All photographs by Mike Falco unless otherwise credited

Landfill to landscape. At Fresh Kills on Staten Island, New York City, the world's largest landfill site continued to grow for more than fifty years, accumulating millions of tonnes of New York's garbage. On March 22, 2001, the site received its final shipment of household waste, and Mayor Rudolph Giuliani honoured a long-term commitment to Staten Island's residents by closing the landfill. New York City Department of City Planning launched an international design competition soon after, to identify a strategy for the site's remediation and return to public use. Enigmatically beautiful, the site's spectacular scale defines its own context. The shaped landfill mounds frame close views across tidal creeks, yet also reveal expansive views beyond, notably towards Manhattan. Offering exceptional opportunities to harness latent energy sources within the mounds, alongside other renewable resources on site, the Fresh Kills project has the potential to become an exemplar of sustainable practice, and a regeneration landmark of worldwide significance. **Murray Smith.**

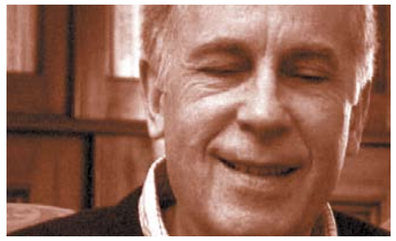
LETTER FROM STATEN ISLAND

by Tamara Coombs

below: Extracts from video-taped interviews with Staten Island residents by Mark van S., November 2001.

‘The farms are gone. The farmers couldn’t pay for the taxes on the land because it was so valuable as real estate land. In fact it was probably the bridge coming that ended the last farm.’

Marjorie Johnson

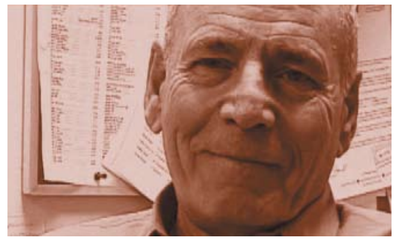


‘The people of Staten Island have had an overdose of ugly things and to make a great beautiful sweep of a landscape would be a healing tonic to this kind of harsh, urban environment.’

Barnett Shepherd

‘I heard that they were going to turn it into a park, but I don’t know if that’s happening. There’s been a lot of developing recently, like townhouses are popping up all over and a lot of historic houses have been torn down. We’ve had a lot of developing and I think we need the trees back.’

Ximena Vengoechea



‘When it was open country it was nothing but farms and farm land around. I am a cowboy, everything about me is cowboy. I sorta stand out like a sore thumb in Manhattan, Brooklyn and Queens.’

Lou Caravone

When Fresh Kills Sanitary Landfill opened in 1948, Robert Moses assured a concerned letter writer that the landfill would close within three years. Moses missed the mark by half a century. To those who had never been closer to the borough than the decks of the Staten Island Ferry, the landfill became the Island’s most famous feature. To those who lived on Staten Island, the landfill was an unpleasant reality and a daily reminder of the borough’s place in the City’s pecking order. The stench was always perceptible to those nearby, generally worse in the summer and often carried inland on the prevailing westerly winds. On top of the engineered hills, flocks of raucous seagulls fought over exposed garbage. Two rows of tall wire fences caught much of the windborne trash, but flimsy plastic bags escaped and festooned the branches of trees and shrubs.

All of this was there to be seen and smelled as Staten Islanders drove the West Shore Expressway (windows up) or went shopping at the Staten Island Mall or to the movies at the Dump. For some history-minded Staten Islanders, the Dump fitted into a pattern of using the Island with its low population and undeveloped land as the site for facilities others didn’t want. This pattern began with the Quarantine Hospital (1799 – 1858) and continued with the Tuberculosis Sanatorium at Sea View (1905 – 1961) and the infamous Willowbrook State School (1952 – 1988).

The lack of vision and long term planning for the borough was demonstrated with the completion of the Verrazano-Narrows Bridge in 1964. Although some may be nostalgic for a perfect past that never existed, there is no denying that much of Staten Island’s peaceful South Shore was transformed into tacky subdivisions and strip malls. Today, traffic jams and inadequate public transportation have given Staten Islanders the dubious distinction of having the longest median commutes in the United States. Surprisingly, thanks to dedicated citizens and true public servants, much of value remains including communities with tree-lined streets and architectural character, a Greenbelt with miles of trails winding through pine oak woodlands and a waterfront of enormous potential. Still, despite its assets, Staten Island has often been viewed disdainfully by the rest of New York City. It has been seen as a boring blue-collar suburb, full of cops and firemen, notable only for its landfill. As one T-shirt put it, Staten Island: World’s Largest Dump.

The Fresh Kills Landfill closed in March of 2001. It reopened September 13, 2001 to accept tons of World Trade Center rubble mixed with the remains of thousands of victims, including hundreds of policemen and firemen. Over 20% of the uniformed personnel lost at the WTC lived on Staten Island. Retired firemen and policemen volunteered for the terrible duty of sorting through debris at Fresh Kills in search of something identifiable to give to grieving families. The unsung men and women of the FDNY and NYPD have metamorphosed into heroes. A despised landfill has been transformed into hallowed ground.

It would be hard to overemphasise the opportunity Fresh Kills presents. From a borough that has been treated as a working class joke could come a world-class example of how to reclaim the planet’s largest landfill and turn it into a self-sustaining landscape environment of great beauty and usefulness. For Staten Islanders, a source of anger and sorrow could become a source of pride and pleasure. It would be a welcome assurance that we can begin to repair what we have despoiled; a note of optimism in a world in need of it.

LANDSCAPE AS INFRASTRUCTURE

Landscape design has to set environmental and human relationships in relief, giving them a face, an expression and a framework in which to develop. Pioneering figures and projects have shaped the landscape architect's professional role in urban planning and design. Looking at these opens up insights into why NYC's Fresh Kills Landfill to Landscape competition ascribed a key role to the landscape architect. It also reveals an interesting thread of connections between New York, Staten Island and the UK.

The Fresh Kills competition brief asked for a 'conceptual planning approach' that set new international standards. The approach had to respond directly to the existing site dynamics, community needs and the regulations associated with landfill. In other words, the brief took a holistic view of landscape, including community context, built environment and existing environmental conditions as generators for design concepts. The proposal had to be specific to the site, but also sufficiently universal to inspire other projects. JMP Landscape / John McAslan + Partners started looking at rebuilding natural systems, providing new local infrastructure and drawing in the by-products and processes of landfill into the park's structure and operation. We inferred that the Client was looking for public parklands, though a park was not specifically mentioned. The shocking history of the site and its devastating impact on one of New York City's richest natural areas, made us assume that 'landscape' in this instance should signify 'regeneration'; the proposal had to be an instrument of urban planning.

This interpretation of the brief and our subsequent approach drew on ideas about the role of landscape in urban development and the role of the landscape architect within integrated, multi-disciplinary teams. Two key figures for the landscape profession – Frederick Law Olmsted (1822 – 1903) and Ian McHarg (1920 – 2001) – stand out for their innovative way of thinking and their influence in shaping the professional role.

