16.3

AFTERUSE OF LANDFILLS

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GENERAL ASPECTS

Municipal solid waste management is consistently linked to a strong interrelationship between technology, the environment, the terrain, and society. In the past, although in the presence of a dearth of disposal technologies, this interrelationship was concealed by the small scale of interventions, low population density, limited mobility of the population, and by a limited (at times absent) environmental awareness. Subsequent economic and demographic growth has raised the visibility of land use and environmental issues deriving from waste management. Means of transport, technology, and the Internet have all promoted an increased mobility and enhanced the possibility of a widespread contact throughout a region.

The locality no longer provides residual spaces to be used for the purpose of waste disposal but dictates how waste management systems should be comprised as part of an overall land use plan, linking the diverse areas of the local area in a process ultimately identifying the intended use of the areas within the context of an organized community. Accordingly, the disposal of waste evolves from an inexpert task into a process and tool intended to foster new forms of land use. The planning and design underpinning the management and realization of a waste disposal facility should represent a planning activity capable of contributing to local land use planning and fully integrating with other urban structures (intended as the locations on which the attention of the community is focused), rather than being seen merely as the consequence of exclusions and concealments or limitations dictated by a state of emergency. Moreover, planning and design should strive toward obtaining consent at the time of decision-making, and in no case later than siting of the works. Consent should never be applied retrospectively in the presence of an organized opposition carried out by the populations concerned (see Chapter 4.1 for further details).

In terms of quality of the local terrain, it is no longer a sustainable practice to earmark extensive areas to be occupied by landfill, although the importance placed on this issue may vary according to the reference context concerned. In some countries, land reclamation is a firmly established condition aimed at guaranteeing quality of life under threat from an uncontrolled industrial development and population growth necessitating use of the land in question and avoidance of misuse (Fig. 16.3.1).

In this regard, a landfill represents potential value in line with the context in which it is located. Functional reclamation of the Hong Kong landfills (Sai Tso Wan, Jordan Valley, Sheung Wan,

Figure 16.3.1 View from the Monongahela River to the administrative district in Pittsburg, USA, 1974. *Photo by John F. Alexandrowicz from Alba (2015a).*

etc.) is a concrete example of this concept (Fig. 16.3.2). The latter landfills, all sited on areas of virgin land, were identified as valuable land to be used in creating leisure facilities and green spaces that were inevitably lacking throughout the territory.

Functional reclamation of the majority of landfills, when envisaged, consists mainly in the siting of revegetation works on the final cover with the aim of mitigating impact, although these works are frequently limited to a mere restyling that rarely leads to an effective functional reuse of the area.

However, numerous cases of functional reclamation of old landfills have been described worldwide, attesting the real possibility of undertaking works for the good of the community. Thanks to a cultural approach that tends to view this type of work favorably; and due to a general lack of space, old landfills in Spain, Japan, and China (for example) are frequently used for the purpose of creating urban green spaces with leisure and sport facilities (Box 16.3.1).

Figure 16.3.2 Jordan Valley, Hong Kong. Formerly, a landfill site with landfill gas and leachate, it was restored and converted into a popular recreational park. It is currently a big green lung in Hong Kong becoming a popular recreational facility for the public. Jordan Valley Park was opened to the public in August 2010. The Park (6.3 ha) features a radio-controlled model car racing circuit, horticultural education center, community garden, children's play areas, elderly exercise corner, jogging track, etc. *Photo by James Tsz Fung Wong (2015), from Waste to Photo, Sardinia, 2015.*

Box 16.3.1 Moerenuma Park, an example of landfill afteruse in Sapporo

Moerenuma Park is unique in its typology; it is the biggest park in the world, entirely, built on a landfill, realized in Sapporo, following a master plan by the Japanese–American sculptor, Isamu Noguchi.

Moerenuma is a comprehensive park that is intended to be the base of the "Circular Greenbelt Concept" that combines the green spaces of the city of Sapporo within a loop. Construction commenced in 1982, and the park had its grand opening in 2005 (Fig. 1).

Sculptor Isamu Noguchi created the basic design based on the concept of "the whole being a single sculpture."

In Fig. 2, the site plan and the main structures of the park are represented.

Figure 1 Aerial view of the park.

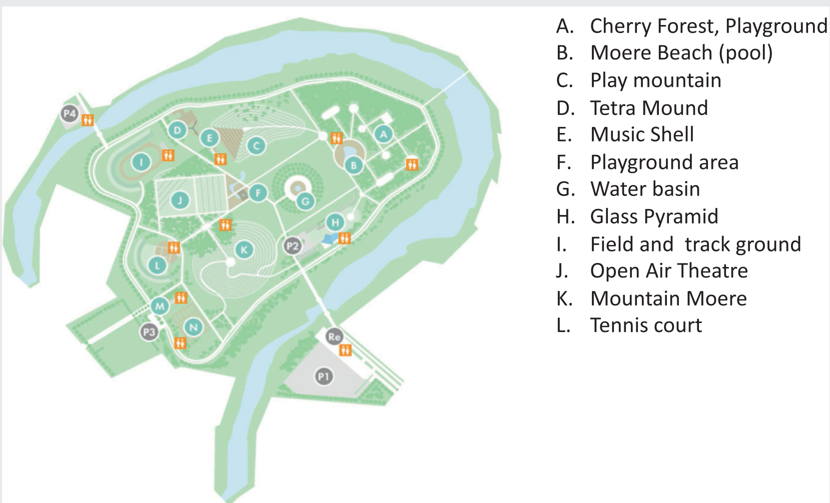

Figure 2 Site plan and the main structures of the park.

