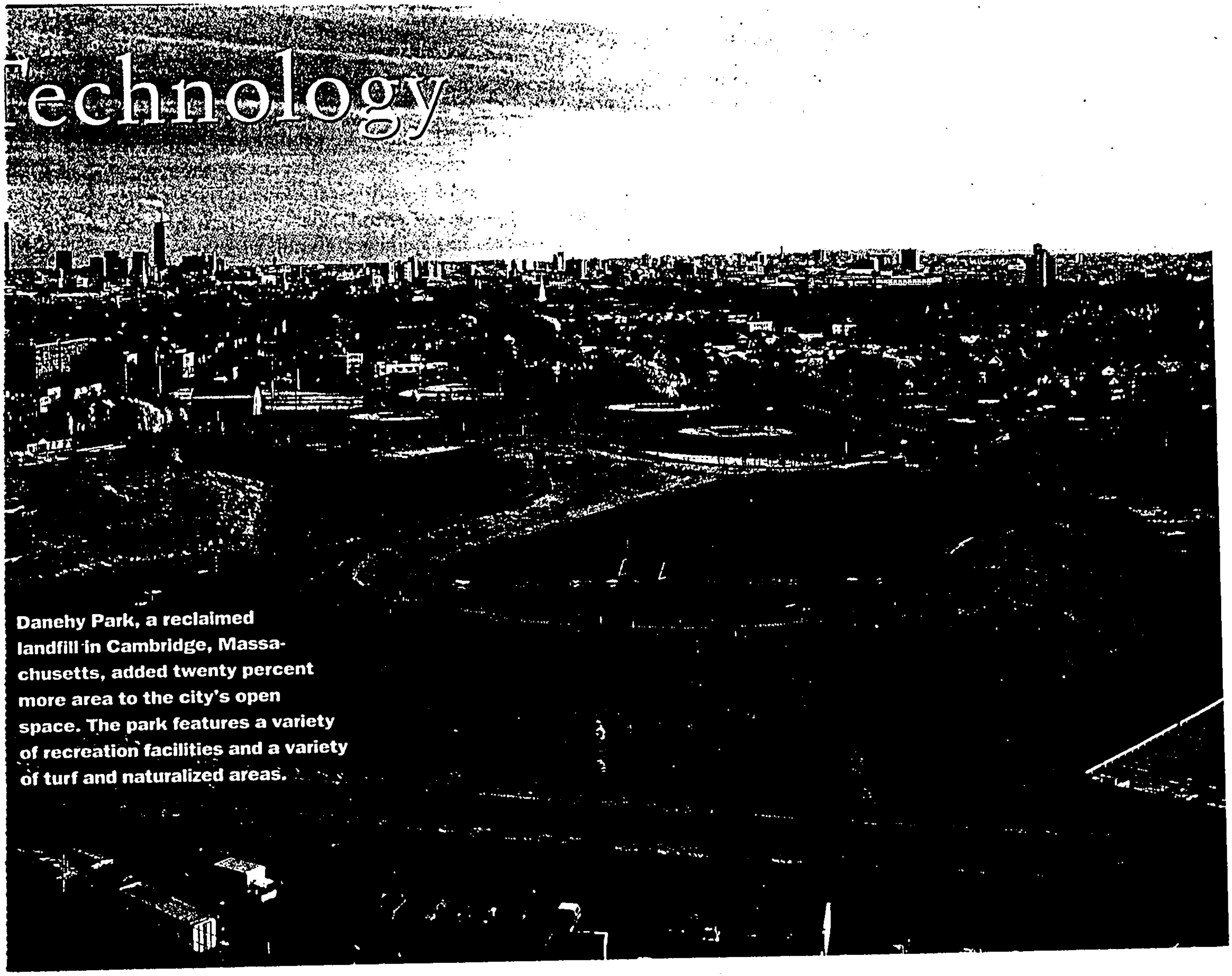


Danehy Park, a reclaimed landfill in Cambridge, Massachusetts, added twenty percent more area to the city's open space. The park features a variety of recreation facilities and a variety of turf and naturalized areas.

Hidden Opportunities

Landfill restoration offers fertile ground for landscape architects. But first practitioners must understand the landfill's underlying technology.

