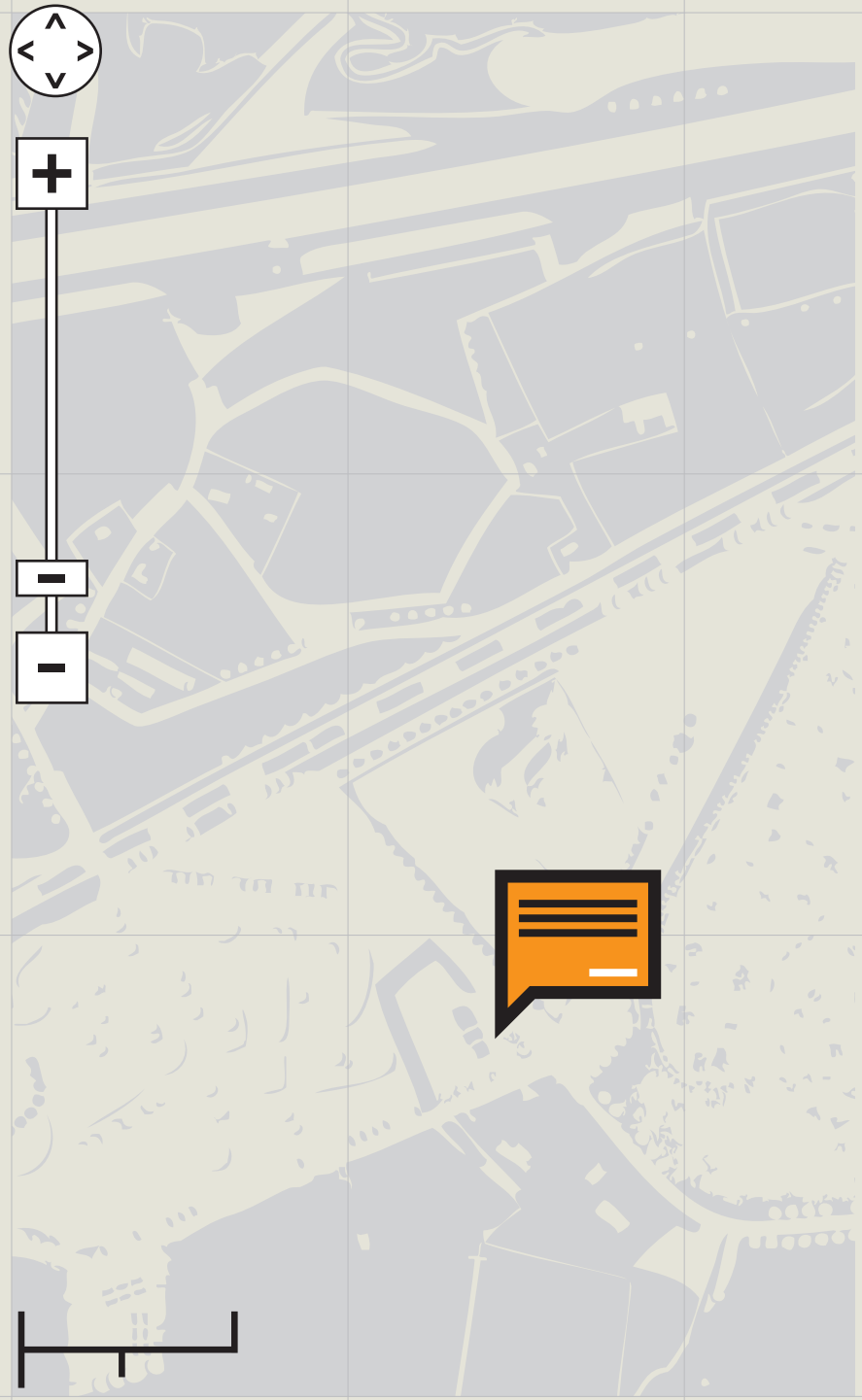

LANDFILL RESTORATION AND REDEVELOPMENT BY LANDSCAPE DESIGN

— A DESIGN RESEARCH OF A FORMER LANDFILL IN BARNEVELD

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Preface

The last period of my MSc I spent working on my Master Thesis. A few months before I started, I decided that my topic would be 'waste landscape'. Later on, this developed into the design of 'landfill', a restoration and redevelopment of former landfill by landscape design.

In the past year, I have researched the impact of landfill's environmental problems on the surrounding landscape and people's life. Consequently I searched for possible adaptation measures, trying to define the landscape architect's role in landfill redevelopment project. I consider the educative meaning the equal importance with the ecological values in my research for design, so various knowledge are involved in my thesis such as engineering and art. Finally, a landscape-based design approach to landfill restoration and redevelopment has resulted in a methodology which forms an interesting basis in my study area.

With this thesis, I hope that I can contribute something to the theory and practice of designing landfill-reuse in the Netherlands.

Several people have helped me during my thesis, and without them, the result would not be the same. Firstly, I have been fortunate to have Rudi van Etteger as my supervisor, so I would like thank him in particular. From the beginning until the end, he has invested time and energy in guiding the process of my thesis and help me to build up my structure. His professional knowledge and attitude during this period will inspire me for long. I am also grateful to Ingrid Duchhart, Sanda Lenzholzer, Renee de Waal and other staff of the landscape architecture group of Wageningen UR who helped me. Besides that, I need to thank my girlfriend Jie who listened to all my topic during the last year and give me lots of help and advice.

To my parents, my wholehearted supporters: thank you come to the Netherlands to see me and encouraging my study, I could not done any of this without you. I love you all! Thank you!

Abstract

And waste, "*the seemingly mundane and oft-neglected residue of human activity came into the public consciousness in a major way during the late 19th century and raised several uncomfortable questions about health, aesthetics, affluence, technology, and quality of urban life*" (Melosi 1981, p. 21). Waste landscapes of obsolescence refer to sites that are designed for accommodating consumer wastes. These mainly include municipal-solid waste landfills in this thesis. (Alan Berger, 2006). Waste is inevitable, and enlarges its influence on urban landscape accompanying with the urbanization/suburbanization.

It is not difficult to find that people's attitude towards garbage is always negative and people behave to avoid direct contact with waste-related sites. When these 'ugly' sites were abandoned and lack of management, they naturally became the malignant tumour of the city environment. How to alter people's subjective opinion on waste landscape and how to transform these sites into human friendly places, at the same time; re-infuse certain functions to the dumps in eco-/socio- system? A number of projects react to this with different aims and approaches, in the face of various contexts. Are these approaches all effective and efficient? Is there any possibility to combine some of the approaches to optimize the social/ecological benefit (or profit)?

The objective of this thesis is to figure out the possible combinations of the existed landfill landscape design approaches, by reviewing the former waste related designs and transforming projects.

Key Words: ***waste landscape, landfill, education, ecology***

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1 Introduction

Figure 1.1 Landfill in Tilburg, photo by author

1.1 Definition & Misunderstanding of Waste

Humans have replaced nature's endless cycling and recycling of materials and processes at the core of the earth's operating system, with an encompassing system of one way flows (Lyle, 1994). This one-way flow system directly causes a result that does not exist in natural systems: waste, and it causes environmental problems, and a global issue. When people prepare to dispose something, they already labeled this stuff as 'waste' in their mind. While, actually, this is an inaccurate understanding of 'waste' (Bontoux and Leone, 1997). Table 1.1 summarizes some definitions of waste.

EU	Waste shall mean any substance or object in the categories set out in Annex I which the holder discards or is required to discard (European Council, 1991)
OECD	Wastes are materials other than radioactive materials intended for disposal(OECD, 1994)
UNEP	Wastes are substances or objects, which are disposed of or are intended to be disposed of or are required to be disposed of by the provisions of national law (European Council, 1993)

Table 1.1 - Some definitions of waste

The common factor seen in these definitions is that waste is something that the holder has disposed of/discarded or is going to dispose of/discard. Principally, both 'dispose' and 'discard' mean 'abandonment', perhaps 'disposal' is more putting it in a suitable place, while discard has the connotation of being useless or undesirable—'tossed aside'. It was assumed that the purpose behind the use of the expression 'discard' instead of 'disposal' by the EU Directive was to broaden its reach, and include the widest possible acts of abandonment of things— with or without interest in the final destination of the discarded things (Cheyne and Purdue, 1995).

The problem with the waste definitions listed in Table 1, is that they deal with existing waste. Such definitions seem to accept the fact that people/institutions throw things away, and therefore, existing legislation appears to be concerned with the 'what to do with it' dilemma. This is understandable, as the main goal of European legislation on waste is the protection of public health and the environment (European Council, 1991).

To conceptually describe waste is not the main purpose of these definitions. The label 'waste' does not necessarily mean that the thing is an ultimate waste; rather, it means that it will be treated as waste. In other words, the waste we usually regard could still have values and is not useless/ non-valuable. It is off use from the perspective of its consumers, whereas might be still of great value for other purposes/uses.

"As a result, waste is an element which is in a state of transition (Moser 2002, p. 102). No material or compound is inherently waste but rather a substance that gains and loses value relative to the being that uses it. This dynamic quality of fluctuating between value and devaluation blurs the definition of waste and makes it more difficult to identify."

-- LM Brandes 2003, p. 4

Thus, it is not sustainable to define 'waste' as a character of the to-be-perished objects that might not be ultimately consumed, or defining it as a character of the final status of production.

Although the classification of garbage is constantly changing, the way of dealing with it has remained relatively unchanged throughout millennia. For thousands of years, the most common method was to simply discard remnant materials by tossing them on the ground wherever one happened to be. Some of these remnants were being found nowadays. This method worked well for hunter-gatherer societies who moved frequently. These societies were small enough to not generate enormous amounts of waste. Whatever waste that they did dispose of probably decomposed or was scavenged relatively quickly. However, as civilizations grew and as people became less nomadic, they could no longer simply run away from their discards. Civilizations began to develop other ways to deal with their trash. These techniques mainly consisted of source reduction, recycling, burning and dumping. These methods are still the most common means of handling waste disposal today.

Through all of the past century's measurable changes in the actual content of solid waste, there is a less easily quantifiable change in the modern society's attitude toward waste. These complex attitudes are a consequence of the increased waste production resulting from industrialization and the ecological awareness of our actions, which have led to recycling and recuperation efforts (Moser 2002, p. 85).

Waste is now a pertinent topic for many different fields: engineering, economics, ecology, history, landscape architecture, and even art (Moser 2002, p. 88). Each discipline has its own attitudes towards waste. For example, an engineer may focus on how to bury trash effectively so that it poses little hazard to the general public. An ecologist would concentrate on the potential environmental effects of burying the trash in the manner in which the engineer proposes. The artist might consider that same pile of trash and how to use its elements to create a provocative statement about the society. Each perspective provides a valid viewpoint regarding waste, and each represents the current pulse of cultural attitudes.

> *"The emergence of these diverse points of view also creates ambivalence and contradictions towards waste. On the one hand, our society respects the need to dispose of garbage safely, yet on the other hand it recognizes the potentially negative environmental and aesthetic impacts of dealing with our solid waste as we currently do."*
>
> *-- -- LM Brandes 2003, p. 12*

As landscape architects, we do not own enough specific knowledge to invent more efficient recycling system or get the complete image of other professions. But we can use landscape as a tool to redevelop wasted place, restore its ecosystem and diversity, more importantly,

we can 'redefine' the traditional definitions of waste that existing in people's mind for decades.

Also, what I should keep in mind is the knowledge I gain about waste management and landfill treatment technologies, which are necessary to complete my design. By incorporating these inter-disciplinary knowledge with our academic background of landscape, an ecological and sustainable vision of the landfill transforming process gets clear.

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Conclusion

As landscape architect, the ecological values and people's demands should be put on the same position. So after knowing the definition and misunderstanding of waste, I decided to choose the terminal of waste (in some extend), landfill, as my main topic. Yet in the midst of this alleged crisis, we continue to generate enormous amounts of waste and dot our landscapes with the burial mounds of this waste. We have created this problem and now we must address its impacts. Few people want to live next to a landfill, especially while it is actively receiving trash. Yet when the landfill eventually closes, there is great potential to see that landscape not as simply a huge pile of discarded items that are negatively impacting the environment, but rather as a time capsule which reflects our cultural attitudes. In the next chapter I will describe the general situation of landfill.

1.2 Landfills

1.2.1 General describtion

Almost all of the organic material remained readily identifiable…onion parings were onion parings, carrot tops were carrot tops. Grass clippings that might have been thrown away the day before yesterday spilled from bulky black lawn and leaf bags…Whole hot dogs have been found in the course of every excavation the Garbage Project has done, some of them in strata suggesting an age upwards of several decades.

- William Rathje describing core samples taken from landfills (Rathje and Murphy 1992, p. 114).

The term 'sanitary landfill' originated in the late 1930's. It describes a means of disposing of garbage in a sanitary manner, covering each layer of trash with a layer of dirt each day to prevent vermin from getting into the trash and to eliminate obnoxious odors from wafting into the air (Hickman and Eldredge 2001).

Landfill as the last step of waste recycling process, usually considered as one of the most unwelcome place in urban environment. Landfills can accommodate various types of waste and vary in size from a few square meters to tens of hectares. They can be in operation for a very short period to several decades. They also have a great influence to its surrounding area - negative effects in most cases.

Figure 1.2 Landfill leachate seep kills all vegetation, Riegel Paper landfill, photos by Bill Wolfe, 2010

1.2.2 Landfill structure

Landfill structure has changed substantially over the past fifty years. The EPA document, A Decision Makers Guide to Solid Waste Management, details important information regarding landfill construction, use, and post-use. This document defines the following key terms regarding landfills: (fig.4.1) waste management boundary, leachate, landfill gas, liner, and cover. ***Waste management boundaries*** are simply the boundary areas occupied by the landfill waste and are measured in acres. ***Leachate*** is liquid that emerges from solid waste and usually contains soluble, suspended, or miscible materials that originated from the solid waste. This liquid must be treated carefully since it may contain hazardous materials and could contaminate ground water and kill vegetation.(figure 1.2) ***Landfill gas*** is a mixture of methane and carbon dioxide generated by the anaerobic decomposition of organic wastes. A ***liner*** is a system of clay or a geosynthetic membrane on the bottom of the landfill which is used to collect leachate and prevent contamination of the groundwater. A cover consists of soil and geosynthetic materials and has two functions: first as a daily cover over the waste at the close of each day's operations, and second as a final cap (fig.1.3)when the landfill

is closed to prevent elements from entering and leaving the landfill mound. The landfill is essentially a self-contained unit with alternating layers of garbage and soil. Appropriate mechanisms must be in place to monitor ground water and methane gas production as well as to collect leachate.

Before construction of a landfill, engineers determine the maximum size for the landfill. The landfill engineers establish the topographic lines which indicate the size and shape of the trash mounds to be built. The maximum slope for the mounds is three to one; therefore the final height of the mound depends on the initial footprint. When a landfill is active, garbage trucks deposit the solid waste into the landfill, compact it down, and then cover it with a layer of soil, thus creating cells of trash within the entire landfill. Compacting the waste in this manner helps to reduce the amount of settling that occurs over time. With proper compaction, the surface will settle to 80 to 85 percent of the original height within five years (EPA Decision Makers Guide 1995, p. 9-14).

Figure 1.2 Typical modern sanitary landfill cross section
Source: http://envplan240.pbworks.com/f/LNDFL_CS.jpg

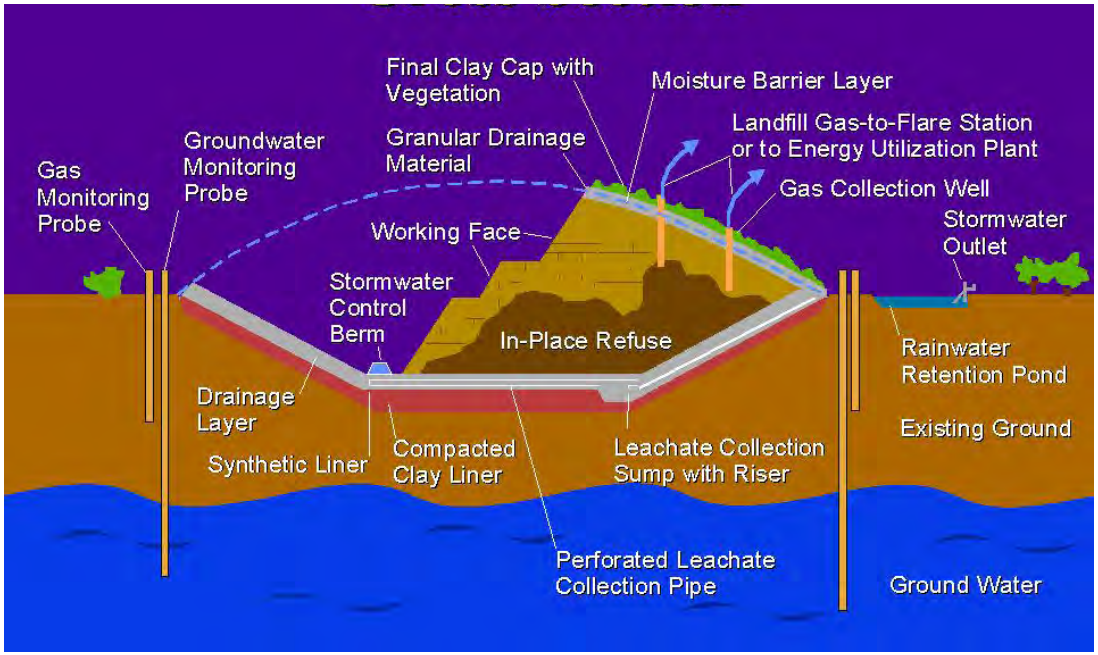


Figure 1.3 Landfill cap cross section
http://www.nycgovparks.org/sub_your_park/fresh_kills_park/

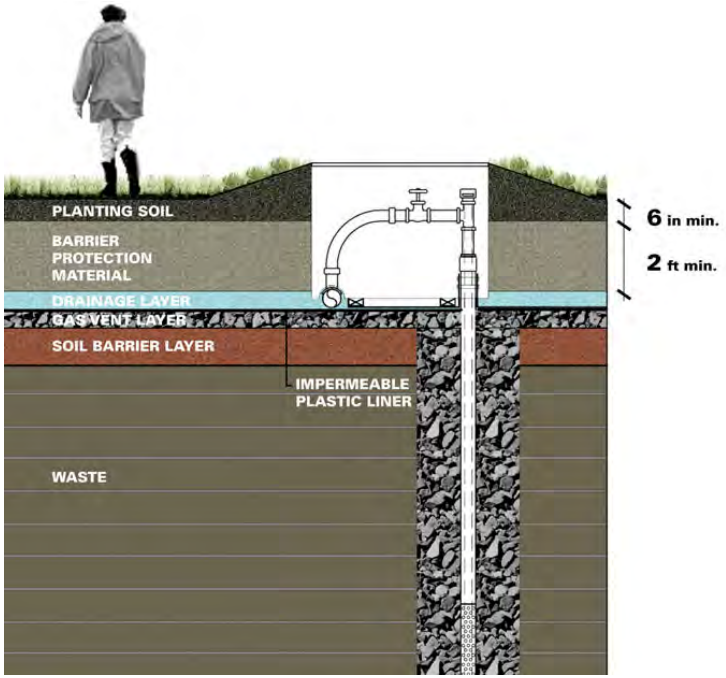


Figure1.4 Different municipal solid waste

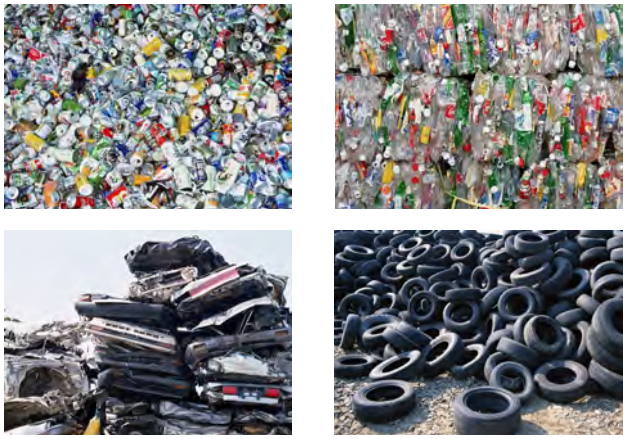


Figure 1.5 Methane from landfill sites
Source: http://www.mnp.nl/mnc/i-en-0160.html

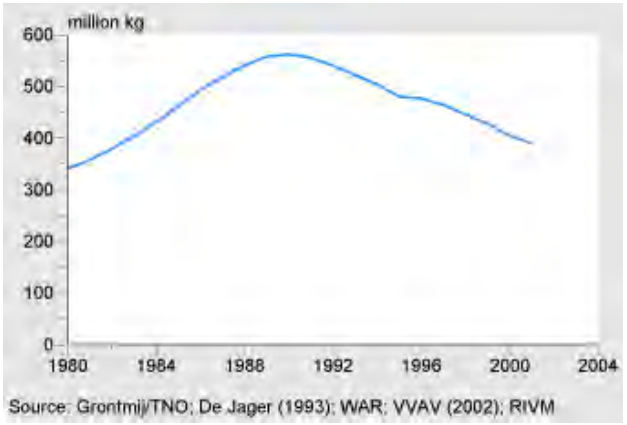
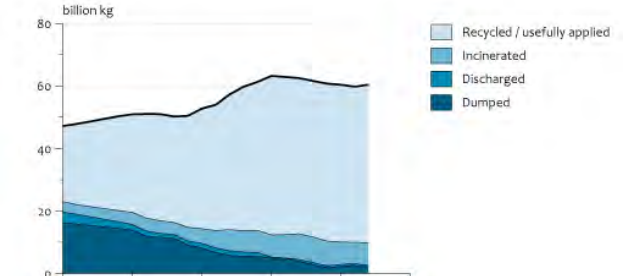


Figure 1.6 Dutch waste production and management



1.2.3 Municipal solid waste

Landfills are huge mounds of trash, but it is important to get a better understanding of the details of this trash to begin to explain the values inherent in the landfill contents. Most modern landfills are classified according to the type of waste material contained in them:

Hazardous waste landfill – waste disposal units are constructed to specific design criteria. These landfills are generally constructed to be secure repositories for material that presents a serious hazard to human health, such as chemical waste. They are restricted, by permit or law, to the types of waste they may handle. These landfill must have a double liner system.

Municipal solid waste landfill – this type is also called modern, engineered or a secure landfill. This type of landfill usually has physical barriers such as liners and leachate collection systems (leachate is waste water created when water percolates through the waste) and procedures to protect the public from exposure to the disposed wastes. Waste has to be covered daily.

Due to knowledge gap and secure constraining, I will mainly focus on municipal solid waste landfill, also, this type is the most common type of landfill.

The U.S.Environmental Protection Agency's report: *Municipal Solid Waste in the United States: 2000 Facts and Figures* defines municipal solid waste (MSW) as everyday items such as product packaging, grass clippings, furniture, clothing, bottles, food scraps, newspapers, appliances, and batteries. (fig.1.4) Contents such as construction and demolition debris, municipal wastewater treatment sludge, and non-hazardous industrial wastes are deposited in landfills, but are not considered MSW and therefore are not represented in the graphs from the report. This EPA report analyzes the MSW in two ways. The first is by material, which categorizes items based on the components of the products, i.e. paper, yard trimmings, food scraps, plastics, metals, glass, wood, rubber, leather, and textiles. The second analysis considers product, which categorizes the trash into types of goods, i.e. containers and packaging, nondurable goods, durable goods, and food scraps. This classification is helpful because it reveals not only the individual materials of the trash, but also the kinds of products that are making their way into the MSW stream.

1.2.4 A brief history of Dutch waste and landfill management

The basic principle of the Dutch waste management is to reduce landfill. On a priority basis are: reduction, reclamation (including composting), and then recycling, incineration (renewable energy), and finally landfill (Safety).

The technology options in Dutch waste management are: recycling and composting (developing new markets and new industries), burning and others, the last technology choice is

the landfill. (fig.1.6)

Landfills in the Netherlands were decreasing gradually, from 400 in 1975, 2100ha, and 300 in 1985, 2265 ha, to 20 in 2005, 953 ha. (fig.1.8) On the other hand, due to the lack of capacity and considerations of treatment costs, the Netherlands exports 400 million tons waste per year.

Although Netherlandsis one of the country which did a great job in municipal waste management in European, (fig.1.7) in the foreseeable future, landfills will continue to play an important role in managing municipal waste in Netherlands, as a final destination for waste, as well as 'land scar' for public and environmental health.

Figure 1.7 Municipal waste management in the European Union
Source: http://www.mnp.nl/mnc/i-en-0393.html

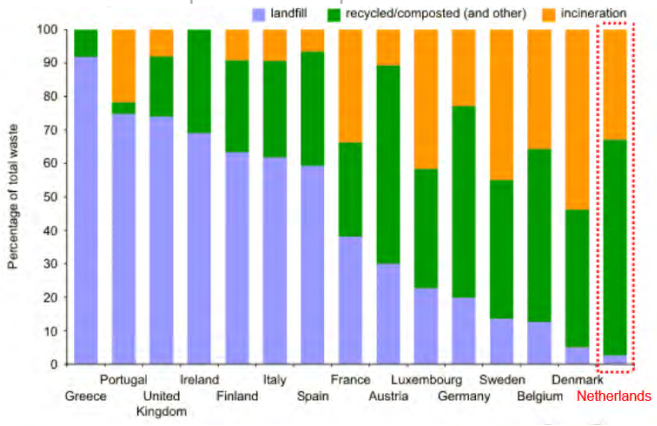


Figure 1.8 Landfill development history in Netherlands

1.2.5 Life-Span of Landfill

No matter how sophisticated landfill technology is, each landfill will at some point reach capacity and will need to be closed.

The 1995 EPA publication, A Decision Makers Guide to Solid Waste Management, states that, *"the primary objectives of landfill closure are to establish low-maintenance cover systems and to design a final cover that minimizes the infiltration of precipitation into the waste".* Planning for the closure of the landfill should begin well before the landfill stops receiving waste. These measures help ensure that the landfill will pose minimum hazards. Post-closure care can last for over 30 years during which time the landfill owner is responsible for the general upkeep of the site as well as the monitoring of the site's environmental features.

The cover that is placed over the landfill is an important barrier which helps to curtail potential contamination from the site; thus it is important to minimize possible damage to this cover. The EPA requires that the final cover system be composed of an infiltration layer a minimum of 18 inches thick which is then overlain by an erosion layer a minimum of 6 inches thick (EPA Decision Makers Guide 1995, p. 9-49). Synthetic liners and soil usually comprise this cap. Settlement of the garbage continues as decomposition occurs. Although this settlement slows after the first few years of closure, this could potentially cause breaks in the landfill cover. It is also important to prevent erosion of the cover. This is often addressed by planting vegetation on top of the landfill (EPA Decision Makers Guide 1995, p. 9-63).

Controlled water drainage and leachate and gas monitoring are also essential aspects to ensuring the safety of closed landfills. Drainage patterns may change as the landfill settles. As a result, drainage channels must be inspected periodically. Additionally the surface runoff must be properly managed so as not to cause flooding or erosion. Even after the landfill cap is installed, the landfill will continue to generate leachate. This leachate needs to be collected and treated either on-site or at an off-site facility. The leachate collection system must be monitored regularly to ensure that no contamination of the groundwater is occurring. Finally, gas emanating from the landfill must be controlled and monitored. Gas monitoring probes should be installed to help detect landfill gas. The gas is composed mostly of methane, a dangerous greenhouse gas. It can either be discarded by flaring it on site or it can be collected and used as a fuel additive (EPA Decision Makers Guide 1995, p. 9-64).

1.2.6 Benefits of landfill redevelopment

Although here are many benefits of landfill redevelopment, some goals are mainly achieved by engineering or policy. Due to my specific knowledge and limitation, I will divide the benefits into three parts which landscape architect can deal with, environmental benefits, social benefits and economic benefits.

Environmental benefits:

- Reduction of development pressure on green fields sites
- Protection of public health and safety
- Protection of groundwater resources, surface water and air
- Protection and recycling of soil resources

Social benefits

- Improving the quality of daily life
- Elimination of the negative social impression associated with the affected communities by revitalizing them
- Reduction of the fear of garbage
- Spreading the knowledge of waste recycling

Economic benefits

- Increasing land value by improving degraded property
- Increased utilization of and reinvestment in existing municipal services

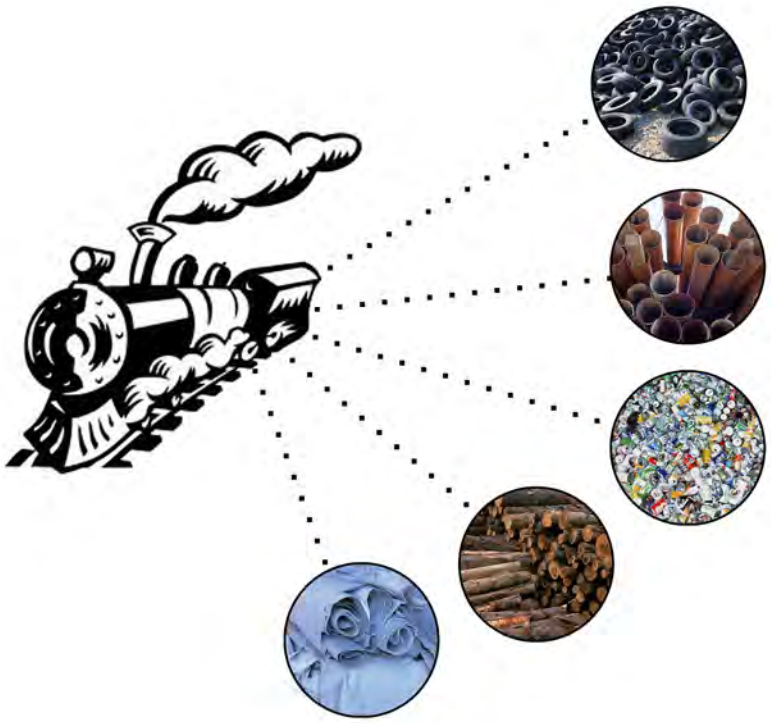


Figure 1.9 Useful materials in the waste have been transported away, made by author

1.3 A Model Strategy of Landfill Redevelopment

1.3.1 Introduction

"...In simple terms, former and abandoned landfills can be defined as areas in the landscape that have been used for waste disposal. Landfills can include various types of waste and vary in size from a few square meters to tens of hectares. They can be in operation for a very short period to several decades. Closed landfills mostly lack environmental protection measures. (fig.1.9) Slush landfills, ditch fillings and crushed-stone foundations are excluded from this definition, as are landfills that fall under the jurisdiction of the EU Landfill Directive. Landfill sites could be viewed as opportunities for redevelopment, offering potential sites for woodland, golf courses, ski runs and commercial, industrial and even residential development...."
-- Landfill examination, aftercare and redevelopment: an integrated strategy, Sustainable use of former and abandoned landfills

The closed landfills in the Netherlands take up amounts of valuable space. (953 ha.total in 2005) Many locations are situated near the edge of cities, towns and villages, where developers, local authorities and residents might otherwise show significant interest in the available land. In order to protect the impacts from the former landfills and reuse them to serve the community, The technical experts and governmental partners of SufalNet(sustainable use of former and abandoned landfills) combined all the best practices they could find and summarized them into a general mode,which called ***the Model Strategy*** to help the Netherlands and other countries manage abandoned landfills.

The Model Strategy can help me to formulate my research framework and built up my own strategies and design principle. More importantly, I can find out the shortage and missed points in Dutch landfill redevelopment through researching the Model Strategy and case studies. So that I can provide these missing parts in my research and design.

1.3.2 The objective of the model strategy

• to reduce risks posed by former landfills to the environment and public health;

• to stimulate the re-use of former landfills through exchange and dissemination of policies, projects and instruments;

• to get the issue of former landfills on to the European agenda and consequently to stimulate local authorities and other public bodies at national, regional and local levels to start dealing with former landfills;

• to involve stakeholders from the waste management, project development, consultancy and public sectors in early phases of decision making concerning the management of former landfills.

"...To achieve these aims SufalNet brought together expertise and good practice from different Member States and developed strategies on the examination, aftercare and redevelopment of former landfills..."
-Landfill examination, aftercare and redevelopment: an integrated strategy, Sustainable use of former and abandoned landfills

1.3.3 Examination, aftercare and redevelopment

SufalNet's strategy on ***examination*** uses a source–pathway–receptor approach to develop a site conceptual model. This can help designers to plan for future action and determine the extent of measures required to manage identified risks. (fig.1.11)

Examination can occur in a phased manner, typically including a preliminary phase; elaboration of a site conceptual model; definition of the investigation strategy; and implementation of the investigation strategy.

Once examination has taken place, risk assessment offers a bridge into aftercare. Implementation of ***aftercare*** measures is crucial to eliminate actual risks and to avoid future risks to human health and to the environment. SufalNet distinguishes six categories of aftercare measures: policies and legislation; technical measures; organization; financing; communication; and legal measures.

The implementation of these measures can unlock the potential for ***redevelopment***. But this is not straightforward in every case. The model strategy seeks to reduce the complexity of the decision-making process and improve the feasibility of redevelopment.

A summary of the decision-making process that brings all three elements together in assessing project feasibility is shown in the figure 1.13.

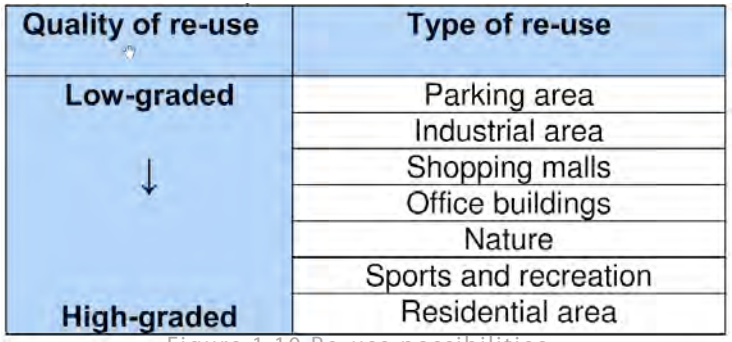


Figure 1.10 Re-use possibilities.
Source: Redevelopment of landfill sites, W.J. van Vossen

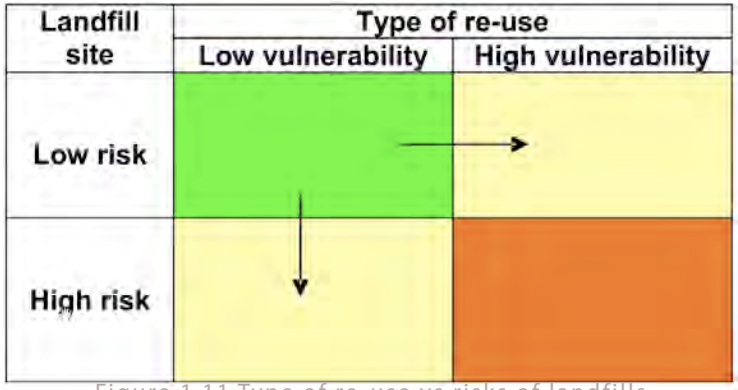


Figure 1.11 Type of re-use vs risks of landfills
Source: Redevelopment of landfill sites, W.J. van Vossen

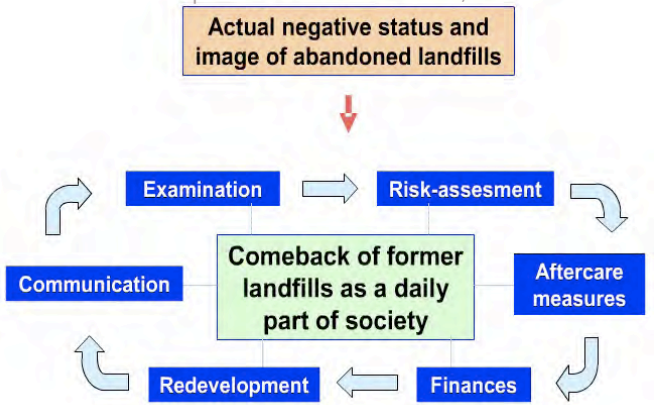


Figure 1. 12 Comeback of former landfills as a daily part of society
Source: Redevelopment of landfill sites, W.J. van Vossen

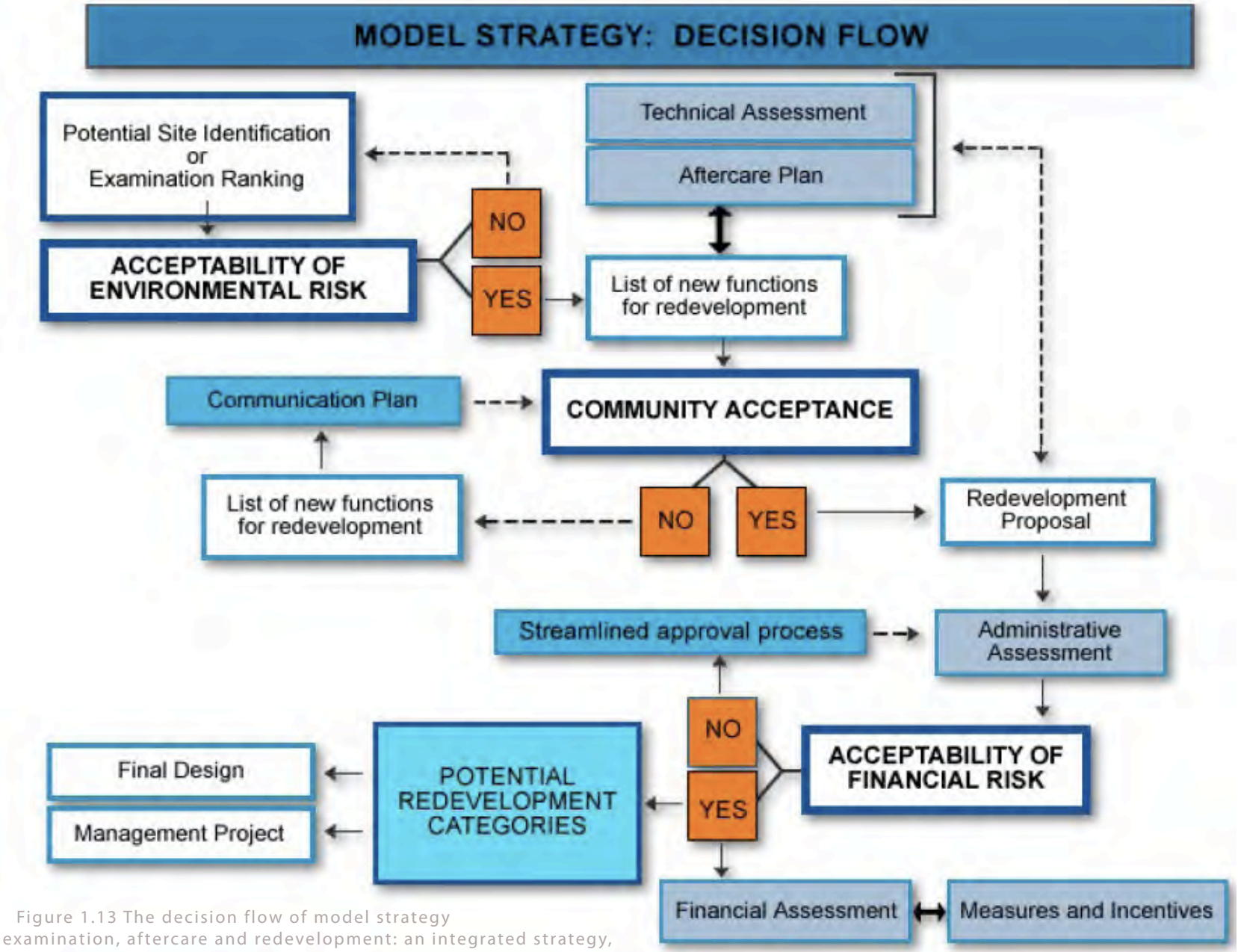


Figure 1.13 The decision flow of model strategy
Source: Landfill examination, aftercare and redevelopment: an integrated strategy, Wellington Green, 2009

1.4 Landfill tour in Netherlands

1.4.1 Landfill in Deventer

The landfill in Deventer is a working landfill site, with a waste recycling company VAR. Close to the landfill there is a natural park Bussloo for conserving the surrounding environment. (fig.1.16) VAR B.V. is a Private organization, founded in 1981, focusing on waste streams for the benefit of recycling. (fig.1.15)

Due to the current function of the landfill , there is no accessibility to the landfill, and the park only provide some recreation activities to the community such as golf and horse riding.(fig.1.17)

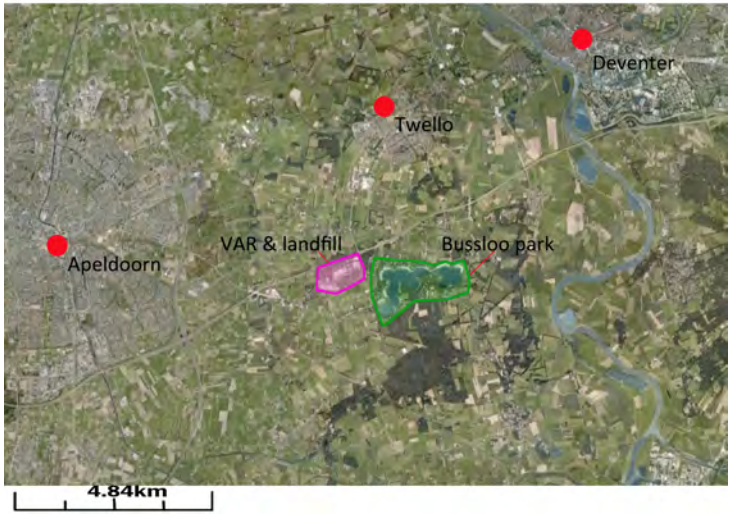


Figure 1.14 Location

Figure 1.15 Landfill and VAR company

Figure 1.16 Landscape in Bussloo park

Figure 1.17 Tourism attractions

1.4.2 Landfill in Tilburg

Tiburg landfill is one of the biggest landfills in Noord-Brabant, Netherlands. At this moment there is a project happening in the landfill, called "Huis ter Heide". This project is aimed at the natural area conservation and landfill treatment. It includes four places: a working landfill and recycling center, a sewage treatment, a lake park called" experience-Island Blauwe Meer" and a plan for natural conservation called Plan "Lobelia". (fig. 1.19)

The landfill treatment and the whole natural conservation plan did protected the environment and provide a natural area for the community, however, no activities and only simple tourism facilities makes it lack of attractions and has no influence to people's life.