Box 16.3.1 *(cont'd)*

The site is designed in a meticulous way. The fountain and hills form many geometric shapes in the expansive grounds, facilities for play equipment are arranged in an orderly manner, and the landscape can be enjoyed as a fusion of nature and art. Visitors may enjoy cross-country skiing and sledding across the snow-covered landscape during winter. The park is conceived to be used for the whole year, with attractions for all seasons.

Serving as the symbol of Moerenuma Park, the Glass Pyramid is the central facility of the park that is considered to be one complete sculpture. This facility accommodates a gallery introducing sculptor Isamu Noguchi with visuals and books, a multipurpose space that serves as a place for citizens' cultural activities, restaurants, shops, etc. (Figs. 3 and 4).

The park is equipped with a green zone that includes seven Play Equipment Areas, which are interconnected by paths.

A shallow pond from Isamu Noguchi's planar form is installed in the middle of the cone-shaped site surrounded by promenades.

Noguchi drew up plans for the park in November 1988, but died, aged 84, just 1 month later.
It took 17 years to complete the final project.

Edited info by Arcoplan Associates, Padova.

Figure 3 The path leading to the top of Play Mountain.

Figure 4 Visitors in winter time.

Options resulting in a renewed use of areas are required to undergo a decisional/design process aimed at assessing the most appropriate final choice in terms of land reclamation, impact on the landscape, environmental sustainability, and community consensus. These options are considerably limited by the fact that landfills are conceived to represent the final solution for a specific area, with reclamation not being taken into account during the important design stage. The limitations to be addressed during this process are linked mainly to management of the waste volumes concerned. Indeed, aboveground waste void space is developed to allow the deposition of as much waste as possible, resulting in the formation of masses that significantly limit reuse options. Old landfills, initially developed with a specific intended use, although not strictly viewed as pollutants, constitute a potential "polluting" presence on the area that frequently deface the landscape and functionality of the area (for example, the typical troncopyramidal shape, etc.).

OPTIONS FOR LANDFILL AFTERUSE

The potential afteruse of landfills and main options can be summarized as follows:

- "Natural" biotope, with or without significant maintenance
- Public park (with or without installations, infrastructure facilities, buildings)
  - Recreational—sport area—thematic parks
  - Botanic garden
  - Golf course
- Grassland
- Agricultural use
  - Grazing land for sheep and cattle
  - Plants for food production
  - Energy crops
- Energy use
  - Photovoltaic installations
- Commercial use
  - Waste treatment facilities (e.g., composting, anaerobic digestion plants, recycling center, etc.)
  - Diverse commercial plants (storage facilities, handicraft businesses, small production business (mostly with office building))
  - Open air research centers
- Housing
  - Houses for permanent living should in general not be built on a landfill. Even if the potential risks have been overcome by means of adequate measures, there will always remain the psychological stress living on a landfill.
  - Concern may arise from, e.g., rumors regarding emissions arising from potential toxic compounds deposited in a landfill. Even if analytical results show no contamination in the atmosphere, often this concern may remain.
  - Offices could be built only if the highest safety precautions are in place (see also Chapter 15.2).

To avoid risks to the environment and to people staying on or adjacent to a landfill, it should only be considered for afteruse if the landfill has a low emission potential and all necessary safety measures have been implemented.

Afteruse of landfills can be manifold. There is a distinction regarding whether the landfill will be open to the public or not. In case the landfill will be used without public access, it may make a difference if food products are grown on the landfill surface or if animals graze on it.

Examples for landfill afteruse without public access are the construction of windmills and photovoltaic plants on the surface. If public access should be allowed, the safety measures should be more stringent. Examples for this kind of utilization may range from recreation areas to commercial use, up to housing. In any case for each kind of utilization, it has to be ensured that there are no direct (e.g., explosions, suffocation) or indirect (e.g., food contamination) risks.

Some examples of potential afteruse options are given in Fig. 16.3.3. Different kinds of utilization can be applied to the same landfill.

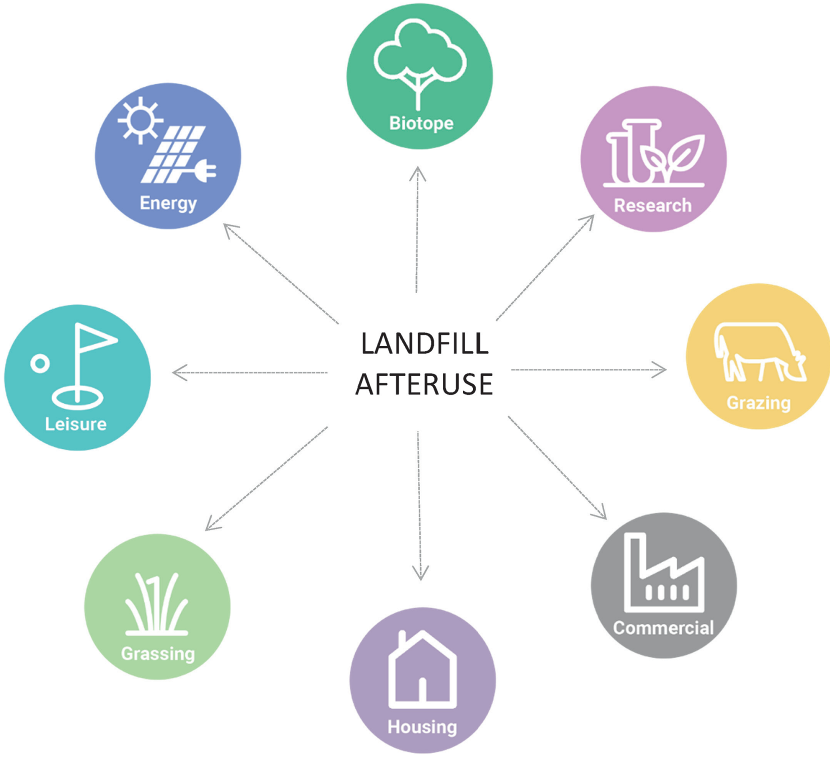

Figure 16.3.3 Graphical representation of the main categories of possible landfill afteruses.