Olmsted, considered to be a father figure to the profession, was one of the first landscape architects to make a stand for public open space as a planning issue. He moved to Staten Island early on in his career, farming a homestead called Akerly Farm, south of Richmond Town, just three miles from the creeks area that would become the landfill a century later. The farm is still in existence, and several of the large trees planted by Olmsted in the 1840's survive. He travelled to England in 1850, from where he returned profoundly inspired by English parks, by their impact on communities, their 'democratic uses' and effectiveness in shaping urban development. Birkenhead Park, by Joseph Paxton, 1847 (the first publicly funded park in Britain) was a particular influence, and was extensively covered in his journals. Olmsted went on to plan and design some of the most internationally known urban landscapes across America, including Central Park and Prospect Park in New York City, Rock Creek Parkway in Washington DC and the Boston Park System. Rock Creek Parkway remains an outstanding design precedent for public highways through a city centre, involving car, bus and truck drivers in the distinctive wooded valley landscape, shielding adjacent residential areas and providing recreational tracks and routes, that dynamically unfold as you pass through.

Olmsted promoted the role of public open spaces as part of the urban infrastructure, incorporating transport and circulation routes, establishing community identity and providing settings for activities. He saw the landscape architect as having a crucial role in urban planning, being equally at home in rural and city contexts and having been trained to design ideas that would only mature in future decades. The concept of an urban landscape not only as a setting for recreation but also as a provider of integrated transport connections was an innovation, shifting the role of 'landscape' and 'park' in urban planning from setting to infrastructure.

Another key stage in the emerging role of landscape is the link between public open space and native vegetation. Now broadly accepted, particularly within Europe, the principle of establishing native landscape has both technical and community values. These issues are directly relevant to Fresh Kills; large sites with difficult conditions are more successfully colonised by plants that have evolved in response to those conditions, creating landscapes that also have intrinsic, recognisably local value to people using them.

Perhaps the earliest and most outstanding example of the integrated approach emerged in the Netherlands, a country which has an extremely developed strategic planning tradition. Covering 2310 acres, the Amsterdamse Bos is one of the largest twentieth century urban parks in the world. Conceived as a planning tool, it was built entirely on artificial land by manual labour under a municipal work creation programme. The purpose of the park was to establish, at rapid pace, a native forest landscape for recreation, a green tract connecting to the Randstad and protected from development. Designed by a multi-disciplinary team, including biologists, engineers, architects and sociologists, the underlying principle was to provide equal amounts of forest, water and open ground, requiring complex modification to water tables and landform. For its time, the emphasis on native species and the connection made between native landscape and active recreation were inspired. It formed the first initiative in the 1935 General Expansion Plan for Amsterdam and remains to this day the prime destination for people to experience 'nature in the city'.

Tracing the emerging role of parks, as both urban infrastructure and native environment, leads us to Ian McHarg; it also brings us back from Europe to New York City and Staten Island.

Belonging to the Rachel Carson era (Rachel Carson's classic book Silent Spring, 1962, brought environmental issues to public consciousness), McHarg was known for passionate 'save the world' rhetoric and his ambition to change attitudes to design. Dramatising the adverse environmental impacts of sprawling development, industrial pollution and nuclear fusion was a hallmark of the time and brought key ecological concepts into mainstream language, elevating awareness of natural processes.

Growing up on Clydeside, close to the

by Lucy Jenkins

natural beauty of the Old Kilpatrick Hills and the Campsies, but just as close to the Glasgow shipyards and factories of the Clyde, McHarg saw the failure to plan, design and build well
as the result of a stubbornness to understand the inherent characteristics and processes of the land. He described this contrast between countryside and city vividly as an enduring lesson of man out of sync with his environment:

"We need nature as much in the city as in the countryside… Man is that uniquely conscious creature who can perceive and express. He must become the steward of the biosphere. To do this he must design with nature."(Design with Nature, 1967)

McHarg wanted to change how planners and architects approached development. To change the way decisions were made relative to the land, meant changing how designers relate to the land. He contributed to this both in practice and higher education, working in the strategic planning sector on public commissions and also in the University of Pennsylvania, influencing how future designers were trained. His core message, drawing together project work and university research, was published in Design with Nature. Commissioned by the Conservation Foundation of Washington in 1967 in order to bridge the gap between ecology and planning, the book is still a classic text for environmental science, planning and landscape architecture.

McHarg's intent to win esteem for landscape architects focussed specifically on their central role in urban design. He felt strongly that to address the major problems of metropolitan development required a far greater understanding of environmental issues than those contributed by urban design or architecture alone. He drew a clear link between successful development and the composition of the design team, with many of his projects, both as a student and later as a tutor, investigating the dynamics and working patterns of multi-disciplinary teams.

As a student at Harvard Graduate School of Design, McHarg's team's thesis project for Downtown Providence was commended by Walter Gropius: 'they have worked with their brains and their hearts, but most of all they have worked as a team. The work of a team is greater than the sum of the work of individuals' (June 1950). The project was adopted as the Central Redevelopment Plan for Providence, aiming to generate business investment through environmental improvements. It was the first to do this, firmly linking investment to the role and environmental quality of public open space.

At the University of Pennsylvania, McHarg also initiated a number of collaborative projects including one in 1959 between students and faculty of architecture (traditionally the dominant discipline), planning and landscape architecture, looking at urban problems and the search for a 'humane city'. The study concluded that successful design solutions required the engagement of all three disciplines and that landscape was a crucial component, providing a bridging role between ecology and design. Penn still retains its reputation for inter-disciplinary design education today.

The success of human design responses to the land depends on how directly they respond to the conditions, resources and processes of the environment.

Challenging the conventions of design teams and their working approaches was also at the basis of McHarg's professional work, practising with Wallace, Roberts and Todd. With them, McHarg began to apply ecology as an underlying principle to planning briefs and found that design decisions based on environmental criteria had the capacity to solve a variety of problems in urban, metropolitan and rural contexts.

The practice, with a diverse skills base including ecology, ethnography, forestry, architecture, legal and financial advice, was one of the most prominent in US urban planning, urban design and landscape architecture in the late 60's and 70's. With projects like the Plan for the Valleys, Baltimore's Inner Harbor and Amelia Island, the practice stood out for its innovative approach and was consulted on highly strategic urban infrastructure issues.

McHarg's method relied on a holistic view of the environment, identifying, mapping and comparing separate factors, in order that ecology could be applied universally, achieving a social value that could not be ignored and, more importantly, could influence decisions. This diverged completely from traditional ecology, which looked primarily at pristine 'natures', and allowed the same natural processes to be identified in areas that had been subject to human change, bringing social systems, needs and values into the equation. It introduced ecology directly into urban planning and design for the first time, a process only formalised in planning law and policy on biodiversity and sustainability thirty years later.

In 1963, commissioned by the Urban Renewal Administration of Pennsylvania and New Jersey States, they undertook a research project, Metropolitan Open Space from Natural Process. This project applied ecology to the problem of selecting open space in a metropolitan region, by categorising land types in terms of their sensitivity to change, productiveness in terms of natural process and suitability for urban use. The categorisations went from surface water (highest natural-process value, least tolerant to urban use), through marshes, flood plains, aquifers, steep slopes, forests and woodlands, to flat lands (lowest natural process value, most tolerant to urban use).