Figure 1.18 Landfill field work

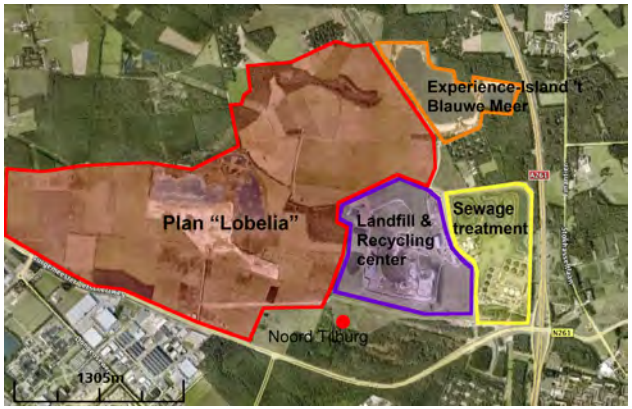


Figure 1.19 Location and "Huis ter Heide

Figure 1.20 Sewage treatment

Figure 1.21 Plan"Lobelia"

1.4.3 Landfill in Zoetermeer

Different from those two landfills, the Zoetermeer landfill is a former landfill; it has already redeveloped into a park called "Buytenpark". On its west, there is a wetland protection park call "Westerpark". (fig. 1.22)

Figure 1.22 Location

The "Buytenpark" has already treated with vegetation restoration, so the environmental condition is quite good. However, due to lack of management, there are still lots of wasted materials on this site, and many places are just empty open space, the land value is quite low. Only some natural relating activities are happening in this site, such as cycling and fishing.

Figure 1.23 Field work in Buytenpark

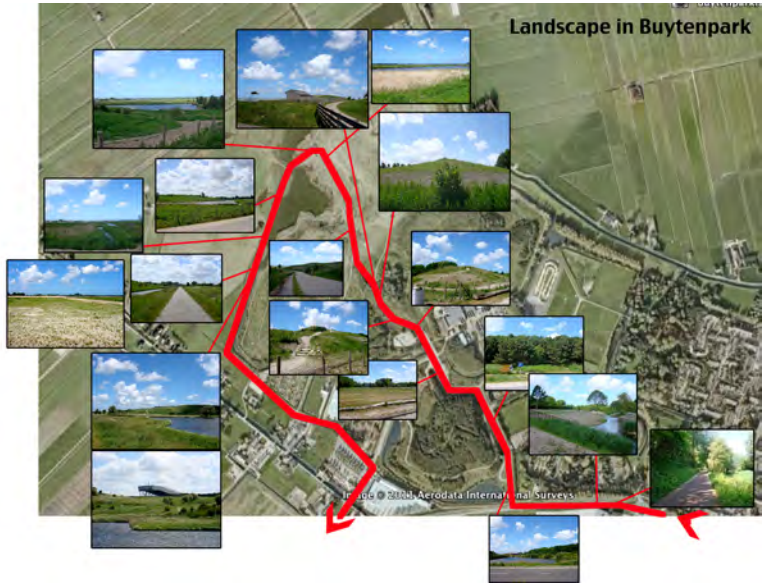


Figure 1.24 Wasted elements and place

Figure 1.25 Tourism facilities

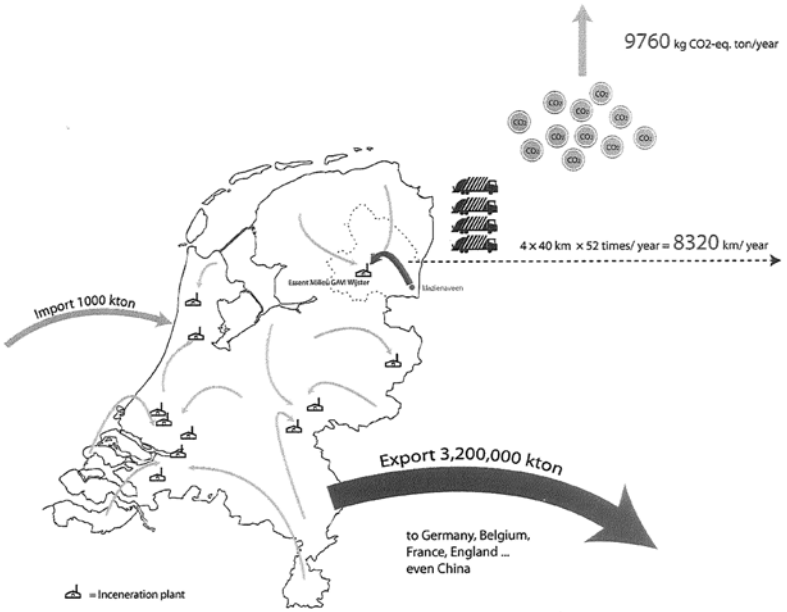


Figure 1.26 Waste transportation and CO2 emission, Source: Utilizing waste for building a resilient landscape, Xiaoyu Xu, 2010

Figure 1.27 A junkwoman in a huge and poor treated landfill in Guatemala, Central America

1.5 Reflection

After analyzing those landfill redeveloping projects in the Netherlands through their design principles, strategies and theoretical basis, for instance, landfills in Tilburg, Zoetermeer, Deventer, etc. A typical Dutch approach of landfill redevelopment could be concluded as ecology restoration and conservation, and infusion of new functions, in which leisurement is predominant. The redevelopment process does create a new, viable landscape for wildlife and reconstruct "nature" for people, but "...it is just a different form of masking the waste that people have a hard time accepting and managing...we continue to inhibit public perceptions and restrain public care for waste problems..."(Engler, 1995) While, it has little influence to people's lifestyle, and misses the opportunity to access people to new spatial and aesthetical experiences, as well as to better understand the urban consuming-wasting process.

As Girardet and Mendonca said, *"...the last few decades have been characterized by economic globalization resulting in an ever-greater expansion of worldwide trade..." (Girardet and Mendonca, 2009).* The globalization creates many chances to upgrade the overall quality of human life and we do benefit from globalization. But on the other hand, the side effects to developing countries is not properly controlled. The developed countries heavily depend on exporting waste to developing countries. (fig.1.28) For the Netherlands, due to the lack of capacity and considerations of treatment costs, 400 million tons of waste are exported to developing countries per year. (fig.1.26) Even more, the Netherlands is only one of the countries generating most and exporting packing waste in Europe next to Ireland, France, Italy and Luxembourg. In average each person in the country generates around 200 kilograms of packing waste per year.(EUROSTAT)

If the design only considers sustainability and ecology superficially, without emphasizing on human consuming behaviors, there might be hardly improvement to the environment in long-term. At the meanwhile, developing countries will continue suffering the importing waste as well as vast waste produced by their own. (fig.1.27) Thereby, a feasible integrated approach for landfill redevelopment should be applied in the future landfill treatment in all over the world, particularly developing countries.

As landscape architects, a global sense should always be in our mind, related to the philosophy of landscape design. Wasting will be a continues expanding process if people are not educated to save energy and resources. It leads to enormous environmental and social problems that are displaying all over the world. Concerning this, the waste and landfill issues should be viewed in a more general context of human consumption. Subsequently, when confronting a design task of landfills, I will broaden my design objective from the single ecological landscape transformation to a more integrated one - combing the transforming process with an educative purpose, to fundamentally achieve a sustainable goal.

Figure 1.28 Flows of waste are directed throughout the world, source: Pierre Belanger "Landscapes of disassembly", 2007.60 Challenges

1.6 Research design

1.6.1 Goals

The main objective of this thesis is to explore the theoretical possibilities and practical applicability to transfer the landfill into a multifunctional ecological site which might include but not limit to air quality, soil quality, waste management, biodiversity, water treatment and leisure landscape design by incorporating utilizing various landscape designing tools (e.g. ecology diversity) Beside that, the educative meaning will be emphasized as an incorporative objective of the site. The design is about creating a healthy, integrated human-nature ecosystem where ecological, leisure and cultural functions co-exist and in which all parts of the system are equally visible, it should satisfy the community needs and desires. Beyond cleaning contaminated land and creating a new self-sufficient system, desirable community green spaces and educative elements are created.

This could be achieved in four steps:

1.Theoretically studying the ecological restoration and waste landscapes related knowledge, defining the general problems.

2. Choosing the suitable study area to apply the idea. Figuring out the current situation and problems of the chosen landfill site, especially in landscaping and ecological perspectives of biodiversity, environmental pollution, leisurements, etc., specifying both the most positive and negative ecological elements of this area.

3. Exploring the local's perceptions of the landfill, finding their potentials to allocate educative landscape elements into the site, to correct people's misunderstanding of waste. Subsequently ranking the most beneficial combined options for the site from a human-landscape-ecological view. Planning the site based on the best developing options (selected after step 2) for the site, incorporating existing knowledge and technology into the research results and site context.

4. Reviewing the whole process, summarizing the expecting effects, and concluding the landscape designing principles for ecological and educative transformation redevelopment.

1.6.2 Hypothesis

A well-designed landfill should have the possibilities to have not only ecology values but also educative meanings, facilitate people to get understand the waste treating process, like how waste is being buried, stacked and recycled, in order to evoke a recognition of saving energy and protecting environment by reducing a wasteful attitude and unnecessary wastes. Also a feasible integrating approach could be applied in the future landfill retreatment in other projects.

1.6.3 Research question

The research will be conducted with several research questions. My main research question is:

How can my studying area be developed into a sustainable and attractive site, where negative impacts from landfill are decreased, and various landscape functions be developed and integrated in a sustainable and educative way?

Then, several sub-research questions are defined:

a) What are the current qualities, threats and potentials of the different landscape type in the landfill study area?

b) What are the spatial manifestations of a landfill site?

c) What are the wishes and demands of local people forwards the future landscape development of landfill?

d) How can the landfill be redeveloped focusing on ecological and sustainable values?

e) How can the educative meaning be incorporated with landscape design using existing resources in a landfill redevelopment project?

1.7 Research Method

1.7.1 Research flow

Methodology is based on "research for design". Research and design are two distinctive activities. A complete research for design is an iterative process, in which, research, according to Zeisel (2006), draws on theory, training, accumulated knowledge, and experience to generate tentative ideas about how to solve problem, and design refines researches direction constantly, like the scheme in Figure 1.29.

The whole methodology map is illustrated in Figure 1.20. The process starts with setting up hypothesis. Literature reviews and case studies play a significant role in gleaning and inducing useful theoretical framework and design tools. As discussed by Forster Ndubisi (1997), substantive theory in landscape planning originates from sciences and humanities, are descriptive (about what), and used for dealing with information, while procedural theories which are prescriptive (about how) focus on methodological issues, and explicate the functional relationships that permit the application of the knowledge. In order to get a complete theoretical framework, theories of two types are both needed. The involved substantive theories include eight waste-related landscape design approaches principles with technique focus on ecological diversity; the involved procedural theories consist of layer approach and a model strategy of landfill redevelopment. The research process is divided to four parts; each part has several steps and a main goal. The methodology map is based on my research process, related with the decision flow of Model Strategy (fig.1.12) into step two and step three. All those steps have a certain contribution on the process and most of them base on a cyclic approach. So after a period of research I will look back to analyze the design or research I have done to rectify mistakes, add more information or make clear directions for next steps.

1.7.2 Design process

The research will be test by a site-specific design. The design will follow an inventory, analysis, concept, design and elaboration process. In the inventory part, data will be collected through site survey, literature review and interview. The environmental conditions, such as topography, traffic analysis, soil structure, land use, etc. these constraints are important for the further design. The research objectives and research questions are also be modified when I gain more information and knowledge about the site. The assessment will follow the design to check if they are suitable or not. If the designs are not suitable, I will go back to the design part again and repeat this circle. (fig.1.30)

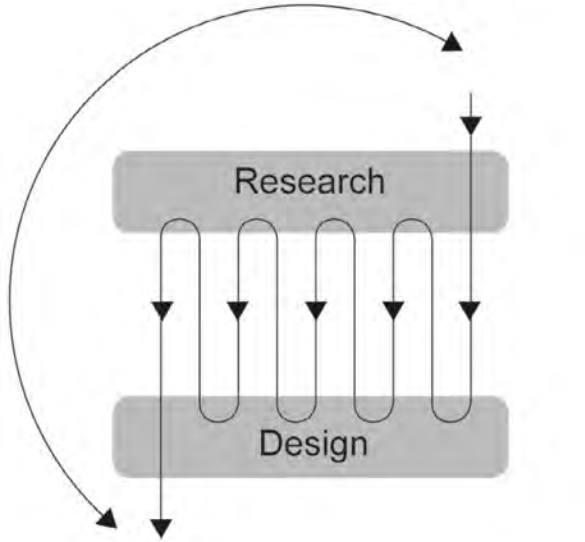
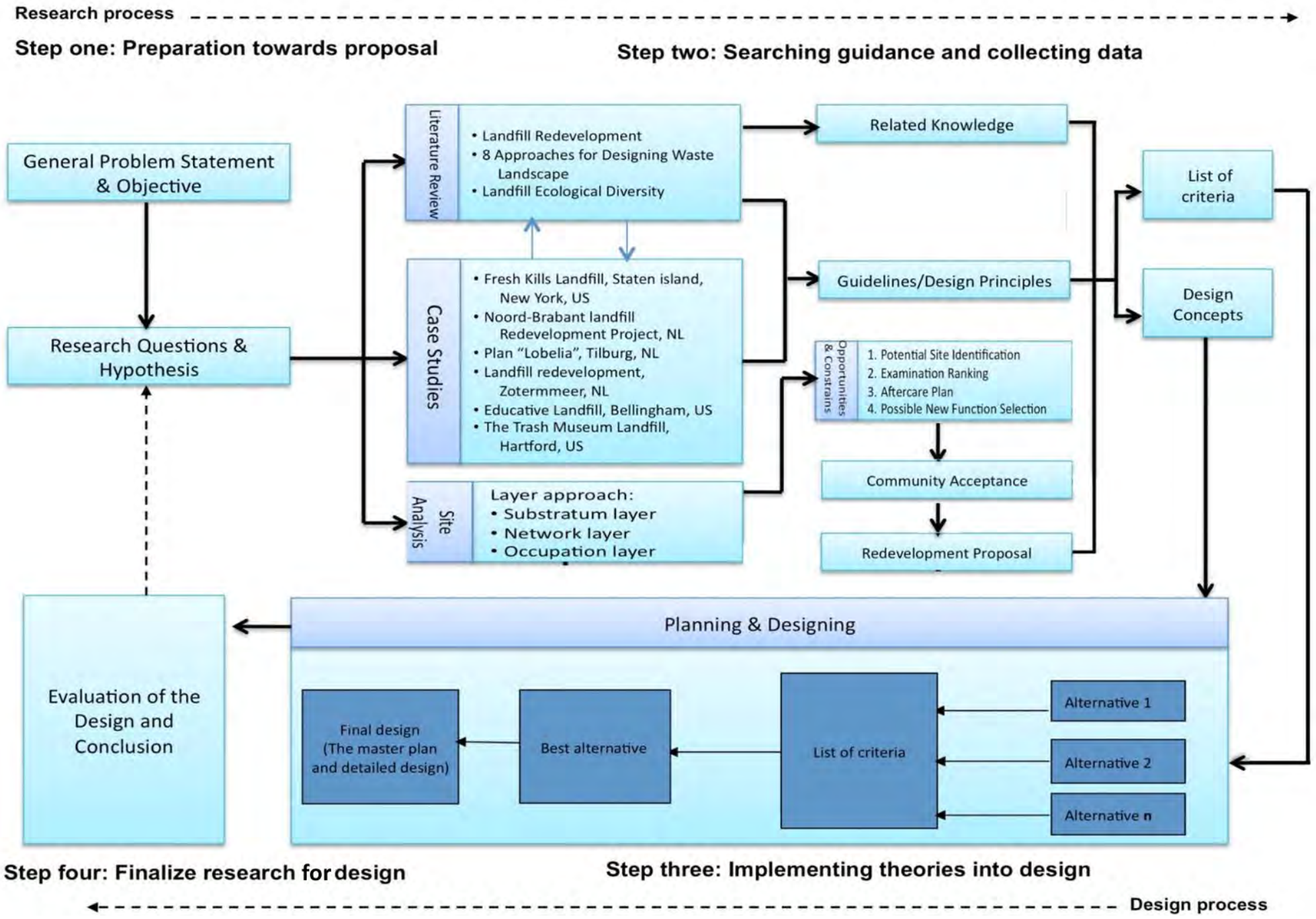


Figure 1.29 research and design
Source: Zeisel, 2006

Figure 1.30 Methodology map, made by author



1.7.3 Methods

Each sub question has its own methods to come to the desired results. To ensure that the sub questions will be closely related to the objective and goals of this research, they are accompanied by a short description of their desired results.

1 What are the current qualities, threats and potentials of the different landscape type in the landfill study area?

Method	Results
Field excursion, analysis on site	Analysis of qualities, threats and potentials in maps, principle sketches, text and photographs
Maps/GIS research	Insight in historical development of different patterns, settlements and land use in relationship to elevation, soil conditions and geomorphology, to understand the current morphology of the landscape

2 What are the spatial manifestations of a landfill site?

Method	Results
Short field trips to other landfill areas in the Netherlands and research (internet/literature)	Photographs, sketches of spatial principles and description of atmosphere, to give an overview of the spatial manifestations of landfill in the Netherlands, with special attention for general characteristics that can be recognized in the study area
Field excursion to the study area	A graphic presentation of the location and characteristics of risk areas where the effects of landfill can be expected to be most severe
Open interviews with local experts and residents	Summarization of most important problems as experienced by local people

3 What are the wishes and demands of local people forwards the future landscape development of landfill?

Methods	Results
Literature research	Overview of demands and wishes that people need for landfill redevelopment
Reference research (internet/literature)	Translation of demands and wishes in design principles

How can the landfill be redeveloped focusing on ecological and sustainable values?

Methods	Results
Research by design	Using the integrative approach combining elements from all the other strategies, integrating the principles of ecology with the philosophy of art

5 How can the educative meaning be incorporated with landscape design using existing resources in a landfill redevelopment project?

Methods	Results
Research by design	Using the acquired knowledge in design sessions to produce models and alternatives for combinations of ecological values and educative meanings

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2 Theoretical basis

Figure 2.1 A former landfill redevelopment: Byxbee Park, California, USA. Photo by Marijke, http://www.interfacility.com/

2.1 Subject and purpose

Study experience in Wageningen University has made me be aware of the significance of ecological planning and design. This awareness, with a serious global problem of waste encourages me to do such a subject. Upon completion of this thesis, the aim is to gain a deep understanding on landfill redevelopment's role/performance in people's attitude about waste as design element and how adopt the educative meaning into the design.

According to Steinitz (2001, p.237), for a postgraduate level education, it requires students to be able to select appropriate methods and theories to study for selected problems, and make adaptations if needed. These qualities should be present in this thesis. Therefore, the basic content of this thesis includes: 1) to select related theories and methods correctly suitable to research questions; 2) to generate guiding principles by adopting and adapting these theories and methods; 3) to apply guiding principles and design tools in design phase and conclude an effective and transferable approach eventually.

The involved theories and methods are drawn from landscape design and planning, which help me to grasp necessary principles and tools relevant to landfill sustainability in research process.

2.2 Landscape Design and Planning

There are various ways to define Landscape architecture. They include: landscape architecture is a design discipline within the scope of ordering of space (,1984); landscape architects is one of the activities dealing with the mutual adjustment of human activities and the space available(Vroom, 1986; Vroom and Steiner,1991); a conceptual approach with a strong emphasis on ecological processes and landscape form are the ingredients of landscape planning(Vroom,1990). In these definitions, design for space plays an important role, and spatial form and ecological processes are two major ingredients in the design (Ingrid Duchhart, 2007).

As Laurie Olin mentioned, *"Landscape architecture as a subfield of art, processed by using a known body of forms, a vocabulary of shapes, and by applying ideas concerning their use and manipulation. "* However, where do these forms come from? It will relate to the Genius Loci of place and memory. The only thing that we can ever know for certain about the world is that which exists now or has existed in the past. So that to make something new we must start with what is or has been and change it in some way to make it fresh in some ways (Laurie Olin, 2002).

2.3 Landscape aesthetic

Rather than of an ecological or environmental aesthetic, I would like use a landscape aesthetic as the definition of my aesthetic experience. Landscape is the real sense of subject, including ecology and environment, and so on. Landscape is composing a lot of things, living and non-living, human and natural, to a total. Therefore, the total is the landscape. Environment means that only the hard, scientific parts of the landscape, and ecology means in favour of the natural part. Landscape should consider the overall layers, from the biological to the non-biological, human, natural, cultural, social and technical, not favouring any of them. In the end, the landscape architect creates a landscape, either only an ecology or an environment.

This statement is supported by an idea of James Corner. According to him, landscape architects have been exploring and developing a range of ecological techniques for the planning and design of sites. For a variety of reasons though, ecology has been used only in the context of something called 'environment', which is generally thought to be of 'nature' and exclusive of the city. Those who have included the city in the ecological concept have done so mostly from the perspective of natural systems (hydrology, air-flow, vegetation, habitats, and so on). Cultural, social, political and economic environments are embedded in and parallel with the 'natural' world. Research and especially practice has to understand and explore more from this point of view. (Corner, 2006)

2.4 Landscape analysis

Prof. Kerkstra built up a well-known classical lay approach model in 1988. It is used as a tool to understand modern landscape which has a loss of soil-dependency, with modernization, development of artificial fertilizer, changes in the water system and the change from rural to industrial.

Kerkstra's theory is mainly based upon the landscape itself. They describe the landscape as follows:" *landscape is the visible result on the surface of the earth of the interactions between man and nature".* (Kerkstra and Vrijlandt, 1988) Their model is known as the triplex model. (fig.2.2) It is built up of an anthropogenic layer, a biotic layer and an abiotic layer. Also, they mentioned that the only factor that is constant in the landscape is change.

Different from Kerkstra, the theory of Kleefmann distinguished two main systems: the natural and the societal. The natural consists of two subsystems:

(1) the abiotic, the non-living natural surroundings, for example soil, water, air etc.

(2) the biotic, which is the living natural surroundings, for example all living organisms, including humans.

The societal consists of three subsystems:

(1) the economic; production and labour,

(2) the cultural; shared patterns of norms and values

(3) the political.

The model is called the 'socio-physical organization model' (fig.2.3) because of its intertwining processes to fit the natural layers to the societal needs. Kleefmann's point of view here is spatial organization. (Duchhart 2007)

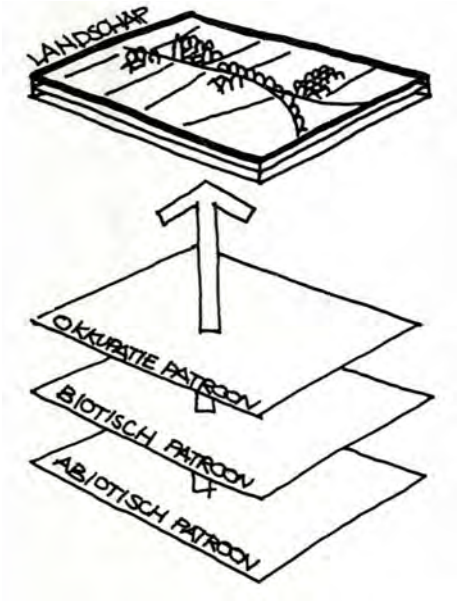

Figure 2.2 The 'triplex' landscape model (Kerkstra en Vrijlandt, 1988)

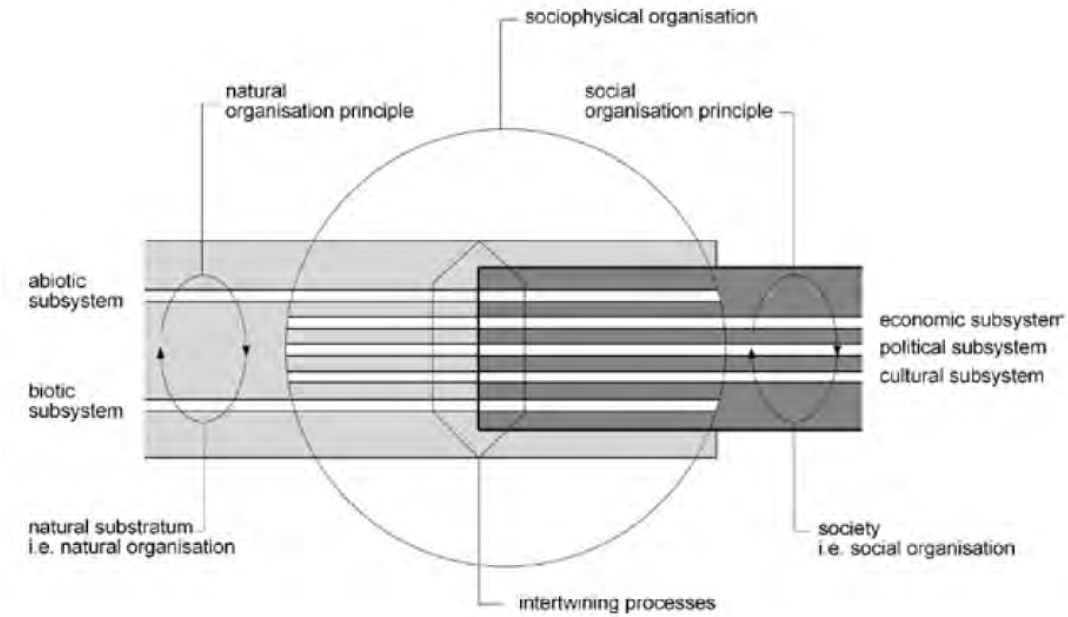

Figure 2.3 The socio-physical organizaiton model (Kleefmann, 1992)

From the two theories described above, Ir Duchhart composed a model that combined the theories of both Kerkstra and Kleefmann for a better understanding of the driving forces underlying the visual landscape. (fig.2.4)

> *"The triplex-landscape model is strong in analysing the (pattern oriented) tangible physical environment and natural organization principles, while Kleefmann's sociophysical-organisation model helps to bring to light less tangible (process oriented) issues, such as cultural taboos, and the way principles of social organization interact with nature."(Duchhart 2007)*

For my thesis, I realize that combing these two theories in this way can be helpful in understanding how the natural environment interacts with aesthetics. Aesthetics reflect the way society thinks about nature, including art, social acceptance, cultural values, policy and technique. This model can also be helpful in combining the scientific, theoretical and architectural design principles.

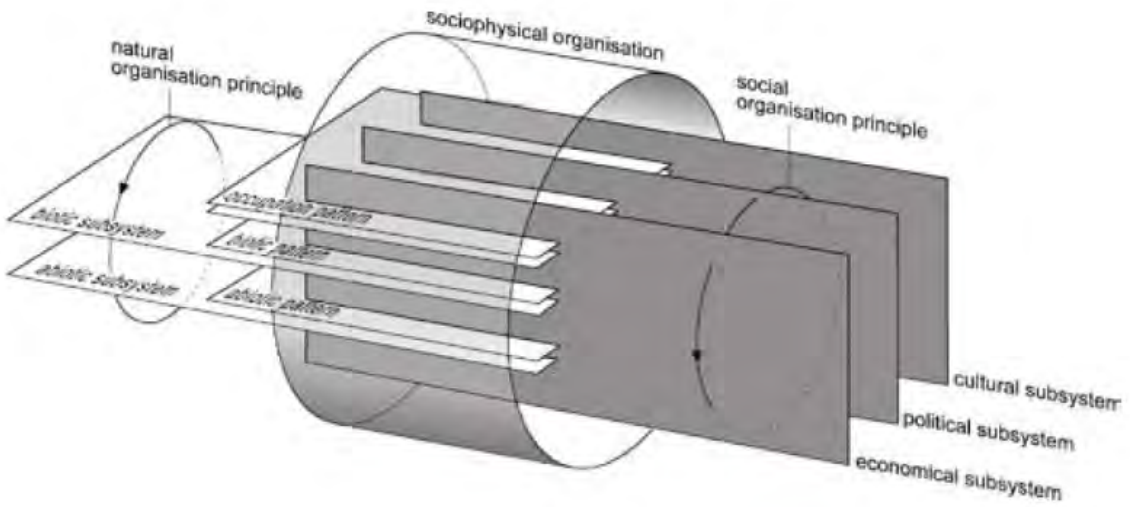

Figure 2.4 Intertwining the triplex model and the socio-physical model (Duchhart 2007)

2.5 Ecological Restoration

2.5.1 General description

Ecological restoration is ***the process of repairing damage caused by humans to the diversity and dynamics of indigenous ecosystems***. While every restoration project is unique, all include the following elements:

1 Judgment of need. The process of ecological restoration begins with a judgment that an ecosystem is damaged by humans to the point that it will not regain its former characteristic properties in the near term (two generations, or about 50 years), and that continued degradation may occur.

2 An ecological approach. Ecological restoration implies that we wish to restore organisms and their interactions with one another and the physical environment. Ecological restoration concentrates on processes such as persistence of species through natural recruitment and survival; functioning food webs; system-wide nutrient conservation via relationships among plants, animals, and the detritivore community; the integrity of watersheds; and abiotic processes that shape the community such as periodic floods and fires. Because these organisms and their interactions define and shape the ecosystem, a "species only" approach will likely fail.

3 Setting goals and evaluating success. Ecological restoration is a deliberate intervention that requires carefully set goals and objective evaluation of the success of restoration activities.

4 limitations of ecological restoration. Ecological restoration in its purest sense is not always possible; it depends on four interrelated social and biological conditions; how nature is valued by society, the extent of social commitment to ecological restoration, the ecological circumstances under which restoration is attempted, and the quality of resorationists' judgment about how to accomplish restoration. Without optimum conditions in all four areas, complete ecological restoration is not possible.

2.5.2 Alternative after-use in landfill restoration

Agricultural grassland is still the most common after-use for landfill sites. (Barker, 1996) Agriculture is not always the most suitable after-use for landfill sites. On many sites the lack of suitable available soils for restoration may make successful agricultural restoration diffcult if not impossible. In many areas there is no need for further agricultural land, especially if that land is of low productivity and requires significant inorganic fertilizer applications each year to maintain productivity.

"...Landfill sites are often located in areas where alternative after-uses are most welcome... The increased demand for amenity land for public enjoyment and passive recreation means that for many sites, especially those near to urban areas, a restoration that provides an attractive setting for such pursuits is most suitable..."(Simmons,1999)

Landfill restoration for ecological diversity can respond to these local objectives and aspirations, and thereby make a positive contribution to the locality in which the landfill is situated. It can also help to make the landfill development less unacceptable to the local population.(Simmons 1990).

Advantages of alternative after-use

- Visual amenity

A bland green space cannot offer improving the appearance and more attractive place.

"... Sites restored with an abundance of wildflowers, shrubs and trees present a more attractive appearance than species-poor grassland, and thereby contribute to the visual amenity of the area..."(Simmons 1990).

- Soil conditions

Nature conservation after-uses require less demanding soil conditions than agriculture. And it also a very cost-effective alternative to importing significant quantities of subsoil and topsoil for restoration.

- Landscape design

With a nature conservation after-use the landscape design can be more flexible, and the aftercare operations are less frequent and extensive. Features such as tree and shrub areas, steep slopes, wetland or water features can be sited where most appropriate given the constraints of the site. Where wildlife habitats are being created, areas of settlement and poor drainage can be positively beneficial.

- Public perception

Schemes to restore land for public open space and wildlife will often attract more public acceptance and support than schemes where agriculture is the after-use.

2.6 Place identity of landfills

Landfill is full-bodied on meaning. They reflect the chaning appraises in our society and com up to the demand to dispose of solid waste. When a landfill has accomplished capability, the landscape will adopt on a new character in the surrounding community. Even though the solid waste disposal chapter is closed down, landscape architects could retell the story imbedded in the landfill landscape since they begin to accommodate it as new demands.

Landfills do create a sense of place identity, not just through their sheer size, but also in the history that they encapsulate. (fig.2.5) By their nature, landfills become places that are enriched with culture and values. They can therefore become places where garbage is no longer viewed as purely negative, thereby allowing communities to regain pride through their reuse of these degraded sites. It is important that communities recognize the uniqueness of the previous site history as they begin to create new identities for these places in order to prevent these waste sites from becoming just another generic kind of landscape.

Exactly how we decide to acknowledge the history of sites becomes a force in itself and in a way begins to direct us into a certain kind of future. In his book, What Time Is This Place?, Kevin Lynch asks important questions regarding the factors upon which we base our decisions to preserve certain elements of the past:

> *"Are we looking for evidence of the climatic movements or for any manifestations of tradition we can find, or are we judging and evaluating the past, choosing the more significant over the less, retaining what we think of as best? Should things be saved because…they are unique or nearly so or…because they were most typical of their time? Because of their importance as a group symbol? Because of their intrinsic qualities in the present? Because of their special usefulness as sources of intellectual information about the past? Or should we let chance select for us and preserve for a second century everything that has happened to survive the first?" (1972, p. 35-6).*

These kinds of questions help us to understand that the very choice of culling through the past affects our present consciousness. Just as the museum curator must choose which artifacts to display to tell a story, designers must also carefully decide how much landscape history to reveal as they try to incorporate present day use of sites.

Landscapes develop through time, not just containing ecological function, but also including human use. In this way, the past is always somehow attached to the present and is *"constantly being broken down and reintegrated and reinterpreted into the present"* (Lippard 1997, p.85). As an example, a landfill has its specific purpose for human society: to safely conceal our waste. The lifespan of that landscape as an active landfill is limited from the beginning. These

Figure 2.5 An image showing the history of a garbage mound at Fresh Kills landfill
Source: http://www.washingtontimes.com/multimedia/

places must one day take on new identities when they cease accepting waste. Yet the history of that place as a landfill has important implications for future uses and interpretations of that site.

The landscape of landfills is layered, both physically and metaphorically. These sites are imbedded with cultural artifacts, and yet at the same time, have serious implications toward the ecology and health of the surrounding landscape and community. These sites do represent a certain time in our history when we have deemed it acceptable to create large mounds of trash. They are visual symbols of our consumption and willingness to discard certain material goods. They also contain artifacts that chronicle our very lives. Acknowledging these levels of meaning can be helpful in determining how to address these places and how the past and present are infinitely connected. Additionally they help point to ways that these degraded sites are important when regarding place identity.

> *"Landfills can create place identity in two ways: first, internally through the waste that is buried and secondly, externally through the manipulations of the topography of the landscape that are the result of burying that waste." (Lauren Marie Brandes 2003, p.40)*

It is important to recognize the past use of landfills after they have been capped because it will help our current culture to comprehend these visual symbols in terms of our consumption of goods. Yet in a larger scale, the connection remains because the garbage, no matter what the contents, still represents our society's willingness to consume and discard. If a capped landfill contains no recognition of its past function, then the sense of place and the connection of that place to society's values will be lost. And I will explain more in detail about how to achieve this goal based on landscape principles and other methdology.

2.7 Education

2.7.1 Landscape as public environmental education

> *"Landscapes can tell the story of a place and the people who use or used it. The story might focus on regional ecology, lost or displaced peoples, or industrial archaeology...methods of storytelling in landscapes are varied, limited primarily by creativity. Interpretive signs and self-guided tours are simple and effective ways of narrating site history. Educational landscapes, however, can go far beyond these basic methods..."*
>
> *--J. William Thompson, 2008*

These were termed eco revelatory. Places of this sort have also been called narrative landscapes or interpretive landscapes….They raise public awareness of landscape as a vital force in history and in contemporary life. Revealing and interpreting the landscape are ways of working against cultural tendencies that tempt people to ignore the landscape except when they are exploiting it.

Visiting places where remarkable things happened is a fascination for many people. At memorials, monuments, and historic sites, "being right there "creates a powerful experience that no distant book or museum can match. This same experience can be used to educate people about natural history, too.

Public environmental knowledge and awareness are key factors in whether sustainability will ever be achieved. In designing and constructing sustainable landscapes, look for opportunities to tell site visitors what is going on. Whether it is a serious interpretive project or a whimsical use of recycled materials, the story told may be as important as the functions fulfilled.

Figure 2.6 Vultures are common sights at landfills
(photo by author)

2.7.2 Education programs

Since of the uncommon site conditions, if a former landfill is going to be adapted for human use, it is most often transformed into a recreation area, with multifunctional use. In that situation, encouraging people to come to the site is an essential part of the following design elements. As studied the successful landfill redevelopment projects, activities such as walking, jogging and cycling can easily be integrated into the site's features. However, based on my objective and hypothesis, it is also reasonable to augment the visitor's experience by adding educational and interpretive elements to the site. These elements are able to be in the form of signs throughout the site which explaining details about the landfill, such as the history of

Figure 2.7 Landfill field trip

Figure 2.8 Scientific research in landfill

the site, how the recycle process works, what is the function of the site, etc. Additionally, park employees can lead walks throughout the site, explaining the characteristics of the landscape

In this chapter, I will list three possible education programs based on literature review and case study. They are raised based on landscape, scientific and public participation, and considering different group of people's demands. However, all the principles are only general ideas. On the coming chapters I will evaluate each of them, to see if they are fitted for my study area or not. Finally I will apply the suitable ones into detail design to achieve my objective.

2.7.3 Exporation of the landscape

Designers can collaborate with educators to develop creative ways to encourage exploration of the landscape. The landfill park can become a place that teachers bring students for field trips. An example of an educational way to engage school children is through scavenger hunts. Scavenger birds such as vultures, crows and gulls are common at landfills. (fig.2.6) The park manager can come up with a list of things that the children must find when they are at the site such as some of the relicts left over from the site's days as an active landfill. Because of safety and health concerns, it would be improbable for the kids to hunt for actual trash, but other items relevant to the site could be part of the hunt.

Educators and park managers should gear educational experiences to many different age levels. This will make the visit to the landfill park interesting and stimulating not just for younger children, but for teenagers and adults as well. These educational activities can change throughout the year, thereby keeping visits to the site exciting and novel.(fig.2.7)

2.7.4 Scientific research

Landfill can not only become recreation areas for communities but they can serve as important places for scientific research as well.(fig.2.8) Gradually, governmental agencies have administered regulations for landfills, but there may be effects from the landfill that may not yet be discovered. Environmental laws already require certain kinds of monitoring such as ground soil testing and methane gas ventilation. Scientists can use landfills as places to research the effects of degraded land on the surrounding landscape and wildlife and to help tell the environmental stories of these sites.

Even though designs for the reuse of landfills should acknowledge the history of the site, designers must also recognize the need to ecologically heal these places as well. Landfills should be used as laboratories to find better, more innovative ways to help clean up and restore these landscapes. An example of this kind of research is phytoremediation of toxic materials from the land through the use of plants. Additional research could include the recycling of materials from the site.

This research can be easily tied into the educative component of the site as well. This educative element can be important to the success of restoration efforts. Oftentimes, ecological restoration involves techniques that observers might not recognize as benefiting the environment. Explaining these techniques and the processes of restoration can help visitors understand the need for those actions. Visitors then may also respect some of the limitations of using that landscape if educational signs describe what is happening to the site.

2.7.5 Naming

> *"Naming is a fundamental strategy of making places, transforming undifferentiated, raw spaces, mass, objects, land…into known places…The named site also becomes a storied place…Place names become abbreviated narratives of various types." (Matthew Potteiger, Landscape Narratives, p.77)*

Naming is one of the easiest ways to give an identity to a place and often serve as a memorials. A name that people bestow to a former landfill site when it becomes a new place for a community can help preserve the history of the site. It is common to name a place after an important people or community members, but this approach may end up erasing particular aspects of that place, especially for landfill. A alternative approach is to honor the site's use as a repository for the community's solid waste by means of retaining at least part of the name of the place from its days as a waste site facility. (fig.2.9)

There are other was to incorporate names into the park features. A closed landfill site has many features that already have names that originated in its life as an active waste disposal place. Often these names distinguish the different mounds of trash. Designers can use the very same names as the landfill managers when designing different areas of the park. There may also be other 'unofficial' names that landfill managers and others who work there use to describe different sections of the site. Their input can be helpful in continuing on the names of certain places in the site.

Figure 2.9 Signs identifying sections

2.8 Integrative approach of redesigning waste site

Figure 2.10 An example of restoration approaches: landfill in Tilburg. Photo by author

Figure 2.11 An example of recycling approach: the Maritime Heritage Center and fish hatchery at Bellingham, Washington

Mira Engler (1995), professor of Landscape Architecture at the Iowa State University, generalized the contemporary waste-related landscape design approaches into eight categories: camouflage, restoration, recycling, mitigation, sustainable, educative, celebrative, and integrative approaches. Engler uses these categories to describe various kinds of waste sites, from sewage plants to landfills. According to Engler, the eight approaches though overlapping and indefinite, each category is traditionally associated with a distinct discipline or profession, representing varying values, interests, and outlooks.

The camouflage and restoration approaches bear upon traditional landscape aesthetics in landscape architecture practice, which promotes and elevates selected landscapes above others.

The recycling approach targets social or economic benefits, which contains a land-value approach turning liability into amenity, a community recreation park or a real estate approach transforming wasteland into profit.

Environmental scientists and engineers prefer ***the mitigation and sustainable approaches***: the scientist is primarily concerned with site remediation that uses natural systems, while the engineer seeks in addition an economic return to support the ongoing maintenance expenses.

The educative and celebrative approaches taken by educators and artists put forth human awareness and perception. The distinction of the two is that the former teaches the reality of garbage, whereas the later uses garbage as a metaphor, denying the ubiquity of waste.

Finally, ***the integrative approach*** represents an infusion of ideas across disciplines and professional boundaries: a collaborative, complex approach that combines the concerns of many of the other approaches (Engler, 1995).

There are many examples of each of these approaches, (fig. 2.10,2.11,2.12) and each example has its own effect in terms of a community's attitudes about that specific waste site. For instance, the camouflage and restoration treatments are somewhat superficial in that they do not respond to the larger issues (Engler 1995, p. 23). Those kinds of designs fail to acknowledge the broader social concerns, such as discussing ways that communities can begin to reduce their waste or helping reconnect people with a greater awareness about waste production. The recycling, mitigation and sustainable approaches consider the site's ecological health, but fail to recognize valuable metaphors in the site that can contribute to a community's knowledge or change in attitude about waste (Engler 1995, p. 24). In contrast, the educative and celebrative approaches do help people see the problems associated with waste, but they might fail to actually bring about any real change (Engler 1995, p. 24).

In fact, Each one has advantages and disadvantages, all individual approaches make up the

integrative approach. (Table.2.1)

Individual approach	***Merits and relevance***	***Short of workable and effective solutions***
The camouflage and restoration approaches	Basic reclamation, short time construction, a popular aesthetic place	Preserve the public's fear and shame of waste, superficial responses to lager problems
The recycling approach	A practical search for immediate benefits in retrieving the worth of the land	Fails to retrieve tis meanings
The mitigation and sustainable approaches	Re-establish a healthy, balanced ecosystem, a natural processes to correct or manage the waste site	Do not contribute to an increased public knowledge or change of attitudes towards waste
The educative and celebrative approaches	Enhance and change people's ceptions and attitudes about waste, help people see the waste problem	Fails to shape and affect public policy and answering community needs

Table 2.1. Advantages and disadvantages of each individual approach, Source: Engler, 1995

After Engler generalized each project into the eight landscape approaches, she pointed out that most of the designers ignored the educative approach in the process. And to meet my objective, it is important to point out strength of educative approach. The advantages of educative approach, emphasizing public awareness, changing of attitudes toward waste are missed.