METHODOLOGICAL APPROACH

Generally speaking, designing a final solution for the area and studying the morphology and configuration the site will possess once waste deposition has been completed, implies an inherent need to identify the relationship that the new development will establish with the surrounding natural and cultural landscape, thus determining the success of future relationships. Therefore, the forms assumed by the environment, the history of the area, the locations, the presence of places of interest throughout the area, should all be reviewed in detail with a view to defining the relationship of the facility with the local context, what functions it may fulfill, and—in case of designing, e.g., a park—what species of plants should be used to cover the site, while at the same time envisaging use of the waste mass as a "plastic" element (an architectural term for rich, three-dimensional or sculptural presence of an architectural element or building) for the reconstruction of a coherent and redeveloped landscape.

Potential risks to be considered in case of landfill utilization

Before planning a specific afteruse project, potential risks that may derive from the landfill should be known. Even if landfills are closed for several decades, there may still be risks that are associated mainly with gas emissions, mechanical landfill stability, and settling. Even if the gas production is very low and restricted to certain areas of the site, landfill gas may accumulate over time (perhaps years) especially in constructions built on, into, or adjacent to landfills. These may be in houses, manholes, shafts, pipes, cable ducts, etc.

Dangers that can emanate from landfill gas emissions may be many:

- Inhalation of toxic trace compounds may cause health effects. In some cases health or well-being of people living close to or on a landfill has been influenced because people were afraid of these toxic traces although they could not have been detected in the living environment of the people, i.e., the psychological effect should be taken seriously.
- There is a great risk for explosions (Chapters 9.3 and 9.4) when explosive mixtures are present in the accumulated gas and a spark is caused, e.g., by switching a light on or open fires. There are many examples of casualties in this regard. At a landfill transformed into a park children entered into a manhole as part of the surface water collection system and ignited a small fire that caused an explosion.
- In shafts and manholes gas may accumulate and substitute oxygen. If people enter this area, they may suffocate. This happened in the past more often than explosions.

Adequate planning and supervision can avoid these potential problems.

Risks associated with the mechanical stability (Chapter 5.2) are as follows:

- Nonhomogeneous settling may occur also at old landfills and can have different effects: landfill surface liners may be affected in their functionality (depressed areas where water can accumulate, fissures, cracks in clay or bentonite liners, as well as holes and tears in plastic liners).
- If the mechanical landfill stability is not secured, e.g., due to water accumulation, sludge disposal, steep slopes, and/or low compaction landfill sliding may occur.
- Because the waste underlying a landfill surface is in general not as stable as soil, another potential danger may be the collapsing of constructions on the surface (e.g., windmills).
- Trees and other deep rooting plants should be avoided because they may influence the integrity of the drain system and the surface liner.

Prerequisite for landfill afteruse

To avoid the potential problems described above, landfills have to be constructed and operated respecting regulations and the state of the art. In addition, the landfill should be biologically stable with a low emission potential (Chapter 16.1). Uncontrolled leachate and gas emissions have to be avoided; residual gas emissions have to be captured and treated or the landfill has to be transferred into and kept in the aerobic stage (Chapter 16.2).

The surface cover system should be engineered in order to be primarily functional to technical requirements according to the different landfill concepts and technologies (Chapter 11.1).

Construction of buildings above the landfill should not be in direct contact with the landfill surface so that air can circulate underneath and infrastructure facilities as pipes, manholes, etc., should be ventilated if necessary.

The standard a landfill should meet may be also dependent on the kind of afteruse. As a consequence, different kinds of landfill utilization may take place at different degrees of stability reached (Chapter 16.1). In each case a risk assessment should be made for the different options.

Monitoring program

When a closed landfill is considered for utilization, or is already being used, an extended monitoring program will be necessary. Potential gas emissions through the landfill surface can be detected, e.g., by means of a flame ionization detector; in all areas where gases may accumulate or where preferential pathways can be expected gas monitoring devices may be used to measure the gas quality (in general CH_4, CO_2). Also inside constructions and buildings the gas quality has to be supervised. In addition to CH_4 and CO_2, H_2S should also be measured and from time to time trace components have to be analyzed. In areas where gas may accumulate also the O_2 content should be measured. Gas control monitoring should also be done in the near neighborhood of a landfill.

Settlement rates have to be monitored. Also the functionality of the leachate collection and treatment system has to be secured and water levels have to be ascertained; eventual uncontrolled leachate emissions have to be detected. Also ground water control monitoring regarding levels and quality is necessary. Of course the prescribed landfill monitoring program in the aftercare phase has to be executed.

Assessment of the surrounding area

The following paragraphs focus mainly on landscaping, integration into the surrounding area, and public perception. In addition, several examples will be presented. In line with the most elementary principles of land use planning, the assessment of the surrounding area undeniably represents the most important step to be undertaken prior to drawing up of the project and irrespective of the type of intervention to be carried out (Fig. 16.3.5, Scenarios A, B, or C).

In the same way as for any other type of area, the renaturalization of a landfill, whether it be in existence or still at the design stage, is largely linked to an understanding of the area and the territorial structures present to enhance the integration of the area and the establishment of necessary bonds with the preexisting urban and natural structures.

The complexity of the landscape and the wealth of elements characterizing the area should be carefully analyzed in the light of the predominant factors present; the stratification of the area should be investigated and the history of the same derived to enable a coherent future development of the area to be hypothesized.

Once the main objectives of the project have been established, the methodological process should include an accurate assessment of the local area.