Their specific interest in the challenges of the metropolitan environment – open space strategy, transportation and land use planning – also brought the team to New York City, both Manhattan and Staten Island.

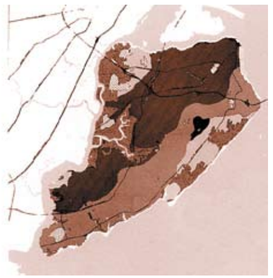
McHarg's plan for Lower Manhattan for NYC's Planning Commission (1966) marks an important phase in the development of New York City, setting out strategies for creating 110 acres of new open space. The plan introduced massive amenity to an extended, infilled west waterfront, providing an accessible linear parkland attracting landward development from which the City could fund the project. Some sections emerged smaller than originally envisaged, but the continuous esplanade remains a development principle for Manhattan and is currently under implementation.

In 1968, McHarg was asked to develop an ecologically-sensitive alternative to a proposal by Moses and Rockefeller for a new highway through Staten Island's greenbelt. The commission evaluated the natural conditions of the site including geology, hydrology and contours, compiling these into a layered model in order to determine the most suitable alignment for the road. The project enabled the land type evaluation system to be applied, showing its capacity as a powerful analytical tool. Comparison tables allow physical conditions, such as suitability of underlying ground for construction, as well as applied values such as existing land uses and economic viability to be measured. The Tri-State Transportation Agency examined the evidence presented and found in favour of ecology; the McHarg scheme was implemented. McHarg described this as an Environmental Impact Assessment, and its methods have since developed into a powerful legislative planning tool, used for ecological planning world-wide.

The study of Staten Island forms a core chapter of McHarg's Design with Nature, showing how a landscape appraisal of the whole island within the context of its natural systems can inform development decisions arising from its metropolitan and suburban contexts. In particular it makes the connection between 'natural' and 'social' values, showing how the most ecologically diverse landscapes are often also those most valued by people and therefore unsuitable for development.

Almost the entire world's surface has been altered from its natural state and subjected to human design. The success of human design responses to the land depends on how directly they relate to the conditions, resources (material and aesthetic) and processes of the environment. At its simplest definition, the practice of building can be seen as adaptation to the environment and is dependant on understanding and responding to a broad spectrum of environmental conditions and resources.

In the urban situation, interpreting the natural processes and conditions – aspect, climate, hydrology and microclimate – that makes sites 'habitable' to people and plants, is every bit as essential as in rural contexts. It is fundamental to place-making, to communicating through design the qualities of and connections between places.

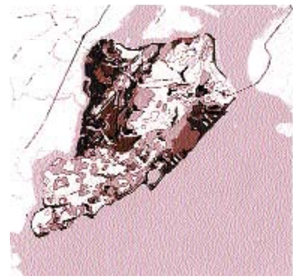


Where Olmsted and McHarg were both motivated by an urgent need to reverse despoliation of the land and unfettered sprawl of development, our attentions today are turned necessarily to the work of rehabilitating landscapes, reconnecting places and returning them to a healthy state for re-use.

Now that planning and development is focussed increasingly towards urban regeneration, land remediation and ecological conservation, the input of environmental disciplines is right at the forefront. Ecology is an inspiration for urban planning and design, providing dynamic processes and structures at every possible scale and a language with universal application. Internationally, both the construction industry and planning process have borrowed heavily from the language of ecology, using terms like 'diversity' and 'regeneration' for new sector names, policies and initiatives. It is significant that this language has been extended to the urban context, referring to 'regenerating' not just ecosystems, but also communities and infrastructure connections in order to bring land back into public use and establish a balanced, self-sustaining environment for the future.

McHarg's Staten Island Study defined the Island as one of the City's richest assets. Describing the daily ferry trip from suburb to city and back as a symbolic connection between nature and city, he pointed to Staten Island as a "unique resource in New York City," saying that "if the land had been evaluated prior to development, Staten Island would have been one of its treasures and high value areas." Even before the full-scale impact of Fresh Kills the dump, he noted that the island's value was fast disappearing precipitated by the "last assault" of the Verrazano – Narrows Bridge. He was, however, optimistic about the potential for a remedy generated by a city planning taskforce, saying that "hope for this island refuge lies almost entirely in the fact that the City of New York owns most of the remaining vacant land."

With its wide reaching brief and potential to influence at regional, national and international scales, the Fresh Kills project is about to put this view to the test.



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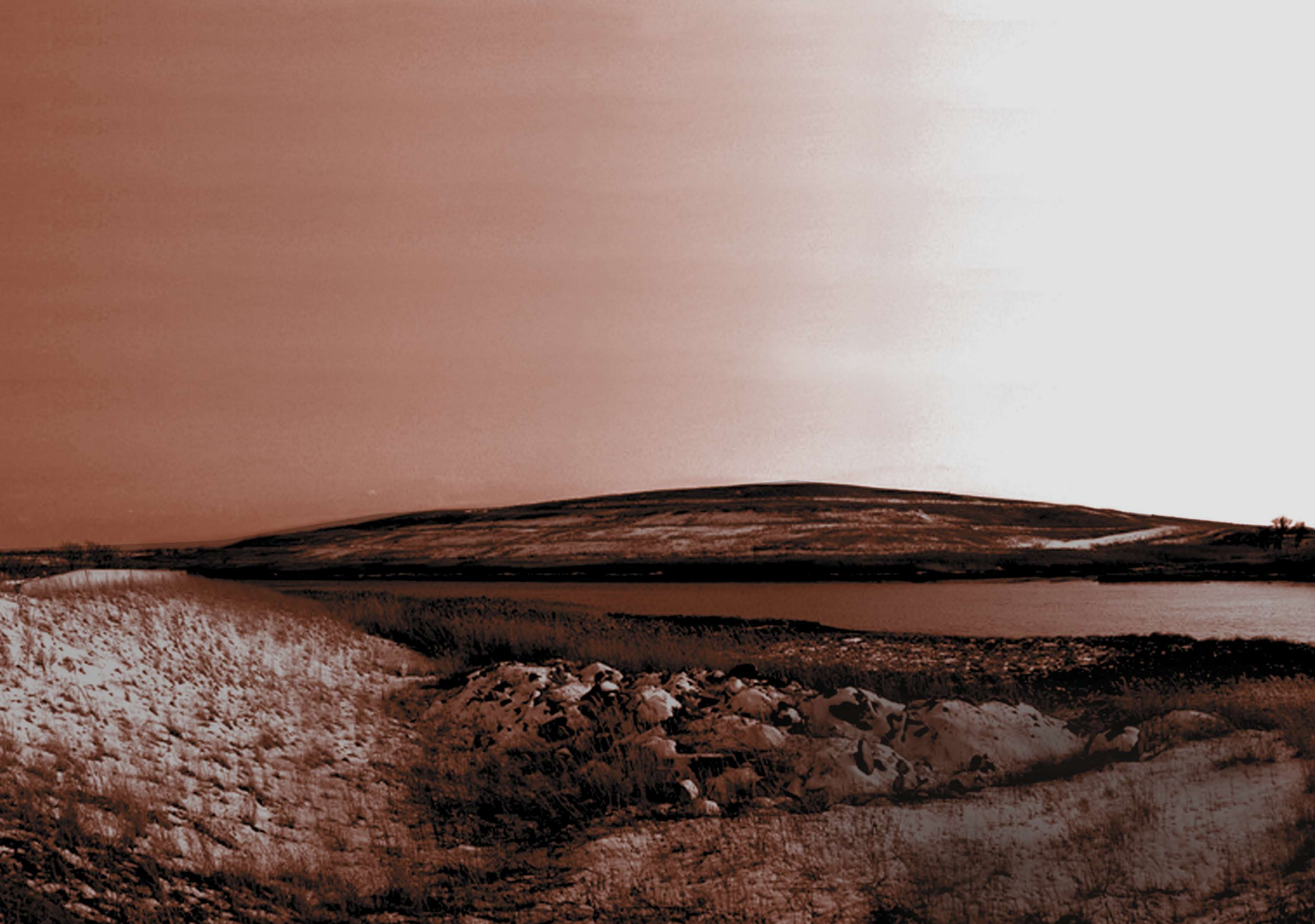
left to right: Aerial view of Staten Island from the south, as it appears in McHarg's Design with Nature; McHarg's analysis of Staten Island's bedrock geology, surface geology, hydrology, and soil drainage environments, from the same publication.