> *"...it invites people to experience the realities of waste institutions and nurtures a more open relationship toward refuse...existing waste facilities are opened to public tours, and special educational facilities are built. As a result, interpretive tours keep the public in touch with waste management in actual or simulated waste environments..." (Engler, 1995)*

As for my thesis, my preference approach is the ***integrative approach***, the one that seems to achieve the most terms of varety of experience. The strength of the integrative approach is in its workable synthesis, it balances program and aesthetics, practical needs and expressive metaphors, natural science and art, public sensibilities and avant-grade aspirations.

Figure 2.12 An example of integrative approach: Byxbee Park, Palo Alto, California

Table 2.2 Eight approaches for designing contemporary waste sites (Summarized from Engler 1995)

Design Approach	Waste Facility Status	Site seen as Public Amenity	Waste Site History Recognized	Creates New Kind of Landscape	Rehabilitates Ecological Function	Encourages New Attitudes About Waste Sites	Overall Characteristics Of Design Approach
CAMOUFLAGE	Active or Stopped	No	No	No	No	No	-disguises waste site facility -appeases community fears about waste facility yet it continues to inhibit public perceptions and restrain public care for waste problems.
RESTORATION	Stopped	No	No	Yes	Yes	No	-seeks to rehabilitate site by returning it to its previous conditions. -creates a new, viable landscape for wildlife and reconstructs 'nature' for people, but it simply masks the waste.
RECYCLING	Stopped	Yes	No	Yes	No	No	-reuses the waste site as a public amenity for recreational, agricultural or private land development.
MITIGATION	Active or Stopped	Sometimes	No	Yes	Yes	No	-weakens the impact or reduces the severity of polluted land or water. -scientific solutions drive the design. It is based on understanding how nature works yet often results in implementing restorative processes that are obscured from the visitor. -sometimes it results in a viable landscape that can be used by wildlife or people.
SUSTAINABLE	Active or Stopped	Yes	Yes	Sometimes	Yes	No	-concerned with the economics, conservation and self-sufficiency of the site. -employs a diverse program that often includes elements of production or reuse of waste resources. -considers waste a valued resource.
EDUCATIVE	Active or Stopped	Yes	Yes	Yes	No	Yes	-emphasizes public awareness and change of attitudes toward waste. -invites people to experience the realities of waste sites and nourishes a more open relationship toward refuse.
CELEBRATIVE	Active or Stopped	Yes	Yes	Yes	No	Yes	-promotes and dramatizes waste sites and facilities through works of art, special design features and unique experiences. -garbage becomes a metaphor of refuse, excess and resources mismanagement. -focuses on reducing the distance between people and their waste and revealing the multiplicity and interconnectedness of waste systems.
INTEGRATIVE	Active or Stopped	Yes	Yes	Yes	Yes	Yes	-combines elements of the celebrative, with the other strategies. -integrates principles of ecology with art. -changes an abused site while at the same time amplifies its reality. -expresses fresh spatial conditions and aesthetic possibilities.

2.9 Reflection

Limitation to landscape architects on waste issue is that we can only follow existing technologies. It is necessary that we borrow the knowledge from other professions to select appropriate tools for our design process, however mostly we can hardly get the complete image of other professions. Landfill is created by the man-made system which has been changing the surrounding landscape immensely, but landfill is not included in normal landscape elements like trees, rivers and forest etc. So when landscape architects are considering landfill, the surrounding environment and system which creates this landfill also need to be taken into account.

> *"Landscape can be seen as a system, a web of structural elements of interconnected biological and geological systems." (Duchhart, 2007).*

As designers, our function is to analyse the complex interconnected biological and geological system to see which process or function is causing the problem, and then we can balance the system by directing functions into spatial forms.

On the other hand, through artists and architects created lots of inspiring art pieces using wasted materials and landscape architects are often inspired by their idea, I think the Wageningen university approach should more focus on solving problem, looking at large scale issue and with ecology and sustainable glasses. Our design discipline is ordering space and directing landscape processes, our main design tools are trees, water etc. We can use our knowledge to adjust the landscape system to let our design products less wasteful and productive. Also, what we should keep in mind is the knowledge we gain from waste management and landfill treatment technologies are also quite important and necessary for our design, by using those tools while emerging to our academic knowledge, a vision of how landscape is transformed can be given.

Literature study is the backbone of the research; it provides core theories to support the research and design. This thesis is related to the topic of 'landfill', which not many landscape architects are familiar with. So I first separated the literature study about landfill from the literature study about landscape architecture. More specific questions will be summarizing a guideline for design concept or principles for design. Data collection and landscape analysis are preparations for site analysis.

After a general study of these previous theoretical components, it is necessary to find a link between them. Also it is worthy to mentioned that both of them will be used individually and integratedly in my research-design process.

The theoretical component of landscape analysis can be used as the major guide in my site inventory and data collecting, quantitative as well as qualitative data is required. The quantitative data is very important for solid base, argumentation and problem formulation. Qualitative data in the form of practitioners, inhabitants and myself is very important for the practical functionality of the design principles and the final design.

The ecological restoration can be considered as an necessary support for my design. I will use this theory on plants selection and design, environment recovery, etc.

As I am searching for the impacts of landfill to people as well as the public awareness about waste issue. These two theories: place identity of landfills and education are quite important for my research and design. By studying those theoretical components I not only gained the deeper understanding about landfill's life-span, future social roles, but also getting to know various alternative methodologies about emphasizing educative meanings in landfill redevelopment.

In the end, Mire Engler's eight approaches is sort of an general introduction and summary of each different strategy and principle of designing waste site all over the world. By comparing those approaches' advantages and disadvantages I decided to choose the integrative approach to design my study area. This approach can perfectly fit with my study goals and research question.

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3 Site selection & Analysis

Figure 3.1 A birdview of Barnveld landfill, Source: Google maps

3.1 Identification and selection

I did my 'landfill journey' after I decided my topic. Identification and selection are seen as processes that can take much time and effort as well as create enthusiasm and initiatives too. So I started searching for a suitable landfill site in the Netherlands.

As I mentioned in the chapter one, my main study goal is to transfer a landfill into a multifunctional site which can serve the community well. The design should contain various design concept and knowledge, not only the ecological value, also including educative meaning. Furthermore, on chapter two, I did the literature review based on my study goal and research question. Those theories can help my build up my own research framework and design principle, using as a guideline in inventory as well. So through study those knowledge, I could be able to raise these site selection criteria to find the most suitable site as my study area.

Site selection

- Is an old multi-use landfill
- Municipal waste & industrial waste
- Potential to contributes to the prosperity of a community
- Is preferably situated within the city limits
- Has redevelopment potential with various functions
- In Netherlands

Furthermore, the feasibility aspects of landfill redevelopment as described in the Model strategy on redevelopment were taken into account as a part of the identification process. These aspects concern:

the technical area:

- environmental risks and benefits,
- landfill and site characterization,
- engineering solutions.

the administrative area:

- political risks and benefits,
- social risks and benefits,
- community involvement and acceptance,
- land use,
- communication and communication plan,
- streamline redevelopment approval process.

the financial area:

- financial risks and economic benefits,
- life cycle costs,
- public incentives and private sector involvement.

3.2 Study Area

3.2.1 Barneveld

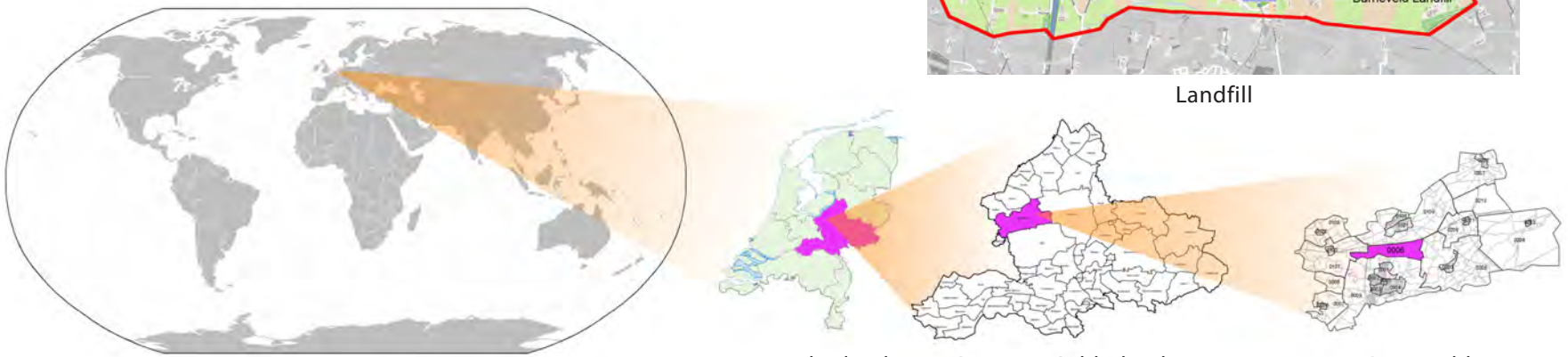
After the identification and selection, ***Barneveld landfill*** is chosen as my study area. Barneveld is a municipality of the province Gelderland located in the center of the Netherlands. (fig.3.2) The population of the municipality was 52,629 in June 2010, and 29,756 of which are living in the town. (CBS)

Barneveld is a small city with lots of rural area and natural area surrounded. (fig.3.4) The landfill lies in Weebcopperweg, the north part of Barneveld, near the industrial area. (0006) Closing to the landfill there are three major transportation line, two of them are motorways, N301 and A30, another one is a railway, leading to the Apeldoom and Ede. (fig.3.5) The location of the landfill site makes it convenient to both for waste transportation and waste resource (industry area). Furthermore, the owner of this landfill, Vink company is also located in this industrial area, which the landfill trucks can go through the highway, to the company and then the landfill. (fig.3.3)

Figure 3.3 The routes lead to the Vink company and highway, made by author

Landfill

Figure 3.2 Location of Barneveld landfill



Netherlands Province Gelderland Barneveld

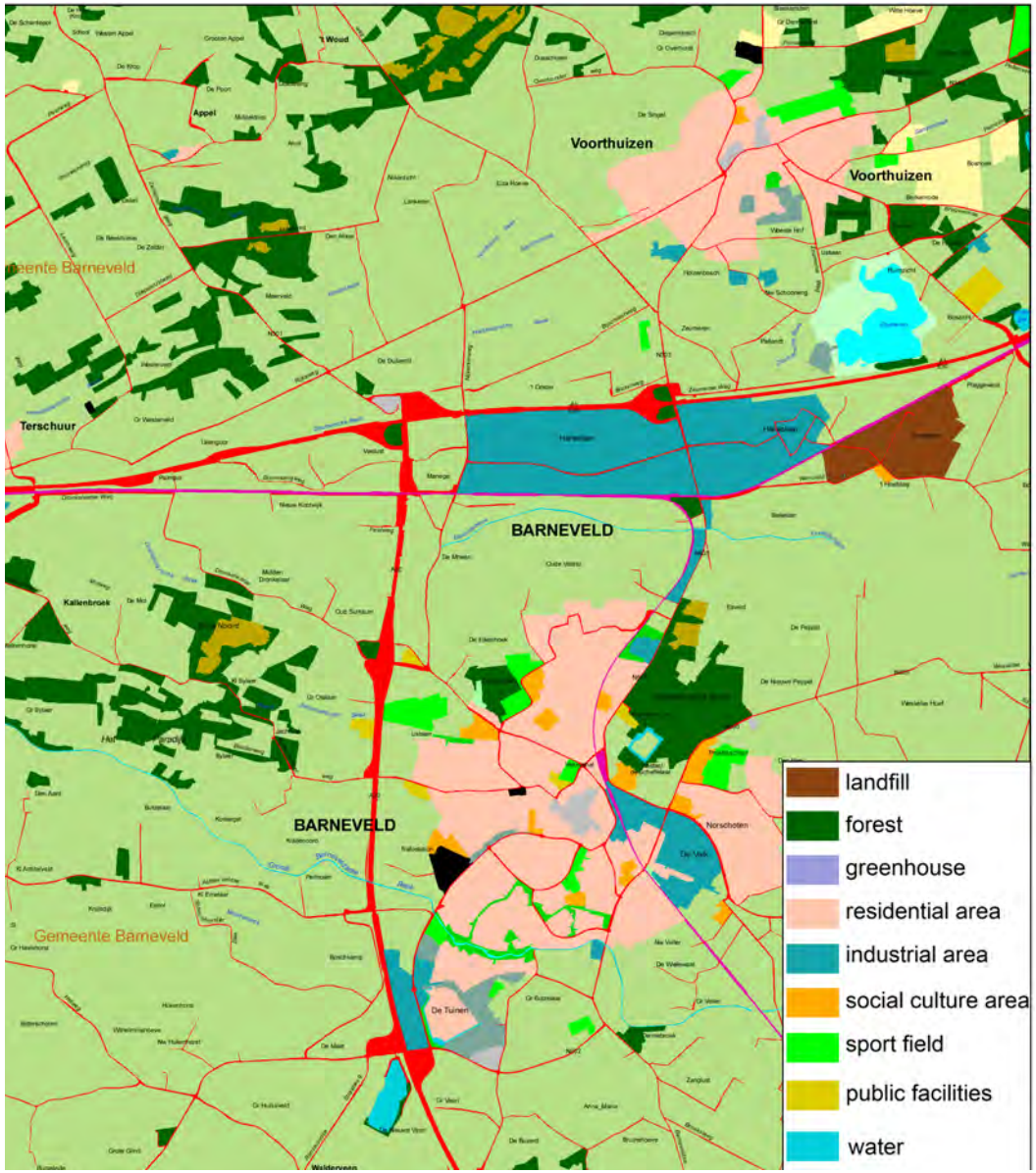


Figure 3.4 Land use of Barneveld

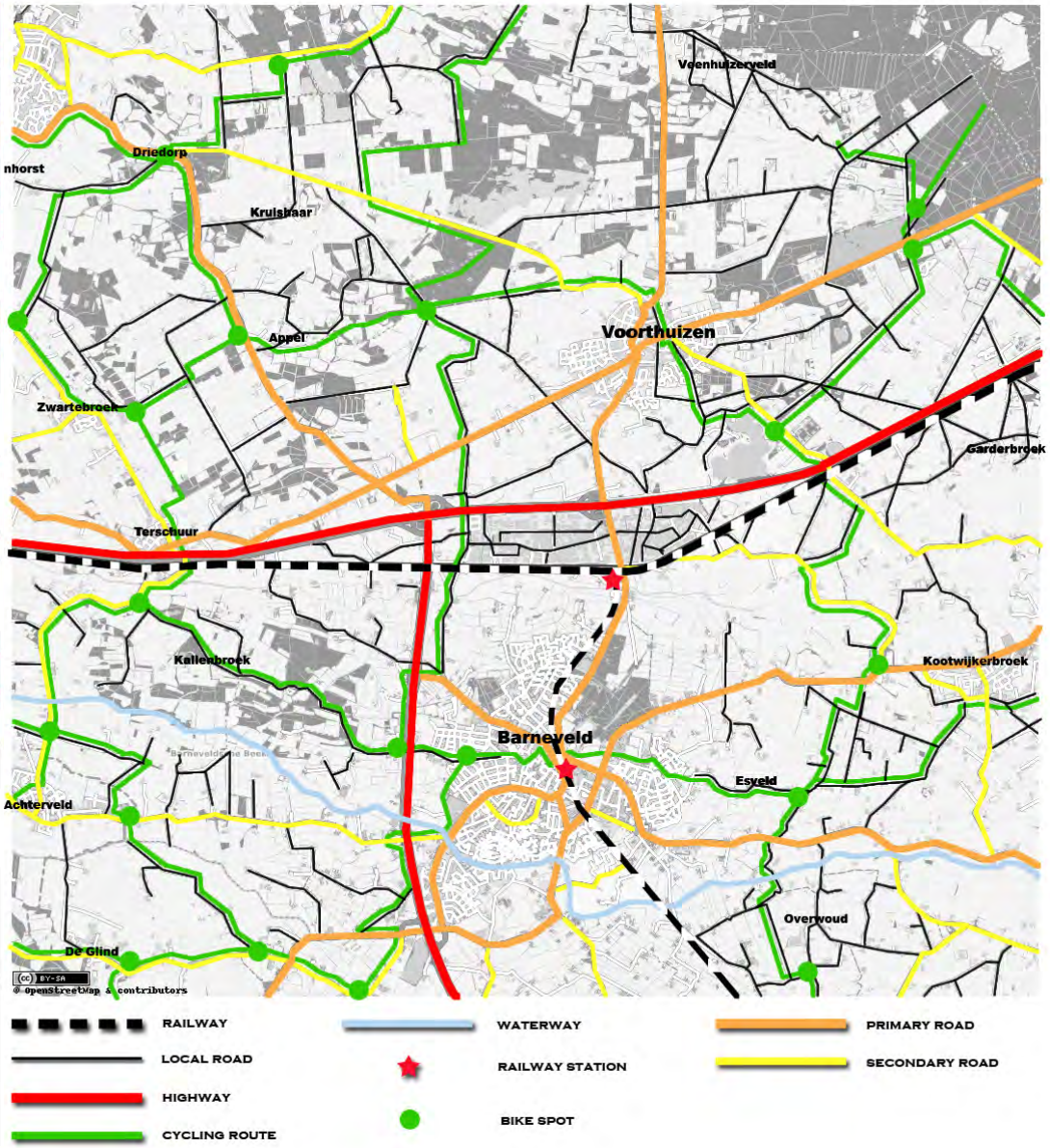
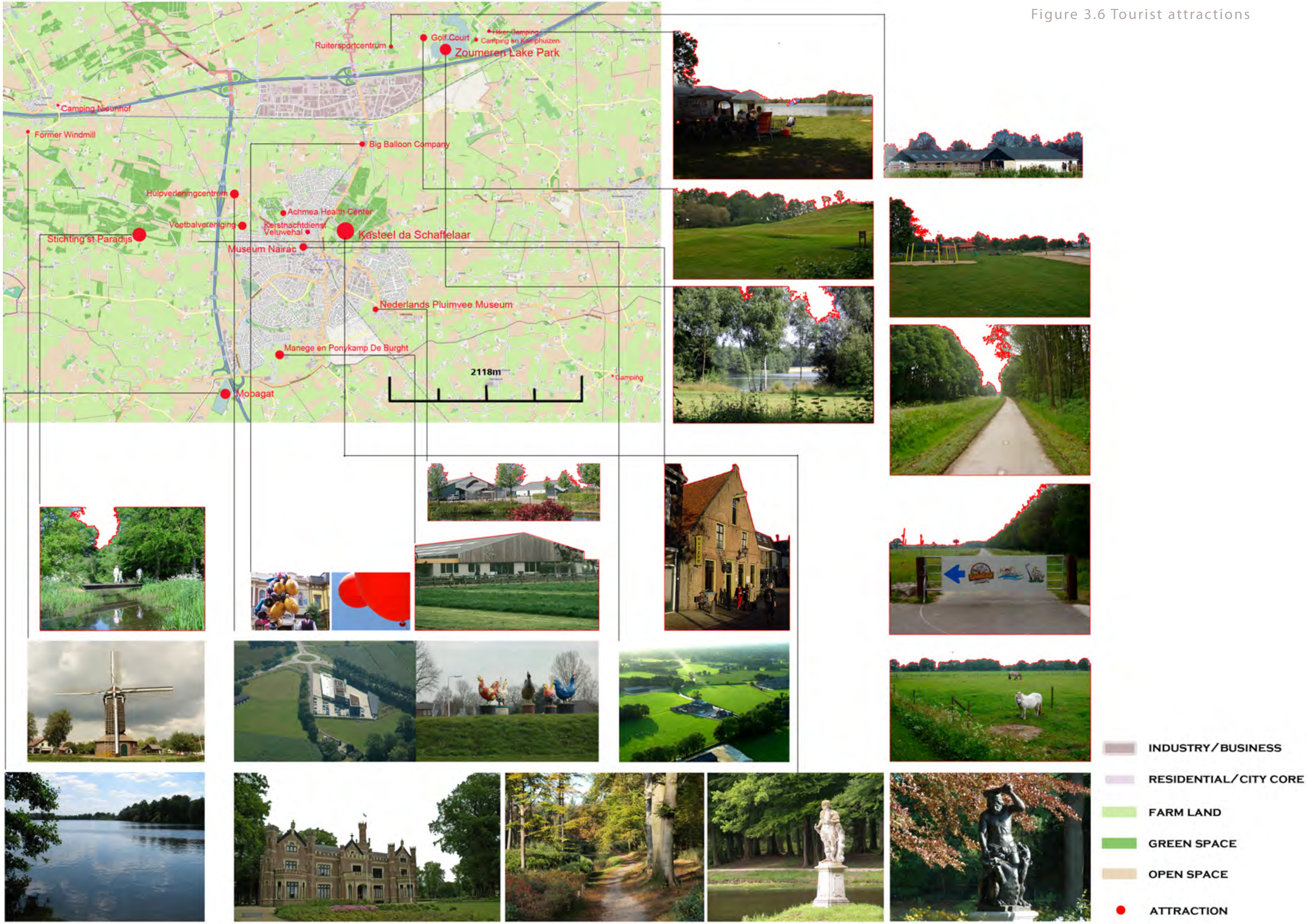


Figure 3.5 Traffic analysis

- The landfill can make negative impacts to the surrounding environment and people
- Convenient transportation
- Have the potential to develop local net work

Figure 3.6 Tourist attractions



Barneveld has many tourists attractions in both city core and rural area. Close to the landfill, there is a lake park called"Zoumeren lake park", providing beautiful waterscape as well as recreation activities such as golf, camping, boating and fishing. In other area, other attractions like former windmill visiting, cultural museum, historic castle and chicken farm visiting (the most famous specialty in Barneveld) are also being popular in tourists. (fig.3.6)

The landfill, however, plays an negative role in the region. Although Barneveld has lots of beautiful landscape patterns and tourists attraction, moreover, many of them are close to the landfill. The landfill actually is one of local people's most unwelcomed places in their daily life. According to my interviews to residents, some people even do not want to go to the landfill's surrounding area just because the "smell and noise from that big mound."

Those attractions' popularity raised new challenges to the redevelopment of Barneveld landfill. Firstly, the landfill should not be the obstacle to those attractions, which means to reduce the impact from landfill to people's daily life. More importantly, the new functions will be developed in landfill should not be overlapped by the already happened activities. The landfill redevelopment should provide unique experience based on its different features.

3.2.2 Site description

Zooming in to the site itself, the landfill site is including two abandoned landfills and one under-using landfill. The main sources of waste are industrial waste and municipal solid waste.

The landfill site is in the east of the industrial area, with many different types of roads connected. (fig.3.8)

D.linearis Underw (ampla)

- Perennial herbaceous plant, mainly grows on the slopes, likes living in acid soil

- can be found on most of the area, means the soil is already too acid to common plants to survive.

Humulus scandens (Lour.) Merr. (scandent hop)

- Herbaceous perennial vine, mainly grows in the fertile soil. (Nitrate > 0.01%)

- can hardly being found in the area, means the soil quality is poor.

Figure 3.7 Examples of indicator plants

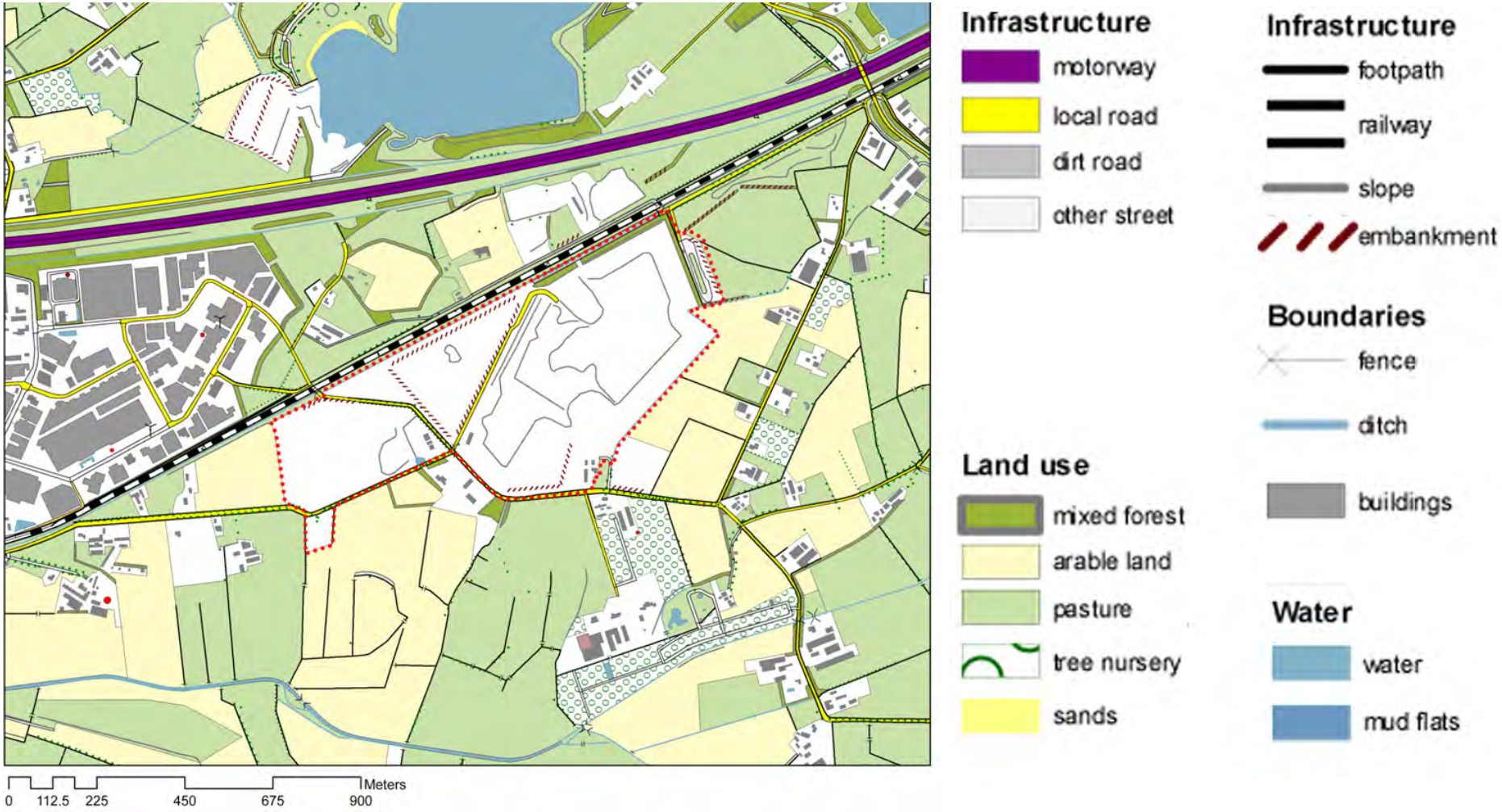
3.2.3 Soil analysis

The landfill site is a private land, which belongs to the Vink Company, and because of the security reasons, I cannot get the particular data about the extent of soil pollution and the main type and composition of the top soil in the landfill site, either from asking the Company or literature review. Since the soil condition has the significant meaning for landscape inventory and design, I tried to use an alternative way to analysis the soil condition: the indicator plants. As we know, plants, especially natural growth plants have the ability to reflect the soil quality by observing their color, leaves or flowers. (More details see 4.1.2 'Indicative plants). I analyzed some species which could be considered as indicator plants to see the soil condition in each area. (fig.3.7) I will summarize the results in "field work".

Due to my limitation, I will mainly use two concepts with indicative plant. First one is to search specific species which only grows in certain soil, whether it grows on the landfill site or not, I can get to know that the soil containing this character it needs or not. Another one is through observing the existing native species and comparing with the same species growing in other normal place. If the soil condition is not good the species will be looked different

Two species communities in the different place of landfill area, the first one grows well, proving the soil condition is good; another one's plants are mostly lower and smaller, reflecting the soil condition is polluted.

Figure 3.8 Land use map of Barneveld landfill



from others, like size, color, etc. this concept can reach a general understanding of the top soil's current situation in Barneveld landfill.

Even though I did this observation, it is still a quite cursory and less convincing database, and may not reflecting the real situation of soil condition. Also some area does not have vegetation such as working landfill. This is a uncertain factor during my research process, and I will continue search the authoritative soil database in future study.

3.3 Field work

3.3.1 Flat ground field work

Barneveld landfill has two different parts from the topography: the flat ground and a landfill hill, and I would like to start my field work on the flat ground. In this part, there are one former landfill and one on-using landfill, and existing road system divided this part into four place. I will analysis them one by one. (fig.3.9)

In photos 1 to 4, there is an empty place, surrounded by trees, 9.1 acres, no roads to access. This place has many abandoned construction materials such as steel pipes and bricks, the soil condition is good.

From photos 5 to 9 is the former landfill area(138.2 acres). This place located more than ten small former landfills, some of them are too small to calculate in. All of them are 3 to 5 meters high, the mainly types of waste in them are municipal solid waste (organic waste)and industrial waste (non-organic waste). The vegetation condition of this place is very poor, only an incomplete trees structure is planted along the edge. There are landfill working roads in this place connecting to the working landfill and highway, so it is convenient to access. Furthermore, in the north part of this place there is a big empty area which are currently used as the parking lots for landfill trucks. It has the potential to be used for tourists because of the good ground quality. A big problem in this site is the slope instability and negative environmental influences from the working landfill.

The third part is a working landfill, photos from 11 to 13. This place is in the middle of Barneveld landfill, 47.3 acres, which could be considered as the main source of all the dust and noise. It is a hard, flat ground with one working landfill, 10 meters high with good road accessibility. The type of the waste is variously, from biodegradable waste, municipal organic waste to non-organic waste such as construction waste and industrial waste. Besides the landfill, another function of this place is waste storage and recycling, there are many waste storage and recycling machines surrounding the landfill. Due to the current situation, the vegetation and environment condition in this place is quite poor, smell, noise, dust, scavenging animals, polluted air and soil are five main problems that the place is facing at this moment need to solve. Besides that, because the landfill will be continuing open for at least two years, it is important to considering these problem from the rest of the site's developing prospects, minimizing the negative influence to other places.

The fourth part is a vacancy open place, 18.3 acres. (photo 14). This place has good road accessibility and connection to other places. There is no waste dumping in this place, only a few abandoned materials in it. This place, as the only way to go to the working landfill and landfill hill, has the great possibility to redevelop into a public activity center with its existing road system.

These different place all have its advantages and disadvantages to redevelop into other functions in the future. Carefully treatment with those threats and use their strength correctly will lead to a successful project to serve the community. Otherwise, no future plan and proper management will lead further injury to both the site and surroundings

Figure 3.9 Flat ground field work, all photos taken by author

1,2,3,4 Wasted material stacked in the empty place

5,6,8 Small former ladnfill slopes

7, Flat ground, poor vegetation

9, Leachate problem

10, Temporary parking lot

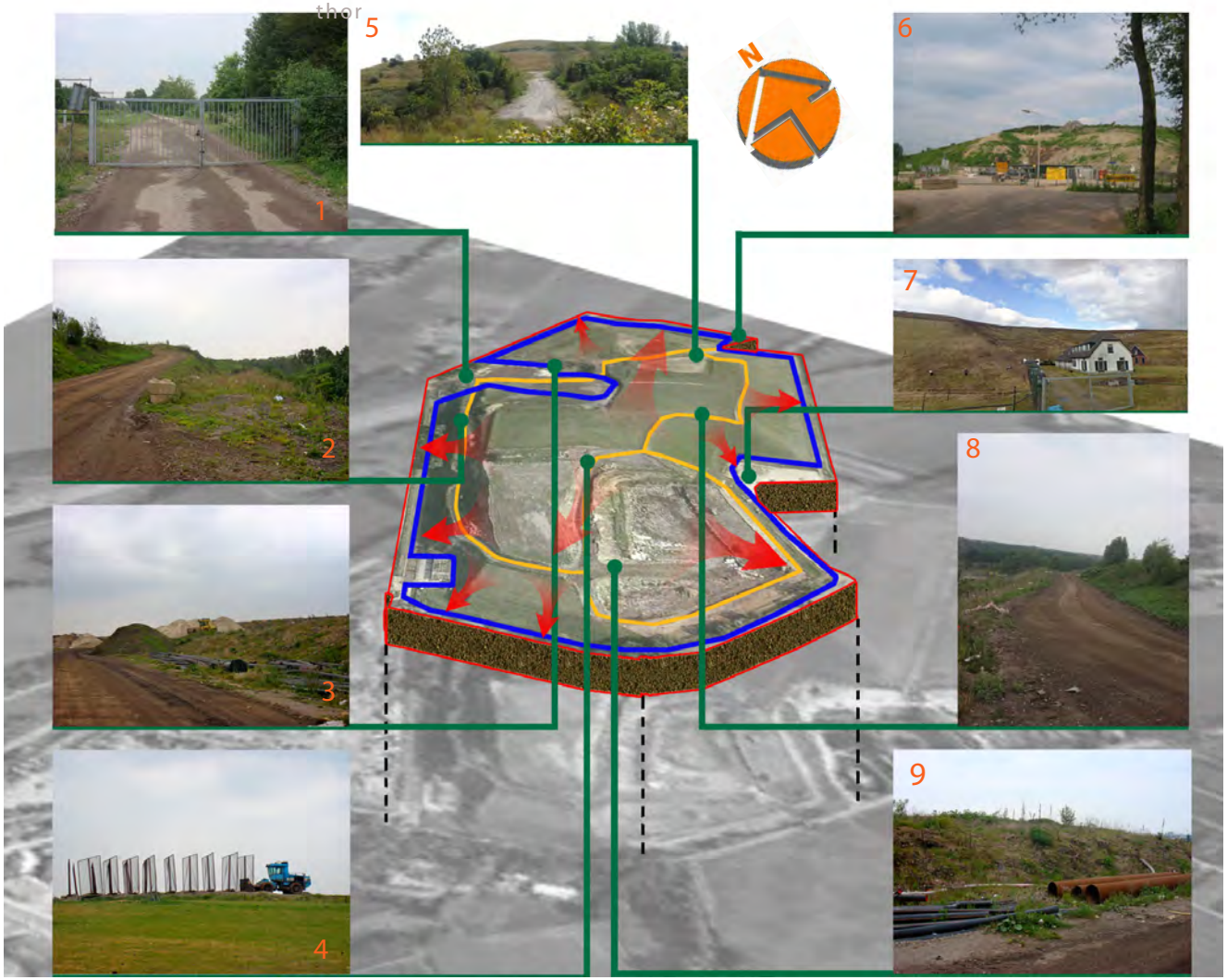
11, Working landfill

12, Entrance of working landfill

13, Landfill infrastructure

14, Vacancy place

Figure 3.10 Landfill hill field work, all photos taken by author



1 No access to the landfill hill from east entrance

2 Road to the top, 3% gradient, 12m width

3 Gentle slope simple road

4 Top of the hill, open space, 20m height

5 Gentle slope and roads, simple vegetation

6 Open space, hard ground

7 Abrupt slope, difficult for stabilization

8 Sleep slope to the top, 6% gradient, 5m width

9 Poor vegetation, wasted materials

3.3.2 Landfill hill field work

The hill is a former landfill, located in the east part of the site. It is a big empty place with some abandoned construction materials. The hill is about 20 meters high, the gradient is from 3% to 6%. The simple roads are used for landfill trucks to transport waste, which are from 3 to 12 meters width.

Due to the unique topography in this region and existing road system, the hill owns the good top view scene and great potential for developing various activities. On the other hand, the hill also has many threats in future reuse. There are three mainly problems, firstly is the possible soil erosion, because of the poor vegetation and lack of management, the disposed waste under the soil may cause the soil become unstable, that will lead to the steep slope collapsing, especially in rainy days. Another problem is the leachate from the waste, when the top soil become soft, the leachate will percolate into the ground and harming the groundwater and deep soil. Furthermore, the methane and CO2 will emit into the air in the open space, that will make great impact to the surrounding environment and became an constraints in developing outdoor activities.

3.3.3 Summary of field work

Figure 3.11 Summary: current condition and potentials

					
LOCATION&ACREAGE potentials	in the west part, close to the road, 9.1 acres entrance for the site	138.2 acres	in the middle of the site, 47.3 acres	communicated with other sites, 18.3 acres	in the east part, 370.9 acres entrance for the site, parking lot
TOPOGRAPHY potentials	flat	flat ground, more than 10 small landfill, 3 to 5 meters high interesting slope for children to play, parking lots	hard, flat ground, one landfill, 10 meters high	flat open space	a landfill hill, 18 to 20 meters high, the pitch of the slope from steep to gentle provide unique view and experience
CURRENT FUNCTION potentials	abandoned area	former landfill sites new functions development	working landfill, waste storage and recycling showing people how landfill works	vacancy area place for people create their own work	former landfill site natural park
WASTE CONDITION potentials	construction materials small playground and public place for relaxing	municipal & industrial waste	various types of waste showing people how to deal with different waste	abandoned waste material public waste art exhibition	deposited waste and waste material storage
VEGETATION CONDITION potentials	trees surrounded	poor vegetation and incompleted trees structure add trees and roads to make a completed park	poor vegetation	small trees and shrubs surrounded	poor vegetation condition vegetation restoration
SOIL CONDITION potentials	unpolluted soil	polluted soil vegetation restoration with landscape value	polluted soil	good soil condition	polluted soil
SPATIAL QUALITY potentials	no road to access	existing road system and slope instability problem stable slope by roots	existing road system for waste transportation, numbers of scavenging animals create an “process of waste” exhibition	existing sample roads add trees and roads to make a completed park	existing incompleted road system various activities for different group's demands

3.4 Biotic analysis

Biotic analysis is mainly focused on plant and wildlife species. Briefly, plants and wildlife can be found in landfill hill and other empty place, while seldom presented in the intensive working place due to lack of habitable nature.

From the flora perspective, the plants in the landfill are normally grass and trees, distributing mostly in the landfill hill and empty space. The species of trees are usually Beech and Hybrid poplar; these trees have the strong ability to absorb polluted gas and dust, blocking the noise, also the potential to improve soil quality. (fig.3.12) Besides tress, the grasses growing on the landfill are usually invasive species, including Ragweed, Redroot amaranth and Pigweed. (fig.3.13) These invasive species are naturally growed up, they don't need specific maintaining and can grow very fast and absorbing the nutrition in the soil, so that the useful native plants do not have space and nutrition to grow even them planted by people. Furthermore, it is also important to considering the risk of those invasive species' roots in landfill because the root could penetrate the landfill cap allowing ingress of water and hence increased leachate production, also roots could dry out clay caps which would then shrink and crack (Restoration guidance by UK, 1986).

From the fauna perspective, the landfill attracts a huge number of scavenging animals, such as seagulls, rats, crows, who rely on the garbage. (fig.3.14) The landfill encourages larger numbers of scavengers, which then have a negative impact on other wildlife. For example, crows may eat the eggs and fledglings of many songbirds that may live some distance from the landfill (Valentin Schaefer, 2004). On the other hand, the landfill is located on the outskirts of cities, in which exists various sensitive animal species. Also, because of surrounding agriculture land, many livestock are also influenced by the landfill.(fig.3.15) *"...Landfill has a number of environmental impacts besides the destruction of wildlife habitat, including leachate and production of gas. Landfills produce methane and sulphur compounds, which can be toxic to wildlife and humans..."(Valentin Schaefer, 2004)*

From the biotic analysis we can see that the species and wildlife in Barneveld landfill have both strength and threats. The strength is the environmental and economic benefits from trees; and the threats is the unbalanced ecosystem and the negative impacts to environment from the invasive plants and scavengers.

Figure 3.12 Functional trees in the landfill, photo by author

Figure 3.13 Invasive grass in empty place, photo by author

Figure 3.14 Seagull is eating garbage in the landfill, photo by author

Figure 3.15 Horses in surrounding agriculture land, photo by author

Figure.3.16: Flora and fauna species discovered in Barneveld landfill

3.5 Social analysis

3.5.1 Occupation layer:

The Vink company who owns the landfill do not have a appropriate future plan for the area and that could lead a further injure to local ecosytem and surrounding. The Environmental Investigation Team Gelderland-Midden/Gelderland-Zuid on Wednesday February 2 2011, arrested the director of Vink waste management company. He is suspected of illegal excavation of soil, the unlicensed dumping of waste into the soil, storing waste in places where it should not and caused water pollution by the dumping of contaminated sludge. (fig.3.18) (Toine van Bergen,2011).

Due to this situation, there are lots of wasted material which cannot be buried or stacked in the landfill site, and the surrounding residence complained about the contaminate environment. However, the director was released, since it was known that Vink has been using this area for storage of waste for many years, the Gelderland Provincial Executive decided to permit Vink to temporarily run this landfill until May 1 2012. That means the one under-using garbage dump and two abandoned landfill will be in charge of Vink for at least one year, and after that, it is going to be redeveloped.

From figure 3.19 we can see that the number of inhabitants per km 2 of this area (Noord Barneveld) is 82 to 212. It is suburban area instead of rural area, which means more people will be involved by the bad condition of this site. And the whole landfill is continuing preserving the public's fear and shame of waste facilities and has no impact to help people change their perceptions and attitudes about waste, and gain knowledge about recycling.

Figure.3.17 Investigation on Henk Vink, the director of Vink
Source: http://www.deweekkrant.nl/

Figure 3.18 Vink company isdumping contaminated sludge
Photo by Toine van Bergen, 2011

3.5.2 Interview

Before starting next step, although the former studies show that a good educative program that takes place in former landfill can have a significant impact on people's behaviour and attitude, it is necessary to look at specific places and to explore in depth what people experience when leading their everyday lives in such places. This requires qualitative approaches, sensitive methods to record the experience, and careful interpretation to tease out any relationship between landscape and well-being; especially I mentioned the importance of place identity of landfill (chapter2.6). But in order to be able to generalise about landscape in any meaningful way, I also need to gather data systematically across number of people and places, and to be able to test how robustly finding stand up when compared in this way.

There are three important questions need to figure out during the interview:

What is people's attitude of waste at this moment?

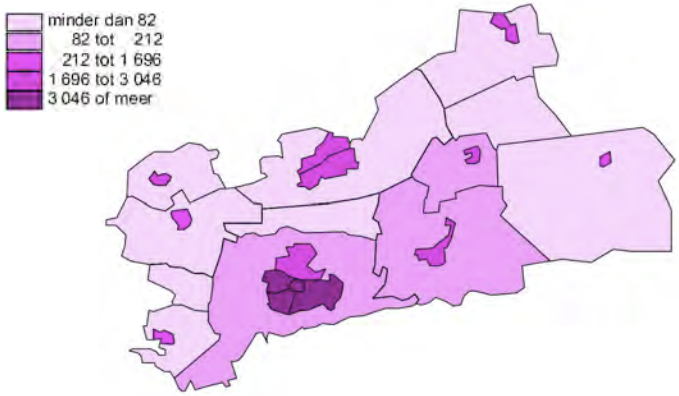


Figure.3.19 Number of inhabitants per km ^{2} of land
Source: www.cbs.nl

What kind of factors that influencing people's behavior?