Analysis of the landscape and terrain

Assessments of the terrain and land use are fundamental with a view to analyzing the predominant features of the area concerned. In particular, a detailed analysis of the agricultural context and the dominant environmental factors is mandatory in identifying the lines to which the new landform design should adhere and to establish the specific land use of the restored site.

This type of analysis is based on the identification of the environmental components that will be involved in the project. The environmental system is thus split into elementary components. In the same way as in routine land use planning, this type of analysis is conducted by means of overlay mapping of the natural system in which the major components (elevations, waterways, etc.) have been broken down.

Analysis of the residential/infrastructural system

This assessment possibly represents the most important stage of the preliminary analyses and is fundamental in ascertaining the size of the catchment area of potential users, also in view of the vicinity/distance from the main towns and cities that will need to be taken into account. A thorough knowledge of the history of the area and of the existing facilities is mandatory with a view to identifying a potential lack of infrastructure and determining future relationships.

Analysis of the productive system

The existence and articulation of resources (underpinning the specific local characteristics) should be highlighted: identification of the latter will contribute toward revealing the magnitude of the environmental values and pinpointing of those areas displaying signs of incompatibility with potential transformation works. Subsequently, any existing restrictions should be examined.

Analysis of prevalent activities—this should be carried out to assess the possible links to the project and to identify potential involvement of the local manufacturing industry.

In general, an activity is subjected to elaboration of the geography of environmental values that correspond to the geography of compatibility of use of the territory.

The concept of an environmental system that summarizes these aspects should be analyzed according to the division of the three main areas affected—population, activities, and locations—which, through their links with the spaces, society, and the economy and the relationships each has with the history of the area will provide a detailed picture of the system concerned.

PROJECT REQUISITES

Downstream of the outcomes of the preliminary territorial analysis, the planning and design should be developed with the aim of fostering a harmonious insertion of the intervention in the local context, in respect of the morphology of the surrounding landscape, and recreating the essential forms and lines of spatial continuity. A project for reuse of a landfill should restore the terrain to its natural moreover providing an added value and meeting the requirements of the local community by bridging a potential gap in the lack of infrastructures. It should furthermore provide a series of educational, social, cultural, and leisure facilities to attract potential users.

The design concept should moreover promote a positive outcome and economies of scale, bearing in mind the economic feasibility of the transformation, and should strive toward creating an "exportable model" for use as a reference project in similar contexts.

Participation and consensus during the design and planning stage

The success of a project will depend largely on the level of consensus received from the local community who will benefit from the presence of a quality-controlled environment, from local manufacturers and consumers. Indeed, an environmental reclamation project, in the same way as any other type of policy impinging on the environment, implies a conflict of interest between preoccupations relating to quality that underpin the project and the need for economic growth and consumer use. Intense dialog and political debate may attenuate these contrasts: the population, businesses, and representative pressure groups should be kept informed of the choices made, the impact of these, and of associated economical, social, and political values to overcome the scepticism of the public with regard to the objectivity of the information provided and the motivations underlying the initiatives. This is particularly important when doubt is shed on the credibility of the institutions in the light of past experiences.

In a context involving a series of different, at times conflicting, interests, public involvement should be focused mainly on establishing a situation of trust between the administration, the businesses, and the end users, in identifying any significant issues for the community, and in raising consensus by limiting occasions for conflict and improving the decision-making process.

The acquiring of consensus may be obtained by means of awareness programs developed ad hoc for each type of user highlighting the objectives to be achieved and the specific reference context. A series of methods are available for use in raising awareness. Experimental studies have shown, for example, how meetings and seminars are particularly beneficial in establishing and fostering relationships of mutual trust and credibility. Two possible involvement processes are illustrated in Fig. 16.3.4. In

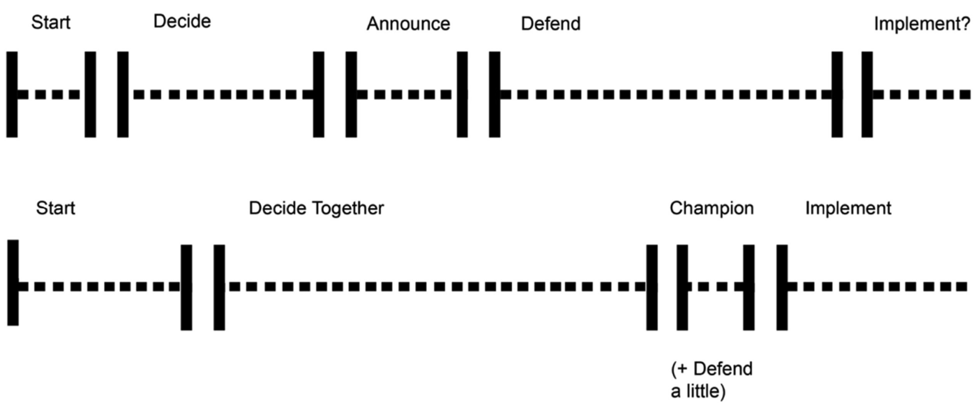

Figure 16.3.4 Involvement processes: diagram 1—Decide–Announce–Defend (common process)—and diagram 2—Engage–Design–Deliver (recommended approach). *Source: (Bishop, 2015).*

the approach "Engage—Design—Deliver," some key representatives of the wider community are brought in at the very start to discuss and agree the scope of the project and the involvement process with the technical team. This takes longer than the start in the old model. The team, the core group, and many others then engage in the process "Decide Together." Then, instead of having to announce the proposals to an unsuspecting public, not only are (most of) the public already aware but some will have contributed directly to those proposals. Instead of objecting they will often support, even "champion" what many by now consider to be "their" project. Some defending is, however, always still needed.