REMEDIATION PROCESS

by Ian Carradice, with Chris Birkett and Tom Puttman

Due to its history and location, the Fresh Kills site has a unique set of characteristics which have the potential to allow resources to be harnessed and utilised in a highly sustainable way; this could be an example of best practice for the rest of the world. Fresh Kills began accepting waste in 1948, the final shipment of domestic waste was delivered by barge in March 2001. The total site area is 800ha and contains four distinct mounds, landfill control systems, creeks, protected natural areas, concrete crushing and composting areas, and internal roads. The landfill volume totals approximately 100 million m^3 and the highest mound reaches a height of 64m AOD.

Waste

Waste is material which has no direct value to the producer and so must be disposed of. The main constituents of UK waste are produced from agriculture (37%), mining (34%) and industry (11%), however a large proportion of this waste is now recycled, and reused. Municipal waste (5%) is the waste generated from urban areas, particularly residential areas, shops and offices. Other constituents are dredged spoil (5%), construction (4%) and sewerage (4%).

Municipal waste forms the bulk of the waste at Fresh Kills; the typical composition of landfill is likely to be:

Component	
Organic	**Weight %**
Food wastes	21.00
Paper	25.00
Cardboard	7.00
Plastics	11.00
Textiles	2.00
Rubber	0.50
Leather	0.50
Garden wastes	10.50
Wood	6.00
SUB TOTAL	83.50
Inorganic	**Weight %**
Glass	9.00
Tin cans	2.00
Aluminium	0.50
Other metal	2.00
Dirt, ash etc	3.00
SUB TOTAL	16.50
TOTAL	100.00

Historically, waste disposal involved dumping waste material either into open-air tips and rivers or the sea. However, the increased volume of waste generated, the changes in composition and the greater understanding of the effects of uncontrolled dumping, means that such methods are no longer acceptable. Currently the major methods of municipal waste disposal include engineered landfill, incineration (energy from waste plants) and recycling / reuse. Engineered landfill is still the predominant form of disposal. However, increased costs and a shortage of suitable sites has created pressure to utilise and develop alternatives.

In 1999, US residents, businesses and institutions produced more than 230 million tonnes of municipal solid waste at a rate of 2.4kg/person/day up from 1.2kg/person/day in 1960. Currently in the United States 28% is recovered, recycled or composted, 15% is incinerated and the remaining 57% is disposed of in landfills (Office of Solid Waste, USEPA).

The number of landfills in the US is steadily decreasing, from 8000 in 1988 to 2300 in 1999. The capacity, however, has remained relatively constant. New landfills are, for economic reasons, much larger than in the past.

The closure of the Fresh Kills landfill site significantly affected the overall capacity in the US and will have a major impact on the costs of waste disposal in New York City. The waste will now largely be disposed of in landfill sites within New Jersey and Pennsylvania with considerable extra transport and disposal costs. A positive consequence of the increased costs is that it will concentrate efforts to recycle and reuse and, equally important, to minimise waste production in the first place.

In the early years of placement the percentage of paper and organic waste was considerably less than it is now; a large proportion of the waste would have been burnt in coal fires within households, and the amount of packaging was significantly less. The increase in organic material, particularly paper, being placed in the landfill site, has increased the gas production potential.

Landfill

Upon placement in the landfill, several chemical and biological processes begin to take place. The paper and organic wastes begin to be broken down by naturally occurring bacteria. Initially this breakdown is aerobic, utilising atmospheric oxygen to convert the organic matter to CO_2, H_2O and bacterial cells. However, this source of oxygen is quickly depleted as successive layers of waste are placed, and generally, within four years of the final capping layer being placed, breakdown of organic waste is taking place anaerobically (in the absence of oxygen). Under those conditions anaerobic bacteria convert the organic matter to methane (CH_4), carbon dioxide (CO_2) and trace quantities of foul smelling hydrogen sulphide (H_2S). The composition of landfill gas is approximately 60% methane and 35% carbon dioxide, other trace gases including hydrogen sulphide account for the remainder.

This breakdown of organic material plus settlement and compaction due to self-weight will result in the mounds reducing in height by 10-15% over the next 50 years. This equates to the mounds reducing in height by up to 7.5m. It should be noted that the settlement is not differential, and overall the natural plasticity of the soils is capable of adjusting to the change over time. Once the integrity of the capping layers has been confirmed, between 5 to 10 years post capping, then the landfill can be opened to the public.

Leachate is formed when water that has been in contact with the refuse has percolated through the landfill site. The main contributor in the generation of leachate is rainfall. Once capped, leachate generation is significantly reduced. The leachate at Fresh Kills is collected and pumped to the leachate treatment plant, where the contaminants are removed prior to discharging into the Arthur Kill River. The treatment plant can handle 3,780m^3 per day, which equates to an equivalent flow of 1,050l/sec. After a few years following the capping of the landfill, there will be significant spare capacity in the treatment plant. This spare capacity could be utilised as part of the soil forming strategy for treating soil wash water with minimum alterations to the existing system.

Modern landfills have to conform to several regulations and laws including the Environmental Protection Agency Federal Regulations and the US Code Section 6924. These regulations ensure that any contaminants are prevented, as far as reasonably possible, from escaping to the air or polluting the soil and watercourses adjacent to the site.

During operation, intermediate capping layers were placed to create isolated 'cells' that prevent the daily deposited waste from exposure to rain and scavengers / vermin as well as containment of migrating contaminants. Intermediate capping layers are not designed and only act as a temporary cover layer.

The mounds are surrounded by a system of leachate collection trenches, monitoring boreholes, Bentonite cut-off walls (impermeable vertical walls that prevent contaminant egress) and clay capping to prevent the migration of contaminants, both gaseous and liquid, from the site boundary.