What is people's expectation from a former landfill closing to them?

There are three main target groups closing to the landfill. In the west, there is an industrial area, locating hundreds of companies; ***the office workers*** surely have their impressions about the landfill, mainly during the working time. Secondary is ***the residents***, in the east part, there are fragmentary some farmer's houses near the landfill, they have a more concrete impression, during day time and night time, summer and winter, former time and current time. The other group is ***the tourists***. Because in the north of the landfill there is a tourism area, including lakes, golf courts and parks. There must be some tourists who have their own experiences about the landfill, whether driving in the highway, sitting in the train or cycling and jogging. Their impressions are incompleteness, partial opinions.

To get know how people's thoughts the first step is to design several questionnaires fitting different group. The first question is about how people's perspective about waste, and also whether the Barneveld landfill influencing this perspective positive or negative. For office workers, question should more focus on their visual sense and noisy. For tourists, question should be expanded also on smell sense, driving experience. For residents, all the senses should be asked.

Possible questions for how people's perspective about waste and landfill:

- Do you think the landfill disturb your daily life?

- How do you define garbage and recycling?

- Can you describe the impression of landfill from visual, hearing and sense of smell?

- Do you consider the landfill helping you gather more knowledge and perspective about garbage? If so, in which way?

The second main purpose is trying to know people's behavior of waste disposal and recycling. In order to have a clear image about what kind of habits should be encouraged or blamed. Aiming at specific habits to present in the educative program.

Possible questions for people's current habitual recycling behavior

Please indicate to what extent the following statements are true for you.

- Condition:

The arrangement of my work place makes it easy for me to recycle

It is convenient for me to recycle

It is difficult for me to recycle

- Attitudes

There is too little concern for environmental issues among my colleagues/friends

People at work should make every effort to recycle paper

Recycling seems like the right thing to do

Recycling should be an essential part of our way of life

More information about the value of recycling should be available at my place

More information about how to recycle should be available at my work place

There is little information about recycling at my place of work

- Motivations

Need money incentive for me to recycle

Recycling is worthwhile only if I get paid to do so

Recycling only benefits people in the recycling business

Recycling is a trivial activity for which some folks have time

The final step of the questionnaire is to ask people what are their expectation from a landfill site, what kind of activities they would like to participate in and what kind of knowledge they would like to learn. The comprehensive way to approach this goal is to provide several scenarios and let people choose their favorite. It is also useful to ask them some simple questions to find out what people really need and avoiding overlapping functions of surroundings.

Possible questions for people's demands

Which activity you want to take place but no available place nearby?

Which part of garbage recycling process you feel most curious?

Would you like to participate in waste disposal and create your own art work with garbage if it's harmless?

Please describe which role you preferring the former landfill play in your daily life. (For example, public space, natural area, educative theme park, etc.)

3.5.3 Conclusion

Since the aspiration of avoiding people's perfunctory answering the questions and get to know their real thoughts, this interview was processed as an informal talking instead of designing an official questionnaire. So I did not ask the same possible questions to each person, which makes me hard to calculate the most popular answer of each question. On the other hand, due to my ability and time limits, the range and amounts of the sample is not big enough on behalf of the whole region. I interviewed 21 persons in total, seven of them are officer workers, the rest are all residents. I did not have a chance to meet any tourists and talk with them. So the interview of one target group: tourist is missed. Those limitations make the interview less convincible. I will continue my research and design more rely on theories study, observations, site analysis and my own knowledge. But still the interview can provide a reference for me to considering those different demands from three target groups in environment and landscape meanings, also the interview can help me better understand the current situation of this site.

The results of people's current behavior and perspective about garbage

- no clear knowledge about recycling and garbage

- negative impressive about landfill

- have specific demands

- big difference between different group

- some donot have the right recycling behaviour

Current situation:

- Low landscape & spatial quality

- Environmental problems & no attractions

Target groups:

Insiders: Farmers – living environment

Outsiders: tourists, drivers in the highway and office workers, leisure activities in short time

People's demands:

- Good landscape & spatial quality

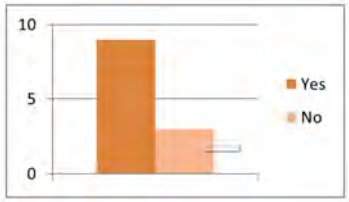
- Unique experience

- Meanings of landscape

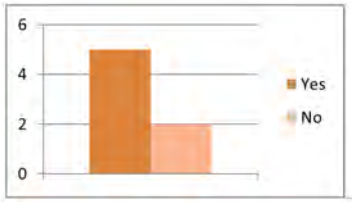
- Economic incomes

Summrize of the interview

Do you think the landfill disturb your daily life?

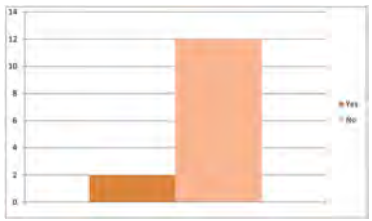


Residents (12 persons)

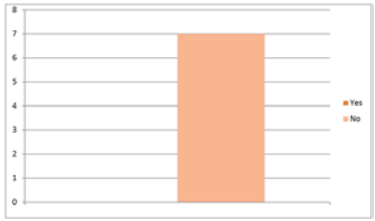


Officer workers (7 persons)

Do you consider the landfill helping you gather more knowledge and perspective about garbage?



Residents (14 persons)



Officer workers (7 persons)

Please indicate to what extent the following statements are true for you. (both for residents and officer workers, the two most popluar options)

-Condition:

It is convenient for me to recycle (55%)

It is diffcult for me to recycle (30%)

-Attitudes

More information about the value of recycling should be available at my place (43%)

More information about how to recycle should be available at my place (26%)

-Motivations

Recycling is worthwhile only if I get paid to do so (35%)

Recycling only benefits people in the recycling business (21%)

Figure 3.20 The influence of landfill to target group: Vision, smell, sounds, environment

3.6 Summary

Strength

- Open space
- Biodiversity
- Various types of waste and both in using and abandoned landfills
- Unique topography
- Existing road systems
- Redevelopment potential in environment and society

Weaknesses

- No attractions to insiders and outsiders
- Bad environmental condition
- Low quality of spatial planning
- Unwelcomed area

Opportunities

- Environmental Benefits

Protection of groundwater, soil condition and air

Protection of biodiversity and ecodiversity

Protection of surrounding environment

- Social Benefits

Improving people's recycling behavior by educative programs

Reduction of people's negative perspective on waste

Providing various activities to the community

- Economic Benefits

Attractive to outsiders and lead to more economic incomes

Increasing land value by improving degraded property

Development of new technology and approach on waste management

Threats

- Environmental risks

Leachate into ground water, soil erosion, air pollution

invasive species and saprophagous animals

Polluting surrounding ecosystem

- Social risks

Low interests of landfill

Negative impression about waste

Overlapping activities and functions

- Financial risks and Long time construction risks

Short of money and need long time to get benefits

High maintenance costs

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4
General strategy & principle

Figure 4.1 One of the largest landfill in the world, Fresh Kills Landfill birdviewing from south, Source: http://cryptome.org/info/wtc-fk/wtc-fk-full.htm

4.1 Vegetation restoration

In the research, my thoughts was to develop Barneveld landfill site into various multiple-use area. To achieving those end uses, establishing and maintaining an effective vegetative stand on the final cover soil is an obligatory step in the preliminary stage. Vegetation restoration is the process of repairing damage caused by landfill activities to the diversity and dynamics of indigenous ecosystems. Phytoremediation has the following advantages: low cost and maintenance costs, easy start, ecological and sustainable, no invasive, visual effects, and easy to be accepted by the public.

The lack of trees and shrubs severely limits the landfill's potential for wildlife habitat/corridors, not to mention visual variety. Another compelling reason to plant trees is to reduce landscape maintenance. Local trees will colonize almost any site unless actively prevented. Preventing trees on landfills entails some combination of mowing and herbicides, both of which carry energy and pollution costs. Trees also have potential for erosion control.

There are lots of successful vegetation restoration cases and methods all over the world. After reviewing the literature and case study. I combined them and developed the general vegetation restoration strategy and principles that most suitable for my site. I will explain them in detail in the following chapter.

4.1.1 Trees improve environmental quality

There are four main environmental problems existing in the landfill that will affect people's life. Air pollution, noise, dust and smell. Air pollution is one of the main problems in landfill, whih will cause lots of diseases for people. (table 4.1)

The impacts of those four problems can be decreasedt due to correct trees selection and planting principle. A trees has the ability to improve the environmental quality in using different parts of it. (fig.4.2) However, engineering supports is also required to solve those problems.

Pollutant	Health effect
Nitrogen dioxide	○ Aggravation of asthma and allergy symptoms ○ Acute respiratory illness in children Increased airway resistance and reduced lung function
Sulphur dioxide	○ Bronchoconstriction ○ Also associated with acute morbidity and alevated mortality in epidemiology studies, ahthough collinearity with particulates is suspected
Ozone	○ Aggravation of asthma and other chronic respiratory deseases ○ Lung function reductions and respiratory irritation ○ Acute respiratory illness
Total particulate matter	○ Elevated risk of mortality ○ Lung cancer ○ Higher prevalence of chronic respiratory disease ○ Acute illness, including work loss and emergency ○ Lung function reductions and sespiratory symptoms

Table 4.1 Air pollution and health, Source: Sukopp, 1990

"Every landscape design must start with the germ of a vision for the site in question and an understanding of how the site will be used and what functions the plants will serve in it. There is no one correct vision, of course. Landscape design is an art form precisely because of its infinite possibilities."

-- Peter J. Trowbridge and Nina Bassuk, 2004

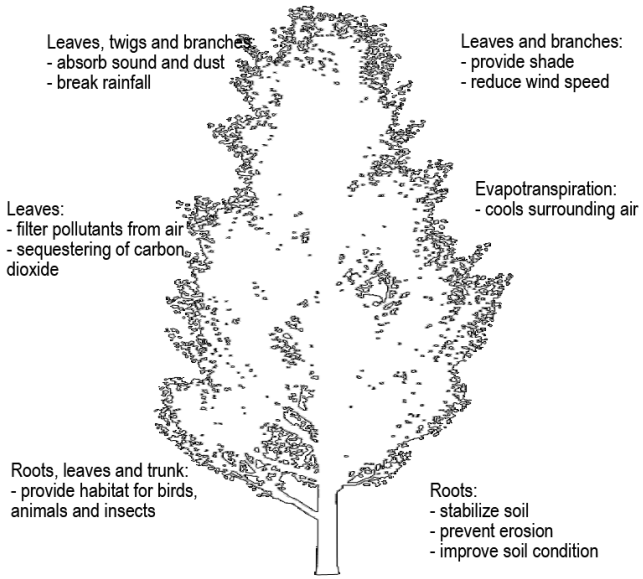


Figure 4.2 Ecosystem services of a tree, made by author

Pollution

Plants play a role in reducing air pollution, both particulate and gaseous. Trees act as natural filters, removing not only particulate matter but also gaseous pollutants including carbon monoxide and sulphur dioxide by absorbing them through leaves and other plant parts. The particulate matter that clings to trunks, twigs, and leaves is usually washed into the soil by rainfall. However, trees do have the ability to absorb low levels of noxious fumes without related damage to the tree. More research is needed into the effectiveness of certain species in the reduction of airborne pollutants.

Noise

A few plants alone do a poor job of reducing noise. However, dense planting, especially combined with solid barriers or land forms, can reduce noise significantly.

Air pollution, noise, smell and dust are all moving through the air flow, and air flow influenced by different obstacles:

1 hard wall: the wind will be guided over, but will come down immediately after the obstacle

2 porous wall: the wind is guided over and will also pass through the wall creating an area which will life the airflow further away.

3 a tree: the wind will enter the crown and collide against leaves and branches. This causes the wind to circulate inside the crown, creating other wind flows to go over the tree and life them higher so they will come down further then option 1 or 2. But the wind has open field under the tree, so some wind flows will enter the area behind the tree.

4 a tree with undergrowth: the tree is lifted over the tree as described at option3. Furthermore, the shrubs will stop the lower airflows. The sheltered area behind the tree is much larger then with the first 2 options.

Also, the air pollution is made out of several layers. The background pollution has been mixed with other air flows and has been lifted higher. To influence all polluted air a combination of higher and lower vegetation should be used.

The air flow that has been lifted by a vegetation structure will lose height after 10 or 15 times the height of the vegetation. When on that location another vegetation structure is placed the whole process of filtering and lifting will be repeated. This way the air is filtered several times and a larger area can be sheltered from polluted air.

When a tree is 60% porous the wind will be able to enter the crown and be reflected on all the branches, resulting in a continuous circling air flow within the tree's crown. The pollution will come in contact with the leaves and be filtered. The airflow coming are being lifted high up into the air. When a tree is more dense, the wind cannot enter the crown and therefore the pollution will not be filtered and the tree will function like a wall considering the influence on the airflow.

For the optimal result the vegetation should be placed in a linear structure, this way the polluted airflows will have the most influence. This means that the crowns of the trees should form a almost joined obstacle. If the plants are placed too far apart then both the green element and the linearity will be lost; on the other hand, if the trees are placed too close together then it will lead to a too dense obstacle.

A linear vegetation structure with shrubs or other (ascending) undergrowth has influence on all air levels (low and high). This is better both for the filtering of pollution and for guiding the air flows over the area behind the structure.

High hedges will block the view from a cyclist, which can create an unsafe feeling and a dangerous situation. Lowering the shrub height might not be ideal for the airflow filtering, but is necessary for a safe design.

Within the given guidelines of linearity and porosity, there is still variation possible. A single line of one type of tree will provide a formal, stately experience, while variation of species and sizes will give a more natural image.

As a landfill re-use as parks, a single species of plants should be avoided. Furthermore, different species also have their different functions and capacities:

- Growing possibilities determine whether a tree can grow on the specific location

- In general; broadleaved trees have a large ability to absorb NO

- In general, coniferous trees have a large ability to catch PM

- A broadleaved tree with featherlike leaves is more porous and is therefore more suitable for catching fine dust and for guiding airflows

- A broadleaved tree with more (accessible) leave surface will catch more pollution than a tree with less foliage

- In winter broadleaved trees lose their leaves, the capacity for filtering the air decreases seasonably (branches and trunk are still active), the capacity to guide flows can still be up to 80%

4.1.2 Indicative plants

As I said in chapter 3 site 'selection and analysis', because of the unavailable soil database I decided to use indicative plants to do my soil analysis. Also, in vegetation restoration, indicative plants are very useful in many parts. In this chapter I will explain them in more detail.

Many plants are very sensitive to the environment change, in particular air, groundwater and soil. These plants can be used to indicate and monitor the environment. Different plants have a range of different adaptation to various ecological factors. Once a narrow-environmental-

tolerance plant species appear in a place, people can identify the local natural environment and ecological factors characteristics according to these plants (or plant communities). This is why these plants are being called "indicative plant", or "indicator plant".

The plant status changes which are able to indicate the environmental characteristic (such as leaf color, plant height, etc.) are known as the instruction characteristics. Indicative plants' instruction characteristics can help people in many ways, indicating climate condition, indicating ground water level and quality, indicative sea and lake's depth, etc. Due to my site characters and my ability limitation, I will mainly use indicative plants for soil analysis and vegetation restoration monitoring.

The relationship between indicative plants and PH

PH actually refers to the concentration in the soil solution, presenting by PH. There are mainly five soil types based on different PH value: strong acid soil (PH<5.0), acidity soil (PH 5.0 ~ 6.5), neutral soil (PH 6.5~7.5), alkaline soil (PH 7.5 ~ 8.5) and strong alkaline soil (PH>8.5).

Species	The range of adaptation	The most range of adaptation
Platycladus Franco (oriental arborvitae)	6.0 - 9.0	6.5 - 8.0
Pinus tabulaeformis Carr. (red pine)	5.5 - 8.0	6.0 - 7.5
Larix gmelinii Rupr. (larch)	4.5 - 7.0	5.0 - 6.5

Table.4.2 Some mainly spcies to adapt to the range of soil PH, Source Shen Yingwa, 1998

Figure.4.3
Rhododendron simsli Planch. (Azalea): shrub, likes living in acid soil, PH 5~6.5, sensitive in calcareous soil

Figure.4.4
Gladiolus gandavensis (Gladiolus): native shrub, the leaves will turns into yellow spot if there is hydrogen fluoride air pollution

The PH value of soil has a very significant impact on soil fertility and plants growth; in general, plants are usually most suitable in the neutral or nearly neutral soil. In the landfill site, since the types of waste is various, the PH types of soil are also different in each area. It is necessary to observe the existing possible indicative plants in the site, identifying the current type of soil. After planting the suitable species based on different soil PH type, more indicative plants can be planted to monitor the improvement of soil's PH value.

The relationship between soil fertility, soil depth and indicative plants

Due to the different soil fertility and soil depth, the same species will often show different size and looking.

The relationship between indicative plants and air pollution

The plant growth has a close connection with the surrounding environment. Any changes of environment and broken ecological balance will be shown in the sensitive plant. (fig.4.4) The indicative plants of air pollution are the species which have the fastest response about pollution information.

Application

There are already some indicative plants in the Barneveld landfill (chapter 3.2.2 site description), such as Ampla and Scandent hop, I will use them to analysis the type of soil through my observation. Other existing native plants also can be observed to get to know the level of air pollution. What is more important in this chapter is I will select more functional indicative plants in the vegetation restoration process. These plants (mainly shrubs) will have the ability to be the air pollution indicator as well as soil pollution indicator. Only if the result from these plants shows the environment condition is getting better, further action is able to be happened. The plants I selected as indicator will be summarized in figure 4.8.

Conclusion

Use indicative plants to analysis the soil condition as well as being an environmental monitor in vegetation restoration has many advantages. It is an ecological and sustainable approach, no engineering impact involved. This approach is low-cost and low-maintaining. Furthermore, many indicative plants are also beautiful wildflowers which can both raise the aesthetic values and biodiversity values.

However, there are also many disadvantages and inadequateness by using indicative plants as an independent method of monitoring. The growth of plants can be influenced by various factors that hardly in control. It is difficult to achieve accurate quantification. Also because there is a concerted reaction between different contaminations, it will disturb the plant growth. The results could be less convincible and accurate.

Anyway, considering of my ability and limitation, the indicative plants can be very effective when using it for inventory and resoration in this academic research and design. For further constructional design, more scientific research and data collection should be involved. (fig.4.5)

Figure4.5 High Acres company's two technicians are monitoring landfill soil condition
Source: http://highacreslandfill.wm.com/

4.1.3 Other advantages

Erosion and runoff

Plants play a crucial role in reducing soil erosion as well as trapping and slowing storm water runoff. Incorporating plants that can significantly reduce our reliance on storm water abatement systems, improve natural water infiltration, and reduce the velocity of water moving over a landscape is important in contemporary design. Plants can provide the ability to reduce runoff on highly erodable soils as well as areas of steep topography. Plants with a highly fibrous root system that yield a more complete ground cover with their stems and leaves work best in this regard.

Plants create spaces

Plants may be used to create physical barriers, directing foot traffic or screening unsightly views. Plants can change the sense of scale to a more human dimension.

Recreation/habitat

Green space can provide necessary animal habitat and are the places where most of the human population connects with the natural world as well as actively pursues recreation. These areas represent critical habitat in which humans can interact with animals in natural settings.

The vast aesthetic possibilities plants offer can be overwhelming to the landscape designer. Yet, be embracing this diversity of seasonal interest, form, colour, and texture we can create wonderfully inventive landscapes. The realization of a design vision for a site and the ultimate success of a built landscape require a thorough understanding of how the site will be used by people and how it may or may not support the long-term biological needs of plants growing there.

"All plants have a genetic potential to grow to a certain size and shape at a given rate under optimal conditions. Knowing the plant's potential and matching its needs to the site's ability to meet those needs is the key to achieving the realization of a design vision. Rarely do site conditions enable a plant to grow to its full genetic potential. However, if enough of a plant's needs are met (especially the appropriate levels of the basic six factors: light, water, nutrients, temperatures, oxygen, and carbon dioxide), the landscape designer can be confident that the proposed planting will develop into what was originally envisioned."

-- Peter J. Trowbridge and Nina Bassuk, 2004

4.1.4 Preparatory work

Landfill is usually covered by 60 to 90 cm depth soil when it closed. It is not conducive for plant's root contacting with landfill contaminants, which is an important factor to constrain the application of phytoremediation technology to restore landfill vegetation. To solve this problem, it is possible to use tillage technology in agriculture, digging up the depth soil to the surface, or using leachate to irrigation surface vegetation.

Before starting vegetation recovery to the landfill. First of all is to lay pipes to collect landfill gas, in order to reduce the effect to the plant growth; secondly, the top layer of waste need to cover with soil when landfill is closed, either too thick or without soil will both affect plant growth, adding fertilizer is necessary in the casing layer.

Through lots of survey, people found that the plants trying to grow in landfills, in particular, woody species with deep roots, facing considerable pressure to survive. Generally believed that the most important limiting factor for landfill plant growth is the landfill gas in the soil (especially the anaerobic decomposition of organic waste generated by CO2 and CH4). On the other hand, the leachate, the top soil quality and landfill gas diffusion are also the main factors to effect plant growth.

For vegetationrestoration in the landfill, controlling erosion will be the primary short-term goal. De-

ficiencies in cover soil need to be corrected before grass or woody vegetation is planted. and also, a barrier should be placed beneath each tree-planting area to protect the root system from harmful landfill gases.

Refuse quality, quantity, age and depth must also be considered along with climate, since these factors interact to form widely different environmental stresses and gas production rates.

4.1.5 Process of vegetation restoration

The annuals provide a quick temporary cover that is succeeded by the more permanent perennials. If the plans for a site include a natural area, consider testing some native species already growing at the site. Efforts to develop a good cover of woody plants should begin by ascertaining that 90 cm of soil is in place in areas where trees and shrubs will be planted.

After the grass has been planted, a l- or 2-year waiting period is recommended before areas are selected for planting trees and shrubs. If the grass cover with its shallow roots dies or fails to germinate because of the influx of gases from the landfill, it is nearly certain that other deeper-rooted vegetation (trees and shrubs) will not thrive at these locations.

Plants selection is a significant step in landfill vegetation restoration. Plants must be chosen very carefully due to their characteristics, to guarantee maximizing using their ability recovering the environment as well as aesthetic considering. Different kinds of plants should be selected in different restoration stages because of different landfill condition. Species selection may require more care on fills with a known end use, since aesthetics and compatibility with the use must be considered along with erosion control. Seed should be sown in the fall. Mixtures of annuals and perennials are best suited for stabilizing soil and preventing erosion. Recommended seeding rates should be followed carefully for the quick cover species to prevent dense stands that prevent or retard establishment of the permanent species.

Furthermore, the non-native plants and native plants selection should be taken into account too.

Process: Adaptability species entering - slowly accumulation of soil fertility - slowly decline of toxicity - entry of new species - the new environmental conditions - new community built up - the improvement of ecological environment in landfill.

Figure 46 provide the framework of vegetation restoration.

4.1.6 Plants selection

Determining depth of cover

Thus enough soil should be present to bring the total depth to 60cm (not including the gas barrier layer) in all areas except where trees and shrubs will be planted; the latter areas require at least 90cm.

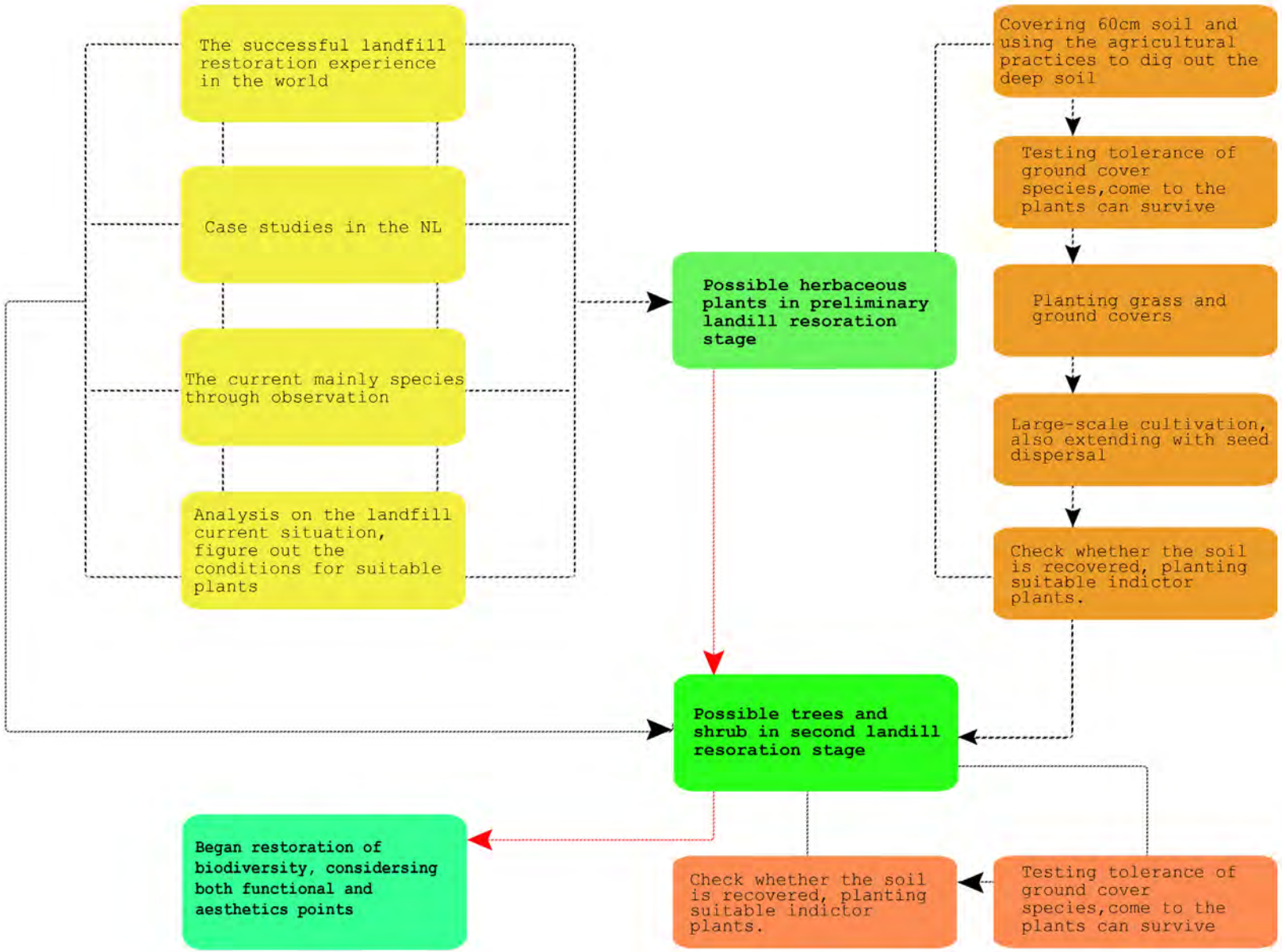


Figure 4.6 Framework of vegetation restoration, made by author

If results show that more soil is needed anywhere on the site, soil can be moved from one part of the fill to another, or it can be trucked in from another site.

Develop grass, shrubs and trees growth

Efforts to develop a good cover of woody plants should begin by ascertaining that 90cm of soil is in place in areas where trees and shrubs will be planted. The least expensive and most practical means for establishing trees on a completed landfill that has been closed for some time is to plant seeds or small whips of species already establishing themselves on the landfill.

Grass should be the first species on landfill. After the grass has been planted, a 1 to 2 years waiting period is recommended before areas are selected for planting trees and shrubs. If the grass cover with its shallow roots dies or fails to germinate because of the influx of gases from the landfill, it is nearly certain that other deeper-rooted vegetation (trees and shrubs) will not survive at these locations.

Slow versus rapid-growing species

According to the article 'Standardized procedures for planting vegetation on completed sanitary landfills' (Edward F. Gilman, 1984), evidence indicates that slow-growing trees are more tolerant to landfill conditions that rapid growing species. Fast growers generally draw more moisture from the soil and therefore require more irrigation. But faster-growing trees may be more desirable with their more quickly produced vegetative cover, and they will produce more total growth on a landfill than slow growers if they are irrigated during the first 3 years.

Small versus large plants

Trees planted when small (1m tall) show significantly better growth on landfills than do those of the same species planted when taller than 2m, regardless of species. A small tree can adapt its root system to the adverse environment in the cover soil by producing roots close to the surface and away from high gas conditions. By the time the large trees adjust to the landfill, smaller trees may equal or surpass them. Larger plant material can be used only if landfill gas is kept from the root system and the plants are well irrigated.

Volunteer species

Volunteer tree species are those trees that already existing in the landfill site. These trees are generally very adaptable to poor soil conditions and are often the best species for establishing trees in earlier vegetation restoration stage.

Natural rooting depth

Trees and shrubs that having shallow root systems are significantly more adaptable to landfills than species requiring a much deeper root system. (table 4.3) The deeper roots are subjected to higher landfill gas concentrations and lower oxygen levels. Some species can avoid this adverse environment by producing a shallow root system.

Grass		Shrub		Trees	
Common	Forage Garss	Small	Big	Shallow root	Deep root
<30	>100	30 - 45	45 - 60	60 - 90	90 - 150

Table 4.3 Depth of root system
Source Shen Yingwa, 1998

The fact that trees on landfills generally develop shallower roots than nonlandfill trees emphasizes the need for frequent irrigation of landfill soils planted with woody vegetation, especially if the gas is not extracted from the refuse. If landfill gas is kept out of the cover soil, roots should be able to grow deeper. Landfill cover soils also need irrigation because they do not maintain as high a moisture content as soils off the landfill.

Flood tolerance

Flood-resistant species may do well on landfills only if they are supplied with adequate water. Dry-site species should be planted if water will not be readily available.

Plant size at maturity

Trees that are small at maturity should be chosen if cover soils are shallow (30cm-60cm), if gas is not extracted from the fill, or if a gas barrier is not installed. Large trees under such conditions run a higher risk of toppling during high winds.

Other details need attention

- Selection of vegetation should always be based on its ability to withstand attack by diseases or insects.

- Trees and shrubs survive best if planted in early spring or fall, planting should not be done during the summer.

- Plants purchased from a nursery and delivered to the site should be planted as soon as possible.

- A planting hole about twice as wide as the root mass diameter and up to 15 cm deeper than the deepest root is well suited for trees and shrubs.

Those factors I mentioned above can be very useful in plants selection in my study area. I will use them as my criteria in plants selection. In the first and third restoration stages, plant type, depth of root, flood and polluted gas tolerance, size, native and non-native are my main criteria. What's also need to take into accounts is the character of growing in low area; plants which fit the above standards but only grow in high sea level area are certainly not suitable to be used in the Netherlands. Last but not least, the invasive species should be avoided; these plants will quickly occupy the top soil and harming to other plants. In the second and fourth stage, the plants are mainly used in more specific demands. For example, in stage two, the plants should be not only met those general criteria but also containing the abilities to monitor the quality of air and soil. And in stage four, since the soil condition is better, trees should be selected more based on their abilities to improve the air quality, absorbing and filtering different pollutants in the air.

4.1.7 Conclusion

I selected six possible species which have the potential to be planted in preliminary stage, as pioneer plants. Through the evaluation with these criteria I realized that there would not be one single species which can fit all the criteria. (fig.4.7) A species which perfectly fit all other criteria but not growing in low altitude or being invasive species is still not suitable for my site obviously. At last, Bermuda grass, Canada Fleablance and Buffalograss are selected to be the major species communities in the first stage, other species such like Ageratum can also be used for species diversity.

Besides fitting most criteria I raised in stage one, the indicative plants should also have their own functions in monitoring the soil and air. (fig.4.8)These plants are all very sensitive when environment is changed. Some of them only grow in the fertile soil; some of them prefer acid soil; and some plants are intolerant with polluted gas.

Because this site is a landfill site, so I also considered some characters that are specific for landfill, such as Ampla is usually growing on slope, useful to stabilize the soil; Redroot amaranth and Blueberry are more growing in roadside or wasteland, need low maintaining, tolerance in flood.

Landscape values are also taken into account. Species which has flowering period and attracting butterfly are favorable than those ordinary grass if their functions are the same.

The way how those species presenting environment change is important as well. The species I selected can be researched in reflecting the environment change by simply observation, instead of technical experiment and testing. So that the construction cost can be reduced and landscape architects can be more involved.

As showing in figure 4.8 Butterfly weed and Gladiolus are the two main species to monitor the air quality. Azalea, Blueberry and Scandent hop are the three major species to test the soil condition and monitor the recovery level of topsoil. Other indicative plants can still be added in this step.

The third stage and fourth stage are mainly about developing shrubs and trees. Besides the functional consideration such like erosion control and air filtering, more aesthetic values should be taken into accounted.(fig.4.9, fig.4.10) The criteria in step one is still useful in selecting trees and shrubs. After the evaluation, Hybird poplar, Oleander, Hankow willow and Chinese Glossy Privet can be defined as the main species communities.

The figure 4.11 shows the whole process of vegetation restoration, from liner system constructing to a whole diversity species community. What is worthy to be mentioned is that this figure is only a conceptual intention image, not a real section in my site. In this chapter I discussed the vegetation restoration and related knowledge. In next chapter I will more focus on ‘how plants should be planted?’ In landscape meanings.

SUITABLE PLANTS IN PRELIMINARY STAGE

Pioneer plants

	Annual herb	Shallow root systems	Flood-resistant	Pollutated gas tolerance	Small size	Volunteer species	Growing in low altitude area	Comments
 Ageratum conyzoides L.	☑	less than 5 cm ☑	unknown	can be grown in high pullutated area ☑	0.5 to 1m high ☑	unknown	unknown	
 Neyraudia reynaudiana (kunth.) Keng	Perennial herb	less than 5 cm ☑	☑	can be grown in high pullutated area ☑	2 to 3m high	No	Growing in 300 to 1500m sea level area	
 Cynodondactylon(Linn.)Pers. (Bermuda grass)	Perennial herb	less than 5 cm ☑	likes well-drained soil ☑	can be grown in high pullutated area ☑	10cm to 30 cm high ☑	☑	☑	
 Erigeron Canadensis (Canada Fleablance)	Biennial herb	less than 5 cm ☑	unknown	grow up in high landfill gas level ☑	5cm to 60 cm high ☑	No	☑	
 Ambrosia artemisiifolia L. (ragweed)	☑	less than 5 cm ☑	☑	☑	20cm to 250cm high ☑	☑	☑	Invasive Species, Strongly renewable and adaptability
 Buchloe dactyloides (buffalograss)	Perennial herb	less than 5 cm ☑	unknown	anti-sulfur dioxide and hydrogen fluoride gas ☑	5cm to 25cm high	unknown	☑	forage plants and for low maintenance areas

Figure 4.7 Pioneer plants

INDICATIVE PLANTS

Air Pollution Indicator

Rhoeo spathacea (Sw.) Stearn
(Spiderwort)

- perennial herbaceous plant
- 30 to 50 cm height
- growing in humid temperate climate, cold-resistant
- prefering sunny
- only grows in the fertile soil

Asclepias tuberosa
(Butterfly weed)

- shrub
- 50 to 10 cm height
- flowering from June to August
- sensitive with SO_2

Gladiolus gandavensis

- shrub
- 60 to 150 cm height
- flowering in summer and autumn
- sensitive with Nitrogen oxides

Soil Pollution Indicator

Rhododendron simsii Planch.
(Azalea)

-evergreen/deciduous shrub
- 2m height
- optimum growth temperature is 12 ℃ to 25 ℃
- likes cool, moist, airy half shade environment
- lives in acid soil

D.linearis Underw
(ampla)

- perennial herbaceous plant
- 30 to 60 cm height
- born on the slopes or forest
- lives in acid soil

Vaccinium bracteatum
(Oriental Blueberry)

- born in the hillside, roadside or bush
-evergreen trees, 1m to 3m height
- lives in acid soil

Humulus scandens (Lour.) Merr.
(scandent hop)

- herbaceous perennial vine, 1m to 5m height
-drought-resistant, likes light
- grows in the fertile soil (Nitrate>0.01%)

Chenopodium album
(Pigweed)

- grows at an altitude of 50 meters to 4,200 meters area
- annual herb, 0.4 to 2 meters high
- grows in the fertile soil (Nitrate>0.01%)

Amaranthus retroflexus L.
(Redroot amaranth)

- annual herb, 20 to 80cm height
- growing in the 3,000 meters to 600 meters above sea level
- more growth in farmland, roadside or wasteland
- grows in the fertile soil (Nitrate>0.01%)

Amaranthus spinosus

- perennial herb, 0.3 to 1m height
-growing in the 350 meters to 1,500 meters above sea level
- more growth in open areas and gardens
- grows in the soil (Nitrate>0.01%)

Figure 4.8 Indicative plants

DEVELOPING TREE AND SHRUB GROWTH

	Growth rate	Shallow root systems	Flood-resistant	Pollutated gas tolerance	Small size	Volunteer species	Growing in low altitude area	Comments
 Melia azedarach Linn.	Deciduous Trees, moderate growing ☑	90cm to 150cm ☑	need ditch exclude water during the rainy season	alkali, barren resistance ☑	10 to 20m high	☑	☑	
 Ligustrum lucidum (Chinese Glossy Privet)	small tree or shrub, rapid growing ☑	60cm to 90cm ☑	☑	strong resistance for SO_2 Cl_2, HF and lead vapor. also can tolerate smoke and dust pollution. ☑	less than 25m high	Unknown	☑	mainly planted on closed landfoll after 6 to 10 years
 Nerium oleander	Evergreen shrub, moderate growing ☑	less than 1 m ☑	no	strong resistance for SO_2, Cl_2 ☑	less than 5m high ☑	No	☑	Highly toxic aesthetic value
 Syzygium aromaticum (Cloves)	Deciduous shrub or small tree, moderate growing ☑	less than 1 m ☑	no	unknown	less than 10m high ☑	No	☑	
 Pinus sylvestris var. mongolica Litv.	Evergreen tree, slow growing ☑	more than 1m	no	unknown	15m to 20m high ☑	☑	☑	Likes acidic or slightly acidic soil, also can survive in soil PH<8
 Salix matsudana (hankow willow)	Deciduous Trees, rapid growing	more than 1m	☑	strong resistance for pollutated gas ☑	less than 20m high ☑	unknown	☑	can be survived in the saline of 0.25% salt content
 Hybrid Poplar	Deciduous Trees, rapid growing	Shallow and wide-spreading ☑	Requires a moist site ☑	strong resistance for pollutated gas ☑	12m to 18m high ☑	unknown	☑	- Windbreaks -Riparian plantings -Roots, stems and leaves are effective nutrient sinks. -Firewood -Energy production biomass

Figure 4.9 Trees and shrubs

POSSIBLE TREE SPECIES FOR IMPROVING AIR QUALITY

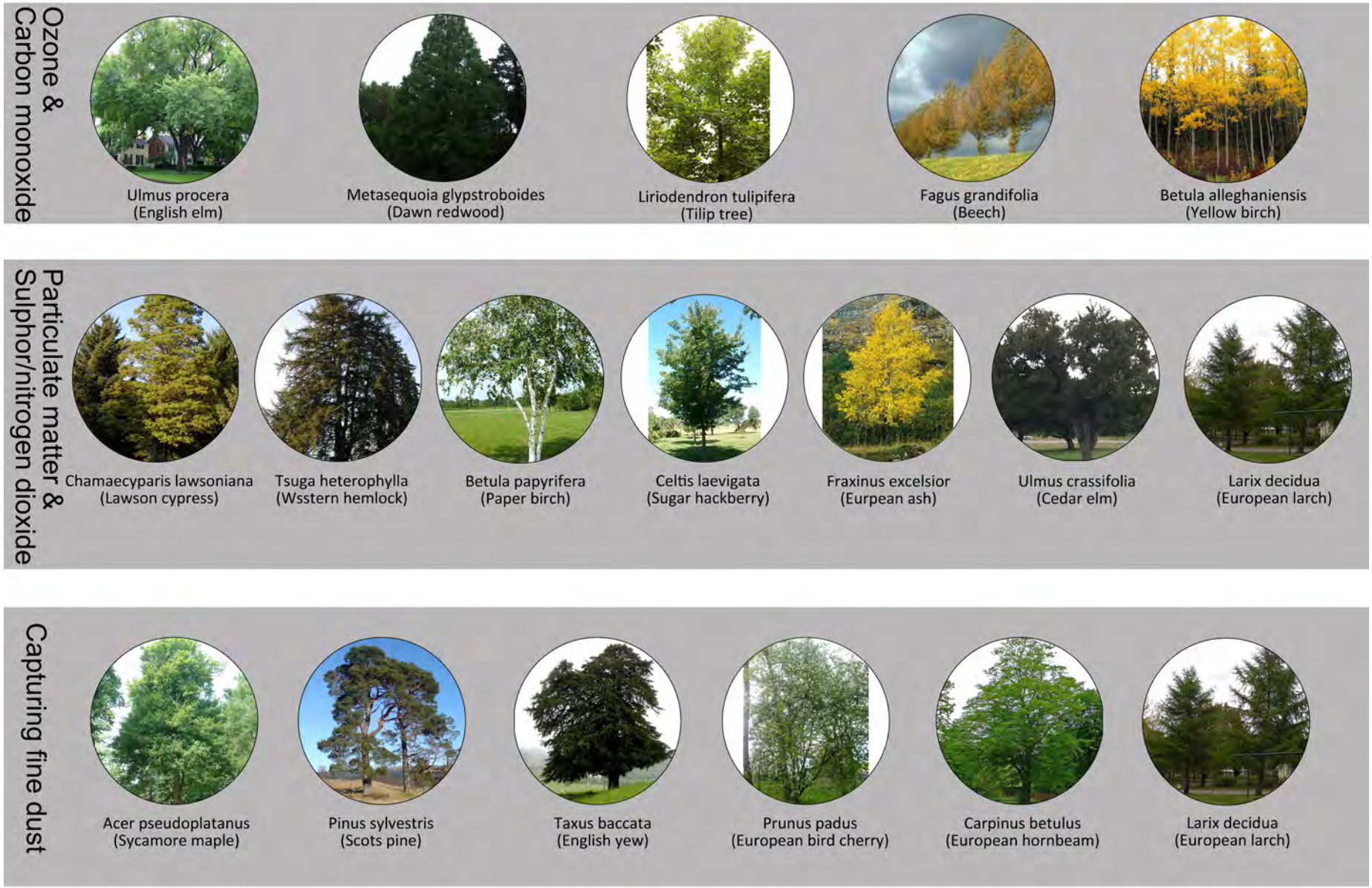


Figure 4.10 Future tree species

Figure 4.11 The process of vegetation restoration, made by author

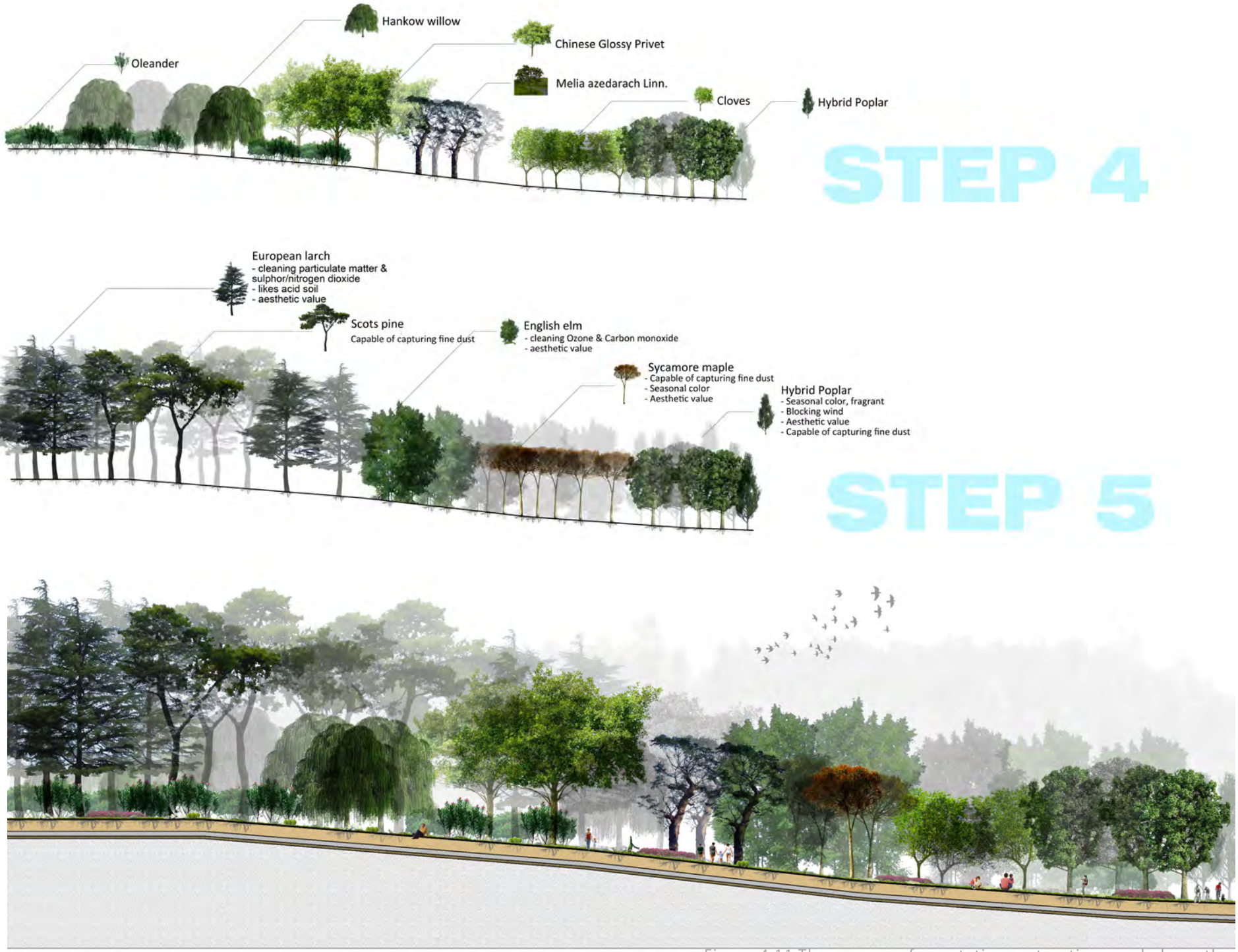


Figure 4.11 The process of vegetation restoration, made by author

4.2 Natural landscaping

4.2.1 Introduction

Natural landscaping provide suitable habitat for native species of butterflies, birds, and other wildlife. They provide more variety in parks by offering myriad alternatives to the over-planted introduced species, cultivars, and invasive species. The indigenous plants have co-evolved with animals, fungi and microbes, to form a complex network of relationships. They are the foundation of their native habitats and ecosystems, or natural communities.