AFTERUSE OF LANDFILLS: POTENTIAL SCENARIOS OF INTERVENTION

When considering the reuse of an existing landfill or hypothesizing the functional use of a landfill yet to be constructed, the main features to bear in mind are environmental conditions, safety, technologies used to mitigate impact, the impact on land use and infrastructure exerted by the facility within the context in which it has been sited, and landscaping in view of the value of transformation elicited on the existing landscape by siting of the landfill on the area.

Functional reuse of a landfill may be envisaged in a series of different situations as follows:

A. Existing landfills requiring works of environmental reclamation or recovery
B. Existing modern landfills either undergoing construction or operational (or in which extension works are required)
C. Landfills still to be designed (details relating to siting, waste volumes to be deposited, etc., may not be known).

Accordingly, three different scenarios are described below.

Scenario A/old landfills: when intended use is dictated by the shape

Reclamation of an old landfill is characterized from the outset by a predominantly negative view of the intervention: to reclaim, i.e., to undertake the recovery of an environmentally compromised situation and reestablish links with the surrounding area. From a morphological viewpoint, old landfills were invariably constructed without any consideration for the landscape or urban planning, with the sole constraint of complying with the height limits defined by the competent Authorities at the time of authorization. In an attempt to maximize the capacity of the facility, landfills were frequently developed without paying due attention to aboveground waste volumes, thus resulting in the formation of improbable-shaped masses that interrupted the natural lines of the landscape. A recurrent skyline was represented by a truncated pyramidal formation that, although designed according to laws enforced at the time (in terms of maximum height, slopes, etc.…), left an invasive and permanent anthropic mark on the landscape. The resulting land conformation significantly limited the choice of intervention, with the preexisting landfill constituting a highly visible element with which the restoration project would be required to interact (Fig. 16.3.5, Scenario A).

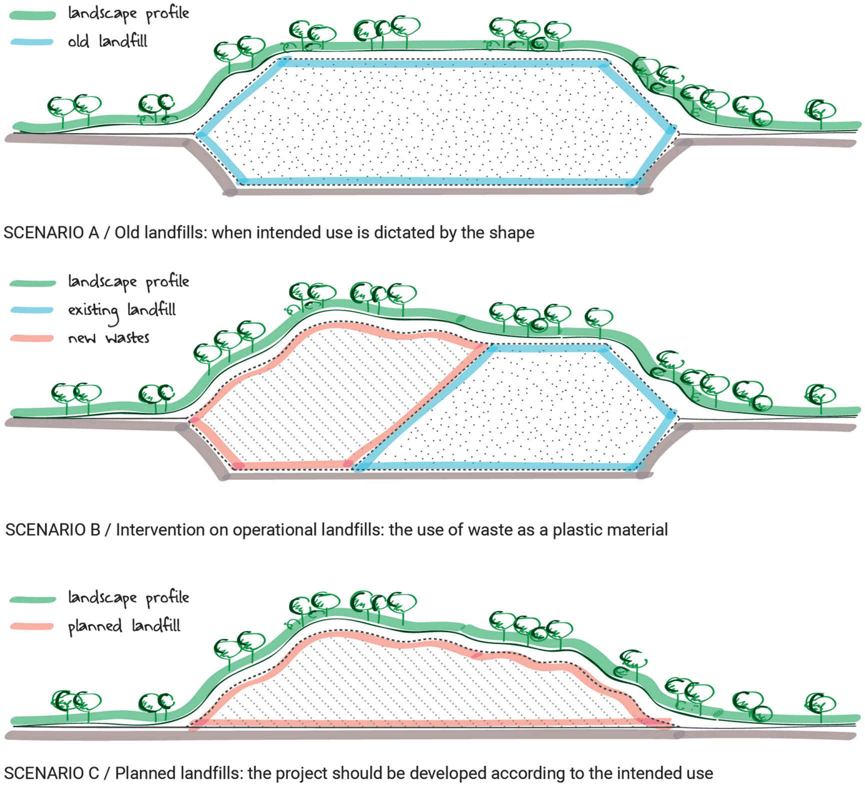

Figure 16.3.5 Scenarios of intervention: Scenario A diagram of the typical truncated pyramidal shape of old landfills, Scenario B diagram of a possible extension in existing landfills, and Scenario C diagram of a future landfill: the wastes are used as a plastic material to shape the land.

A good functional rehabilitation project should therefore assign an appropriate role to the preexisting landfill, without attempting to mitigate or conceal the same, but rather seeing it as a means of interpreting the entire project, as a continuing testimony to the previous life of the site.

A relevant example that clarifies this concept is provided by the restoration of the Hiriya landfill in Tel Aviv, an impressive 60 m high "mountain" of waste distributed over an area of more than 450,000 m^2 (Fig. 16.3.6). The landfill restoration project provided for transformation of the area into one of the largest urban parks in the world, thus changing the aspect and features of the "mountain" of waste from a negative element of the landscape into a symbol of ecological renovation. The volume of the old landfill stands at the center of the project like a large evocative totem, in clear view of visitors in all corners of the park. Taking into account the preexisting facility, the transformation of the Hiriya landfill was designed as a sort of enormous theme park focusing on waste recycling and evolved into an innovative center for research on recycling technologies that also hosts educational activities.

Figure 16.3.6 Hiriya Landfill, Tel Aviv. *Courtesy of Studio Latz + Partner.*

As a general rule, a functional restoration and landscaping project will need to address the issue of the complex management of a landfill during the postfilling stage. It will need to take into account the presence of the visible impact of some infrastructure (i.e., leachate drainage and/or treatment plants, biogas extraction plants, etc.), of subsidence and settling of the waste, of the existing slopes and topography in general, of water management and layering of the final cover. All these elements, and potential safety problems, if not assessed previously with a view to final recovery, will further limit any possible form of reuse.