A major difference between new landfills and Fresh Kills is that they all now require a double lining in the base to prevent leachate migration. The absence of a base lining system at Fresh Kills resulted in the need to construct the Bentonite cut-off walls to prevent significant off site migration of contamination.

Energy

Landfill sites around the world can act as generous energy sources if the gases are abstracted effectively and in a controlled manner. As a general guidance, if the volume of waste is greater than 15million m^3, and it was placed recently, then the landfill is likely to be capable of generating methane in quantities which make its recovery and use economically viable. For old landfill sites with a smaller volume it is less likely to be economically viable and under these circumstances flaring is frequently used to dispose of the landfill gases in a controlled fashion.

Currently an 18 year contract has been let to a private operator to collect, process and export the gas into the local gas supply network. The gas production within the site will reduce with time due to the capping of the mound, which allows the landfill to progressively dry out. The landfill gas production and leachate generation can be calculated using the Extended Buswell Equation, which is widely used within the waste industry. This equation, generalised below, estimates the volume of gas produced when given the percentage make up of household waste, density and yearly placement rate.

Generalised Chemical Reaction

$$\textit{Organic Matter (Solid Waste)} + H_2O \xrightarrow{\textit{bacteria}} \textit{Biodegradable Organic Matter} + CH_4 + CO_2 + \textit{Other Gases}$$

This equation is based on assumptions of waste composition and other physio-chemical variables within the landfill, such as temperature, compaction, moisture and leachate, and hydrogen sulphide production. The other gases produced, such as ammonia and hydrogen sulphide, are only in small quantities and are not usable. These hazardous and unwanted gases are separated from the usable gases through scrubbers, which contain iron shavings, or through other proprietary scrubbing devices.

Proposed Methane, Water and Soil Strategies

A proposed integrated solution to enhance this potentially massive source of energy is through using a drip-feed leachate re-circulation pipe that can re-activate the waste to create more landfill gas. This can be achieved by installing the filtration pipe network prior to the mound being capped, together with a horizontal collection pipe that lies at the landfill base. The base collection pipe, which runs through the entire length of the mound, will draw down the leachate from above together with the peripheral pipes to prevent the migration groundwater flow to the bay in the low permeable soil beneath the mounds.

If this process were implemented at Fresh Kills, reactivation of the waste could either extend the period of gas production by 20 – 30 years or double the current production rate. By extending the methane production, the rate of subsidence of the capped landfill will increase marginally but is unlikely to cause settlement problems, indeed it will provide a more stable landform in the long term. We also propose that 10% of the current methane production be utilised for the proposed development. By utilising a trigeneration plant, which efficiently converts a single fuel source into three useful energy products: electricity, steam or hot water, and chilled water, all the energy demands of the site could be met. The remaining energy generated will be sold into the local grid network.

This will provide a solution that will not only provide a significant financial return but provides an efficient method to maximise energy generation while benefiting the development, the surrounding area and the environment.

The site also has a relatively high potential for wind and solar power production. Although the potential for wind energy created by the mounds is significant, it could conflict with other ecological aims (the bird population for example) and aesthetic concerns. Solar energy collection systems are rapidly advancing and there may be future potential to sustain the energy demands of the site.

Potable water is a scarce resource with a high cost for import. The site already has surface waste run-off attenuation and silt collection ponds installed, which can be modified to capture run-off for re-use and the creation of Freshwater Wetlands. Surface water drainage from buildings and paved areas could be added to the system.

The water from the freshwater wetlands can then be utilised for irrigation and restrooms, which will be the two main demands for water. Small wind pumps would be ideal for powering distribution of this sustainable system.

Planting trees on the site as it stands is not feasible. The landscape strategy requires a huge amount of additional soil which we estimate to be in the order of 2.5 million m^3, – far more than all the topsoil in Central Park. Importing soil was rejected for cost and environmental reasons, and also, we would miss a unique opportunity to showcase how soils can be generated from waste materials.

The soil processing and blending would require materials from the following sources in the New York area: foundation excavation, building rubble, compost, dredged material and digested sewage sludge.

The majority of material could be barged to the site. Currently the City pays approximately $642 million for the disposal of the majority of these materials. Soil production is not common globally, but people are beginning to utilise the opportunities whenever applicable. Fresh Kills is ideally situated to use this method as a global example of sustainable soil production, due to its location, scale and the available infrastructure required for the processing. The Fresh Kills Project soil demand would potentially create savings of $114 million; the financial benefits in recycling these materials is huge.

These methane, water and soil strategies will enable New York City to set new world standards in sustainable resource utilisation. Not only will they produce materials, for example soils, for the City's parks and gardens, the techniques developed will provide a catalyst for sustainable brownfields regeneration for the City of New York.

AVIAN ASPIRATIONS

by Dominic Woodfield

Contemplating the ‘world’s largest landfill site’, the mind’s eye is naturally disposed towards images of despoilment, not diversity. However, while the landfill operations have unarguably rendered large areas of Fresh Kills devoid of much in the way of wildlife, a surprising array of habitats can be found, not just in neglected corners, but permeating the entire fabric of the site.

At its core, and from the air, Fresh Kill’s most striking and enduring attribute is not in fact the engineered landfill mounds, but the system of sinuous tidal creeks that divides them. Surviving along these are valuable areas of saltmarsh: beds of salt-tolerant grasses in the zone between high and low tide which have a staggeringly high diversity of associated species, as well as performing invaluable roles in pollution control and coastal stability. Along with exposed mudflats and ‘salt scrub’, the survival of these habitats represents a direct link with the marshlands of pre-landfill days, and in these areas, characteristic and declining species with evocative names such as clapper rail, muskrat and snapping turtle have hung on throughout the operational life of the landfill.

While interventions such as the installation of bulkheads have negatively affected this system, the legacy of human disturbance has not always been to the ultimate detriment of wildlife. The herons, egrets and ibis which feed along the creek systems congregate in the breeding season at a regionally important heronry on an island in the midst of the site, where up to nine species nest yearly in an isolated grove of trees which have grown up on ground raised above the saltmarsh by the past dumping of dredgings.

The landfill mounds present an immediate and stark contrast to the creek systems, and represent human intervention at the opposite end of the spectrum. Although gargantuan in scale, they are not overtly imposing, replicating as they do the natural ridges of the eastern and northern part of the Island and lending a sense of enclosure to the site core. They are however designed features, with an attendant engineering purpose and maintenance burden, the result of which is a uniform topography and compacted substrate which does not lend itself easily to re-vegetation, even if this were permitted by the current regime. Even so, they are not entirely devoid of wildlife: the broad expanses of sown grasslands attract open country birds which are uncommon or rare in the rest of New York City, and in more neglected areas the ranks of tall weeds are alive with finches and sparrows, and in the summer teem with butterflies and grasshoppers.

Defining successful objectives for the site’s future as a semi-natural habitat, a wildlife resource and recreational asset therefore relies on recognition, understanding and utilisation of the processes

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and resources that are already there – whether as a product of survival, adaptation or burgeoning recovery. The interplay of modified and natural processes, between the highly engineered mounds, and the creek systems and marginal land that together make up over half of the site, is both unique and powerful. To impose a prescriptive solution which ignores and work's against this dynamic is likely to guarantee failure.

