to make changes rather than installing material that would not meet the specified soil performance and thus would not support the plant material to be planted.

The hoped-for result will be a truly sustainable landscape, one that not only successfully considers all the environmental qualities of a built, natural space, but also attains status as a thriving, well-loved landscape. It is hoped that Teardrop Park will excite its visitors visually and encourage them to learn more about their natural environment. It is also hoped that it will add to the natural world, rather than taking from it, for many generations to come.