The landscaping and agronomic management of the site should be carefully investigated during the planning stage. The area should be planted to enhance a correct balance between surface runoff, infiltration, and evapotranspiration, thus promoting a correct control of infiltration water (see Chapter 11.1).

Indigenous trees and shrubs are to be preferred, having roots that are suited to the substrate and do not interfere with the surface liner and leafy coverage to enhance runoff and evapotranspiration. Herbaceous species should be fast establishing, hardy, and with a low degree of flammability.

In the context of Scenario A, Fig. 16.3.5, possible outcomes are represented by nature parks or green spaces with leisure facilities (theme parks, motocross tracks, cycle paths, golf courses, model plane fields, and sport and leisure facilities in general). Other more complex and structural constructions are hard to achieve.

It is, however, possible to achieve a good outcome in the functional reclamation and landscaping of old landfills denoted by high quality architectural features, as attested by a wide series of projects undertaken throughout the world.

Reclamation of the Barcelona landfill, situated in the Vall d'en Joan in the natural Garraf Park, is still today deemed a reference project of excellence for this type of intervention. The project for restoration of the landfill was drawn up by the Spanish architects Enric Batlle and Joan Roig, and in one sole intervention was aimed at achieving three major aspects: solving a complex technical problem, creating a new community area, and providing a new landscape (Figs. 16.3.7 and 16.3.8).

The complex technical issues deriving from the closure and final covering of the landfill underpinned the rationale behind the working hypothesis: the organization of the stepped consolidation

Figure 16.3.7 Land view of the El Garraf Massif, Barcelona. Project for a community park on the Vall d'en Joan landfill designed by the architects Enric Battle and Joan Roig (Sànchez Fabra, 2015).

Figure 16.3.8 Aerial view of the El Garraf Massif, Barcelona. Project for a community park on the Vall d'en Joan landfill drawn up by the architects Enric Battle and Joan Roig (Sànchez Fabra, 2015).

terraces, the containment banks and road access marked the geometry of the landfill and determined the placing of the pipelines required by the gas treatment plant to generate electricity, for the drainage system and the transfer of leachate. The third objective, the development of a new landscape, was influenced by a desire to merge the old landfill with the Natural Garraf Park. Naturally, the morphology of the site today differs vastly compared to the original features. However, the Garraf Park comprises cultivated valleys that have been modified by means of agricultural techniques (Fig. 16.3.9) purpose adapted to the local geography using a system of terraces, drainage, and cultivation to meet the technical requirements of closure and final covering of the landfill.

The final outcome saw the construction of eleven stepped terraces planted with native drought-tolerant species compatible with integration of the landscape. Moreover, an irrigation system was set up throughout the area to facilitate watering. An underground drainage system was devised to separate the pollutant liquids and recirculate the water to irrigate the park. The landfill also provided biogas used in the production of electricity.

Some wastes were left on the top of the landfill in large steel cages to remind visitors of the origin of the site (Fig. 16.3.10).

Figure 16.3.9 Constructive and vegetation systems, inherited from traditional agriculture (Sànchez Fabra, 2015).

Figure 16.3.10 Detail of plant walls, built of nondegradable products of the old landfill (Sànchez Fabra, 2015).

A similar strategy was adopted by the architect Israel Alba who curated the transformation of the Valdemingómez landfill in Madrid (Fig. 16.3.11). The project for the recovery and transformation of the Valdemingómez landfill in Madrid required the application of complex environmental engineering processes, as well as new architectural strategies. Today, it is a place that can be incorporated, with full guarantees, into the city structure, as long as it is viewed as a monumental public space. It is

Figure 16.3.11 Valdemingómez landfill, Madrid. Project by Israel Alba.

recovered ground, capable of becoming a new, free metropolitan space that can respond to the current and future needs of society, especially if it remains as such over time.

The architectural project undertaken involved the proposal of new strategies to create an area that would remain open, flexible, and dynamic throughout time, in a search for equilibrium between city and nature. The Valdemingómez landfill constitutes an example of a proposed model of continuity between the forest and the surrounding area; a pseudobotanical garden with indigenous species seeking integration into the Parque Regional del Sureste (Southeast Regional Park). It was transformed into a free, public area with pedestrian paths and bicycle lanes, along with woods and wetlands, which have helped to create small, localized ecosystems. The life of both the nature and the city can be observed within.

The project for the general reclamation of the old "Fresh Kills" landfill in New York is one of the most widely known. Firstly, as it is the largest existing landfill worldwide, since closure of the landfill in 2001, the value and significance of this urban site of more than 890 ha have changed considerably. This artificial landscape located to the east of Staten Island is viewed today as an extraordinary resource for the fast-growing population of New York with its pressing need for green spaces. Only 45% of the Fresh Kills site has actually been used as a landfill. The remaining area features the extensive swamps that have characterized the New York archipelago since its origin. The wide variety of natural environments present forms a habitat for numerous indigenous and migratory animal species. The aim of the project was to transform Fresh Kills into a 21st-century urban park (Fig. 16.3.12), while maintaining both the large dimensions and the essential underlying character of the area. The buildings and the activities are all confined to specific areas, thus leaving the rest of the site as open and natural as possible.

The project will be completed over a 30-year period, with the first challenging 10-year stage comprising work on the northern and southern sections of the park. The implementation strategy is based on a series of flexible and incremental steps aimed at ensuring a balanced execution of works to close the landfill, start up the site management processes, and transform the area into a public park (Fig. 16.3.13).

Figure 16.3.12 Illustrative aerial view of Fresh Kills Park (Alba, 2015a,b).