Such landfill restoration often benefit from the plants being evolved and habituated to the local climate, pests and herbivores, and soil conditions, and so may require fewer soil amendments, irrigation, pesticides, and herbicides for redeveloping a beautiful, lower maintenance, and more sustainable landscape.

The benefits of natural lanscaping:

- More attractive landscapes

- Easier maintenance

- Lower water, waste, and energy bills; less need for fertilizers and pesticides

- Better storm water detention and filtration

- Better air and water quality

- Better habitat for wildlife and people

- Higher property values

The natural value of revegetated landfills could be greatly improved by landscaping with attention to this need for vegetative complexity. The prospects for using restored lands to enhance biodiversity are sufficiently strong to deserve attention.

If the vegetation were improved, the former landfill site could contribute significantly to local biodiversity by adding wildlife habitat that would help link other uses land. Also, urban greenbelts could be enhanced or buffered, and habitat of at least marginal quality could be added to important bird migration corridors.

On the other hand, full-scale natural landscaping to restore landfill can be prohibitively expensive. A hopeful alternative is that a modest natural planting of an appropriate mix of native species can promote the development of diverse natural communities in places that would otherwise remain wastelands.

4.2.2 Design guideline

There is one major guideline of natural landscaping: the planting should look natural, the aesthetic qualities of vegetation can be employed to enhance the enjoyment of a landscape. Success requires the development of a sense of taste and appreciation for the visual aspects of native communities through contact with them.

Color, line, and texture are among the principal aesthetic elements nature offers.

Color: Because much of nature's color is seasonal, planning for it throughout the year requires the use of a variety of species. (fig.4.12)

Line: in nature, lines are created primarily by the trunks of trees, their branches, and the stems of shrubs and herbs. They can be used to direct the eye and shape a space. Like woody plants, tall grasses can be used effectively to outline and enclose an area. In addition, their growth as the season progresses creates a dynamic effects by changing the size and feeling of a space. The arrangement of lines also affects perception. (fig.4.13)

Texture: texture is the term used to define the visual quality of a surface, and, like lines, plant textures can be used to alter the perception of an area.

Light: the ever changing direction and character of natural lighting can add to the effect of color, line and texture. (fig.4.14)

Spatial design: the perception of an area, the feeling it gives, is in large part shaped by the nature of the vegetation that surrounds it.

Emotional qualities: Among the emotional qualities that can be designed into a space are mystery, suspense, surprise, and tranquility. The first two can be created with dark, tunnel-like plantings of shrubs and trees, surprise is a greater challenge, because once a device has been experienced it wears thin. One of the best possibilities is a vivid display of flowers that appears suddenly around a corner. Because they will bloom only for a brief period, the effect is rarely worn out. Tranquility is perhaps the most important emotional attribute a landscape can have. Cool, intimate spaces during the summer, sunny areas warmed in winter, and shaded areas with an expansive or dramatic overlook are a few of the designs that can be used to create a relaxed or pensive mood. (fig.4.15)

Start with the soil

- Plan to protect soil around trees and preserved vegetation from compaction.

- Plan to stockpile and reuse site topsoil, if practical.

- Plan to amend disturbed soils with compost, prevent recompaction, and mulch beds after planting.

Figure 4.12 Popular in different season

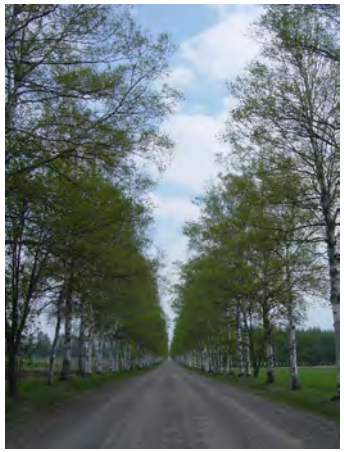


Figure 4.13 Alinear pattern acts as a space divider, Komabanamiki. Source: Google map

Figure 4.14 Sunshine goes through leaves
Source: http://www.wallpaperpimper.com/

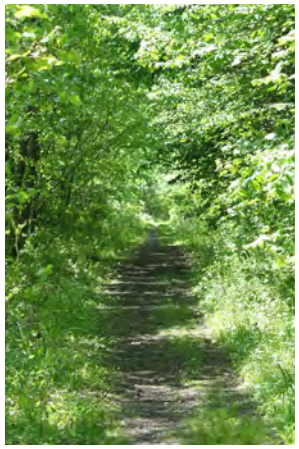


Figure 4.15 Tunnel space entry,
Photograph by Brian P. Fischer

- Consider getting a site soil sample, and any imported topsoils, tested at a soil lab. Follow the lab's recommendations, and verify proper installation.

- Design landscape for recycling fall leaves and chipped prunings as mulch, and mulch-mowing lawns, to help maintain long-term soil and plant health. Plan a composting or leaf/chip storage area on site.

Minimize impacts, to maximize benefits

- Protect tree root zones (twice the drip line diameter) and soil areas being preserved.

- Stockpile site topsoil for reuse – cover piles with chip mulch or breathable fabric during storage.

- Prevent site erosion – compost blankets, berms, and socks are effective, and the compost can be reused later as soil amendment.

- Leave areas close to waterways and slopes undisturbed, in native vegetation.

Make space for nature

- Zone highly maintained landscape elements (lawns, flower beds) closer to public space.

- Leave or restore wilder, "buffer" areas toward perimeter, near slopes.

- Use native plant communities where possible, and select plants, shrubs, and trees to support birds and beneficial insects.

- Leave room for nature to move – trees to fall, plants to grow, or streams to meander – by limiting hardscaping and avoiding linear/geometric designs. Curves and softer engineering are more forgiving and easier/cheaper to maintain and repair.

4.2.3 Wildflowers

The environmental contamination, the odors and misplaced trash affect people living near landfills, and property values in the area often decrease as a result. Planting has evolved because, when a landfill is closed, it must be capped with an appropriate soil or geotextile membrane liner and seeded with fast growing vegetation to stabilize the liner. So besides planting grass, shrub and trees, wildflowers as an alternative for landfill revegetation is necessary to not only ecological values but also creating an attractive landscape on landfill.

The advantages of introducing wildflowers into natural landscaping process are various. Usually, aesthetic value is an important factor in the public's acceptance of disturbed areas such as landfills. In aesthetic value, wildflowers are dynamic landscape element, easy to move and swinging through wind. Their unique color, smell, human scale and seasonal changing shapes are also attractive for the public. For the ecological value, careful selected wildflowers also have the ability to improve the soil quality. More important, research on landfills shows that wildflowers provide a stable source of seeds for consumption by birds and insects, which could stimulate local biodiversity and natural seed dispersed. Last but not least, for the economic value, wildflowers are usually cheaper than those species growing in the garden; they need just low maintenance, and resistance to trample and poor environment.

Possible species of grass and wildflowers in detail design

Figure 4.17 shows some possible species including grass and wildflows that fit in above criterias. The figure includs the height of the species, their flowering season, characters and whether they can attract birds and insects or not.

Figure 4.16 Wildflowers

Figure 4.17 Species slection

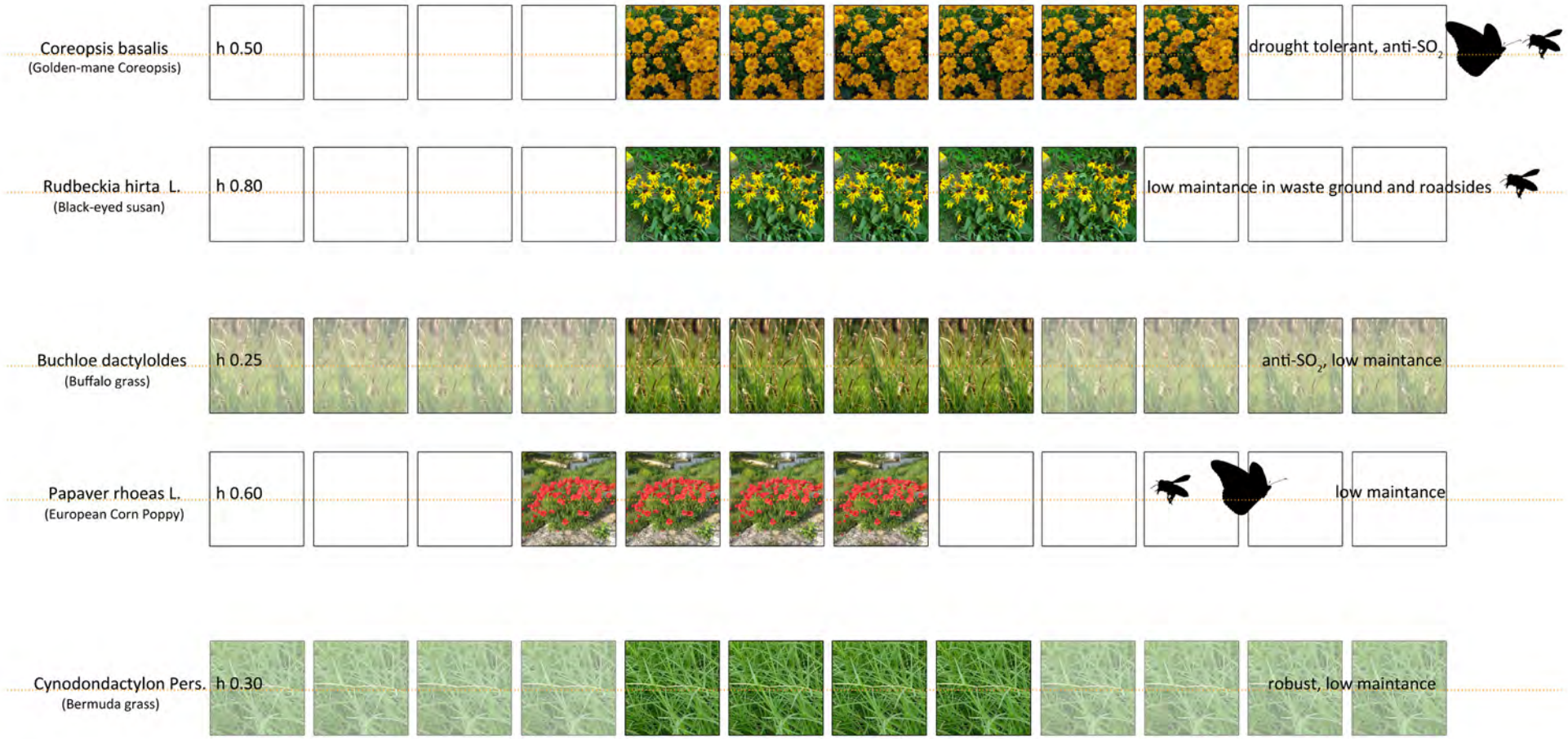


Figure 4.17 Species slection

4.3 Design open space to provide various activities

4.3.1 Main restrictions on developing closed landfills

Certain processes in the closed landfill cause environmental and potentially public hazard problems. The organic matter in the waste undergoes decomposition by bacteria. In the course of the process, gases, mostly CH_4 and CO_2, are emitted from the landfill. Methane coming into contact with oxygen might combust or explode; it is also a greenhouse gas.

Landfills, especially ones in the early stages, may emit a series of toxic volatile materials. Waste may contain a wide range of materials that are potential pollutants, such as organic compounds or heavy metals. Percolating rain water dissolves pollutants in the waste forming a solution called leachate, which might percolate vertically through the soil into the groundwater or horizontally to open water bodies and pollute them.

These problems necessitate engineered reclamation of closed landfills, which mainly comprise final waterproof capping to prevent water percolation through the waste, placing a layer of topsoil and vegetation to prevent erosion, and installing a runoff drainage system and a gas ventilation system.

Engineered reclamation protects the environment from potential hazards and nuisances caused by landfills. Basic engineered reclamation usually creates a large mound, having no specific use and no role in community life. However, this situation, whereby landfills remain bare mounds, is not necessary. Often, the size and location of the landfill offer an opportunity for land recycling and the establishment of an after-use on the landfill.

Certain physical, public safety and environmental problems are encountered in the development of a closed landfill site. The four main problems and their implications for development are described below.

1. The process of biological decomposition of the waste causes differential subsidence as part of waste mass is emitted from the landfill in the form of gas. The subsidence is increased by the mechanical pressure of the layers of earth on the waste. This subsidence is differential, i.e. the surface of the landfill subsides unevenly. This imposes restrictions on the subsequent use of the area. Structures sited on landfills may be unstable and are at risk of buckling.

2. The gases emitted from the landfill tend to accumulate in closed structures and create a safety hazard. In addition, the presence of landfill gas in the soil may adversely affect plant growth.

3. The capping system (designed to prevent leaching) imposes restrictions on the use of vegetation and water bodies in landfills.

4. Waste structure is mechanically unstable, a fact that creates a stability problem in steeply sloped landfills. Since waste composition may vary widely among different sites, and in the same site, mechanical properties of the waste are not predictable, and high safety coefficients are used for calculating acceptable loading. This problem imposes restrictions on development load.'

Three of the four problems – differential subsidence, gas emission, and slope instability –decrease with time, as more of the organic matter in the waste is decomposed. Slope stability increase may be small. The cap, however, should be maintained after final settlement, since the risk of groundwater pollution remains. Landfills reach final stability about 30 years after closure. During the stabilization period, development is restricted and further efforts might encounter difficulties.

Various ***engineered means*** are used to overcome limitations created by landfill problems. A literature review and consultation with various experts provided the following list of the main engineered means, classified according to the problems they solve:

- Means for overcoming differential subsidence: pile foundations, and mat foundations for structures. In some cases, waste compaction enables loading the landfill with a light foundation and light structures.

- Gas emission: engineered means prevent the accumulation of gas in buildings and injury to plants. Means for preventing the former include: passive venting of the gas through perforated pipes, and active venting using extraction wells and suspended floors that allow ventilation of the gas before it reaches the building space. Means for preventing the latter include applying a cap (which is mandatory) and using containers for planting, especially for trees.

- Preventing injury to the cap by trees, thus preventing rainwater percolation and leachate formation. The means include using a synthetic geo-textile in the cap, placing a thick layer of topsoil to contain the entire root system, and planting small trees to decrease the chances of wind overthrow.

- Slope stability: can be improved by regarding and using berms, as well as various retaining means, such as retaining walls and reinforced soil.

The main ***planning means*** are

1 designating the landfill site for a compatible land use

2 selecting compatible functions and arranging them in a suitable spatial plan, avoiding the use of problematic functions such as water bodies and heavy structures, and using plans of phased development according to landfill settlement rate.

The use of planning means can reduce the need for engineered means. (table.4.3)

Using landfills as open spaces requires applying various means to overcome problematic environmental conditions. This requires both considerable planning efforts and financial investments

Due to environmental problems and to prevention of risks to the public, there is an advantage in designating closed landfill sites for open spaces, rather than for construction. The risk of physical failure and the cost involved will be much smaller for open spaces. Gas emission in the open air is dispersed and does not pose a danger of explosion or implicating health hazard. In addition, landfills usually have unique topographical features that may be used to enrich the inventory of open spaces and activities.

In general, ***the advantages of design open space in landfill***:

- Low costs and maintaining
- Gas emission in open air
- Unique topographical features
- Various activities can be added step by step

Process	Mechanical compression	Biological decomposition	Leachate production	Unstable waste structure
Problem	Differential subsidence	Gas presence in soil	Water percolation prevention	Slope instability
Implications	Difficulty in building structures	Plants injury	Restrictionson use of vegetation	Restrictions on development lload
Potential	Open space	Ecological restoration	Plant selection	Long time period plan

Table 4.4 Main four restrictions on redevelopment in closed landfills:
Source: Selecting a compatible open space use for a closed landfill site, Ayala Misgav, 2001

The literature reviewed describes various experiences in applying planning means to landfill reclamation. Examples of designating landfills for compatible uses include golf courses,, nature reserves and parks. In some cases, phased development was used. Finch and Bradshaw (1990) reported a variable rate of success in reclaiming landfills for various uses in Britain. The lowest rate of success, 33%, was achieved by attempting housing, the construction of large building, and forestry. Natural regeneration achieved 41%. Amenity trees and sports and leisure facilities enjoyed a success rate of 54-55%. The multiple functions reached a higher degree of success, 75-79%.

4.3.2 The selection procedure

An inventory of 11 types of the most common open spaces was identified from the literature review. These open spaces were included in the procedure and form the range of potential after-uses for the landfill. The open spaces were classifies as intensive or extensive. Intensive open spaces include ***municipal sports centres, regional sports centres, municipal parks, metropolitan parks and waste parks***. Extensive open spaces include ***extensive parks, planted forests, nature reserves, field crops, pastures and undesignated open spaces***.

The procedure can be expanded to include additional open spaces.

Based on the literature review, each open space type was characterized according to the following three factors: ***function, planning characteristics, and a list of possible activity environments.***

In addition, each activity environment was characterized according to its physical properties. Thus, a full physical characterization of each open space was made.

The three-factor characterization of the 11 open space types forms the database used to define the criteria for selecting an open space for a landfill site.

The selection procedure includes three main stages (fig.4.18)

1 the preliminary steps of data collection and goal formation;

2: the selection of suitable open spaces using planning suitability criteria;

3: the selection of suitable open spaces that are compatible with the environmental conditions. Environmental compatibility is determined by using environmental compatibility criteria for activity environments.

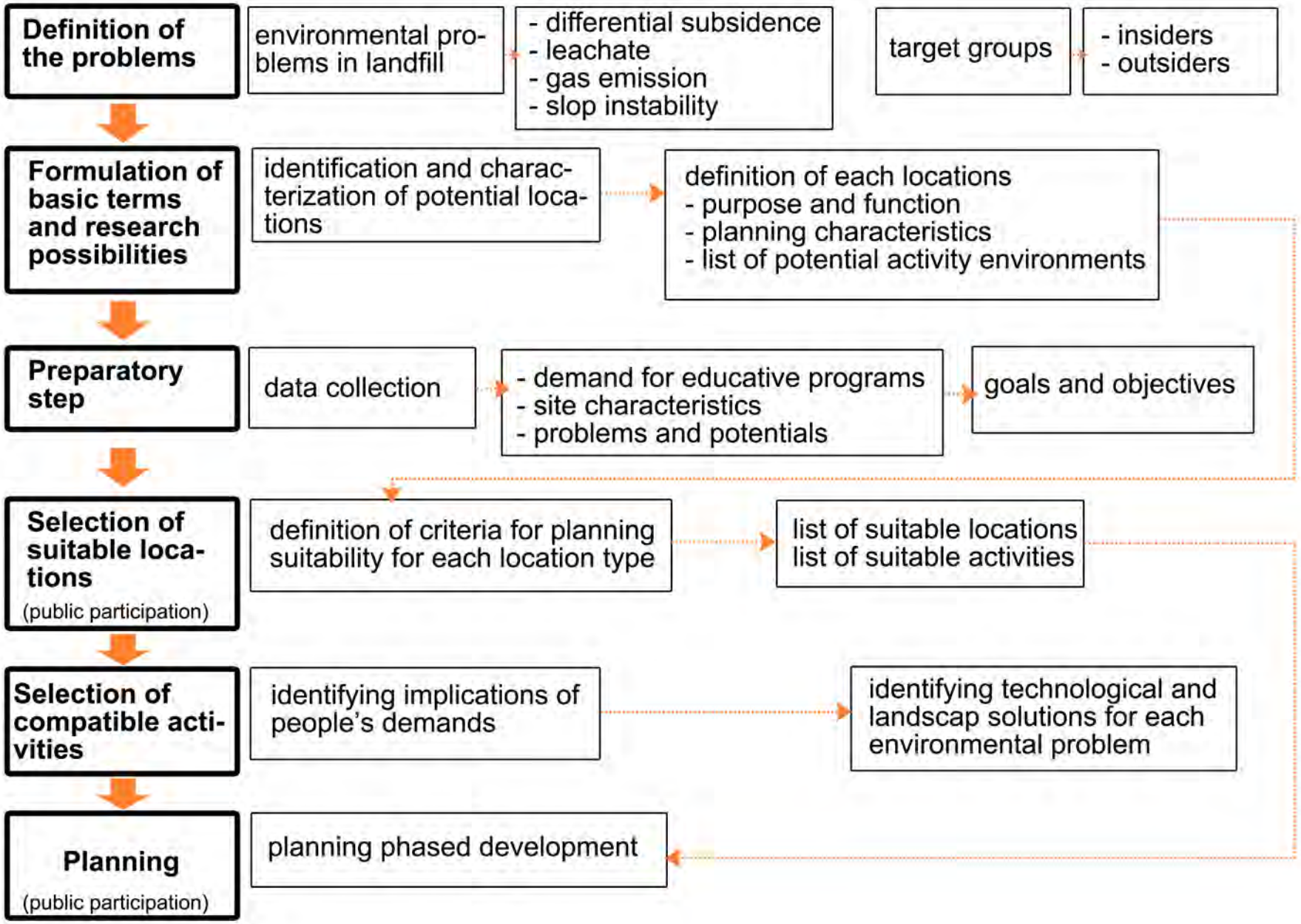


Figure 4.18 Criteria for function selection

4.3.3 Consider from site limitation

Three kinds of criteria for physical compatibility of activity environments to a landfill were identified:

1 Characteristics of the activity environments themselves

2 Physical characteristics of the landfill site

3 Criteria for using various technological solutions, which bridge the gap between characteristics of the activity environments and the ability of the site to accommodate them.

Each activity environment has a certain combination of measures of sensitivity. This combination determines the overall sensitivity level of the activity environment to the problem.

As tables below, the activities were divided into groups of sensitivity levels having similar combinations of measures. These groups of sensitivity levels can be useful for locating activity environments on a closed landfill.

- Table 4.5 List of activities

Place	Hill	Abandoned landfill area
Potential activity environments	Pedestrian paths, seating areas, open theaters, picnic grounds, undesignated open space, recreational areas, certain natural areas, biking paths, performance stages	Parking lots, seating areas, pedestrian paths, performance stages, playgrounds, active recreational areas, exhibitions, museums, buildings for recycling activities.

- Table 4.6 Classification of activity environments – open space

Group of activity environments with similar physical properties	Activity sensitivity to vegetation injury	Vegetation types	Cover rate	Sensitivity to gas
Pedestrian paths, biking paths, performance stages, roads and parking areas	none	-	-	1 (lowest)
Seating areas, open theatre, picnic grounds, certain natural areas, undesignated open space	low	Herbaceous and shrubs	large	3
Ball games, football fields	high	Herbaceous and shrubs	large	3
playgrounds	low	trees	small	3
Planted forests, active recreational areas	low	trees	large	4 (highest)

- Table 4.7 Classification of activity environments – structures

Group of activity environments with similar physical properties	Foundation type	Structure type	Sensitivity to gas
Structures for exhibitions	Mat foundation	Open	1 (lowest), 2
Museums, buildings for recycling activities	Pile foundation	Closed	3 (highest)

4.3.4 Phased development

Three of the four problems – differential subsidence, gas emission, and, to a lesser extent, slope instability – decrease with time. It is possible to locate less problematic activity environments shortly after landfill closure, and later add more problematic activity environments. The classification of activity environments into sensitivity level groups can be used to create tracks for phased development.

The cumulative list of activity environments is shown in the last column. The top cell presents all the activity environments that can be located in stage A for all three problems. The cell underneath it shows all activity environments that can be located in a landfill during stage A or B for each of the problems/ the activity environments appearing in the cell above it, which could always be located during stage A, are excluded.

The result presented in the column shows the groups of activity environments that can be located in a landfill in each stabilization stage. This list of compatible activity environments determines the compatible open spaces in each stabilization stage.

The cumulative list given here is based on the assumption that a certain level of differential subsidence corresponds with given levels of gas emission and slope stability. This is true only to a certain degree concerning subsidence and gas emission. However, it is possible to examine specific landfill sites and construct an accurate cumulative list for each site. The list will show the compatible activity environments for each stabilization stage for the specific site.

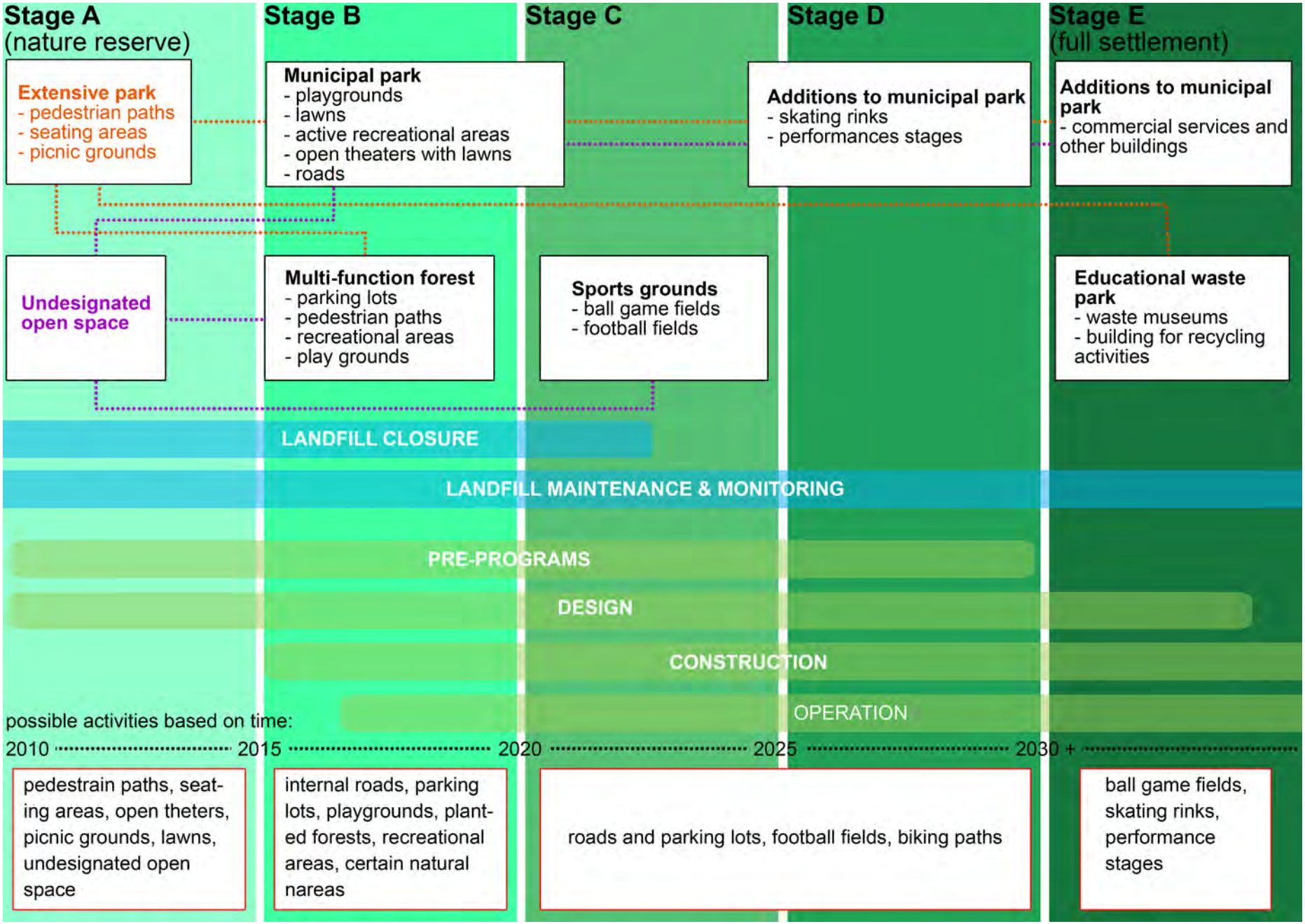
Based on the cumulative list, a flow chart(fig.4.19) was developed, presenting tracks for phased development based on two principles:

1. Natural stabilization process in landfills.

2. Minimum changes in transition from extensive to more intensive uses.

Using the flow chart, I can select the most appropriate chain of uses and be presented clearly and briefly with all the logical alternatives.

Figure4.19 Tracks for phased development, made by author



4.3.5 A quick research of Consideration different people's demands

Besides considering different activities from site limitation and eological values. I also want to take different people's demands into account. One answer must be to look at specific places and to explore in depth what people experience when leading their everyday lives in such places. This requires qualitative approaches, sensitive methods to record the experience, and careful interpretation to tease out any relationship between landscape and well-being, especially if the researcher is to get a sense of what are likely to be several different mechanisms at work simultaneously. But in order to be able to generalise about landscape in any meaningful way, I also need to gather data systematically across number of people and places, and to be able to test how robustly finding stand up when compared in this way.

> *"Research in environmental design, as outlined above, is likely to be focused on needs from and responses to the environment that are common across most of the population. How can on environment best enhance well-being for the diversity of people who spend time within it? As the Forman approach, the primary focus would be on biological needs-those aspects of the environment that serve our best fundamental requirements for survival and well-being at an instinctive level – and indeed it would be an enormously valuable contribution to landscape planning if our understanding of fundamental needs for engagement with the natural environment were better understood."*
>
> *-- (Catharine Ward Thompson, 2010)*

If I am to understand what qualities of the environment are important to people's quality of life, I need to acknowledge the diversity as well as the commonality that exists in people's capabilities, experience, desires and needs. I need to understand to cultural , the social and the individual influences on what people seek for, perceive and experience in the landscape around them.

It is important to mention that the necessary of considering different age. Due to people's own experience, education level and social behaviors, they have various expectations in the journey, which could be classified into five types: the transportation method, favorite activities, social interactions, communicating media and interests from journey. (fig.4.20)

• ***Teenagers*** (15 to 25) usually take public transportation to get there. They prefer sports activities in open space, holding some interest activities such as BBQ and parties. Internet would be their first choice to communication and gathering information.

• ***Young people*** (25 to 35), like me, prefer cycling or motor-cycling in nature, enjoying, breathing and touching nature. Group activities involving more interactions, theme tours assembling people with same interests (e.g. photographing, hiking etc., music festival) and adventures are expected.

• ***Middle age people*** (35 to 50) like driving their own cars to certain places or walking in certain distance, like jogging, fast walking, or walking their dogs. During a trip, they would like to visit some places or monuments inheriting culture and knowledge. Beside, sometimes they will choose relaxing journey routes to enjoy weekends with their family.

•***Elderly people*** (50 to 70) are of slow-speed life comparing to others, so are their choice about travelling. They would like to choose short distance walking with spouse, natural sight views, etc. are appropriate for old class. For the mobile tool, public transport and pooling cars/bus are preferred.

In summary, the younger people, from 15 to 35. They usually want to influence objects and surroundings through changing forms or surface. On the other hand, younger people have high energy, crave kinetic activity, need special shape to climb and jump. Also, they have an active imagination and observation and preferring to develop a new setting for stories and social interactions. The elderly people, from 35 to 70, however, usually feel self-conscious and is afraid to let go, they need simple, artful and attractive deign. Furthermore, elderly people is busy and constantly under daily pressure, they would like to choose places to sit and breathe, closing the nature, need a chance to get away from their daily monotonous routine.

Reflecting to design, driving experience, diverse outdoor activities, close to the nature, impressive educative programs could be introduced here, in order to improve the people's attitude and behavior about waste and landfill.

Public participation can take place in two stages. In the first stage a process of public participation will be integrated with the application of the planning suitability criteria. Here the public influences the inventory of open spaces relevant planning wise. This stage can reduce the scope of the second stage of physical and engineering criteria by avoiding redundant tests, by screening open space types that are not supported by the population will be at the end of the procedure, after employing the engineering criteria. Here public participation will be expressed by influencing the selection of the optimal alternative, out of the variety of alternatives formed. The stage of detailed planning can also include public participation.

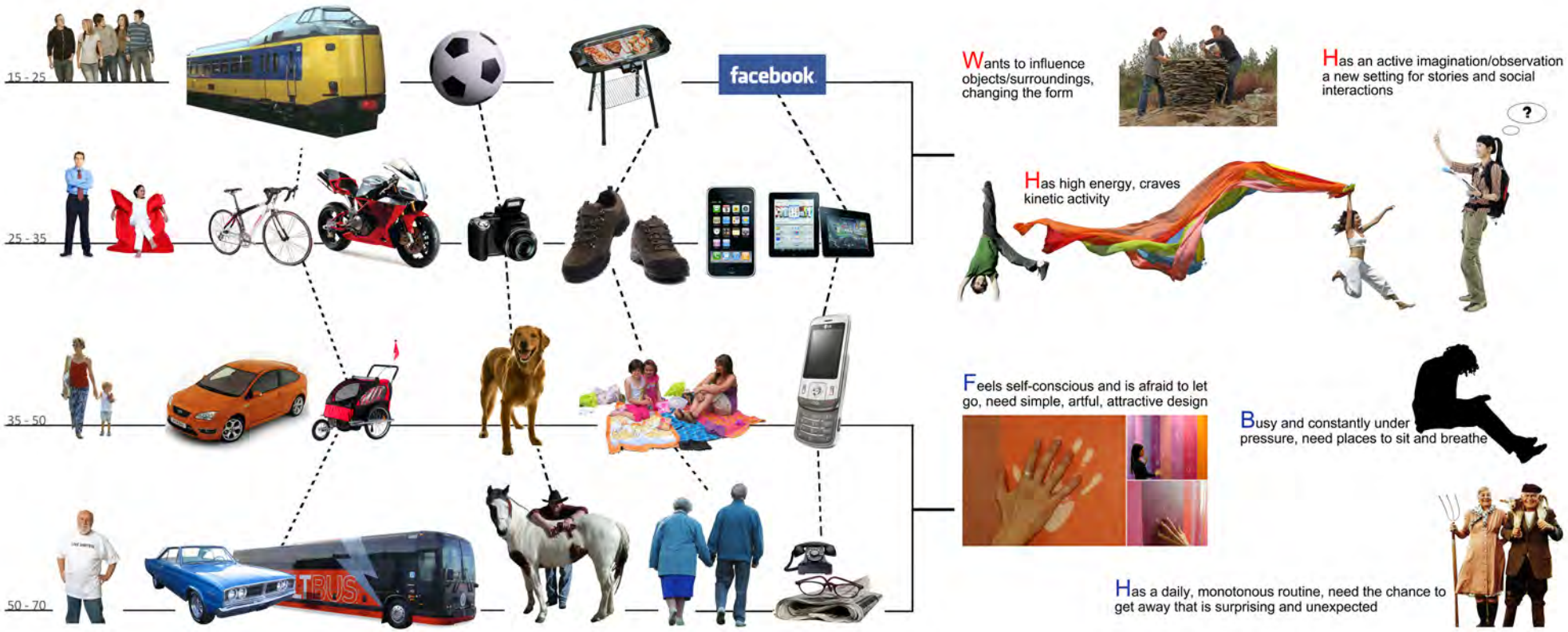


Figure 4.20 Different people's demands

4.3.6 Conclusion

The goal of this open space activity research is to develop a procedure for selecting a suitable open space for a landfill while extensively relating to the environmental and public risk problems stemming from the location on a landfill site. Such a procedure would increase the rate of success in developing open spaces on landfills, thus enabling an increase in the inventory of open spaces for the benefit of the community.

The procedure was developed using the framework of the rational comprehensive model in planning, and includes three main tools for selecting a suitable open space: planning suitability criteria for selecting an open space that complies with general planning requirements; environmental compatibility criteria for selecting activity environments compatible with landfill conditions; and considering from people's demands.

In a way, the procedure is a practical tool for applying the principle of "land recycling." Land is a fixed quantity resource. Furthermore, in Netherlands, where the land is in high density. Under such condition, efficient land use becomes increasingly more important. Two components of efficient land use are on the rise: the intensity of use, and land recycling. Although the procedure contributes mainly to land recycling, it also aims at achieving high-intensity open spaces on landfills when possible and suitable. Careful land use planning should become economical in more cases.

4.4 Public space

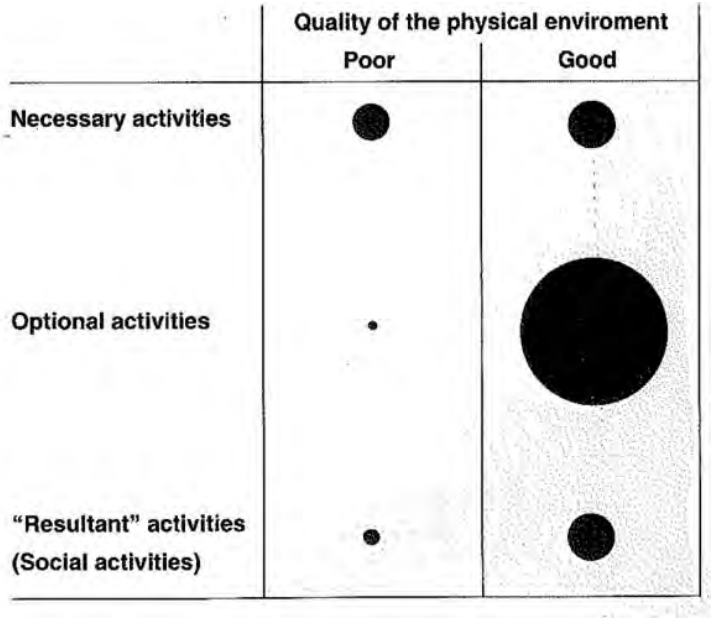


Figure 4.21 Graphic representation of the relationship between the quality of outdoor spaces and the rate of occurrence of outdoor activities
Source: Jan Gehl. 1987

Human concentrating in space and time is a prerequisite of any activity happening. However, what more important is the type of activity to develop. It is far from enough for only creating the get in and out space. Designers should create the appropriate conditions of space for people to hang around, holding activities and participating in various social and recreational activities.

The spatial quality of outdoor space has a great influence for various outdoor activities, especially many recreational, social spontaneous activities. Improving the quality of outdoor space will create favorable conditions for these activities; on the other hand, the deterioration of the outdoor space quality will result in these activities tending to disappear.

Walking, staying, sitting, watching, listening, chatting, etc. These basic activities are used as a starting point because they are part of almost all the other activities. If space could make those basic activities to be pleasure, which in itself is a very important spatial quality. What's more important, this spatial quality can provide a good base for developing other various activities, like recreation, sports, public events, etc. this is because many of the variety activities have the same environmental quality demands, also because of many more complex community activities are naturally developed from normal daily activities. In other words, a large number of small activities promote the large event.