An adaptable and re-active framework of habitat objectives is therefore proposed, within which small-scale patterns, deviations and anomalies can not only be accommodated but also encouraged. This is based on the establishment of a range of broad ecotypes appropriate to the site and the region, which are then allowed to develop individual diversity in response to the site's own conditions, harnessed and steered by targeted interventions. At their most simple, these ecotypes can be defined as upland and lowland forests typified by hickories and oaks, swamp forests characterised by sweet gum trees, expansive meadows rich in goldenrod and other flowers, and the full transition of wetland habitats from upland streams through to broad brackish lagoons and saltmarsh. The scale of the site, and the diversity of the conditions is such that an end product vastly more diverse than these simple definitions is guaranteed.

Fresh Kills currently stands out as the 'missing piece' of the jigsaw of green spaces and protected areas which make Staten Island New York's 'greenest' borough. The re-active approach to habitat creation will also facilitate the integration of the new forests, grasslands and wetlands with the wider matrix of fragmented habitat survivals on Staten Island. By bridging the gap between otherwise disjunct areas, and providing conduits along which flora and fauna can disperse, colonise and re-colonise, processes of interchange will be encouraged which counteract the terminal loop of isolation, fragmentation and degradation which too often results in such small protected areas diminishing in value with the passage of time.

A larger, integrated system of protected habitats has the potential to not only be more resistant to degradation, but possibly to recover and ultimately support species previously lost. Size is crucial to the ability of an ecosystem to support the full range of its component species – its 'carrying capacity'. Carnivores, birds of prey, large grazing animals and the rare and specialised are the first to disappear when carrying capacity falls below a critical threshold. Even in isolation, Fresh Kills is the single largest tract of undeveloped land in New York City – three times the size of Central Park. Added to the wider framework of protected woodlands and tidal wetlands to which it links, the potential to encourage the re-colonisation of, or even reintroduce larger species long lost from the metropolitan area, begins to emerge.

Nowhere is the potential of Fresh Kills more clear than in the context of migration, and again the site's size, urban location and interconnectivity, are also integral to the potential success of the most ambitious objective of the ecological strategy – to create a unique 'Migration Centre'. This is the main interface between the ecological objectives of the project and those for resource utilisation, visitor experience and design innovation, themselves a product of the site's unique attributes.

At the core will be an attempt to engineer existing migratory patterns across the site to enable one of the most awesome spectacles nature has to offer to be magnified, concentrated and showcased within easy reach of one of the world's greatest urban centres. To understand the reasoning behind this ambition requires consideration of Fresh Kills' wider context at the scales of Staten Island, New York State, the Eastern Seaboard and the twin continents of the Americas.

above: Wetland habitat of broad brackish lagoons and saltmarsh at the heart of Fresh Kills landfill site.
right: Migrating birds follow the 'Atlantic flyway' along the eastern seaboard of the United States.

In the natural world, topographical features such as the coast, and inland mountain ridges and river corridors cause migratory species such as birds and insects to move along broadly predictable paths. New York City is strategically sited on the 'Atlantic flyway' a loosely defined corridor along the eastern seaboard of the United States which is used by numerous species of birds in their spring and autumn migrations. Some species make mammoth journeys – a white rumped sandpiper the size of a postcard may make two journeys a year between breeding grounds in the Canadian arctic, and wintering quarters in southern South America, passing through New York Bay en route. Rather less celebrated, but no less spectacular, are the similar movements of insects, in particular the impressive monarch butterfly.

The urban areas of the city are, unsurprisingly, inhospitable to many of the species that pass through, causing them to congregate in available areas of greenspace or undeveloped land. In these areas, the result can be spectacular 'fall-outs' of small birds such as warblers, skies filled with soaring birds of prey, shorelines crammed with wading birds, and spectacular concentrations of butterflies and dragonflies.

This phenomenon is widely recognised, and many people enjoy the spectacle in some form each year, perhaps most famously in Central Park, Manhattan in which an extraordinary number of different birds and other migratory species have been seen. For the same reason, the Staten Island 'Greenbelt', the network of upland forests running along the backbone of the island, also enjoys a lesser degree of notoriety.

The location, landform and habitats at Fresh Kills indicate that this enormous area of undeveloped land is almost certainly of equal importance to many migratory species travelling through the New York City region. The site represents an extension of the Staten Island Greenbelt, with the added contribution of coastal wetlands. The mounds also replicate the upland ridge of the eastern side of the Island, and continue the availability of updrafts used by soaring birds of prey.

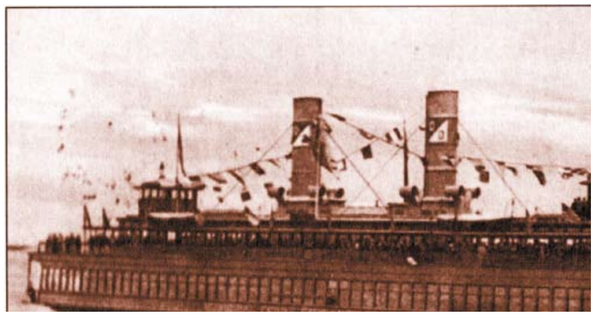
Restoration of the site provides opportunities to enhance these functions, and to manipulate them to influence migratory patterns across the site. The near 'blank canvas' presented by the mounds presents an opportunity to 'engineer' both vegetation and landform to not only mimic natural bottlenecks, but attempt to maximise congregations of migratory species. By steering migrants into selected areas of the site, and keeping them there by providing optimal feeding, roosting and other 'staging' conditions, spectacular concentrations may be encouraged which with innovative interpretation design forming part of a designated 'Migration Centre' can be easily viewed, studied and enjoyed with minimal disturbance.

Any project aiming to rehabilitate modified landscapes over an extended timeframe cannot afford to be overly prescriptive. A strategic and re-active approach is therefore necessary. The overriding ethos behind the ecological strategy is to define realistic objectives for habitat creation and modification based on a sound understanding of the governing processes currently at work. However, the site's scale also presents opportunities to influence or modify such processes to expedite the achievement of targeted objectives of a more ambitious pedigree, as well as exploring new methods of landscape rehabilitation. To meet this challenge will require the simultaneous application of principles at a multitude of scales. It is a huge but inspiring task.

Nowhere is the potential of Fresh Kills more clear than in the context of migration, and again the site's size, urban location and interconnectivity are also integral to the potential success of the most ambitious objective of the ecological strategy – to create a unique 'Migration Centre'.

STEPPING STONES

by Penny McGuire



Staten Island is part of the sprawling estuarine complex that is New York Harbour; '.... a rich aquatic wilderness surrounding the world's greatest city', the harbour was 'once a pristine estuary bristling with oysters and striped bass, visited by sharks, porpoises, and seals.' Humankind's predations and rampant environmental abuse over centuries, particularly during the latter half of the 20th century, have diminished the harbour's plant and animal life and despoiled the land around it. But nature is dynamic and is fighting back with the help of a public anger fuelled by recognition of what has been lost, as well a growing and sophisticated environmental awareness and political will.