Figure 16.3.13 Chronological evolution of the landscaping of the Fresh Kills landfill, New York. *Graphics: Studio Arcoplan.*

Scenario B/intervention on operational landfills: the use of waste as a plastic material

Reclamation works performed on a landfill will have a far greater chance of success when studied and developed during the stage of active management of the landfill (during the construction stage, during waste deposition, or at the time of a potential extension). Indeed, the employing of new wastes as a plastic material with which to mold the shape extends the pool of potential uses assigned to the project and provides greater freedom in reinventing the final configuration of the area (Fig. 16.3.5, Scenario B), in addition to facilitating important budgetary savings in terms of material to be delivered to modify the structure of the site.

The possibility of intervening during the operational phase of the landfill rather than during the postmanagement phase not only enhances the possibility of modeling the banking of new wastes in line with the project design (Fig. 16.3.14) but also enables operations aimed at the functional recovery and landscaping of the area to be commenced when the landfill is still operational (e.g., in the previously established closed sectors). In other words, when carrying work as described in Scenario B, Fig. 16.3.5, an immediate functional use of the areas is obtained with a progressive involvement of other sectors.

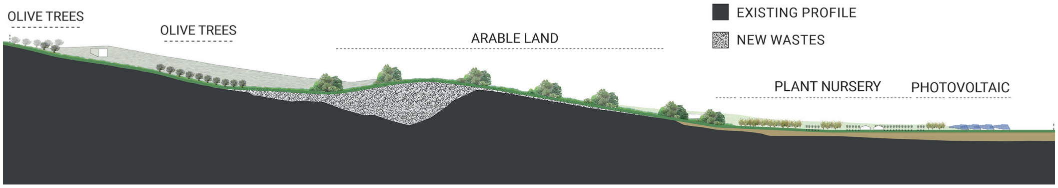

Figure 16.3.14 Cross section of the landfill. The wastes are used as a plastic material to shape the land. *Graphics: Studio Arcoplan.*

The main difficulties encountered in the planning and design are due to coexistence of the ongoing operations of waste deposition and remediation of the landscape, thus requiring careful planning throughout. The establishing of a timeline representing the chronological development of the project is fundamental and should define the different operations to be carried out in line with the state of waste deposition in the landfill sectors (Fig. 16.3.15) according to a series of future short-, medium-, and long-term scenarios developed over a period of no less than 30 years.

The distribution of vegetation should be implemented in full compliance with the original existing landscape and should be completed taking into account not only the technical aspects described above but also the functional reclamation of the area to be achieved once waste placement operations have terminated and the relative sectors have been covered. Plant distribution throughout the area therefore should be envisaged in synergy with the operations and functions provided for by the reclamation project (Fig. 16.3.16).

Furthermore, the undertaking of works at this stage enables the planning of more complex operations that foresee a marked local involvement, thus promoting a widespread consequent positive impact. Accordingly, a project for valorization of an area should be developed in line with the specific aim of creating important synergies with the locally present manufacturing and entrepreneurial concerns.

Scenario C/planned landfills: the project should be developed according to the intended use

When designing a project on the basis not solely of the designated use of the site as a landfill, but rather in view of the ultimate use established, wastes may be employed from the start of the project to shape and model the final morphology of the landscape. From the outset therefore the structure of the project is dependent on the final use of the area. Accordingly, in line with the parameters established by the project, the deposited wastes may be used today as a shaping material for the purpose of creating the area for tomorrow (Fig. 16.3.5, Scenario C).

The location, the form, and the volume of wastes to be banked, the architectural materials, and language of the buildings destined to house the facilities, together with all other features of the project, will need to establish operational synergies to enable this dual function: the first temporary function associated with operations of disposal and treatment of the wastes, and a second more permanent aspect linked to the future intended use determined during the stage of landfill design (Fig. 16.3.17).