BY DEBORAH MARTON

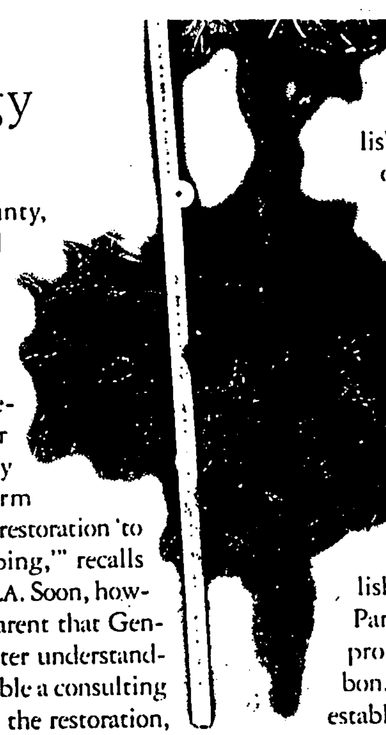
As sources of traditional commercial and residential landscape architecture work dwindle, large tracts of land are quietly being freed for development. Located in densely populated areas, with limited recreational space and even less natural habitat, these sites have immense potential as high-profile design projects in their communities. The unlikely source of this gold mine of opportunity is trash—the landfills that constitute our primary method of solid-waste disposal.

According to the Environmental Protection Agency, nearly half of the nation's six thousand municipal landfills were capped by the early 1990s and thousands more will close by the end of the decade. The hundreds of thousands of acres that become available will not be amenable to traditional development strategies because construction on these sites involves extremely high costs and serious structural problems. In fact, it will be virtually impossible to develop this land as anything other than parks or recreational areas.

Landfill restoration is a relatively new phenomenon in the United States, where land has been plentiful and inexpensive, and landfills first established in the nineteenth and early twentieth centuries are only now reaching capacity. As a result landscape architects practicing in this arena have been hampered by a lack of practical information, and efforts to revegetate former landfills have achieved limited success (with some important exceptions) because of problems related to capping, leachate breakout, and gaseous emissions. Recent technological advances have significantly addressed most of these problems, however, clearing the way for successful restoration.

Of all the professions certain to vie for the lead role in landfill restoration, landscape architecture alone integrates knowledge of the various disciplines crucial to successful project execution. The Solid Waste Authority

RYMIE PAYNE CAMBRIDGE ARTS COUNCIL



of Palm Beach County, Florida, recognized this when it handed control of the Dyer Landfill project to George Gentile & Associates. "We became involved after we were called in by the engineering firm hired to manage the restoration 'to assist with landscaping,'" recalls George Gentile, ASLA. Soon, however, it became apparent that Gentile's firm had a better understanding of how to assemble a consulting team to accomplish the restoration, and the firm ended up as team leaders. "Ultimately, we were managing a team that included botanists, hydrologists, hydrogeologists, biologists—and, of course, engineers. By coordinating the efforts of these professionals we were able to create a landscape that not only met the community's aesthetic and recreational needs, but one that is environmentally sound."

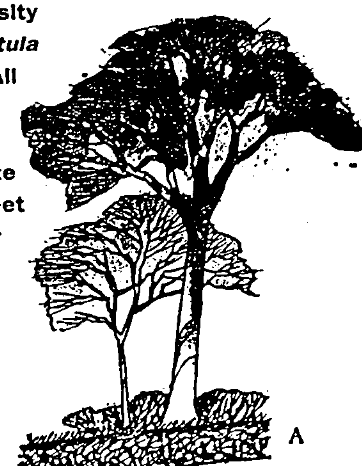
The success of Danehy Park in Cambridge, Massachusetts, can also be attributed to effective teamwork and careful long-term planning. For a full ten years before the park opened to the public in 1990 local environmental consulting firms Camp Dresser & McKee, Inc., (CDM) and Haley & Aldrich monitored the site, investigating such issues as settlement, combustible-gas migration and generation, air and groundwater quality, storm-water drainage, and even radioactivity. "Landfills are unique sites," notes project manager John Kissida, ASLA, of CDM. "The high exposure, steep slopes, and thin soil cover give them an almost alpine quality that may be totally at odds with surrounding ecosystems. And once you've created a landscape, you can't just walk away. Some level of maintenance will always be required or the project is destined to fail." CDM continues to maintain the park to this day.