Outdoor activities in public spaces are divided into three categories:

- Necessary activities

- Optional activities

- Social activities

When the quality of outdoor area is good, optional activities occur with increasing frequency. Furthermore, as levels of optional activity rise, the number of social activities usually increases substantially. In a good environment, a completely different, broad spectrum of human activities is possible. (fig.4.21)

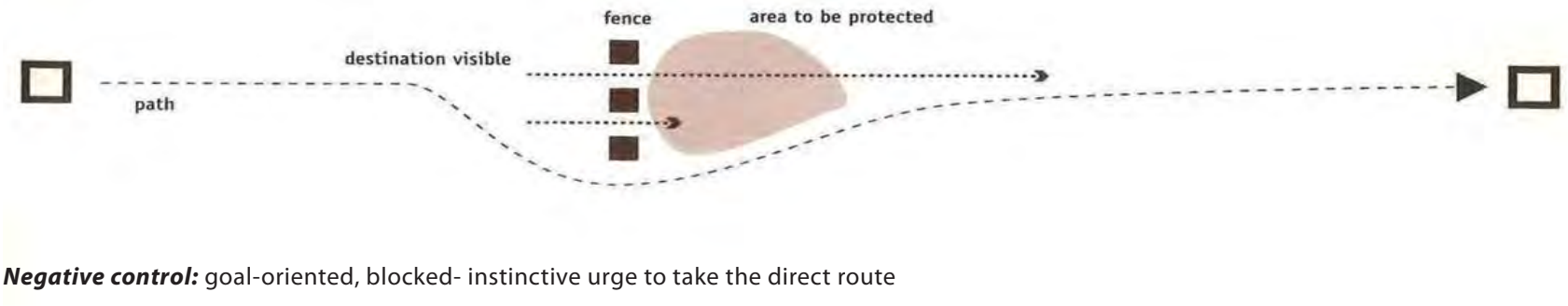
4.4.1 Walking

Walking is firstly one of the traffic types. Walking need space, the basic requirement is people being able to walk without bothering by each other. The challenge is how to identify the level of people's patience while walking. So that the space can not only be compact but also has the room to provide wealth experience.

Different people and groups in different situations have very different requirement and tolerance for walking space.

To determine the appropriate distance under certain conditions, the perception distance is more important than the actual distance. A flat, monotonous and 500m path without protection will make people feel long and boring. However, if the journey can provide a variety different experience, people would feel shorter in same distance. For example, a little circuitous path can make the space more compact; so the walking distance would not be so clear. Therefore, the appropriate walking distance is not relating to the length of the path, but also to the quality of the path, including the protection of roadside and the impression of walking experience.

The journey will be uninteresting if the distant destinations is in a glance; furthermore, if the destination can be seen but had to detour, it will be disappointing and even more unhappy. For the conclusion, the route design should prevent the walker directly see the distant target, but also need to maintain the general direction towards to the destination. A negative route control is a goal-oriented control, urging people to take the direct route. A positive route control should make the main destination invisible at the beginning, and the motiva tion to the destination will divert from some intermediate goals. (fig.4.22) An attractive intermediate goal (seating, viewing point, special plants etc. is used to distract from the direct line to the destination.



Negative control: goal-oriented, blocked- instinctive urge to take the direct route

Positive control: diverted path-main destination not visible, motivation to divert comes from intermediate goal

Attractive intermediate goals(seating, viewing point, special plants etc.) are used to distract from the direct line to the destination

Figure 4.22 Nagative control and positive control Source: Stefan Bernard, 2003

When ***passing a large open space***, neither across the space or walking into the center are generally not very comfortable. On the other hand, while walking along the edge of space can not only experience large-scale space, but also to appreciate the wide view landscape and the details of the border. Pedestrians will get two different experiences, rather than only one. One side is the open space, on the other side is the closely forest edge. Furthermore, it has more additional advantages to walk along the protective façade at night or in bad weather. (fig.4.23)

Figure4.23 Passing a large open space
Source: Stefan Bernard, 2003

Goal-oriented paths insist that the destination is reached rapidly. The whole path's perception field is primarily directed at the intended destination. (fig.4.24)

Figure 4.24 Goal-oriented paths
Source: Stefan Bernard, 2003

For ***less goal-oriented paths***, the line is shifting to provide visual access to changing scenes/images. The pathline becomes a way of reading the open space. (fig.4.25)

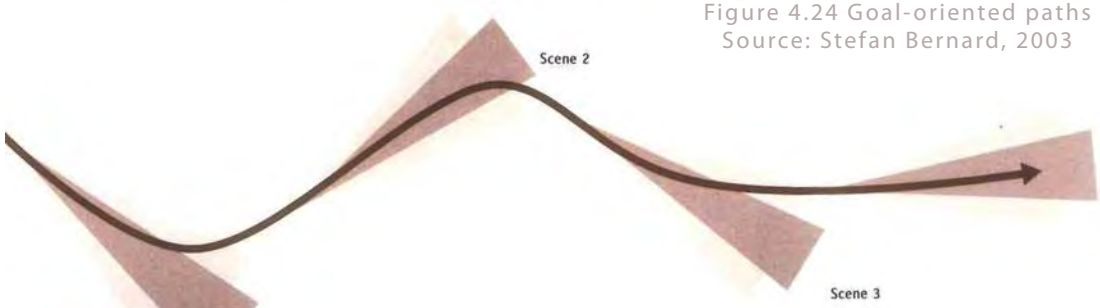


Figure 4.25 Less goal-oriented paths
Source: Stefan Bernard, 2003

Every shift in the line of the path has to derive from actual topography factors and/or scenic ones (***attractive visual links***).

(fig.4.26)

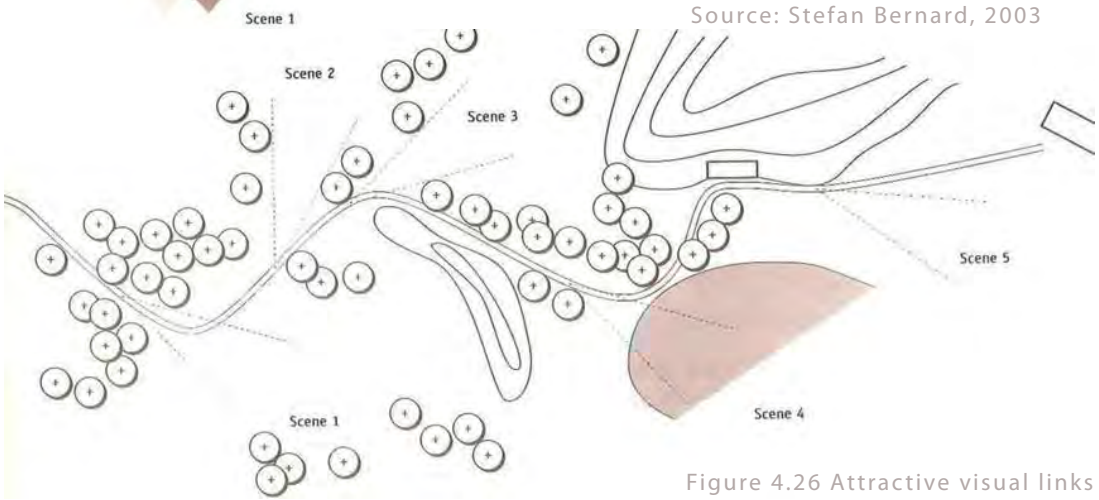


Figure 4.26 Attractive visual links
Source: Stefan Bernard, 2003

Individual features accompanying the path can give a strong sense of direction. (fig,4.27) A wide open air elements are suitable for this. Path markers can accompany a path in the form of a line or intermittently.

Figure 4.27 Individual features, Source: Stefan Bernard, 2003

4.4.2 Staying

Comparing the physical environment requirements of stop and stay, walking and sit require more and also more comprehensive. However, due to standing activities clearly reflects some important characteristics of many static behavior activities in public space, it is necessary to analysis them comprehensively. Surely it is important to stop in the public space, but stay is the main key word.

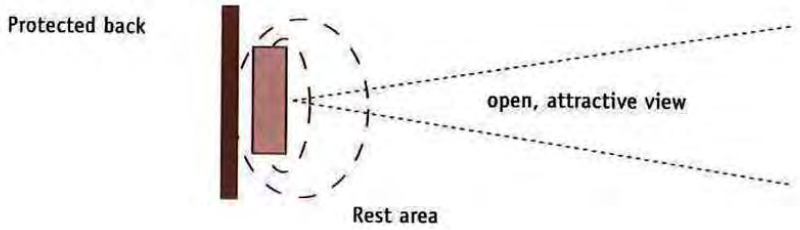
Stay for a while

Whether for the short stay or functionality stay for activities takes place, if someone stayed for something or seeing someone, or enjoy the surrounding scenery, there is a demand for finding a good place to stay for a while.

Boundary effect

Psychologist Derk De Jonge proposed the theory of boundary effect after studying the preferable area for Dutch residents. The theory pointed out: the edges of grove, plaza, open space in the forest, etc. were people's favourite areas, while the open wilderness and places had fewer men to visit, unless the edges had been overcrowded. Edward. Hall further pointed why the space border effect existed: when people stayed in the border region with less part exposed than staying in other parts of the space, they could see everything clearly, meanwhile the back was protected, and people could walk to any adjacent space when watching.

Figure 4.28 Well-protected places to sit, with an unobstructed view of the surrounding activities, are always more popular. Source: Stefan Bernard, 2003



4.4.3 Sitting

In many different kinds of public space, it is special significance to make appropriate arrangements for people's sitting and resting. Only if favourable sitting conditions is created for people's sitting, people would like to stay for a longer time. If the condition is few and poor then people will just have a glance and pass by. In this situation, the time people staying in public place is very short, furthermore, many attractive and valuable outdoor activities

will be disappeared.

Good seating layout and design is the premise of many attractive activities in public space such as picnics, reading, nap, chatting, and so on. And these activities have significant effects of public space quality.

For improve the quality of the outdoor environment in an area, the best approach is to create more and better conditions to enable people to sit down comfortably.

Seat selection

As discussed before, the boundary effect also can be observed when people selecting their seats. The seat along the edge of space is more popular than those in the space. The same of "stay", people tend to search the support materials from the subtleties of the physical environment. The seat located in the cavity, ends of a bench or those defining space are more popular than those cannot divide space clearly.

Seating arrangement

Seating arrangement requires careful planning. Many seating arrangements are too focused on the aesthetic principles, let seats "float" in the public space freely, ignoring the basic psychological consideration. The result is those seats appear to be created various possibilities for people's sitting, but in fact only provided many unsatisfactory seats. A good public space design should avoid the above situation, seating arrangement should be taken into fully consideration about the space of the area and the quality of basic functions. Each seat or resting area should have its own specific suitable environment, placed in a smaller space within the whole space, such as recesses, corners, they can provide warmly, safety and good micro-climate conditions.

Orientation and view

Orientation and view play an important role for the seat selection. When people choose to sit down in a public environment, they will always immediately notice the various advantages in this place, such as special terrain ,unique space, comfortable climate, beautiful landscape and other aspects.

As mentioned before, having the opportunity to watch various activities is one of the key factor in choosing seat. On the other hand, other factors such as sun and wind directions also should be taken into account. In conclusion, seats which have good protection, good open view and observing surrounding activities without interrupted are always more popular than any other seats.

Basic seat

The basic form of the seat: beach and chair, on the one hand they can provide all kinds of users that have the demands, the other is to take into account the needs of a seat is not too much of the occasion. As long as there are enough available seats, people will always choose

the best location and the most comfortable seats, which requires sufficient basic seats and placed them to carefully selected place where can provide favourable conditions for users as much as possible.

Optional seats

As the demand for seat increasing, in addition to the basic seats, many optional seats also are required, such as stairs, parapets, stones, etc., to meet temporary needs. These optional seats can use the existing materials, and set up as landscape points.

There is another advantage according to a relationship between small amounts of basic seats and a large number of optional seats, it can works well when there are only a few users. Otherwise, many empty seats will let create a depressed impression and relate to abandoned and forgotten.

> *"Most of the time, people outdoors require direct sunshine and protection from the wind to be comfortable. On all but the warmest days, parks and plazas that are windswept or in shadow are virtually deserted, while those that offer sunlight and protection from the wind are heavily used."*
>
> *-- Peter Bosselmann,1984*

4.4.4 Conclusion

In this chapter I researched the general strategy and principle of how to design public space in good spatial quality. To consider the whole area as an open space, those ideas can help me to create a pleasant and comfortable park for people. Only if a good route design is completed as a basic foundation, more outdoor activities can have the possibility to be developed in next step.

4.5 Construction

4.5.1 Reuse materials

"Let reuse be reinspiration."
-- J. William Thompson, 2000

Recycling is more than just a practical way of saving energy and resources. Clearly, it is worth doing for simple pragmatic reasons. But like necessity, it can be a source of invention and creativity, inspiring both designers and users of landscapes.

The uniqueness of specific places has been diluted by modern communication and transportation, until many people feel adrift in a featureless landscape of convenience. Reusing cast-off materials is a link to people and places and gives a sense of continuity that many people deeply want. The results may be as quiet as the "character" a site gains from worn, used stone or as obvious as an old tractor planted with petunias. Large or small, tasteful or garish, reused materials have an identity that is hard to buy new.

Use local, salvaged, or recycled materials

Recycled materials are remanufactured between their first and second use. In general, recycling is supported, but careful analysis is required to know which materials are environmentally cost-effective to recycle. Although it is one of the most popular causes endorsed for sustainability, some forms of recycling do not save enough energy to be environmentally sound. Materials like aluminium can be remanufactured at only a fraction of the energy cost of new production; add to this the necessity to collect and transport materials for recycling, and the net energy saving may vanish. For some materials and some uses, recycling can only produce a second-rate class of material; this is called "downcycling." Recycling, like salvage and reuse, does keep materials out of landfills; sometimes this is reason enough to continue recycling a material when energy savings are borderline.

Yet in a way, greenwaste uses the landscape as the medium of recycling. The concept of renewability also relates directly to the landscape; Only products that can be grown can truly be called renewable. Wood is the only really renewable construction product, with the exception of a few plant-based paints and varnishes.

Sustainable use of materials has many complexities, and the well-known slogan "reduce, reuse, recycle" needs to be taken as a list in priority order. Using less materials, reusing them in their present form, and finally recycling them is a sustainable path. When recycling, or even reuse, becomes an excuse to continue using more and more materials, or to use materials with extremely poor environmental records, it makes a mockery of hopes for sustainability. Likewise, using a locally produced but highly toxic material is of little environmental benefit.

Use on-site materials

If using local materials follows the "close-to-the-source" principle, then the closest source is the site itself. The great majority of materials for traditional construction, soil, wood, and rock were taken from the site or very nearby. Limitations on locally available materials played a strong role in the development of regional technologies and design styles.

Far from being just a constraint, these local materials awakened a creative design response that has become one of the most popular and imitated styles today. A wide range of on-site materials may be productively reused in the landscape-if they are considered creatively. Creative use of local materials offers not only environmental benefits, but the basis for artistic rebirth.

Boulders, stone, brick and timber

Rubble from demolished buildings or paring can be reconstituted as paving surfaces. Concrete rubble was pieced together and cemented to form the basis of a new driveway and parking area. This significantly cut requirements for new cement.

General principles about chosing materials:

1 whenever possible, specify locally produced products

2 use less processed materials

3 when specifying materials, perform a rough audit of the energy required to mine, produce, ship and install them.

4 explore the availability of recycled materials. Specify reusable materials, for instance, stone, brick, or concrete pavers rather than poured concrete.

5 avoid petroleum-based materials whenever possible. Asphalt and many plastics are indispensable in a few uses, but not for every purpose.

6 use durable materials with high carbon content: the carbon locked up in these materials offsets the release of greenhouse gas carbon dioxide from other sources.

7 protect existing vegetation, use new plantings or bioengineering

8 minimize use of materials that are toxic, either on-site or during manufacture or disposal.

Figure 4.29 Local materials

4.5.2 hold slopes in biotechnical erosion control

Biotechnical erosion control includes a wide array of applications. Almost all make use of the remarkable ability of some plants to sprout from a fresh cut twig stuck in the soil. The most vigorous of these are willows, poplars, or dogwood. These and a few other species are the most commonly used materials of bio-engineering. When cut, they have neither roots nor leaves, making them almost as convenient to work with as very small boards or stakes-yet they are alive, and within days or weeks begin to weave new roots deeply into the soil.

Soil bioengineering: a simple system in which live woody cuttings and branches provide both structure and growth. Mulch and natural or synthetic fabrics also play a major role, preventing surface erosion until the cuttings leaf out. Once the cuttings take root-usually within one growing season-they provide long-term stability for the slope and are self-repairing and self-maintaining. (fig.4.30)

> *"Soil bioengineering is useful for repairing gullies and controlling shallow landslides and slumps, on wet soils or dry, on cut or fill. It is probably most widely used for stabilizing stream banks."*
>
> *-- J. William Thompson, 2000*

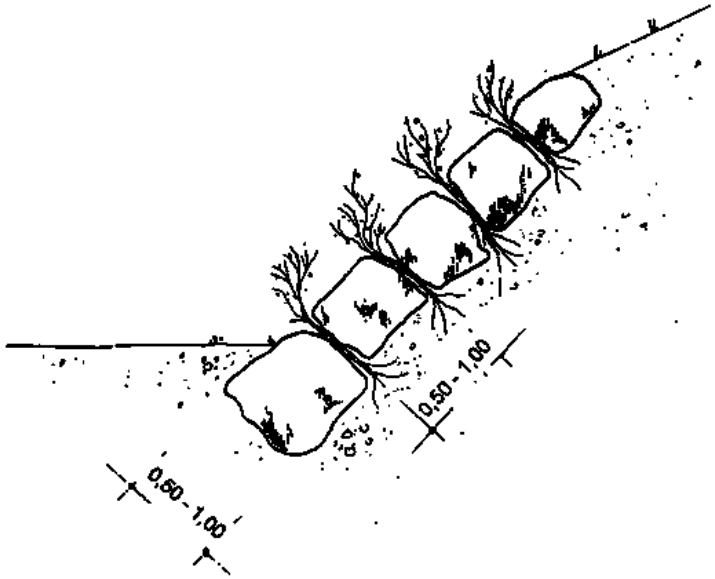


Figure 4.30 Section of soil bioengineering
Source: Florin Florineth, 2003

Here are some of the ***advantages that bioengineering provides***:

- A flexible, self-sustaining, self-repairing, structure.

- Cheaper installation and maintenance than hard structures.

- Greater strength than standard surface plantings, due to deep burial of cuttings, and interwoven stems, roots, and geotextiles.

- A practical alternative where heavy equipment cannot be used.

- Wildlife habitat, air and water quality filtering, and other functions of plants.

Suggested practices for bioengineering

- Soil bioengineering must be tailored carefully to site, plant species, and environmental conditions.

- Successful bioengineering requires an experienced practitioner.

- Vegetative systems may need supplemental retaining structures on extremely steep slopes. (greenwalls) (fig.4.31)

- Bioengineering methods may be limited on rocky or gravelly slopes lacking of soil for plant growth, or in extremely arid regions.

- Where possible, obtain cuttings of native species from the immediate locale. Do not harvest on ecologically sensitive sites.

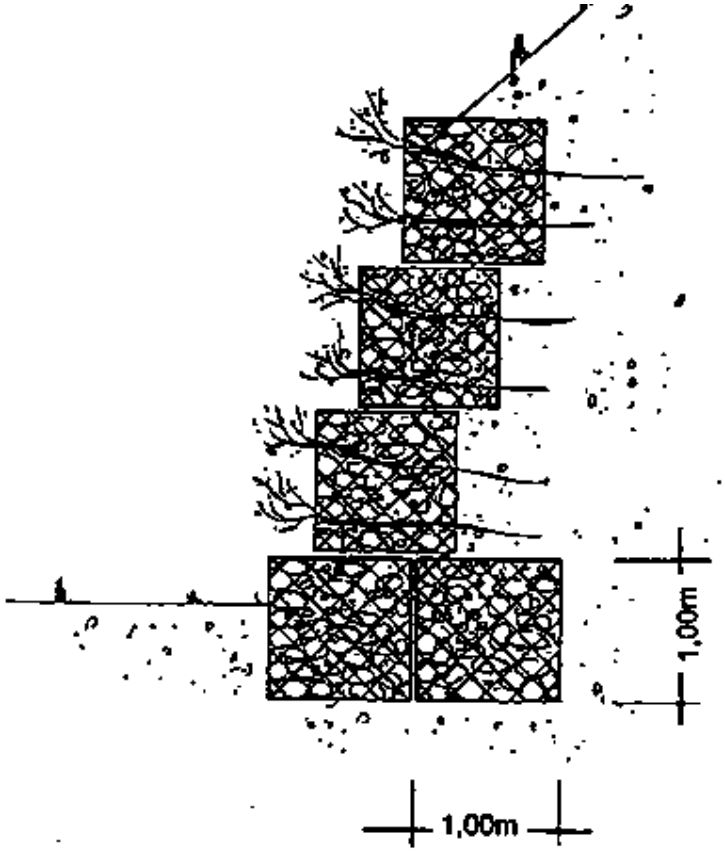


Figure 4.31 Section of soil bioengineering on steep slope
Source: Florin Florineth, 2003

- Limit the removal of vegetation on-site. Stockpile and protect topsoil and protect exposed areas during construction.

- Build to withstand stormflows immediately, or divert or drain runoff while the project is newly in the ground.

- Maintain bioengineering like any other planted work, for at least a one-year establishment period.

On near vertical slopes, soil bioengineering by itself may not be enough stabilization, and some non-living retaining structure may be required.

> *"In cases like these, bioengineering uses structural supports through and over which plants can grow. In various forms, these achieve strong structures with a green face. Closely related to the ecoroof concept, greenwalls are part of the large family of bioengineering techniques that rely on flexible, living materials for functional purposes."*
>
> -- J. William Thompson, 2000

Advantages of greenwalls

Greenwalls offer compelling alternatives to landscape structures of concrete, metal, or wood. A vegetated surface suits many aesthetic preferences'; it deadens and diffuses noise, cuts heat and glare, holds or slows rainwater, traps air pollutants, and processes carbon dioxide, while providing food and shelter for wildlife.

4.6 Art, engineering and recycling

"As the playing field of the global waste economy levels off, the golden age of mass-disposal is now being supplanted by the age of mass-recycling."
-- Pierre Belanger, "Landscapes of disassembly", 2007.60 Challenges

Besides dumping waste underground, landfill also has the responsibility of recycling. In this field, artists and engineers did a lot of research and projects that could also be applied in landscape design. Artists can help raise public awareness and increase educative meanings; engineers can provide technical supporting relating with landscape design tools. Both of their work can inspire me to build up alternative possible solutions in my design.

• ***Landscape architect's role***

- give different identity, structure and meaning to landscape
- use designs to influence the opinion and behaviour of people towaeds environment
- provide opportunities for artists and people
- provide public participation

• ***Artist's role***

- rising awareness of environmental problems
- create inspiring art to educate people
- address waste issue in art work
- bring information to public from his own understandingt

• ***Engineer's role***

- waste management
- technology support
- landfill maintenance and monitoring

Figure 4.32 Exhibition and films in Fresh kills park
Source: www.nycgovparks.org/freshkills

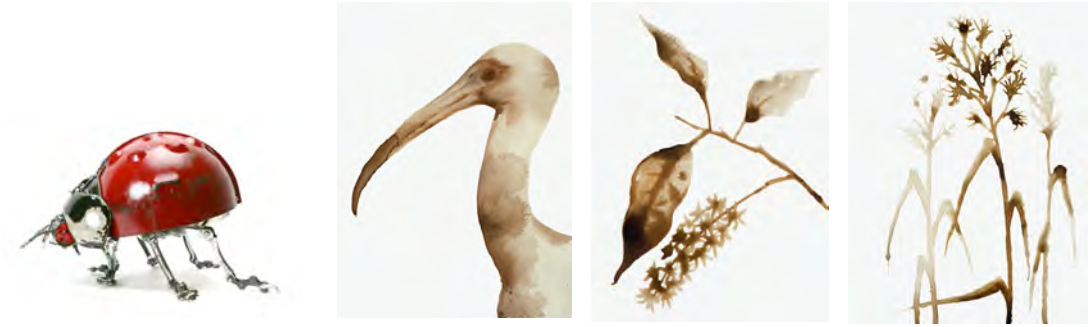


Figure 4.33 Leachate-made pictures, photo by Colleen P. Popson, 2002

Figure 4.34 Land art projects in Byxbee park, California, Photo by Marijke Rijsberman

4.6.1 Art

Waste is not only a concern of waste management and technology scientists. In recent decades with the rising awareness of environmental problems, artists created many inspiring art pieces to educate people. Waste materials in combination with rich imagination are used to make fine pieces of art.

Different than scientists, artists most of the times do not have the intention to solve real problems, but by addressing the issue in their work, they bring information to public from their own understanding. Landscape architects are often inspired by artists. Though landscape design is aiming at real problems, quite often also bring information to people. By giving different identity, structure and meaning to landscape, designs may also influence the opinion and behaviour of people towards environment.

Possible solution inspiring by artists

-- (case study from fresh kill park and Byxbee Park)

- documentary film about environmental issues (fig.4.32)

- an exhibition highlighting the problem of using art to raise consciousness (fig.4.32)

- some graphic diagram to understand the processing of garbage at landfill

- visual, physically, scientifically, historically and sociologically

- pictures relates to the general topic of ecology, made from leachate, the noxious liquid that oozes out of landfills (Alexis Rockman, 2002) (fig.4.33)

- consider the landfill not just as a big dump but as a giant, land-art, living and breathing organism (fig. 4.34)

- small motorized, methane-fueled vehicles built from parts salvaged from dumps, recycling issue (Marguerite Kahrl)

- an simulation of a section of a dump. Piled up in a gallery corner is a mountain of household rubbish, behaviour awareness (Steven Siegel, 2002)

Figure 4.35 Students field trip in Zotermeer landfill (photo by author)

Those programs are mainly aimed to increase the public awareness, reminding landfill history, gaining recycling knowledge and providing educative meanings.

Those recycling programs can affect consumptive as well as recycling behaviours which ultimately impact on both natural resource utilization and the landfill problem. For community recycling programs to be successful, ease of access is a key requirement and has typically been achieved through regular curbside pick-ups and/or conveniently located drop-off centers. (fig.4.35) The planning of a successful educational/ awareness program requires an understanding of consumers themselves, including their waste disposal practices and their environmental attitudes.

After studying artists work. I could build up my general strategy and principle about how to use educative approach in my design. In the "detail design" chapter I will explain how to use these principles into detail design.

The main purpose of educative program

- Reversing people's negative view of garbage

- Changing people's habits of waste disposal behavior

- Increasing people's awareness and knowledge for garbage recycling as well as landfill

• ***Means***

- Making the waste disposal process accessibility, visualization, and easy to understand

- Enhance people's participation, for example, use garbage to create landscape and art work.

- Show the positive results to people

• ***Shows***

- The process of vegetation restoration

- The process of garbage collection and classification

- The process of garbage dumping in landfill

• ***Considering***

- Considering whether the existing and surrounding activities, overlapping of functions

- Considering the actual needs of people

4.6.2 Composting

There are various ways of disposing of biodegradable waste which avoid one of the drawbacks of landfill – the consequent free emissions of methane, a very potent greenhouse gas. One option is anaerobic digestion, which can generate some usable energy, but this method still leaves a residue which has to be disposed of somehow. Incineration is another well-supported option, but an imperfect one, since wet biodegradable waste is not particularly fitted to incineration, as it reduces the calorific value of the waste. Thus, the third option, composting, looks to many as the most cost-effective way of moving forward.

Many people are familiar with domestic on-site composting in the garden, in which biodegradable waste is collected from the garden and placed on a compost heap along with selected kitchen vegetable waste. Most local authorities are involved in active initiatives to promote this sort of composting, because it's obviously one of the best ways of diverting biodegradable waste. No transport at all is involved, since the waste stays at home, and households create their own compost, which can then replace some of the inputs that would otherwise be used in the garden.

An alternative centralized option is open-air windrow composting. There are always going to be some wastes that have to be collected at the curbside and brought to central sites for composting. At present these facilities are usually located outside the city boundaries, or even in the rural areas. The material is fed through a large shredder in which it is macerated to make it uniform and more accessible for micro-organisms. These facilities do not have to be large-scale, smaller-scale equipment is available for use in parks and by garden landscapers, with the shredder simply mounted on the back of a tractor.

After shredding, the material is placed in what are called windrows – long heaps, usually around 2 meters high and 3 meters wide. The material stays in the windrows for about twelve to sixteen weeks. And it is during this time that the composting takes place.

Most of the compost produced by centralized units, and of course all the compost produced in domestic units, is used by the domestic sector. This compost is suitable for use as a soil improver without any further treatment, it can be dug in before vegetables are sown or incorporated into the soil, around the roots of newly planted trees. It can also be mixed according to balanced formulae with things like bark, or other wood fibre, to make a growing medium for container-grown plants; the unblended compost is rarely suitable for direct use as a potting compost. Compost can also be formulated with fibrous materials, such as bark, for use as a peat replacement.

Figure 4.36 Compost cycle
Source: Eric Brennan, 2009

Sorting industrial waste

- Processing: sorting of industrial waste
- Production: secondary raw materials and fuels
- Recycling: 73%

Wood waste

- Processing: sortering and reducing
- Production: raw material (chipboard industry) fuel (stoke in power station)
- Recycling: 96%

Rubble waste

- Processing: sortering and en breaking
- Production: granulate and granulate products
- Recycling: 99%

Dirty soil waste

- Processing: extraction cleaning
- Production: categorie 1 sand
- Recycling: 75%

Figure 4.37 Different waste recycling

4.6.3 Conclusion

Combining both artists and engineers work. The following picture shows some solutions to increase educative meanings which could be applied in my study area.(fig.4.38)

Figure 4.38 Summary of art, engineering and recycling, made by author

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5 Alternative designs

Figure 5.1 Landfill restoration: landfill in Zoetermeer, Photo by author

5.1 Intruduction

"Landscape is a process, not 'designed' or 'constructed', but 'grown'."
-- James Corner, 2005

Based on the previous research, the design should be a process of environmental reclamation and renewal on a closed landfill, recovering not only the health and biodiversity of ecosystems across the site, but also the spirit and imagination of people who will use the new land. The landscape should be about dynamic staging and cultivation of new ecologies at Barneveld landfill: restoration of soil and air; of vegetation and wildlife; of programing and various human activities; of environmental technology and educative meanings. Understanding landscape as a process is central to the whole design and planning.

"For a site of this scale and complexity cannot be designed in total, or constructed overnight. Rather, it must be 'grown', as in seeding, cultivating, propagating and evolving."
--James Corner, 2005

The plan anticipates an over thirty-year program, in each different period, design should be emphasized in different field. (fig. 5.2) Thus, the design is as much about the design of a process of transformation as it about the design of specific places.

Figure 5.2 Site timeline

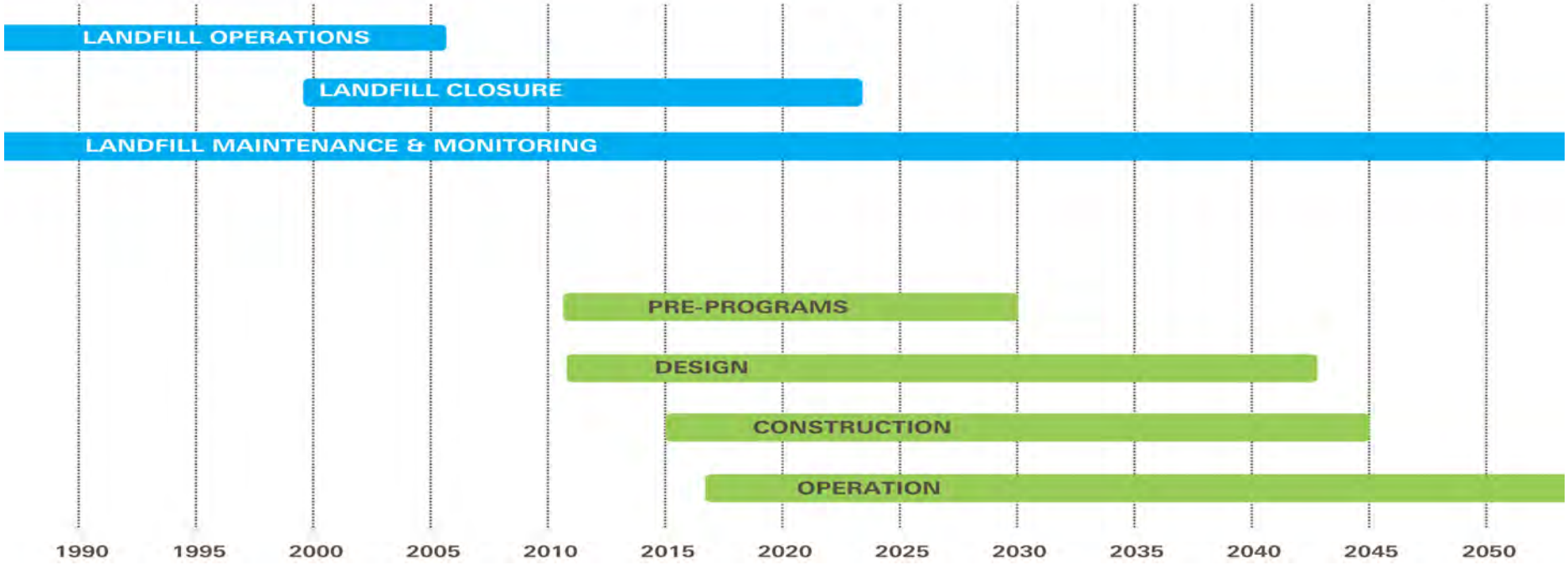
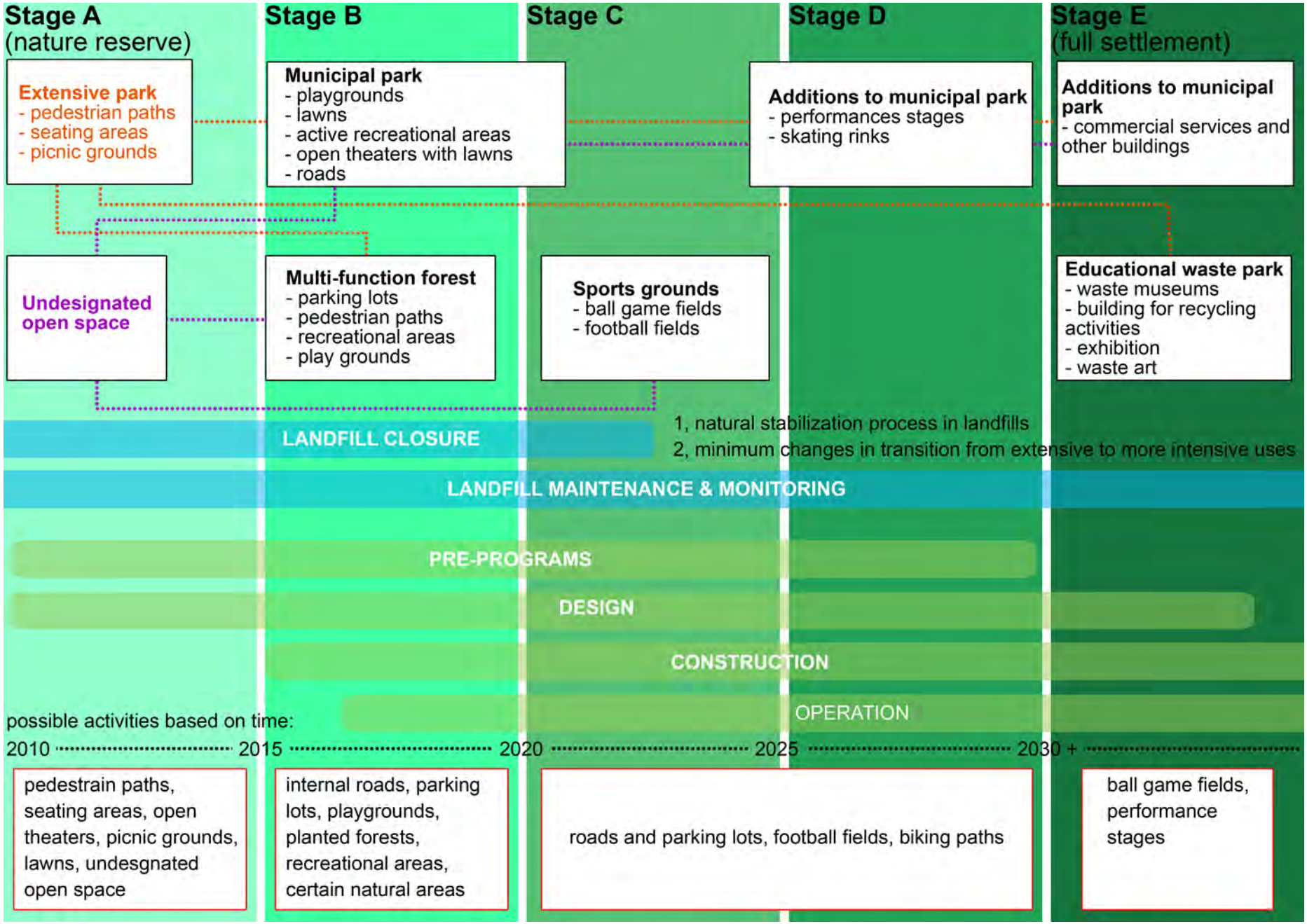


Figure 5.3 Tracks for phased development



5.2 Two alternative designs

Due to the landfill current condition, landfill maintenance and vegetation restoration should be the first two stages. However, during this process, possible activities should also be added in different potential places. So I will build up my alternatives mainly aiming at "possible activities". These alternatives are developed from the principle of "design open space to provide various activities", relating with my field work in each place. As I already explained in chapter 4.3.4'Phased development', the original activity located in specific place should have the potential to develop into another one or multifunctional activity in time. And surely different strategy will cause totally different results in the final stage.(fig.5.3) Following the two main tracks for phased reclamation activities, I decided to develop two alternative designs, one concept is short term, intensive functions, and another is long term, extensive functions. I will design different original activities in each place of the site based on its own characters, to see how each of they will grow in the future. At last, I will use the criteria from my SWOT analysis (built up for site condition, people's demands and my objective) to evaluate these two alternative designs, and choose the most suitable one to complete my final design.

5.3 Alternative one

The first alternative design is a short term, with intensive functions. (fig.5.5) For this concept, the landfill operations will start from now and completed within ten years, the process of landfill closure will be five years, from 2015 to 2020. On the other hand, landfill maintenance and monitoring will be continued from now to 2050. Because of the short period of operations, the restoration stage should be maintained for a long period, from 2020 to 2050. That means the ecological value will be the core objective in this alternative design, and natural reservation should be the main approach. To follow the activities changing track, the first stage is to build up an extensive park, with simple facilities which requiring low demands from environment such like pedestrian paths and seating areas. This activity will be developed into multi-function forest (around 2015) and educational waste park (around 2030) when the environmental condition is good enough to construct such projects. In this process, possible functions are including parking lots, recreational areas, waste museums and exhibition.