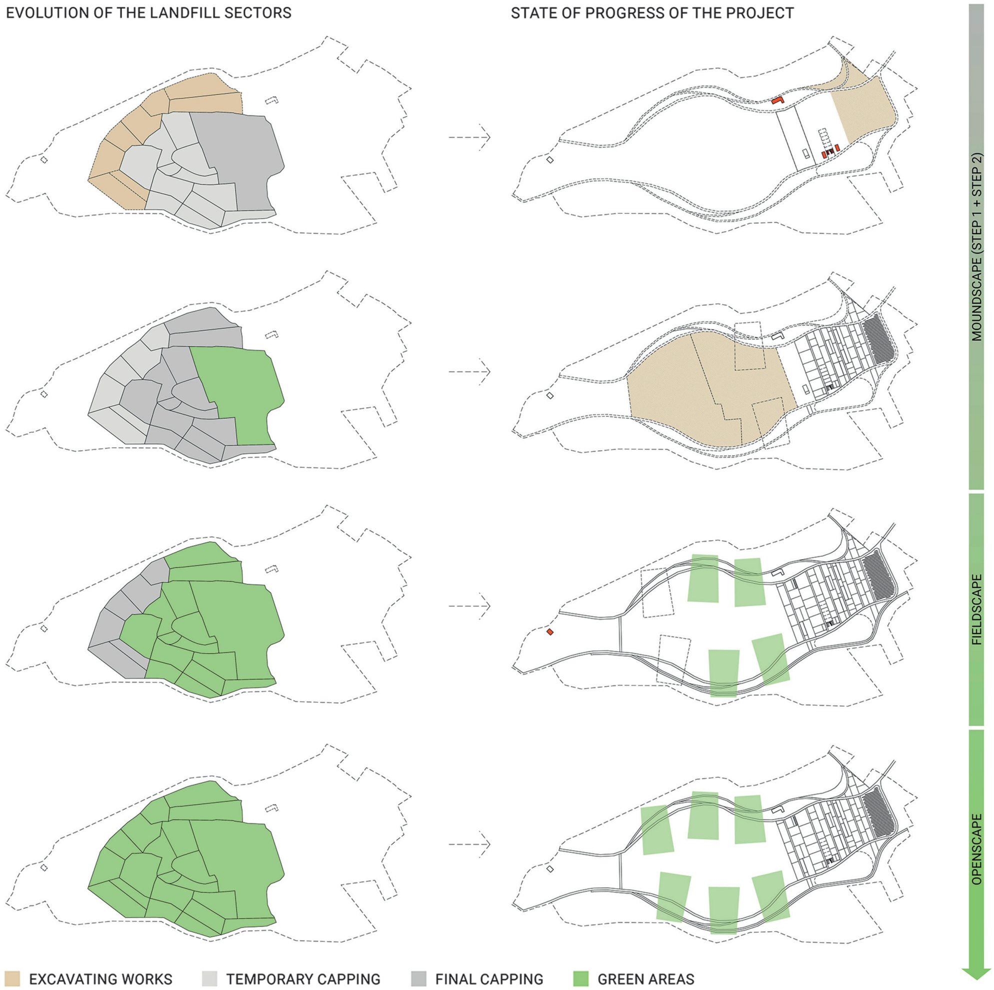

Figure 16.3.15 Example of a timeline: state of progress of the project with regard to evolution of the landfill sectors. The chronological study of the project establishes a link between the banking of soils excavated from the new areas undergoing development and the reclamation works being realized. *Graphics: Studio Arcoplan.*

The planning and design phase for a new landfill therefore provides all the necessary conditions to envisage a coherent contextual change in line with the needs of the locality.

The construction of a new landfill according to a project aligned with the surrounding landscape and urban spaces is dependent on a fully integrated project strategy and a multidisciplinary approach that can only be achieved by relying on a team of designers with competence in numerous sectors (environmental engineering, geology, agronomy, landscape architecture, etc.).

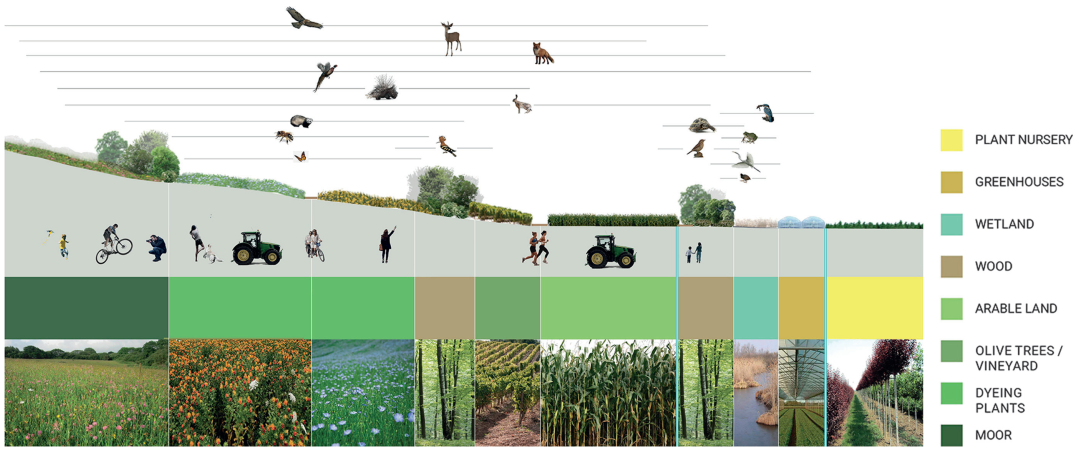

Figure 16.3.16 Example of landscape design based on the intended use provided for in the general project. *Graphics: Studio Arcoplan.*

Figure 16.3.17 Aerial view of the future use of a landfill site. *Graphics: Studio Arcoplan, Padova.*

The above principles are, however, deemed extremely innovative when compared with common practice as they dictate a change in the terms of the project; we are no longer the designers of mere landfills, but rather of community spaces.

To make provisions for the project as a whole, the planning of the intended future use of the area should be articulated on the basis of the three subsequent levels of in-depth technical analysis provided for by current law, i.e., a preliminary design, a definitive project, and an executive project. The study should be subjected to detailed analysis to provide for a detailed budgetary control from the outset. This will allow sufficient sums to be accrued during the operational phase of the landfill to effectively finance the carrying out of all works.

These important concepts, which should drive the planning and design of new landfills and shift the focus of the designer, unfortunately often fail to be taken into account.

CONCLUSIONS

A sanitary landfill, intended as the last link in a circular economy, should be seen as an endeavor that is developed throughout the duration of the operational phase. Completion of construction will only be achieved once the global project has been terminated. Accordingly, the operational phase of a landfill should be seen as an extension of the building of the concern.

In a vision of a circular economy, landfills occupy an unavoidable rather than a disputable position and should be viewed as a necessary facility in the same way as all other services a community relies on. Indeed, it is the overwhelming need for landfills to legitimize construction of the same and likewise justifies the need to ensure they remain in the vicinity of the community they serve.

An environmentally sustainable landfill should assume programmatic significance through a planned intervention that contributes toward the overall design of the locality and meets the requirements of the two life phases of the landfill itself: the operational phase (temporary use as a landfill) and postoperational phase (final use created on the basis of the deposited wastes). Therefore, a precise time horizon and specific technical regulations should be established in line with the final intended use of the site as determined in the initial project.

Municipal waste sanitary landfills should therefore be seen as an integral part of local area planning with a functional rather than a "disposable" intended use. It should thus no longer be construed merely in the light of its intended use, but as a process heralding the development of a "new form of intended use."

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