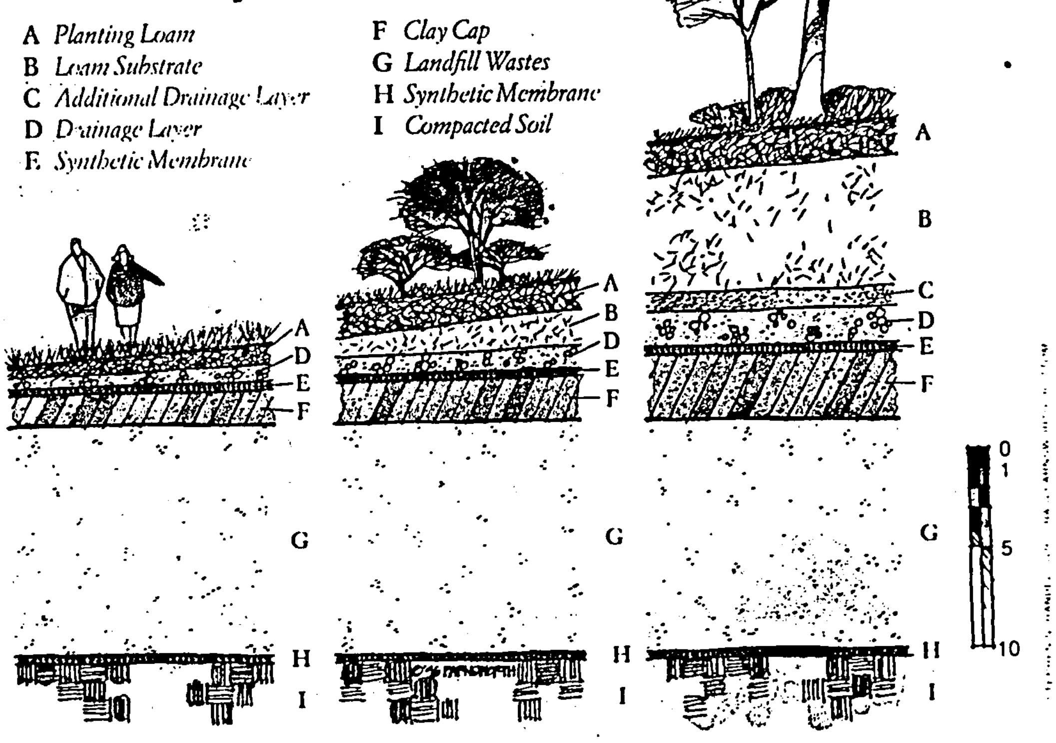
At Byxbee Park on San Francisco Bay (see ASLA Awards, *Landscape Architecture*, November 1993) lack of maintenance led to the establishment of exotic weeds that are outcompeting the native grasses originally intended for the site. "It's a fallacy that native landscapes are easy to maintain on these sites," says George Hargreaves, ASLA, of Hargreaves Associates of San Francisco, the designers of Byxbee Park. "They're only easy to maintain once they're established." Lessons learned at Byxbee Park contributed to a new landfill project under construction in Lisbon, Portugal, where Hargreaves has established the first three years following initial construction as a period of heightened maintenance, which puts a different frame on the project for the client and the contractor. "It's not a one-shot 'hydroseed it, then leave and pray for rain,'" says Hargreaves.

What exactly is involved in landfill restoration? Before designing a landscape for this difficult environment practitioners must have some understanding of the landfill's underlying technology, which will dictate to a great extent the possibilities for surface treatment, and may actually form the basis of the site's design. To control leachate and gaseous emissions, modern landfills are physically sealed with a clay cap or synthetic membrane or both. Federal regulations mandate a minimum clay thickness of 1.5 feet and a minimum six-inch "erosion layer" of soil capable of sustaining vegetation—although such a soil depth will sustain little more than turf. Many state laws specify soil and plant requirements in more detail than federal law.