By using this approach, several intensive functions will be provided; the damage and accident in function transition process will be minimized. Also, because of the less human disturb and long vegetation restoration, the nature environment will be protected properly. The land value cn be increased in the early stage. For the insufficient part, lack of various outdoor experience and unique activities might lead to people ignoring this land, and the

Figure 5.4 Future image about alternative one

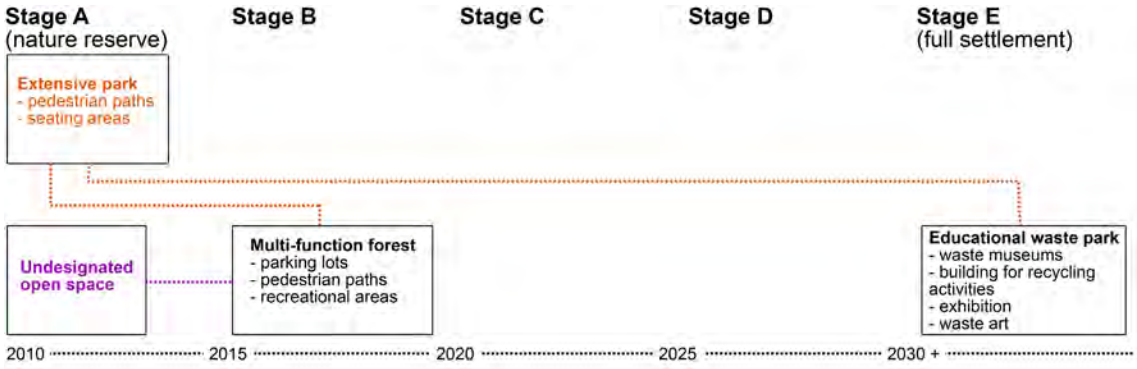


Figure 5.5 Concept one: short term, intensive functions

- Earlier landfill operations & closure
- Earlier park operation
- Educative approach through art pieces and memory landscape
- Mainly focus on natural reservation
- Provide intensive functions, minimum changes in transition

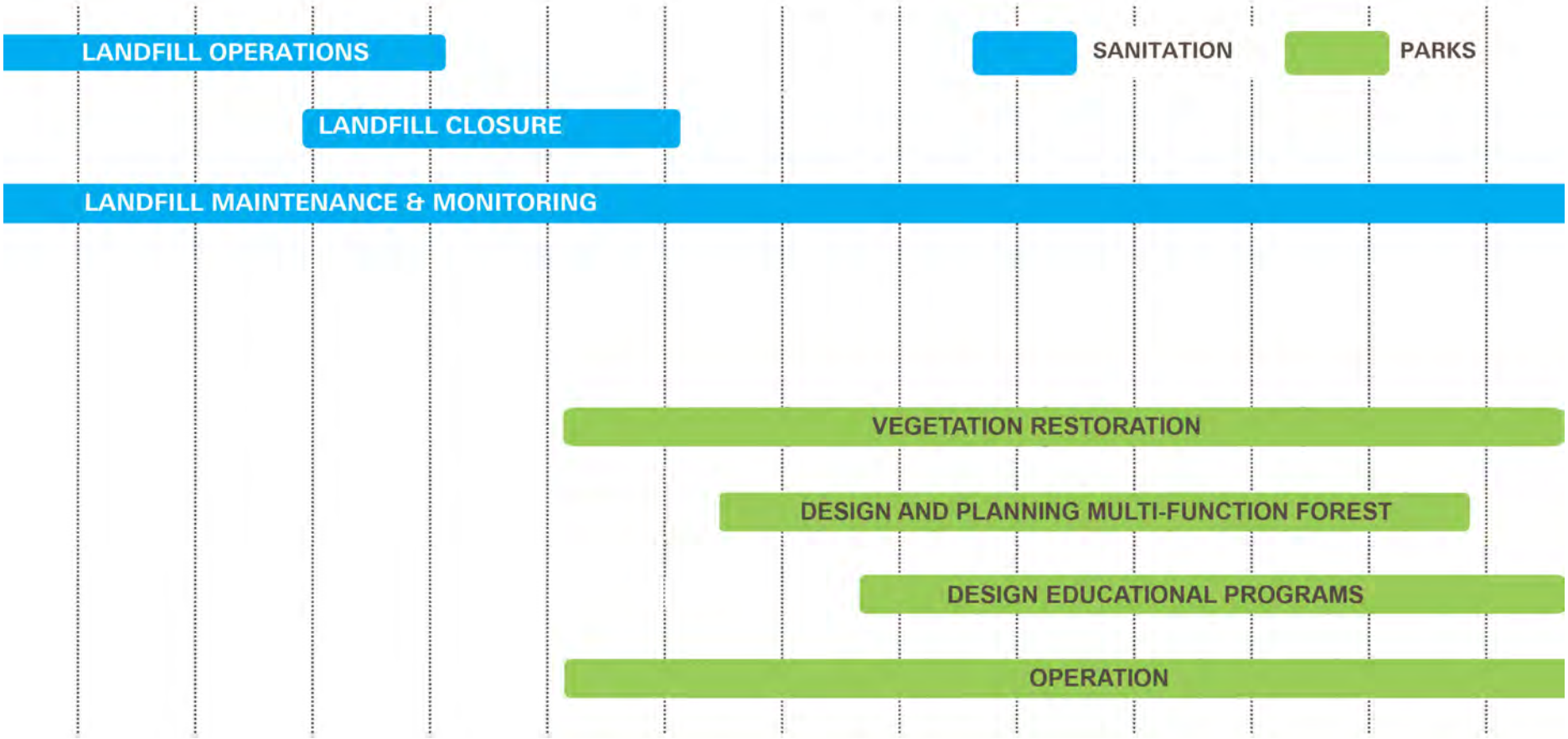
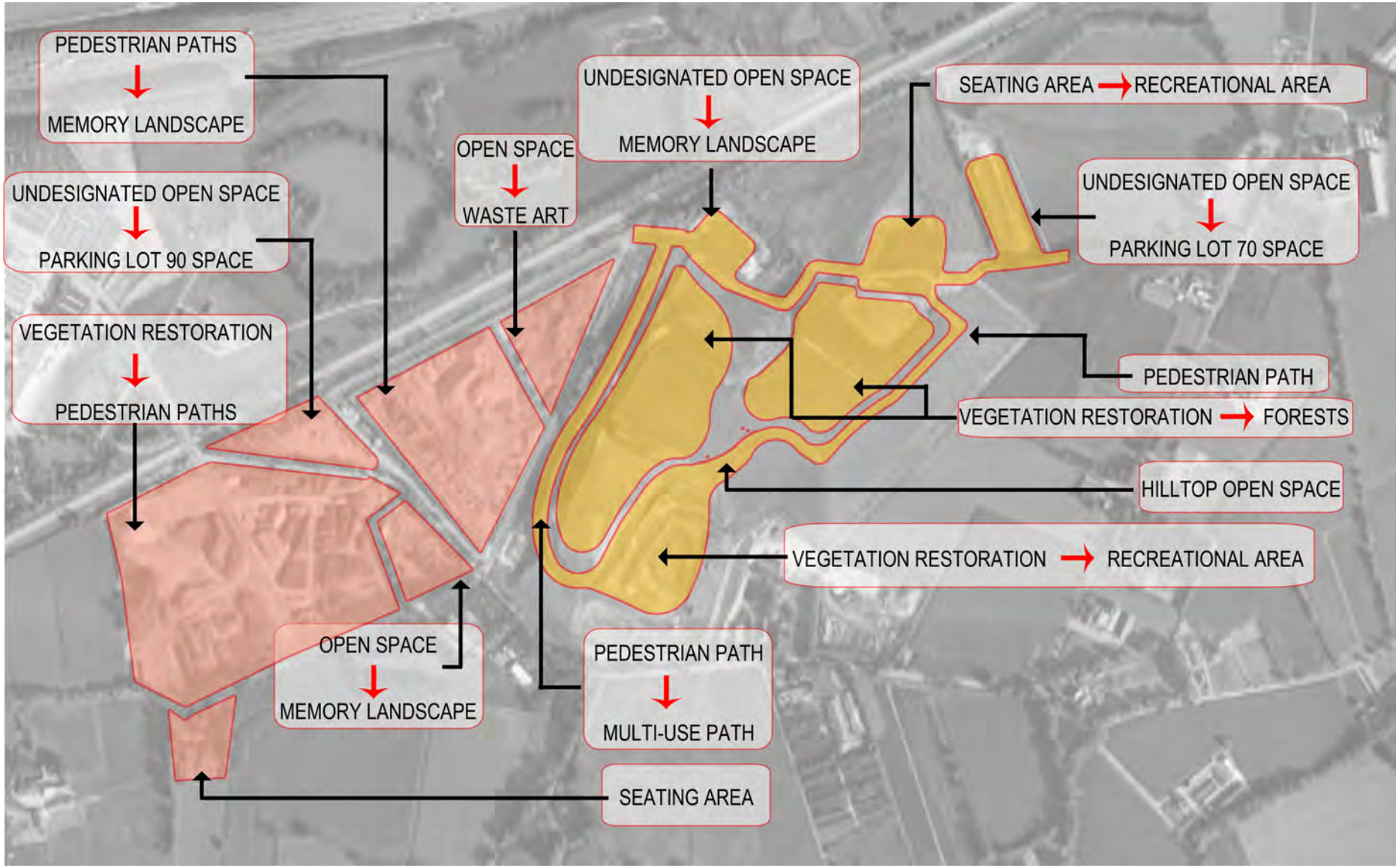


Figure 5.6 Proposal Alternative one



meaning of education and identity are not strong. In order to emphasize the educative meaning, memory landscape and museum can be built up in later stage.

The proposal of alternative one is showed in figure 5.6.

5.4 Alternative two

Different with alternative one, another alternative design is using a long term, extensive functions concept. (fig.5.8) The landfill operations will be continued for a relative long period, from currently to 2025. At the meantime, the closure period also will be longer responsively. The landfill maintenance and monitoring will be still lasted from now to 2050. Since the landfill will be open for longer time, the park operation will be started later, in around 2020; the vegetation restoration process will be shorter than alternative one, only lasting about five years.

Because of the long construction period, more activities could be added to the municipal park step by step. The starting points are also extensive park and undesignated open space, with low environmental requirement activities such as pedestrian paths, seating areas and picnic grounds. Depending on the level of soil recovery, the basic functions can be transited into new functions slowly. Playgrounds, cycle paths, open theater and parking lots can be added to municipal park in around 2015. Meanwhile, visiting the working landfill can be also added while the landfill is still open. When the project goes into 2020, sports activities can be also developed from the undesignated open space. After 2030, when the environment is good enough, more and more commercial services and facilities can be built up.

In this approach, various activities and functions can be provided to satisfy different people's requirements. Because of the short vegetation restoration period, more space could be used to provide other various experiences. Long time landfill working will provide a good opportunity for people to get to know the waste relating knowledge. Furthermore, the land can provide more potential place for both artists and public participation to emphasize educative meanings and other interesting issues. The weakness of this approach is mainly about environmental benefits and economic benefits. A long time landfill working period and many human activities might exceed the limitation of the land could stand and cause the damage that cannot be restored in the future. However, careful developing new activities and good landfill management will prevent this problem. The general rule is to give the land enough time to recovery, and in the meanwhile, providing technical support.

The proposal of alternative two is showed in figure 5.9.

Figure 5.7 Future image about alternative two

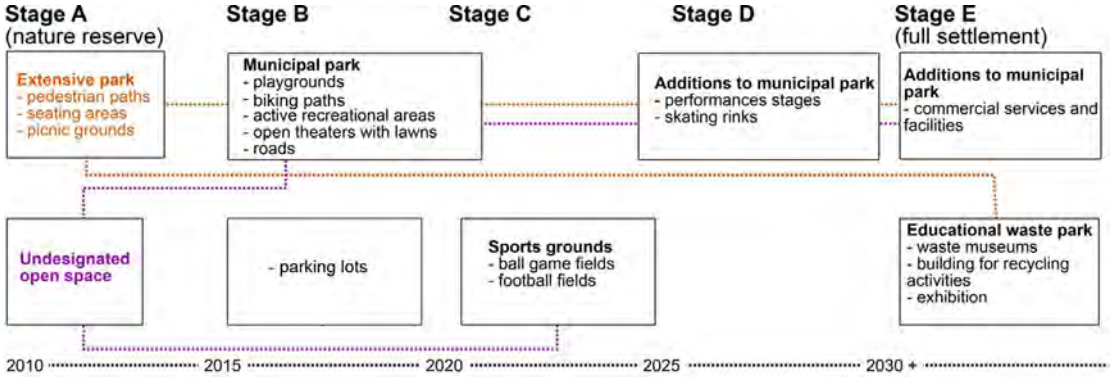


Figure 5.8 Concept two: long term, extensive functions

- Later landfill closure and operations
- Later park operation
- Educative approach through exhibit recycling process and public participation
- Mainly focus on social and cultural benefits
- Provide extensive functions, new functions adds step by step

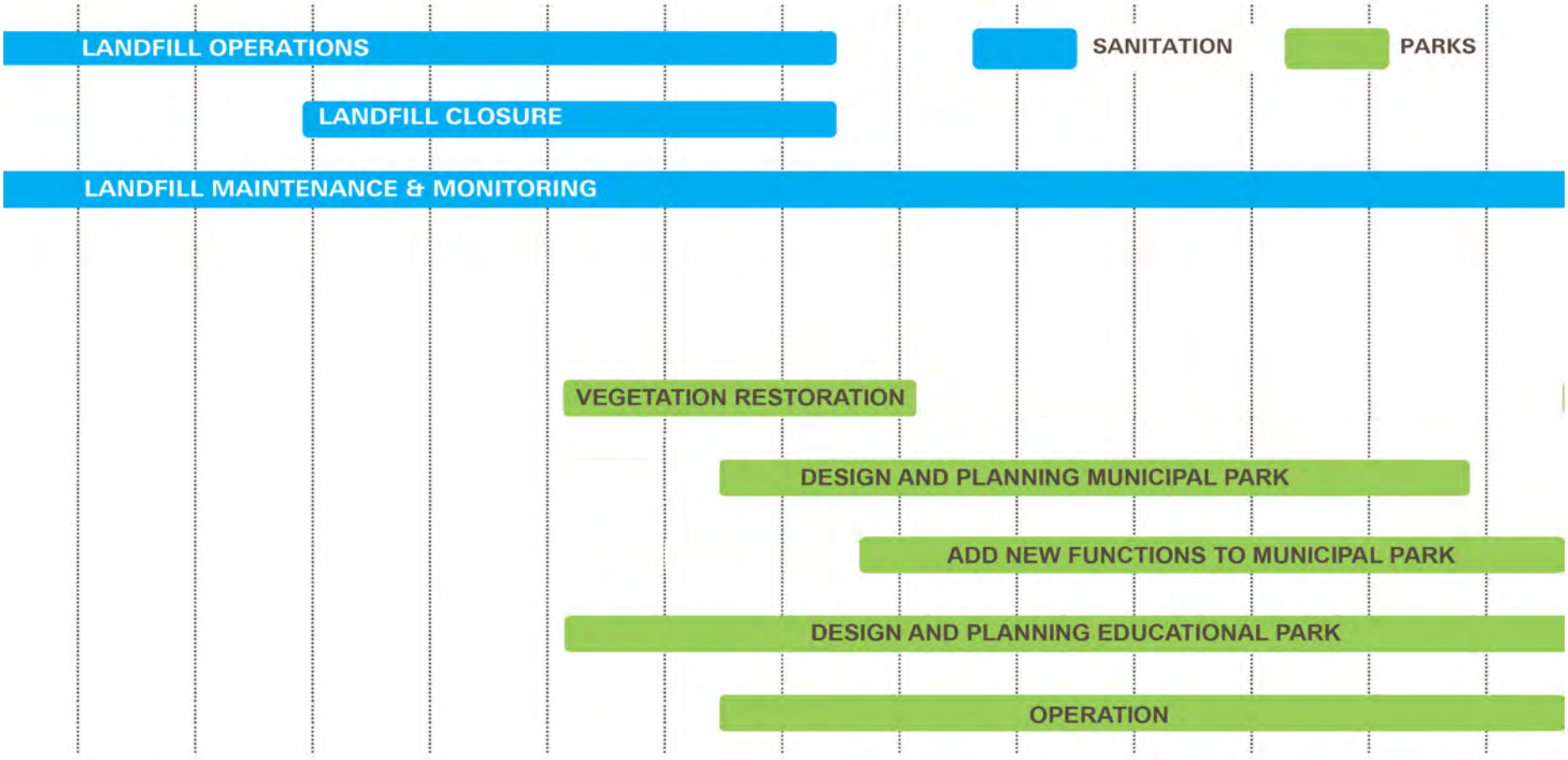
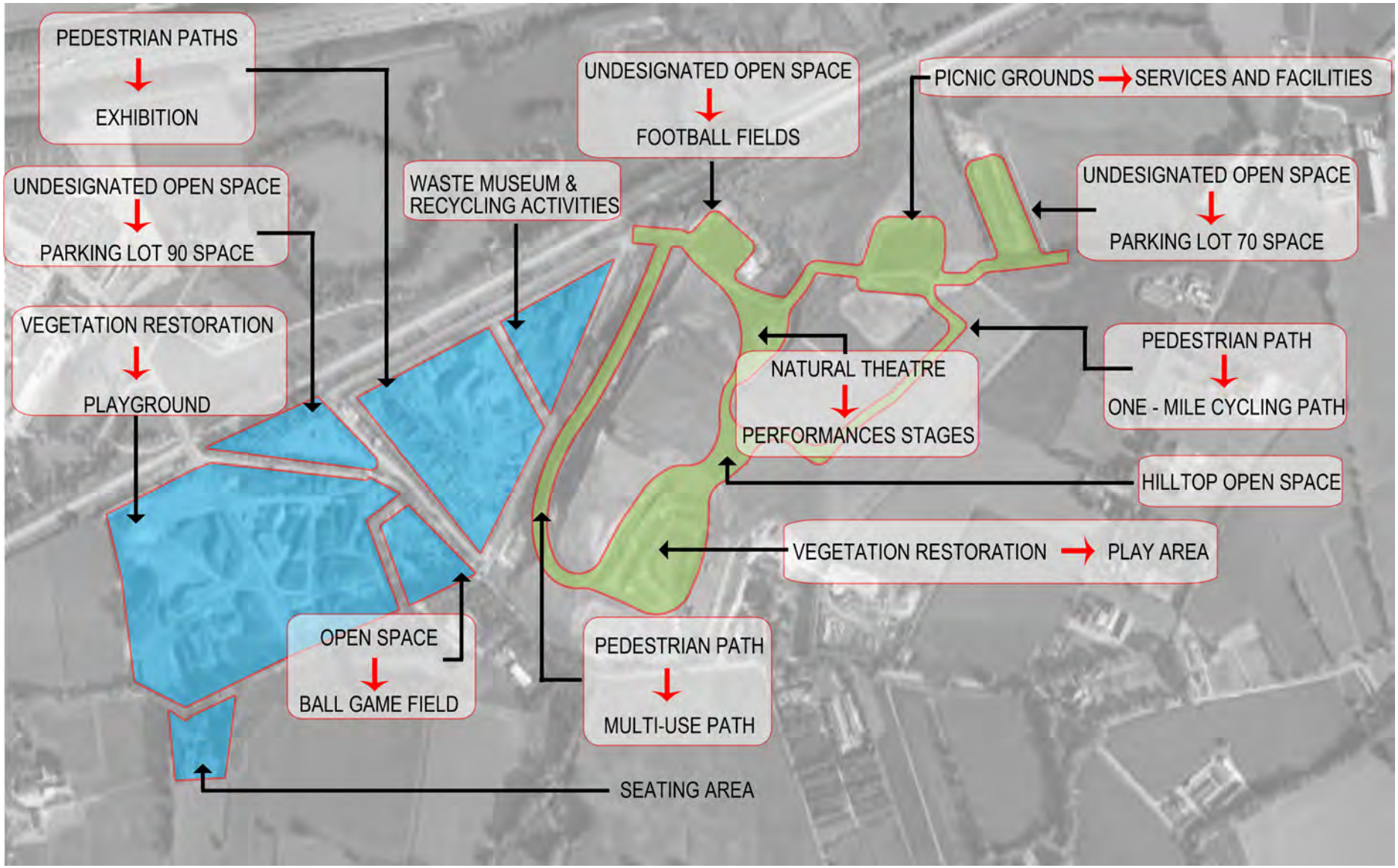
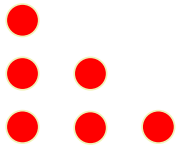


Figure 5.9 Proposal Alternative two



5.5 Evaluation

	Alternative 1	Alternative 2
Environmental Benefits		
- Protection of groundwater, soil condition and air	●●●	●●●
- Protection of biodiversity and ecodiversity	●●●	●●
- Protection of surrounding environment	●●●	●●
Social Benefits		
- Improving people's recycling behavior by educative programs	●●	●●●
- Reduction of people's negative perspective on waste	●	●●●
- Providing various activities to the community	●●	●●●
Economic Benefits		
- Attractive to outsiders and lead to more economic incomes	●●	●●●
- Increasing land value by improving degraded property	●●	●●●
- Get incomes quickly and support long term construction	●●●	●



hardly meets the needs

cover the basic needs

completely satisfy the needs

Conclusion

From the evaluation it can be seen that alternative one can perfectly achieve the environmental benefits and reach the basic need of economic benefits, however, it misses the social benefits and can only provide little benefits. On the other hand, the alternative two provides less environmental benefits than alternative one, equal economic benefits to alternative one. But alternative two can get the maximum value in social benefits, which is one of my main study goals in this research. Alternative two is also better fitted in my strategies and principles. As a result, I will choose ***alternative two*** to complete my final design.

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6 Planning & design

Figure 6.1 Landfill restoration: landfill in Zoetermeer, Photo by author

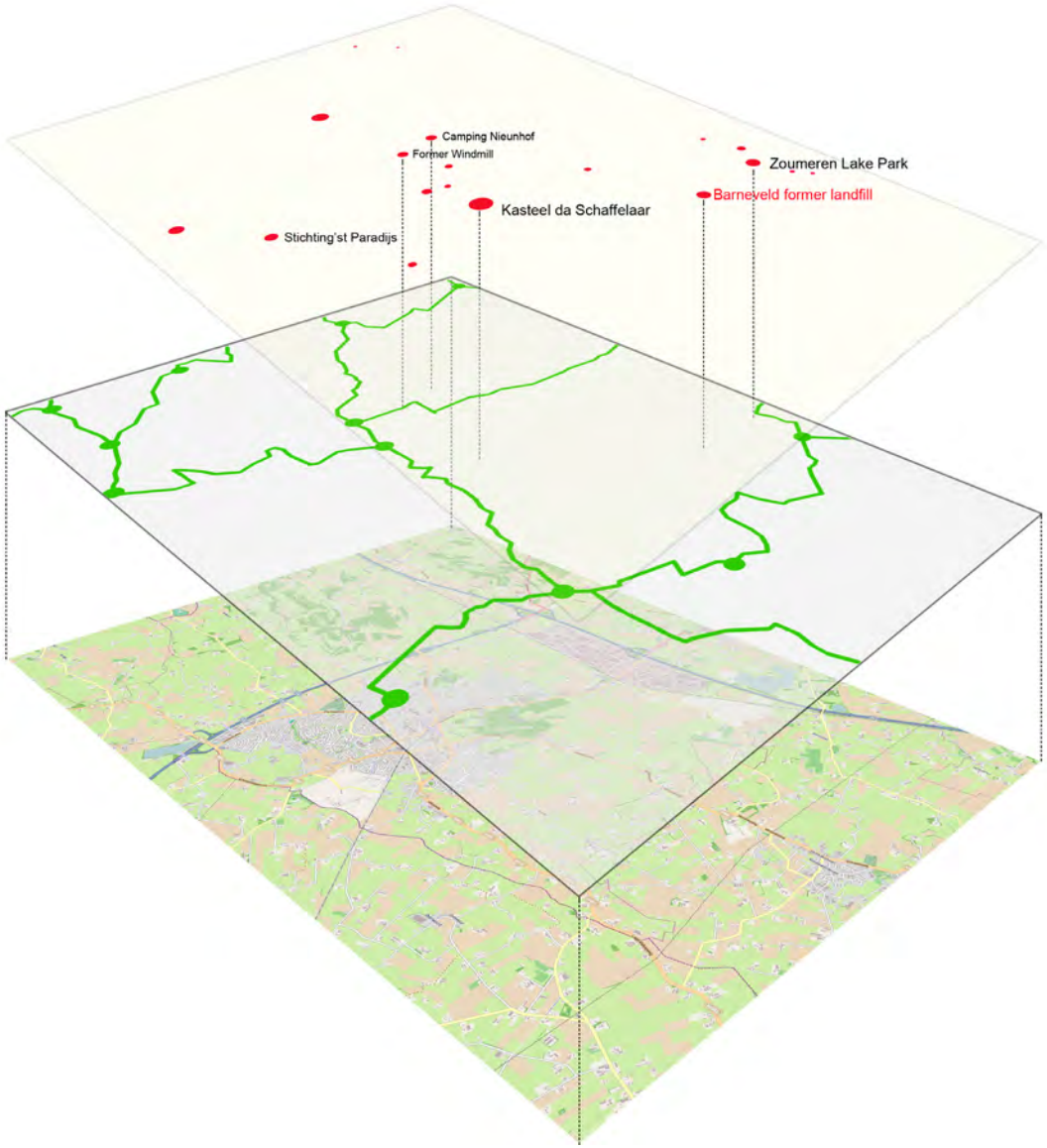


Figure 6.2 Tourism attractions and road system, made by author

6.1 Road system

6.1.1 Objectives

Before start dealing with the landfill site, it is necessary to first consider the road system. As showing in the chapter three of site analysis, there are many problems existing in the traffic network. Firstly, besides the highway, the local roads are quite few and narrow. This will lead when peaking the most popular tourism period, local roads are not sufficient to carry the traffic. Also, the landfill site is very less accessible, (fig.6.3) only three narrow local roads connect with it to the highway, mainly for waste transportation; there is no designed walking path and cycle road in the site, and the condition of the roads surrounded the site is quiet poor. Furthermore, when looking at the whole region, there are actually many tourism attractions around the rural area, but most of them are just individual points and lack of connection to each other especially to the landfill site. It is difficult to put the landfill site into the region tourism network even if it redeveloped as an attractive park.

In order to solve those problems I list four main objectives for the road system:

- Provide access to Barneveld landfill

- Connectivity to local/regional network

- Minimize or avoid impacts with landfill infrastructure and protected natural features

- Provide park-like experience for people

6.1.2 Accessibility and Connectivity

From fig. 6.2 we can see that different tourist attractions located in each individual area, and besides the two highway, their connections are quite few. Especially the accessibility to the Barneveld landfill.

From the site analysis, we can see that the highway and

Figure 6.3 Blocked connection in landfill and highway in east entrance, photo by author

railway in some extend become the obstacles to stop tourists and cyclists visiting different attractions. In order to make the whole region as one complete "cycling circle" and due to the current situation of cycling roads, I added three new cycling and walking roads in this area. All of them are designing based on the existing local road. (fig.6.5)It is preferred to construct footpath or cycle way to close the gap, since they are low-cost, easy to maintain, good for human health, ecological and sustainable. The new roads will connect camping Nieunhof to Ruitersportcentrum and Zoumeren lake park, Kasteel da Schaffelaar, Museum Nairac and Barneveld former landfill. (fig.6.4) The proposed linkage is helpful to avoid extra journey between certain cycling spots and missing attractions, formulate a complete recreational journey, and directly lead people to travel from one attractive point to the other one.

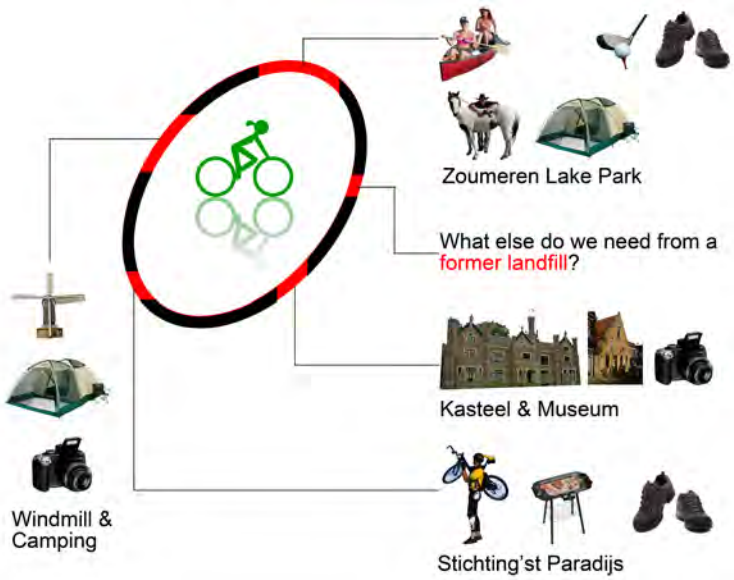


Figure 6.4 "Cycle circle", made by author

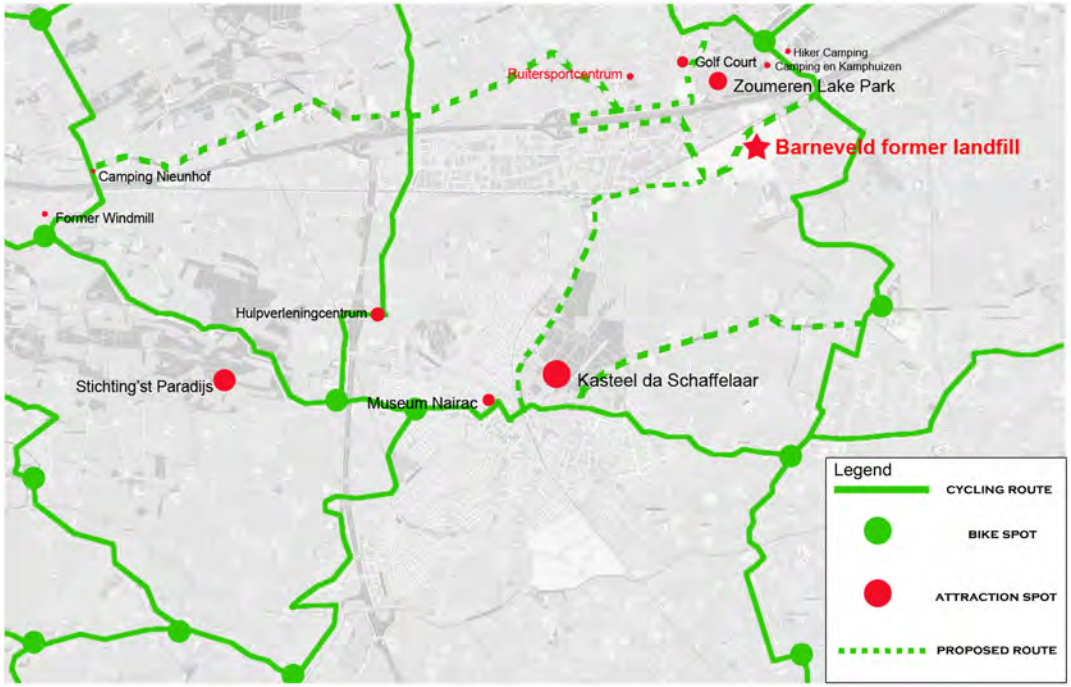


Figure 6.5 Current roads and proposed roads, made by author

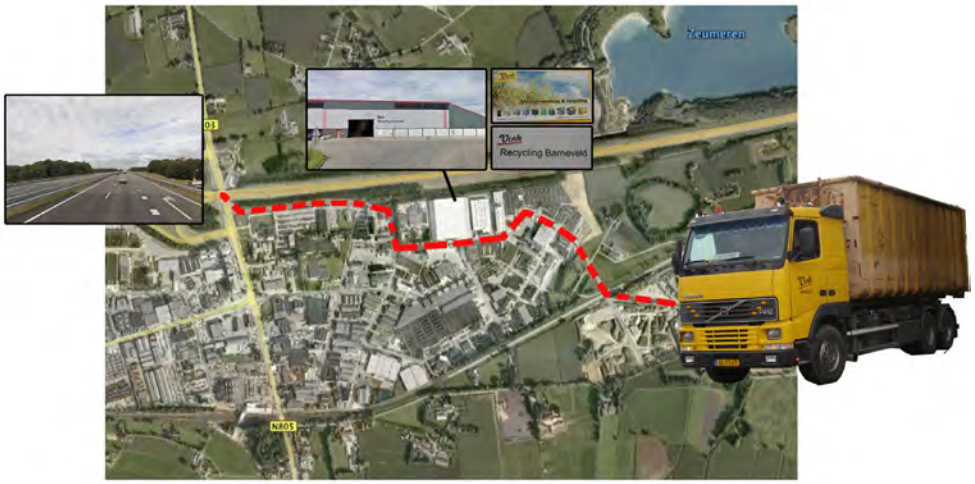
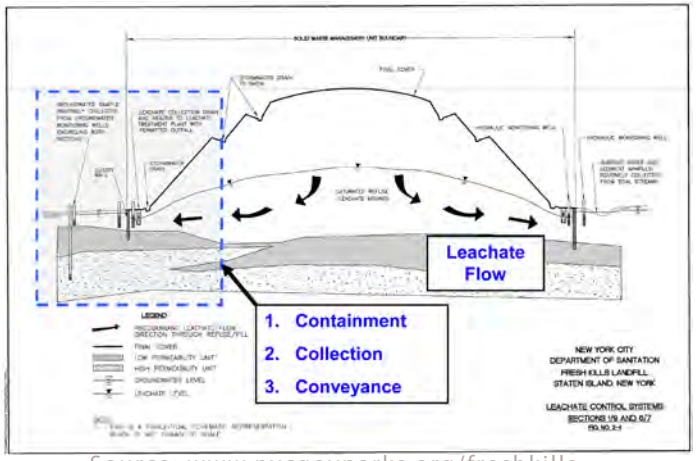


Figure 6.6 The routes lead to the Vink company and highway, made by author

Figure 6.7 Garbage trucks in the landfill, photo by author



Source: www.nycgovparks.org/freshkills

1
2 3 4 5

1. Leachate management system conceptual schematic Figure 6.8

2. Leachate collection ditch construction Figure 6.9

3. Typical cutoff wall construction Figure 6.10

4. Hydraulic monitoring well Figure 6.11

5 Leachate collection drain, photo made by author Figure 6.12

6.1.3 Infrastructure impacts and park-like experience

As any other functional landfill, the route in Barneveld landfill is designed for garbage trucks and other working motor vehicle such as forklift. There is no specific route for walking and cycling. On the other hand, the three original entrances are also used for garbage transportation. The routes in the landfill are connected with the Vink waste company in the industry area and the A30 highway. (fig. 6.6)

Besides the traffic influence, another impact is the leachate management system in the landfill site. Leachate is liquid that emerges from solid waste and usually contains soluble, suspended or miscible materials that originated from the solid waste. This liquid must be treated carefully since it may contain hazardous materials and could contaminate vegetation surface and ground water. The system in Barneveld landfill is mainly containing the cutoff wall and leachate collection ditch around the edge of the landfill. And the leachate will be transported to leachate force main and leachate collection pump station in the end.

For the construction and process of leachate management system there includes lots of engineering specific knowledge, which I will not explain into detail. (fig.6.8) However, this system must be protected in order to continue the landfill treatment. To follow this rule, the road construction in the landfill must not compromise the integrity of the leachate management system. And the cutoff wall and collection ditch are permanent features, (fig.6.9, 6.10) cannot be destroyed or moved. (I will achieve this goal more clear in my detail design).

In order to create a park-like experience, firstly new routes for tourists should be created. Since there is one landfill hill still in use for several years, the noise and dust caused by trucks will influence people ‘e touring experience; on the other hand, people’s activities will also disturb the transportation. Based on this problem, the first rule for

designing walking path and cycle route is to avoid trucks and people meet in one road. (fig.6.13) I retain the main transportation line from highway and Vink Company to the working landfill and designing two main entrances for the trucks. Both of these two entrances contain the parking lots. These parking lots have big proportion enough to park big trucks. As long as the working landfill is closed down in the future, these parking lots can turn into social parking lots. Besides those car roads, I also designed the main guide roads for both people and bikers to visit the landfill park. Those roads are used to connect each place in this area, based on the existing main roads because of their good construction quality. There are three main entrances for tourists; they are located in west, east and south. Those entrances can basically meet the visitors in different directions. Expect the main roads; I also planned the pedestrian paths and biking paths in each place. Those routes are designed based on the principle 'public space' I raised in chapter 4.4. They are created not only using the existing roads and paths but also new ones designed due to the topography, tourism attractions and possible motivation. (fig.6.14)

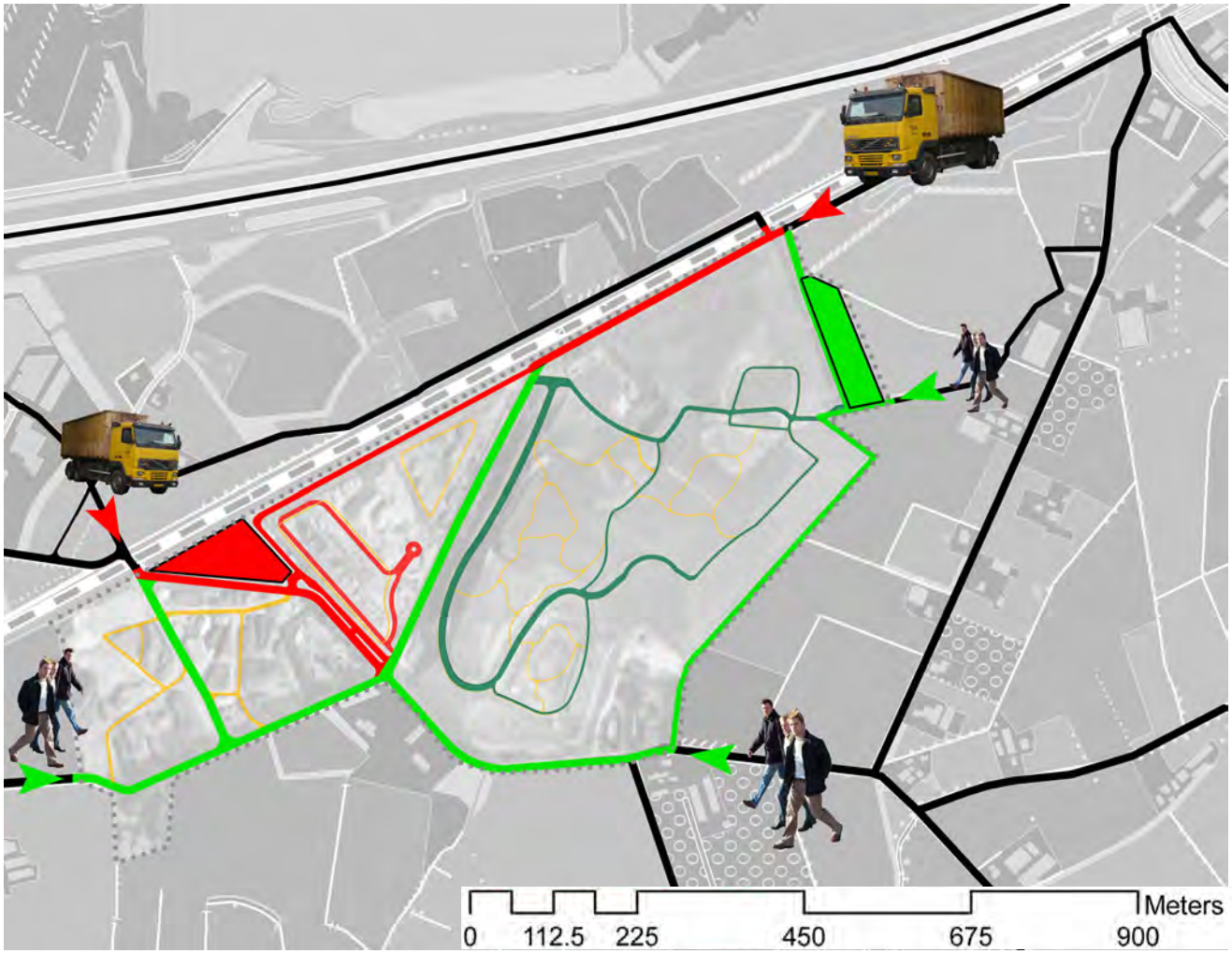


Figure 6.13 Road system planning

6.2 The process of plan

The plan of the site should be completed by different steps. Long period is needed not only for vegetation to grown, for working landfill to close down; but also necessary for activities to develop(see chapter 4.3 'Design open space to provide various activities'), for people to reverse their negative impressions about landfill.

The first step is from now on, ***the current situation***, focusing on ***spatial planning***. That's mainly about road system design and protecting special natural features and landfill infrastructure. (fig.6.15)

Three years after, when the spatial quality becomes better and the inventory work is done. The ***manufacturing soil and habitat*** part can be started. This step is focusing on ***habitat layer***. That means I can use the principle 'vegetation restoration' (chapter 4.1) and 'natural landscaping' (chapter 4.2) as the two main approaches to improve the environment and ecosystem. (fig.6.16)

After the habitat layer is completed, another three years is needed to wait the soil recovering its ability. Then ***the circulation layer*** can be commenced. This step is about imitating access and activity. Design new ***roads and entrances*** for visitors, also providing them park-like experience. (fig.6.17)

At this moment, the Barneveld site is still more defined as a "natural park". The ecological value has been achieved, but the social benefits and educative meaning are still very small. So ten years later. The fourth step: ***program layer*** can be started. This period will be continued for more than twenty years, and the design priciple is following my alternative design two. The original activities can develop into new activities based on their own characters. This step's objective is about ***building spaces, diversifying ecologies and uses, growing new life.*** (fig.6.18)

So during the totally thirty years, the process of design will focus on different goals at different time position. Every step is related and influencing by each other. Each site will play different role based on its unique character. When the planning is finally accomplished, the place will be transferred into a multifunctional ecological site which includes both ecological values and cultural values.

The master plan (fig.6.14) presents what Barneveld landfill will look like in 2030. That is somehow between "building spaces" and "diversifying ecologies and uses". From the master plan it can be seen that the landfill slopes in the west part have already been recovered and becoming new landscape elements. The working landfill is still in use, but the exhibition routes have been created to encourage people understand the waste cycling process. On the landfill hill, more functional species have been introduced to ameliorate the environmental problems. Park routes and outdoor activities also have been created to provide various unique experiences for people. After 2030, the located outdoor activities will be continuing in developing. I will present their visions in the chapter of detail design.

Master plan in 2030 Figure 6.14

Legend

landfill slope

working landfill

sitting area

waste storage

sports fields

parking lots

Figure 6.15 Current situation

- Today

Spatial planning

Figure 6.16 Habitat layer
- Vegetation restoration

- 3 years

Manufacturing soil and habitat

Figure 6.17 Circulation layer
- Roads and entrances

Figure 6.18 Program layer
- New programs being added

- 6 years

Initiating access and activity

- 10 years

Building spaces

- 20 years

Diversifying ecologies and uses

- 30 years

Growing new life

References

New York city, Department of sanitation, ***Fresh kills landfill***, Staten island, New York, 2005

James Corner, ***Lifescape – Fresh Kills Parkland***, Topos, Vol.51, 2005

7
Detail design

Figure 7.1 The top view of Barneveld landfill hill, photo by author

I chose eight places to develop them into detail design. (fig. 7.2) Those places are chosen based on their function transition, timeline development, and use landscape design playing the main role.

As I already did the function division, it is necessary to name each of them for tourists. From chapter 2.6.5 “Naming” it can be seen the importance of a good name’s influence and how to name a place to give an identity to it. There are many ways to give a place a good name, due to the landfill character and how it will develop, name each place after an important or community members is obviously not appropriately, also, because each place have its own functions, it is also difficult to name everyone due to its current use or waste type. In the end, I decided to name each place with its location or its future function, such as north park, east park, nature park and parking lots. Also, every place will have a theme based on the major activity developed on it. (fig. 7.3)

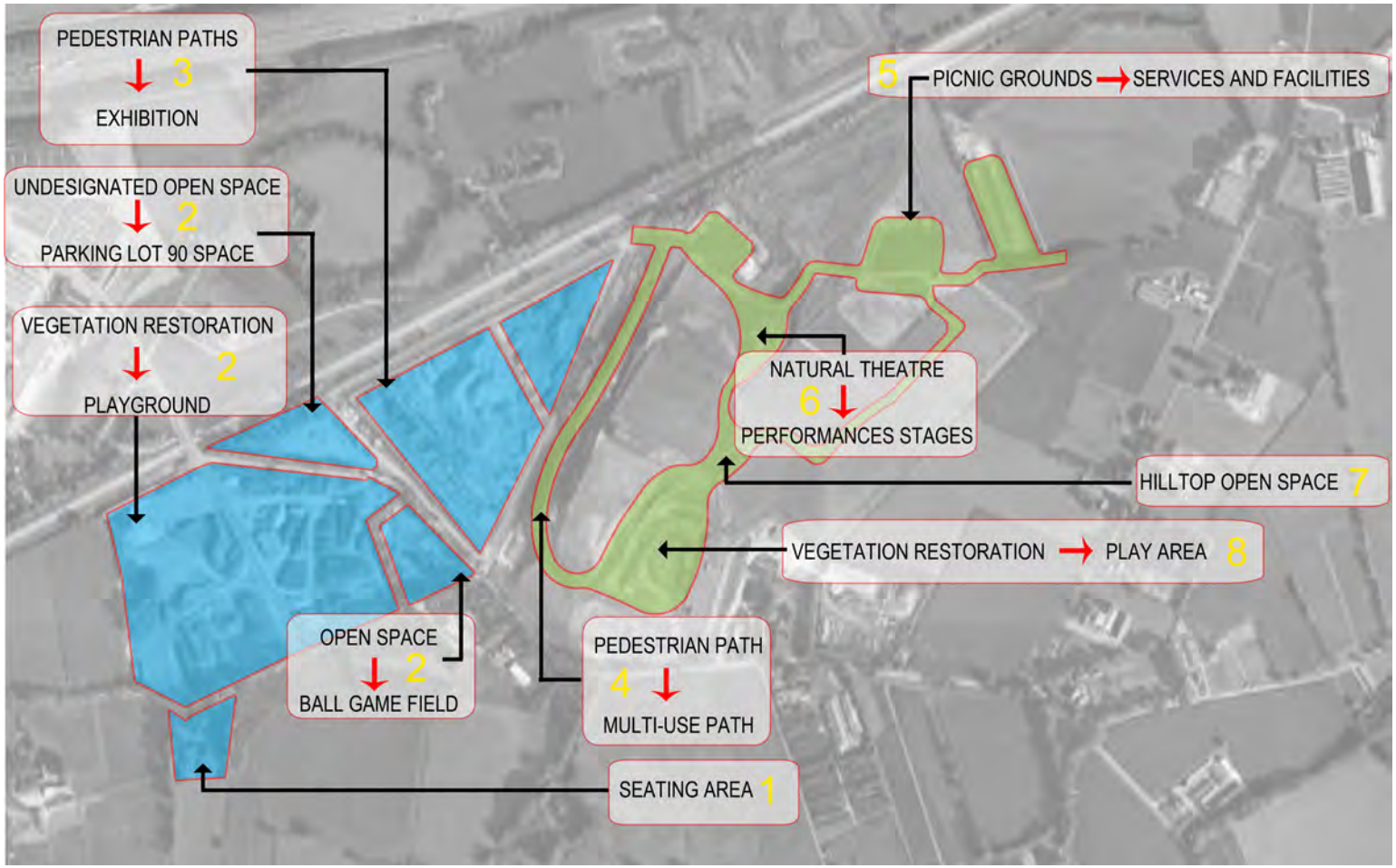


Figure7.2 Detail design selection

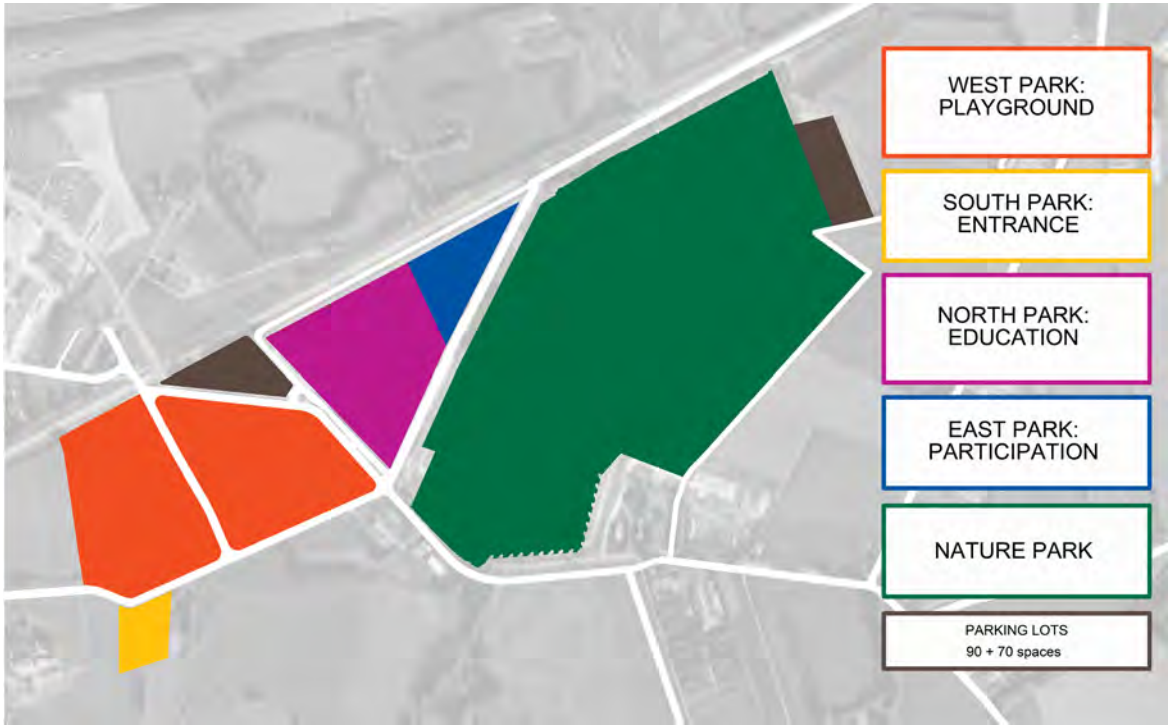


Figure7.3 Name of each place

7.1 Detail design one: entrance, seating area, playground (south park)

7.1.1 Site introduction

The first site is located in the south west part, closed to the local roads. (fig. 7.6) As already proposed in Framework 2050, degraded this abandoned area will be renewed as the small playground and public place for relaxing as well as one of the main entrance for this whole project, and this process mainly involves reusing the abandoned construction materials in this site, providing good spatial quality.