There is hope. Improved sewage treatment has allowed Seagate Beach on Coney Island, South and Midland Beaches on Staten Island and all New York City beaches to be reopened. Shellfishing has resumed off the Rockaways and in Raritan Bay and an artificial oyster reef has been built in the harbour, just south of Liberty Island. Sea turtles have been spotted in the Verrazano Narrows and East River, and birds, including raptors like the peregrine falcon, bald eagles, snowy owls and ospreys are returning, as are colonies of common tern and migrating snow geese. New York Harbour is gradually being reborn.

Perhaps the most significant event in the rebirth of the harbour was the final closure in March 2001 of Fresh Kills landfill on the marshy western shores of Staten Island. New York City authority and local determination to transform the giant landfill from a massive blight to a sustainable benefit, will have wide repercussions. If transformation is realised, it will not only contribute to revival of the harbour's ecology, and to the health of the island and islanders, but will stand as an example to the rest of the world.

The landfill was established as a temporary refuse dump in 1948 when environmental controls barely existed. In spite of their melancholy beauty, municipal authorities considered salt or intertidal marshes as empty places of little value, and they were commonly used for municipal dumping; the question of their ecological importance hardly arose. For more than fifty years, Fresh Kills has been fed with a steady stream of New York City refuse which has exhaled foul gases into the atmosphere, and in spite of modern safe guards, has continued to pollute the waters.

Today, the place contains four mounds ranging in height from 90 to 220 feet. Two of them are fully capped and closed: the other two are being prepared for final capping and closure. Other parts of the site, never filled with garbage or filled more than 20 years ago, have anything from landfill infrastructure and roads to intact wetlands and wildlife habitats. Fresh Kills, which is so large as to be visible to orbiting astronauts, was the last of the City's landfills and incinerators to be closed.

As a constituent part of the ecology of the harbour and the third largest borough of New York City, Staten Island cannot be disassociated from the greater entity. From Manhattan, the island is, after all, only half an hour away by boat. For visitors, it is at the end of one of the most magical – and cheapest – ferry rides in the world. With lower Manhattan silhouetted against the north sky, you are taken past Governor and Ellis Islands and the Statue of Liberty south towards the Verrazano Narrows bridge and Staten Island's hills, to the towers and spires of St George on the island's north-eastern tip.

Geologically, Staten Island – like the rest of New York Harbour – was sculpted during the Pleistocene or Ice Age by broad glacial advances and retreats. The island's backbone, the spine of rocky hills that runs down its centre as far as La Tourette Park, is the consequence of glacial deposits. Its highest point, Todt Hill (409.2 feet) is also the highest point in New York City and on the Atlantic seaboard, south of Maine. Most of Fresh Kills sits in an ancient glacial lakebed which evolved by slow degrees into an intertidal marsh with winding streams. Wide low areas along the south shore are composed of the finer-grained sediments that washed out from the hilly moraines.

It is humbling to realise that Staten Island has been inhabited since 10,000BC. Its first people were Native Americans; at first hunters of large Pleistocene animals, these early inhabitants gradually turned, as these animals became extinct, to small game, fishing, shellfishing and plant-gathering. Native American occupation continued until 1670 when the Lenape Indians ceded possession of the island to the British.

Under centuries of Indian occupation, the island's landscape had altered little. Settlement over the next century by French Huguenots, and Dutch and English immigrants (and a number of Africans, most of whom were slaves) established farming in earnest and flourishing maritime industries. By the beginning of the 18th century, self-sufficient farmers and fishermen lived in small settlements close to ferry landings and farms. Commerce prospered. Richmondtown, the first real village, became the county seat in 1729. The American Revolution (1776 – 1783) interrupted this pastoral idyll and Staten Island became a vast military camp from which the British could launch attacks with barges built on the island. Though largely Loyalist, the islanders found the presence of large numbers of soldiers a considerable strain on resources. Forests were cut down for firewood and hilltops cleared for strongholds.

But with the Patriot victory, the islanders resumed their agrarian and maritime livelihoods. In 1829, young Cornelius Vanderbilt started a ferry service to Manhattan; Staten Island became a seaside resort attracting such luminaries as Longfellow and Melville, and Garibaldi spent three years on the island during his exile from Italy. For Thoreau, Staten Island was 'like a garden and affords very fine scenery' (1843).

From the early 1800s for almost a century, the Island's chief industries were farming, salt hay (for bedding and packing) and oystering. The 19th century streets of Tottenville, on the southern tip of the island, were paved with oyster shells; and oysters from nearby Princes Bay were considered so fine that menus of fancy New York restaurants designated them by name. Beds of oysters and clams were so extensive that it could not be imagined they could ever be consumed. But by the 1900s, pollution had put a tragic end to the industry.

Rapid industrial growth had hit Staten Island before the Civil War as a consequence of growth in other boroughs. Cargo ships serving the flour mills and farms of Richmondtown sailed up Fresh Kills Creek, and up Richmond Creek which, like Main Creeks, was navigable for more than a mile. Several brick factories which quarried the local clay were built to the south of Fresh Kills and, by the 1850s, a railway ran between Clifton and Tottenville. After the war, development and industrialisation resumed. In Travis, north of Fresh Kills, the American Linoleum Company established Linoleumville. Further south, Charles Kreishcher, a Bavarian immigrant, built the eponymous town of Kreishcherville for German and Irish workers at his factory which manufactured clay bricks and terracotta building products. After the factory closed in 1927, the town was renamed Charleston. Memory of that industry resides in the abandoned quarry of Clay Pit Ponds, a remote and beautiful area of pine barrens.

The benefits of industrialisation were partial and development was slow. The island was notoriously malarial; and an investigation carried out in 1871 found that drainage was abysmal and communications difficult. In particular, the ferry service was poor; few of the recommendations were implemented.