A major problem in the past was that subsidence posed a significant risk to the seal and new ground surface of a closed landfill because the surface could settle thirty per-

At Fresh Kills Landfill on Staten Island, Rutgers University scientists unearthed such trees as this gray birch *(Betula populifolia), above,* that had taken root over the cap. All trees were found to have shallow root systems. The cross-sectional diagram *below* indicates the structure of the landfill. Six inches of planting loam and substrate (A and B on the diagram) are required for turf; three feet for shrubs and small trees; and eight to twelve feet for a forest in which succession may occur.





cent or more of the landfill depth. Although compaction and consolidation techniques on modern landfills reduce settlement to fifteen percent or less, some older landfills may not be taking advantage of these new techniques and may still be subject to extreme settling. Because most subsidence occurs in the first few years after closure, postponing final plantings, especially of trees, beyond this period will minimize the loss of plants due to settling.

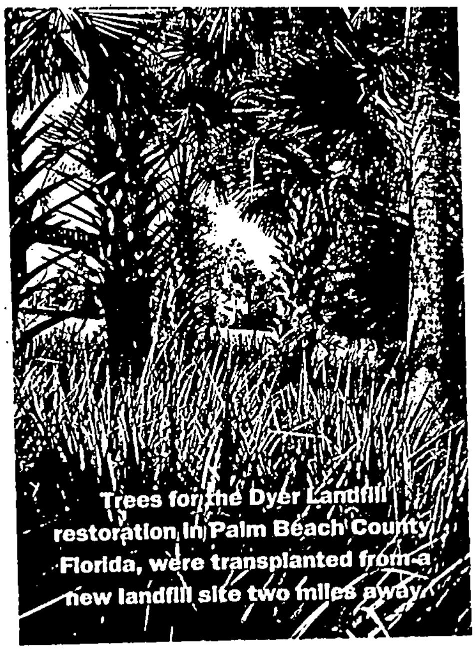
Controlling leachate (the liquid produced through interaction of wastes with infiltrating rainwater or groundwater) is a problem only where flaws in the cap allow water to seep in uncontrolled. If this occurs leachate may pose a significant risk to groundwater quality. The harmful effects of landfill gases (mostly methane and carbon dioxide) stem primarily from gas leaking through a flaw in the cap and displacing oxygen in the soil, producing anaerobic soil conditions on the landfill surface. In modern landfills improvements in capping and venting are eliminating such leaks; gases are passively vented, burned off, or processed as fuel. Although such technological improvements minimize damage to plants from landfill gases, landscape architects working on older landfills should be aware of the possibility of such damage.

Even under the best of circumstances growing conditions on closed landfills will be stressful to plants because of limited moisture retention, erosion, possible gas seepage, shallow or poor-quality soil, and a host of other problems. Federal guidelines recognize the fact, however, that plants are necessary to the closure process because their root systems ensure that soil remains in place to protect the cap. Plants also increase evapotranspiration, moving moisture away from the cap to the soil surface.

Including trees in planting plans for closed landfills has been extremely controversial—it is, in fact, prohibited by many states because of a belief that tree roots pose a risk to the integrity of the cap. As a result, grasses and wildflowers have been the most common cover. But European experiences in landfill revegetation and recent studies conducted at Fresh Kills Landfill on Staten Island, New York, do not support these fears.

Roots only grow in that part of the soil in which moisture, aeration, and mechanical properties are favorable. Although capping materials are designed to be impenetrable, they may develop flaws that make the design of the soil conditions (such as sufficient rooting depth) essential to minimize the potential for roots penetrating the cap. Although widely held conceptions of tree-root architecture depict the root system as a mirror image of the tree's trunk and branches, lateral roots may in fact extend up to three times the tree's height, while vertical roots rarely grow deeper than three feet. Studies conducted at Fresh Kills by a team led by Steven N. Handel, a professor in the Department of Ecology, Evolution, and Natural Resources at Rutgers University, support these assertions. Trees excavated following seven years of growth on soil one foot deep had extremely shallow root plates with deformed tap root growing above and parallel to the clay cap. This research is bolstered by experience with timber crops and recreational woodlands successfully established on landfills throughout Great Britain and Scandinavia.

Of course, any plant will have trouble growing without sufficient soil cover. Realistically, the minimum soil depth appropriate for cap protection and plant growth should be at least two feet deep in all areas except those where trees and shrubs will be planted. (There, the depth should be at least three feet.) The issue of soil depth is a tricky one and, depending on capping material, plant species, and geographical area, much greater depths than those just mentioned may be appropriate as a safeguard against root penetration, especially where soil is subject to freezing and thawing.