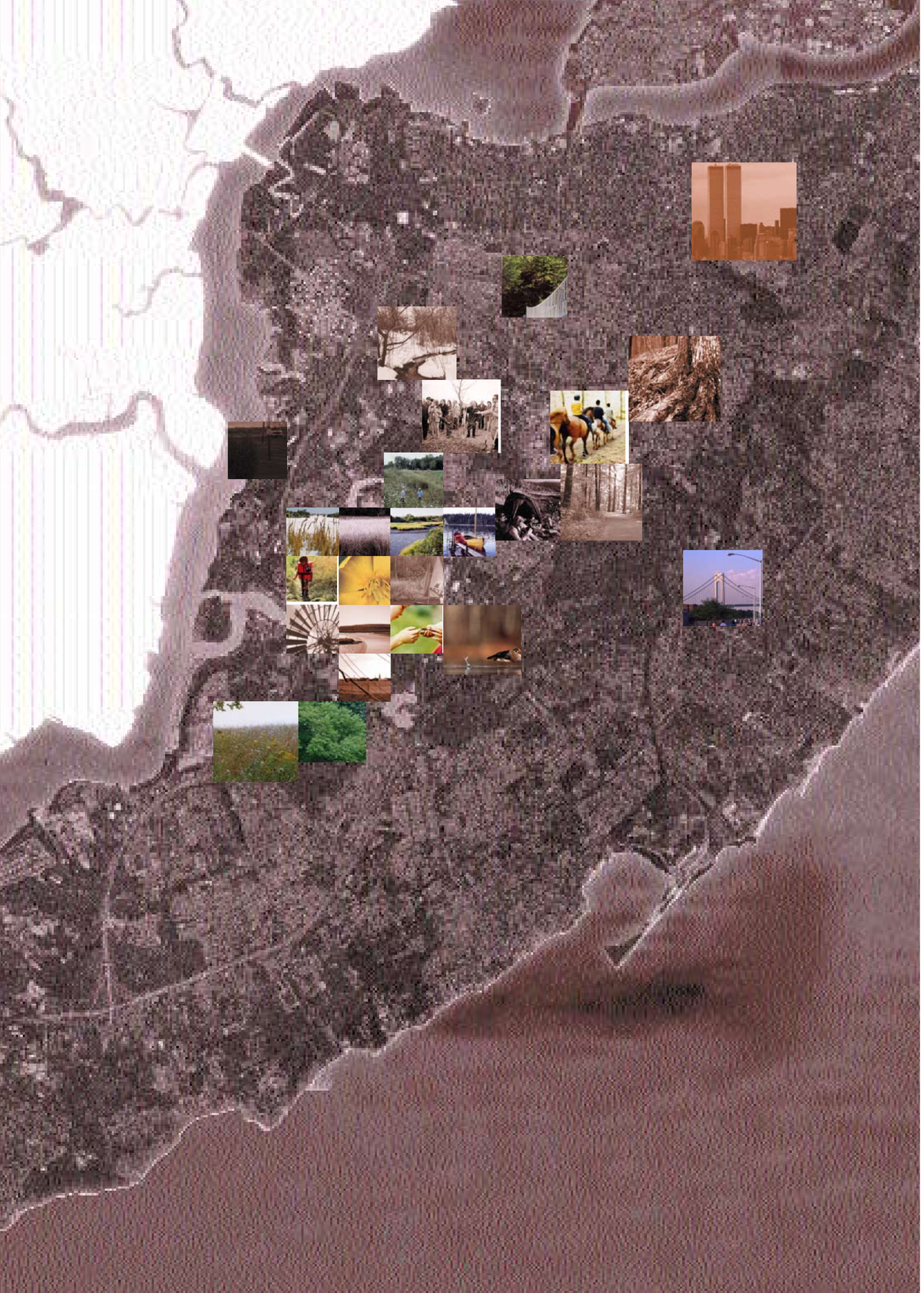
Nevertheless, Staten Island remained a pastoral haven longer than other satellite areas of Manhattan, up until the postwar period. Early in the 20th century, immigrants from Scandinavia, eastern Europe and Italy added to the rich cultural mix already established on the island. Growth of the ports of New York and New Jersey fostered industrial development on the shores of Arthur Kill and Kill van Kull; by 1922, two thirds of islanders lived in the north and east of the island.

Staten Island has never really been cut off from the mainland. As early as the 17th century, it was part of a popular stage coach route between New York City and Philadelphia. Travellers crossed Arthur Kill by boat, at first near Rossville and, later, further north at Travis. Construction after 1931 of the cantilevered Goethals Bridge from Howlands Hook to the Bayway section of Elizabeth, NJ, of the elegant steel arch of Bayonne Bridge, and the Outerbridge Crossing, created vehicular links between Staten Island and New Jersey (ironically known as the Garden State).

But the two events that had the most profound effect on Staten Island, were the commencement of landfilling at Fresh Kills, and the construction a quarter of a century later in 1964, of the Verrazano Narrows Bridge. If the first grew slowly into a communal blight, the secon d had immediate effect on the island's growth and development. Connecting the island to the rest of New York, the bridge brought new industry, residents and crime. Development soared. Today, 380, 000 people live on the island. The north, east and south sides of the island are covered with buildings, in places up to landfill peripheries, and real estate prices are rising sharply; Staten Islanders are concerned. Only the establishment of the Greenbelt in 1984 and state protection of forests, wetlands and seashore, has saved what remains of the natural beauty of the island.

And at the same time, it must be remembered that the special character and history of the island make it unique. Up until the turn of the 19th century, the very nature of much of the island's landscape, predominantly gentle and pastoral, with rolling farmland, orchards and forests of oak and chestnut, feathery reed beds, salt hay marsh and watery channels, ensured its vulnerability. Gentle landscape is so very easy to spoil. But still, in spite of rampant growth, the island is still the least densely populated of all the City's boroughs, and Staten Islanders are emphatic that it should remain this way. Those residents who are passionate about what remains of the natural beauty of the island, about the extraordinary indigenous richness of animal life and vegetation, and about the strange diversity of its open spaces, are determined that Fresh Kills should not fall victim to untrammelled development. They want a hand in controlling the shape of the future.

left to right: Staten Island's relationship with New York City is variously represented in images of Vanderbilt's Staten Island ferry service to Manhattan (1829); the practice of garbage dumping into the Hudson River from barges (1896) before landfilling commenced; the dramatic impact of the Verrazano Narrows Bridge (1964).



JMP Landscape / John McAslan + Partners and Arup (London and New York) is one of three finalist teams selected by the City of New York in the masterplan competition to be eligible for the end use consultancy for Fresh Kills Landfill on Staten Island, New York City. As the largest landscape project in the region, Fresh Kills will become a key open space for the island, city and region as well as setting new standards for landscape regeneration projects world-wide.

Covering 2,200 acres, the site contains a significant area of tidal saltmarsh together with the largest capped landfill in the world, generating an immense reserve of methane. No other site in the world has this combination of natural resources and latent 'free' energy, each instilling the landscape with a powerful dynamic for change. Our proposal envisages the park as a vast working resource, in which ecosystems, energy cycles and human activities are self-sustaining and interact, giving the opportunity to restore, renew and reconnect.

In the first phase, resources are used to generate the raw materials – plants, soil, energy (and revenue) – that are vital to bring Fresh Kills back to life. In time they will develop into an unusual park with built environments, providing a world class educational, visitor and investment opportunity and contributing to the wider regeneration of Staten Island.

RESOURCE PARK

At the heart of Fresh Kills will be a family of buildings interpreting the site's impressive resources – nature, energy and people – to create a dynamic new experience. These are the Migration Center – bringing the spectacle of bird migration to a broad audience, the Energy Center – focussing on renewable energy technologies, and the Earth Center – generating a full range of native plants from local seed together with tonnes of soil and compost from local recycled materials. Large open-span Eco-sphere structures will contain sub-arctic, tropical and temperate climate zones, replicating the diverse ecologies along the length of the Atlantic flyway. Challenging the boundaries of technology, these structures – unlike any other facility of their type in the world – will be entirely sustained by the energy on site.

opposite page: Illustrative site aspiration diagram.
left; top to bottom: Site analysis diagram showing Natural Systems, Transportation Network, Green Belt, Land Zoning and Community Flows.
above: Concept diagram showing mosaic of inter-related resource 'fields' across the landfill site, including methane gas recovery, solar collection, wildlife habitats, woodland creation, nursery gardens and recreational amenities.

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The planning and design proposals described herein are those of the JMP Landscape / John McAslan + Partners and Arup team and have not been adopted by the City of New York, nor do the author's views necessarily reflect those of the City of New York.