Trees for the Dyer Landfill restoration in Palm Beach County, Florida, were transplanted from a new landfill site two miles away.

One significant risk that cannot be controlled through cap quality is windthrow (the blowing over of trees by strong winds). This is a threat to the integrity of the cap because the uprooted tree may have soil bound up in the roots, leaving the cap exposed to weathering. The greatest factor contributing to stability will probably be soil depth and quality. In general, coarse-textured soils, such as those with high sand content, seem less able to support trees than clay soils, especially when wet. Although sandy soils may be desirable for their ability to drain rapidly, windthrow risk should be considered in designing a soil specification.

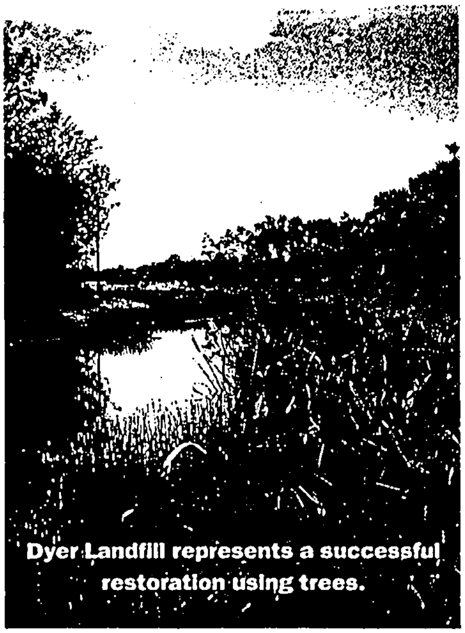
An austere maintenance budget does not rule out the use of trees. One strategy for low maintenance is to design a landscape that relies to some degree on plant succession for maturation. The key to sustainability of this type of landscape lies in developing a planting plan that encourages connectivity with seed sources in the natural habitats of the region. Fortunately, the location of most landfills at the edge of human development encourages such connectivity. The new habitat could help link remnants of natural forests and wetlands

GEORGE GENTILE & ASSOCIATES, BOTH

and enhance or buffer urban greenbelts. But because highways, parking lots, and even the ecologically impoverished suburban environment may block plant colonization from off-site sources, it is crucial that the landscape architect expedite the natural succession process by specifying native local species in the planting plan.

Another way of expediting colonization from off-site is to encourage seed-dispersing birds. But many birds will not land in areas without perches of adequate height—at least five feet. For this reason areas seeded only with commercial grasses may remain monocultures indefinitely. One obvious solution to this problem would be to include some trees in the restoration plan to attract birds. But because tall trees and shrubs will have a more difficult time adapting to landfill conditions than seedlings, an interim solution could be to construct artificial perches. In some regions wind may be the primary seed disperser, making prevailing wind direction and the effects of landform on seed deposit important considerations.

Finally, consider cluster planting: the concentration of woody plants in specific areas provided with deeper soil cover. Clusters can also be reserved for colonization by native species, the remaining area receiving a higher level of maintenance, such as an annual mowing. Without maintenance, species in these pockets could spread to areas with soil cover inadequate to sustain their rooting depth.


Dyer Landfill represents a successful restoration using trees.

Once a landfill has been successfully revegetated, the biggest challenge may be the unrealistic expectations of visitors unable to perceive the site's prior use. As Kissida observes, "When we tell soccer players who show up for a game the day after a storm that they can't use the field, they get angry. People don't remember the park used to be a landfill." A solution to this problem could be to reveal the site's history through design. In Lisbon, Hargreaves Associates is working with environmental engineers to develop a plan that expresses the pipeline network and collection wells. The interpretive quality of this type of design need not exclude ecological diversity—natural habitat doesn't necessarily look like wilderness. As work on such postindustrial sites as landfills increases, landscape architects have an enormous opportunity to develop a new design vocabulary that reconciles the difficult task of restoration with sound ecological planning. **LA**

Deborah Marton, who holds degrees in both law and landscape architecture, is the principal of Marton Landscape Consulting in New York City, specializing in landscape restoration and design and compliance with relevant laws. For a complete bibliography and other information on landfill restoration and revegetation visit her World Wide Web site at http://gramercy.ios.com/~dmarton.