Figure 7.4 Current situation, abandoned materials photo by author

7.1.2 Proposal

Spatial planning:

As the current situation of the site, it has the surrounded trees and unpolluted soil. So the first step is to provide accessibility for this site, use the existing local roads as the pedestrian paths and biking paths. Secondly, use the trees to create enclosured space, make it a completed entrance. The construction could be started at early stage because of the good environmental quality.

"Taking play seriously!":

The abandoned construction materials (pipeline, structural timber) have the great potential to become the play elements in this site. For different users like adults and elder people, they often need simple, artful and attractive design, they are usually busy and constantly under daily pressure and need places to sit and breathing freely. Responding to their demands, pipeline and woods can create unique shapes and form and provide seating space in a natural way.

On the other hand, kids and younger people want to influence objects and surroundings, change their forms. They normally have an active imagination and observation of a new setting for stories and social interactions, with high energy, craves kinetic activity and great curiousness. (fig. 7.45) In order to satisfy the different demands, the pipes and woods are built in a simple way, people can use them

"The simple act of "play" is a ritual, necessary to the achievement of euphoria. This is a pure notion, a way to break away from the monotony of daily life. To achieve this ecstasy, the space challenges all of the assumptions internalized thus far. It provides places to explore and reinterpret everyday material. As one journeys through the sight, their story is recorded by the sensation of touch."

--KEM STUDIO Group B, Project 3: PLAY, 2005

to create their own interests. Furthermore, the construction materials not only provide seating area, but also provide a playground for various high energy activities. (fig. 7.4)

Figure 7.5 Different groups of people's demands, made by author

Figure 7.6 The location of south park

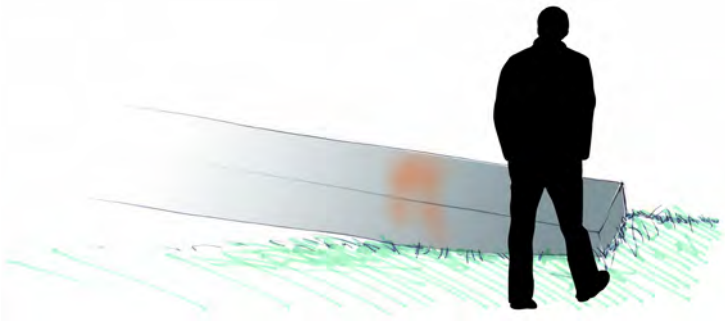


Figure 7.7 The human scale of construction material

Figure 7.8 Image of south park in 2015

7.2 Detail design two: playground, ball game fields, parking lots (west park)

7.2.1 Site introduction

The second detail design is named as the "west park". This place locates 11 landfill slopes; a transported road divides the place into two parts. (fig. 7.9 7.10 There are one parking lot and one empty area in this place as well. (fig. 7.11)

Figure 7.9 The location of west park

Figure 7.10 Birdview at the current situation of west park, source: Google earth

Figure 7.11 Current situation of parking lots, photo by author

7.2.2 Proposal

- Habitat layer and Circulation layer

After the spatial planning step is completed, vegetation restoration should be used to recover the soil condition. Considering ecological values as well as aesthetic values, I choose the wildflowers (see chapter 4.2.3 wildflower) as the main landscape tool to improve the environment quality and landscape quality.

In the west park, people can visit the former landfill site by using the designed pedestrian paths. Elderly people can walk along the road and see those beautiful wild flowers; young people can climb on those human-scale small slopes and use it as the playground. The parking lot will be continuing to use for landfill cars before the working landfill closing down. Another empty area will be used for the ball game fields.

In order to avoid the leachate polluting the ground water, the leachate management system will be protected. The leachate will be collected in the leachate pipe and flow away through the ditch. Collected and recyling in the Leachate station. Ground water will be protected through the low permeability clay and leakage monitoring system. Each landfill will be built the leakage detector to monitor the situation of leachate. (fig.7.13, 7.14)

Main plants in manufacturing soil and habitat stage:

- Grass:

Bermuda grass is a perennial herb, mainly growing from May to August. It has a shallow root (less than 5 cm), which could be survive in landfill's soil layer in earlier stage. The grass is a native species, easy to plant, low costs. It is robust and only need very low maintaining, so it can be grown in high polluted soil. On the other hand, the root has a great effect to improve the soil quality and stable the slope. For its landscape value, Bermuda grass is 10cm to 30cm high, surviving of treading. People can walk or sit on it and will not harm it.

Buffalo grass has a similar character with Bermuda grass. Furthermoret, it has the potential to absorb the dioxide and hydrogen fluoride gas.

- Shrub:

Coreopsis basalis is a perennial herb, with a long flowering period, from May to October. It

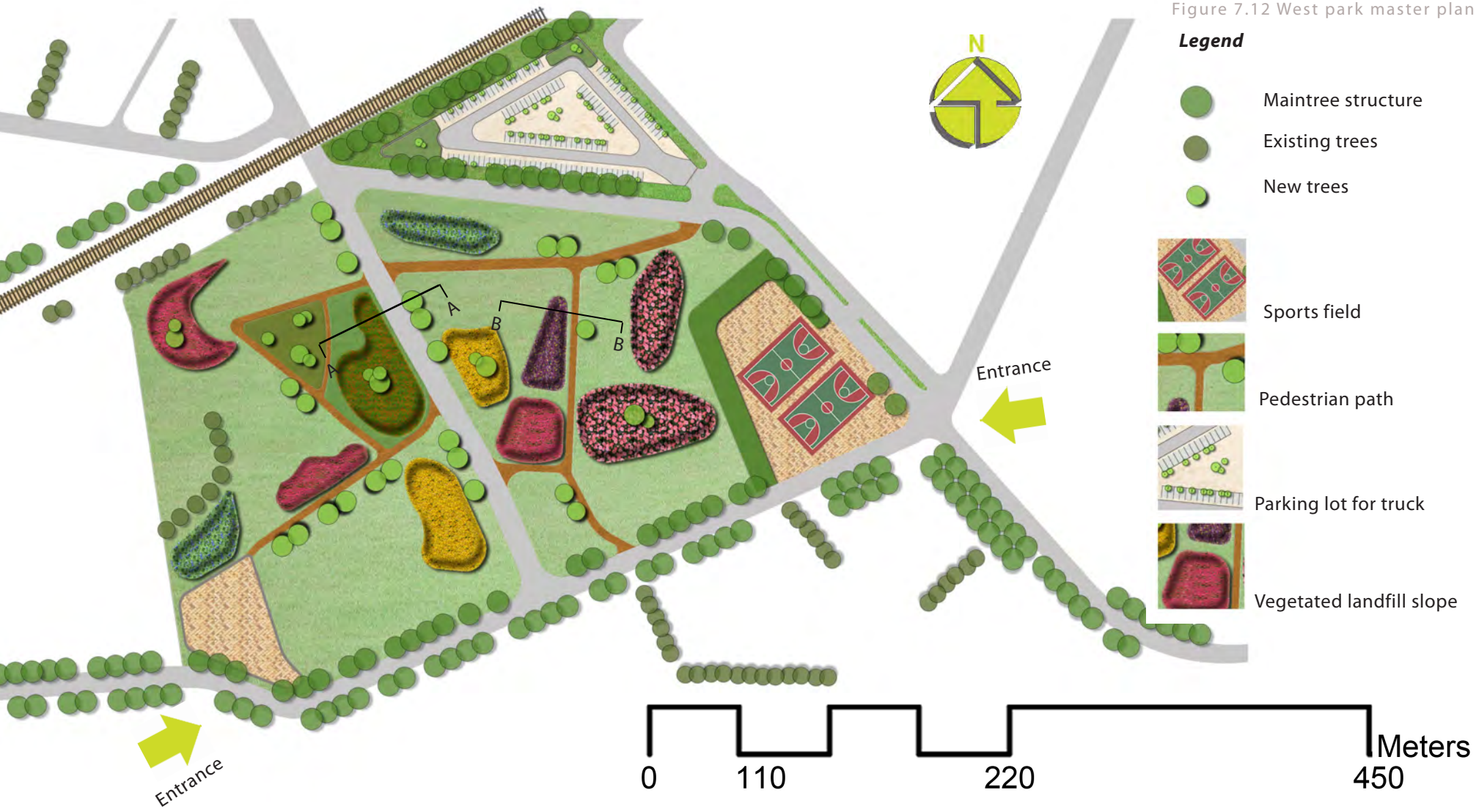


Figure 7.12 West park master plan in 2015

- Today

Spatial planning

- 3 years

Manufacturing soil and habitat

- 6 years

Initiating access and activity

Figure 7.13 Section A-A

Vehicle road:

- planting roadside trees
- blocking noise and dust

Foot path and cycleway:

- open view
- close to the landscape

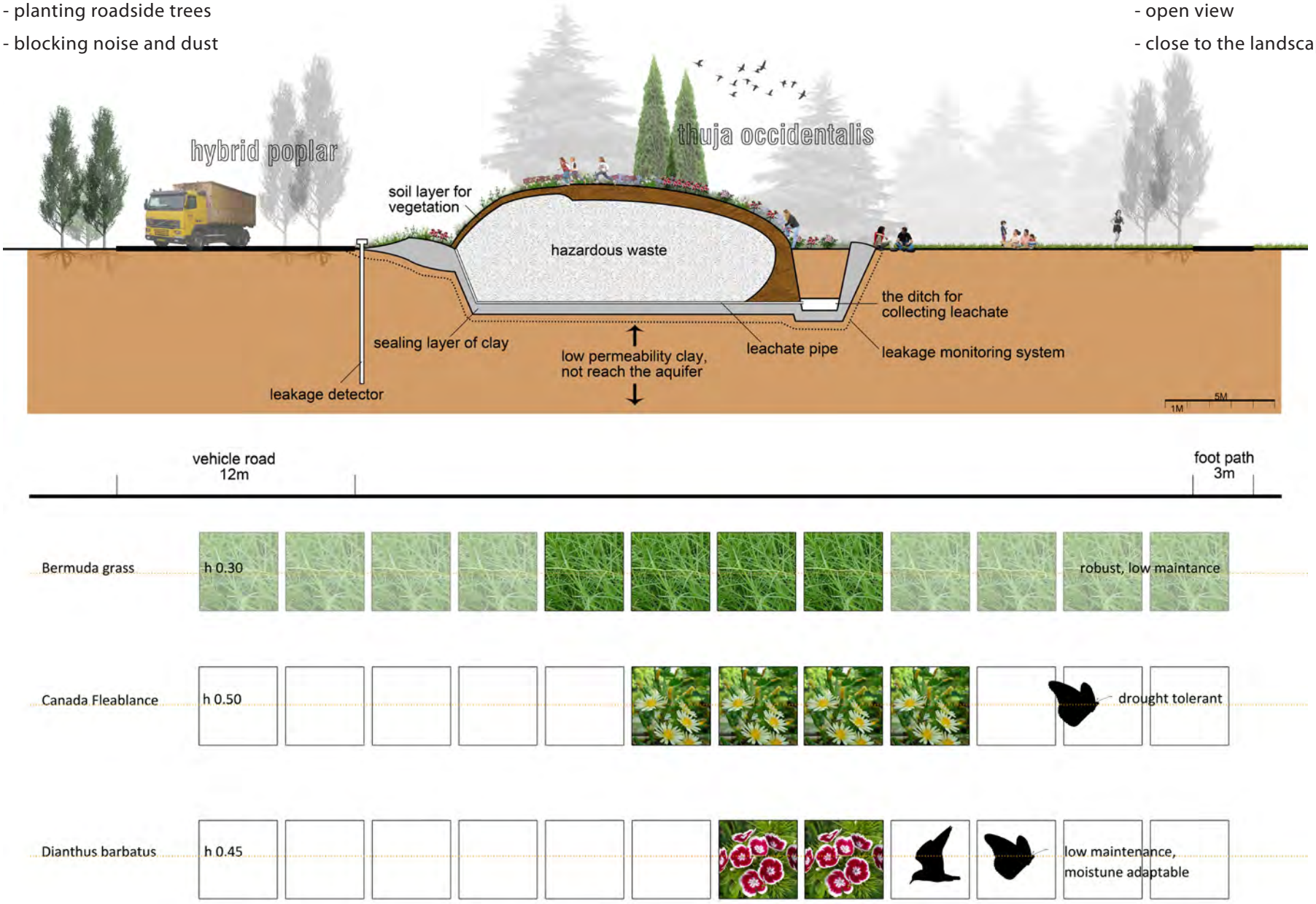


Figure 7.14 Section B-B

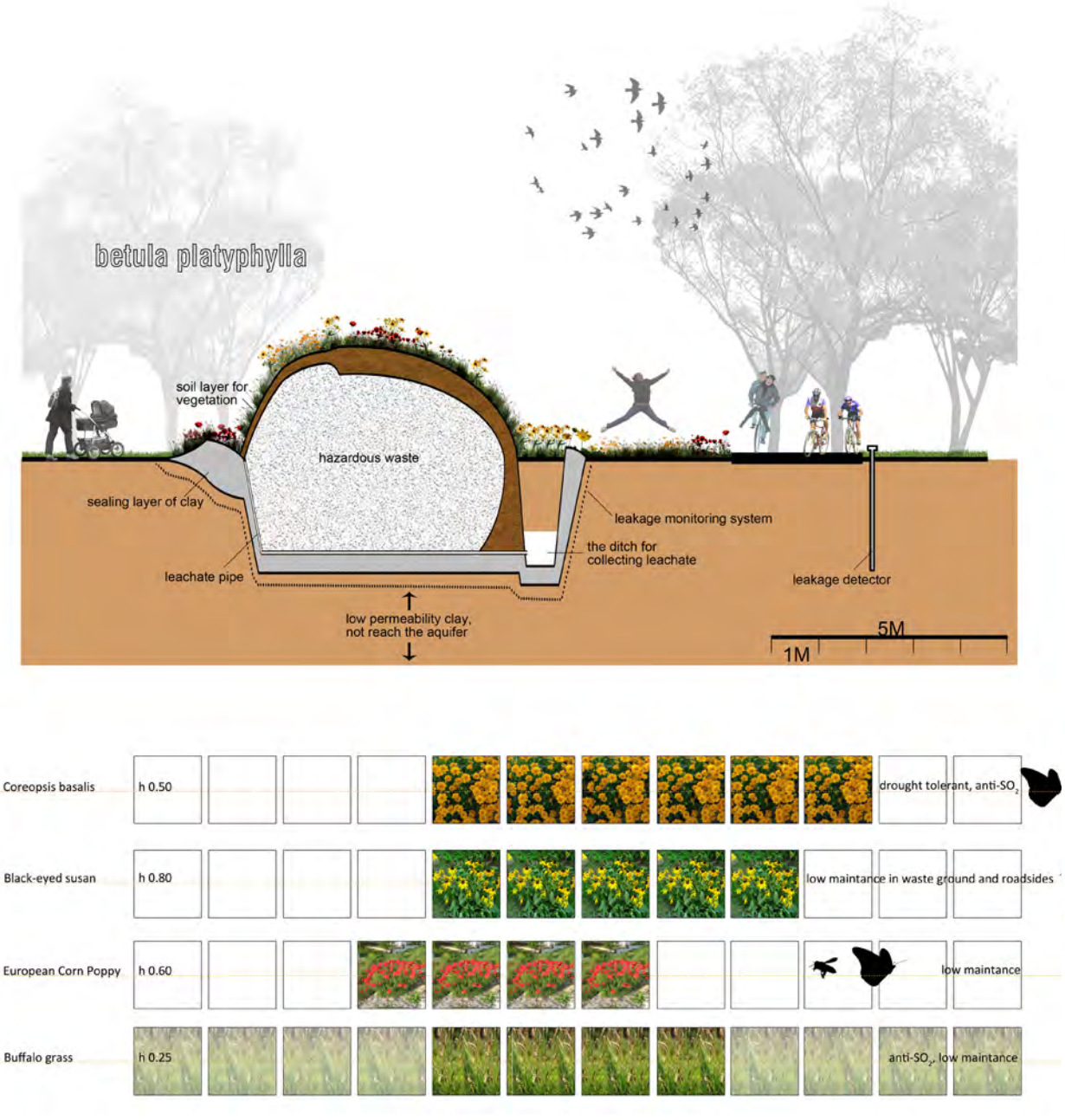


Figure 7.15 Current situation of landfill slopes, photo by author

Figure 7.16 Image for the west park in 2015

Figure 7.17 Playground in 2050

Figure 7.18 Sports fields in 2050

has strong drought tolerant and anti-SO2, suitable for growing on poor soil. It also attracts birds and bees to spread its seeds.

Black-eyed Susan is a weedy forb. It mainly flowers from May to September, usually planted in disturbed prairies, waste ground and roadsides.

- Program layer

When the west park has been defined as the "natural area" for more than twenty years, the function will begin to transfer into new ones. (fig. 7.20) In 2040, the landfill slopes will still remain to be the playground for young people, but along with the recovered soil and also people's new impression to this place, the playground can be constructed in more specific one. (fig. 7.21) On the other hand, the parking lot for trucks will be used for tourists since the working landfill has been shut down. And the entrance which is former used for transportation cars will be used for tourists.

Figure 7.19 Current situation

Figure 7.20Intension images of possible activities in playground

Figure 7.21 West park master plan in 2050

- 10 years

Building spaces

- 20 years

Diversifying ecologies and uses

- 30 years

Growing new life

7.3 Detail design three: education and participation (north park and east park)

7.3.1 Site intruduction

North park owns the only working landfill in Barneveld landfill site, which bring it both advantages and disadvantage. This place is located in the centre of the site, (fig. 7.22) having good road system, mainly for landfill transportation cars, also, for the educative meanings, people can clearly see the recycling process and how the waste dumping into the landfill. For the disadvantage, the environmental problems and the influence of landfill infrastructure to the tourists are two main design challenges.

East park is an open place at current situation. It does not have specific function and just used to temporarily park some trucks.

Figure 7.22 The location of north park and east park

7.3.2 Proposal

- North park

The working landfill in north park provides a great opportunity to let people know the waste disposal process and gain recycling knowledge. Based on my observation and interview (see chapter 3.4), most people do not have clear knowledge about recycling and many of them have negative impressive about landfill. So the main objectives for education should be making the waste disposal process accessibility, visualization, and easy to understand; showing the process of waste collection and classification; showing the process of waste dumping in landfill. Since there is already one circle road for trucks in the north park, I designed a walking route along the truck road so that people can walk like in a museum or exhibition to see how the process of waste recycling and disposal. Introduction board will be built up along the roadside to make people have more clear perspectives about waste.

This project will start from six years later, in order to guarantee that the surrounding environment has already been recovered. And in the future, when the landfill is closed down, the north park can become a waste museum and exhibition, to provide the history and identity of this place as well as waste knowledge. (See chapter 2.5 place identity of landfills) Furthermore, due to my principle of "reuse materials" (see chapter 4.5.1); local and recycled materials are the most recommended materials as landscape tools. The waste storage in north park can provide many different suitable materials for other area in this site such as boulders, stones, bricks and timbers.

- East park

For the east park, it can be used as the public area for people and artists to create their own art pieces relating with waste and recycling. As I said in chapter 4.6.1 Art, various forms can be created in this place. The East park will be connected with north park in 2050 to create a whole area both for exhibition and art creation. (fig.7.24) For landscape architects' role, it is better to just provide the suitable place and interest theme to let people develop it themselves. (see chapter 4.6.3 increase educative meanings to landfill redevelopment)

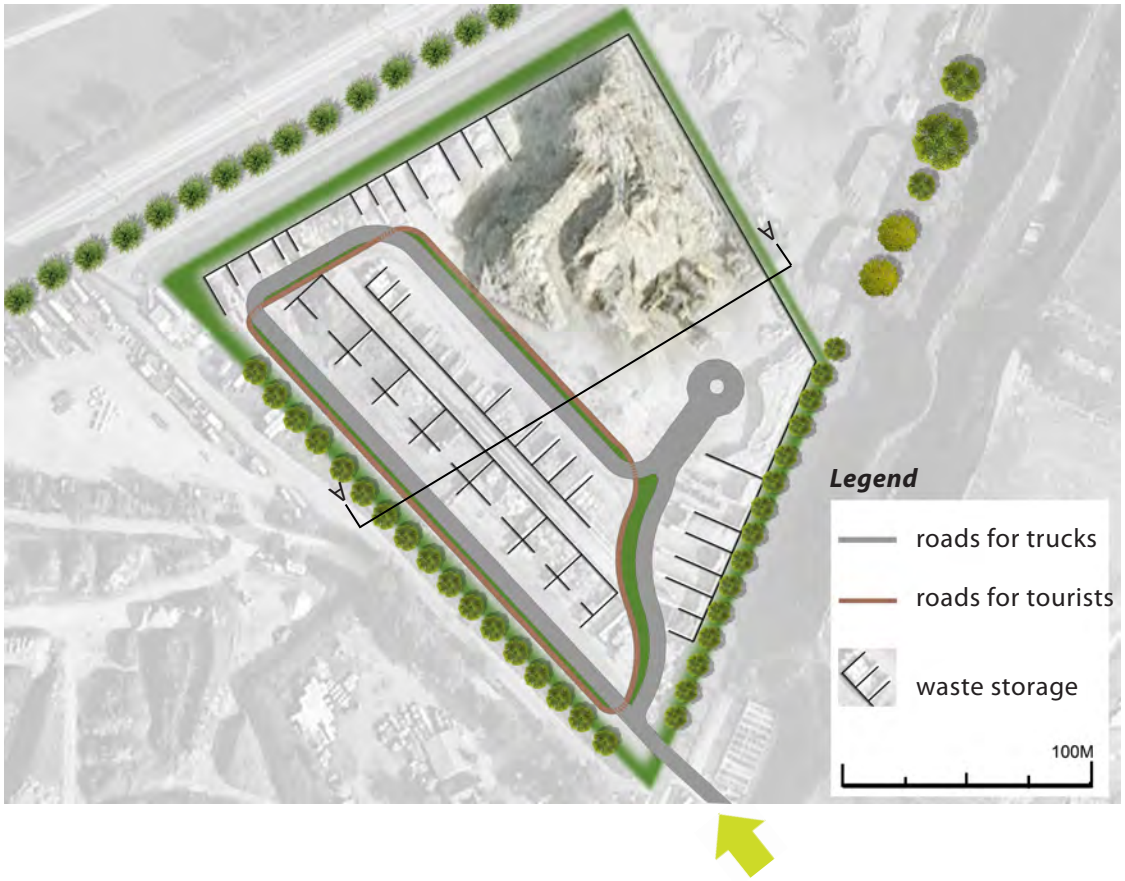


Figure 7.23 Master plan of north park in 2020

Figure 7.24 Master plan of north park and east park in 2050

Figure 7.25 Section A-A

- Today ***- 3 years*** ***- 6 years*** ***- 10 years*** ***- 20 years*** ***- 30 years***

Spatial planning ***Manufacturing soil and habitat*** ***Initiating access and activity*** ***Building spaces*** ***Diversifying ecologies and uses*** ***Growing new life***

Figure 7.26 Working landfill in north park, photo by author

Figure 7.27 Waste storage in north park, photo bu author

Figure 7.28 Empty space in east park, photo by author

Figure 7.29 Image of north park in 2020

7.4 Landfill hill detail design

As a closed, large scale man-made mound, the landfill hill can be seen as a symbol for a waste dumping site. It can influence people through the visual and smell, especially the Netherland is such a flat country. The hill in Barneveld landfill also has these characters as other landfill. The general rule of detail design on landfill hill should be considered to use the topography and open space value, to provide unique experience for people. (fig.7.32)

Vegetation restoration should still be put in the first stage. After the environment condition is better, various activities can be added step by step. Other principles, such as biotechnical erosion control to hold the slopes can be integrated with the main design principle.

Fig. 7.31 listed several activities I wish to develop on the hill. On the following chapters I will select some of them to continue showing my detail designs.

Figure 7.30 Location of landfill hill

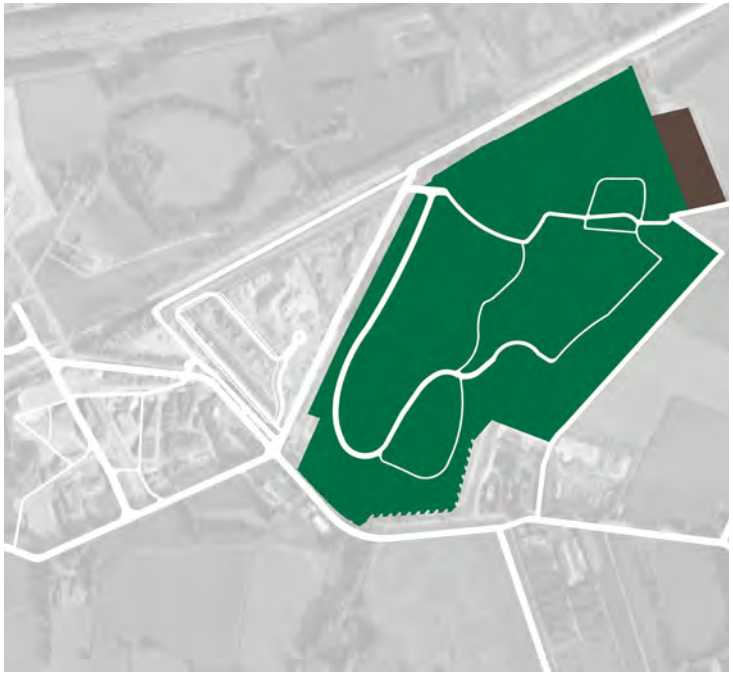


Figure 7.31 Outdoor activities distribution map: 2.2 - MILES MULTI - USE PATH

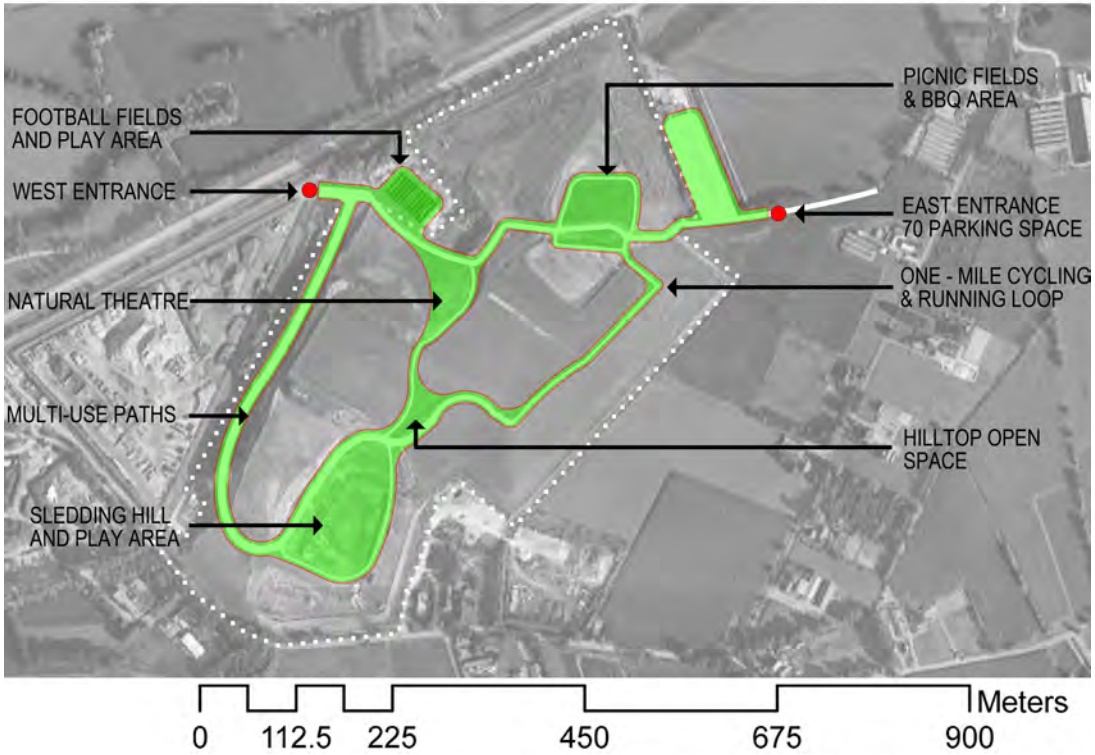


Figure 7.32 Intention images of outdoor activities

7.5 Detail design four: multi-use paths

7.5.1 Site introduction

There is an existing road which leads to the top of the landfill hill. (fig. 7.33) The road is built for landfill transportation cars. The width of this road is about 12m, the length is about 350m, the condition of the road is good. (fig.7.35)

7.5.2 Proposal

The project of road should be start from three years later, after the vegetation restoration, to provide accessibility and nice climbing experience to the hilltop. Firstly using it as the single pedestrian path, then adding bike paths after soil recovered and expanding the road if necessary. The width dimensions of cycle path and walking path should be following the general rules of infrastructure design. (fig.7.34) For roadside plants selection, the plants should have both the ecological functions and aesthetic values, for example, Hybrid poplar and Canada fleablance.(fig.7.39) A last rule is using the existing wasted materials to paving the road as far as possible such as stones and boulders.

Figure 7.34 Widths for cycle tracks and footpaths, Source: Cycle Infrastructure Design

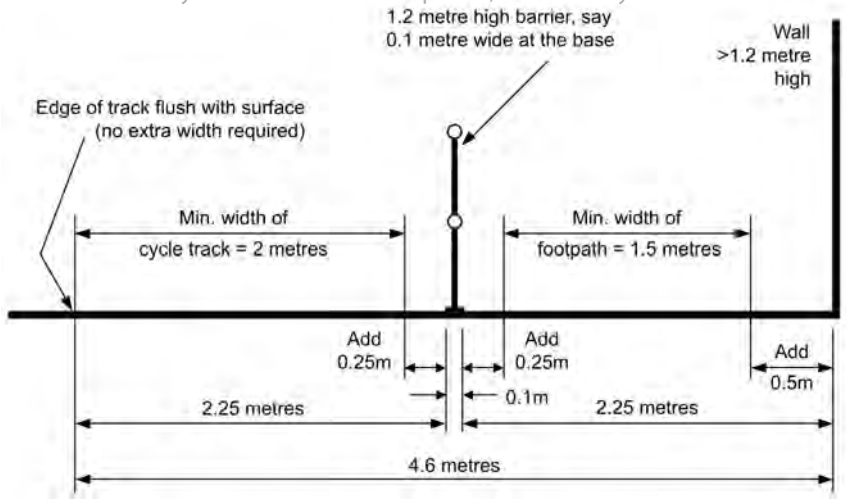


Figure 7.36 Intention images of climbing

Figure 7.33 Location

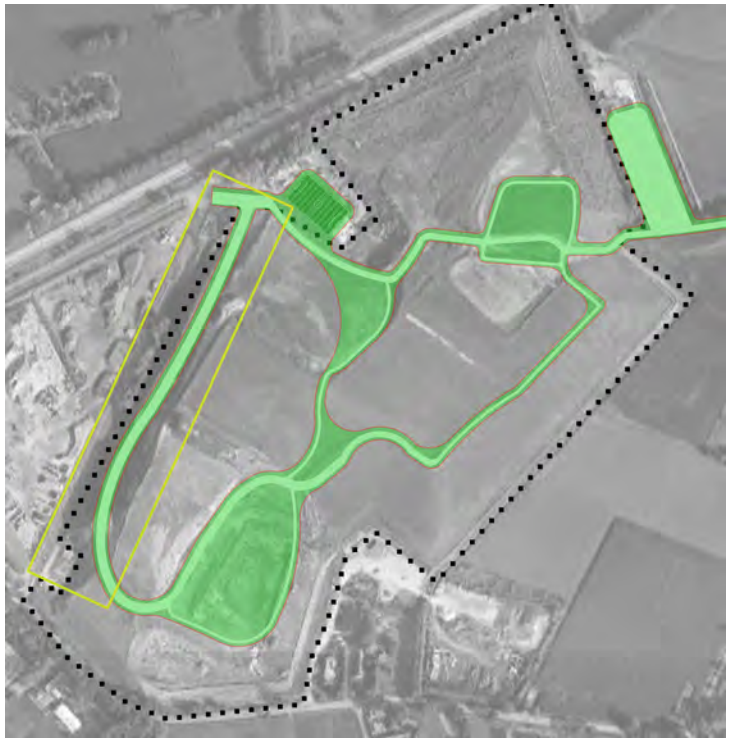


Figure 7.35 Current condition, photo by author

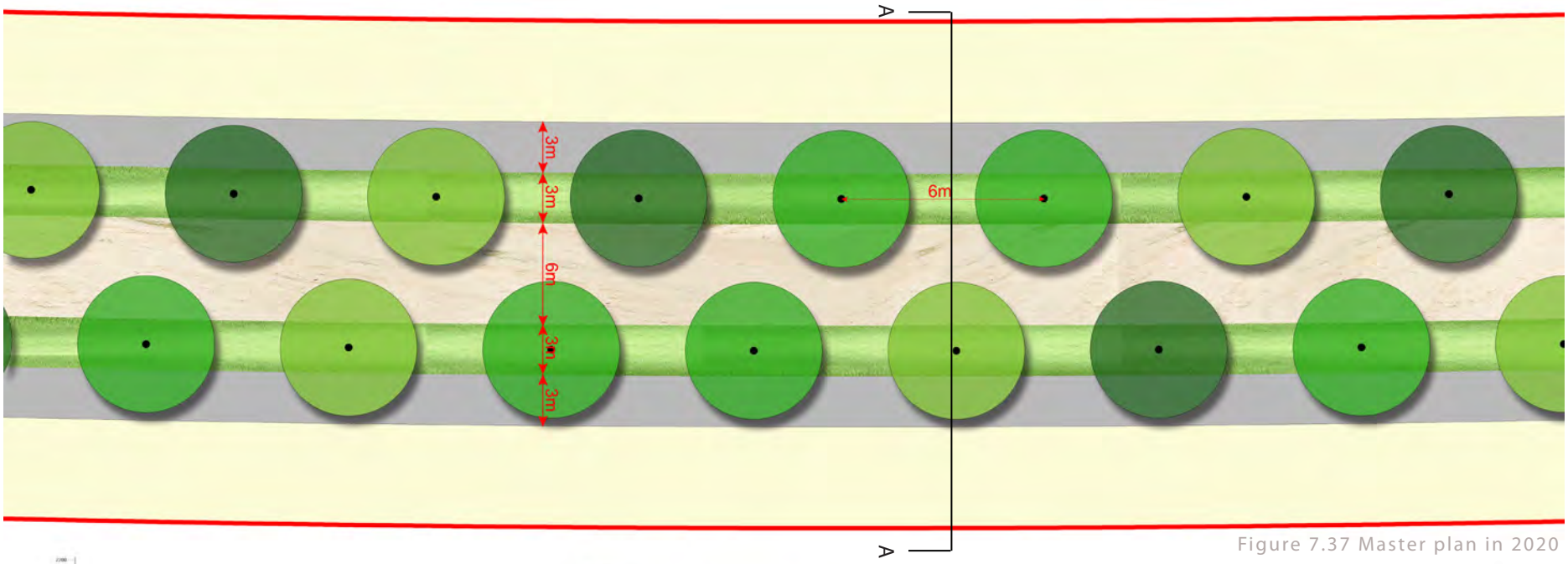


Figure 7.37 Master plan in 2020

Figure 7.38 Section A-A

TREES

Hybird Poplar

SHRUBS

Ligustrum Licidum
(Chinese Glossy Privet)

GRASS

Cynodondactylon(Linn.) Pers.
(Bermuda Grass)

FLOWERS

Erigeron Canadensis

(Canada Fleablance)

Ageratum Conyzoides L.

Figure 7.39 Plants selection

Figure 7.40 Image of multi-use paths in 2020

7.6 Detail design five: picnic ground

7.6.1 Introduction

My fifth detail design locates in the north east part of the landfill hill, close to the east entrance and a parking lot of the site. (fig.7.42) The topography of this area is a slightly slope, suitable for both walking and cycling. There is one existing road (6m width) in the area, with several plants surrounded. (fig.7.41)

Figure 7.41 Current landscape looking from entrance, photo by author

7.6.2 Proposal

The location of the area let it become the continuation of the entrance. The objective is to provide resting area as well as interesting outdoor experience for people. After the vegetation restoration, necessary facilities can be constructed such as chairs and bicycle parking lot. People can sit under different species trees, holding family picnic, or parking their bicycle in the parking lot and take a rest before starting their journey. (fig. 7.52) The topography can be designed in special spatial quality. And the ground and facilities will be constructed in local re-used materials. (fig. 7.49) The plants are being chosen based on principle of vegetation restoration.(fig. 7.51)

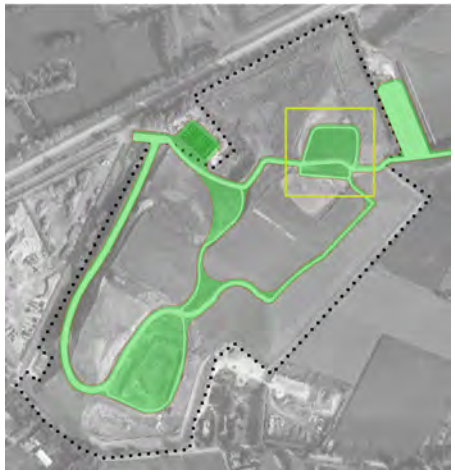


Figure 7.42 Location

Figure 7.43 Master plan in 2015: vegetation restoration

Figure 7.44 Master plan in 2020: circulation layer

- Today

Spatial planning

- 3 years

Manufacturing soil and habitat

- 6 years

Initiating access and activity

- 10 years

Building spaces

Figure 7.45 Master plan in 2030

Figure 7.46 Section A-A

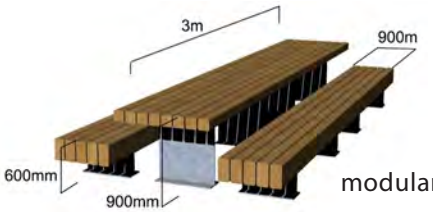
Figure 7.47 Section B-B

Figure 7.48 Image of picnic ground in 2030

Figure 7.49 Local materials

300mm

300mm



modular bench + table

Figure 7.50 Different scales of shrubs and trees

Figure 7.51 Plants selection

Figure 7.52 Intention images of picnic activities

7.7 Detail design six: natural theatre

7.7.1 Site introduction

The sixth detail design is located at the center of the landfill hill. (fig. 7.53)There are two existing roads intersect in this place. One is leading to the top of the hill, another one is leading to the east park. Due to the different directions of these two roads, a flat open space is formed and being surrounded by the roads. (fig. 7.54)

7.7.2 Proposal

In order to take advantage from the topography and also to provide interesting experience, I decided to design a "natural theatre" in this place. Using the flat open space as the "stage", it is also the lowest space. The natural slopes are naturally occurred the elevation and they can be used as the "auditorium". The planted trees can be used as the "wall" to create an enclosure space without disturb.

> *"Greening artistic values have spawned land-art, site-specific dance, nature writing, and music with whales."*
>
> *--U Chaudhuri, 2005*

Theater is both immediate and communal and this may in part account for its absence from the genre of "nature writing". Theater functions as a field of exchange where myths take flight, moving between the permeable spheres of self and community and then out into the terrain of our lives. Natural theater can discover the ecological value of theater and its potential to awaken ecological sensibilities in us.

> *" Always an immediate, communal and material encounter among embodied performer, audience and place, theatre is ecological even as it is representational."*
>
> *--U Chaudhuri, 2005*

Indeed, theatre's artifice has seemed a virtual monument to humanity's triumph over natural forces.

The theatre can be used to held various outdoor activities, not only outdoor music festival, comic drama, etc. but also public broadcast relating waste issue and public environmental awareness education. (fig. 7.55)

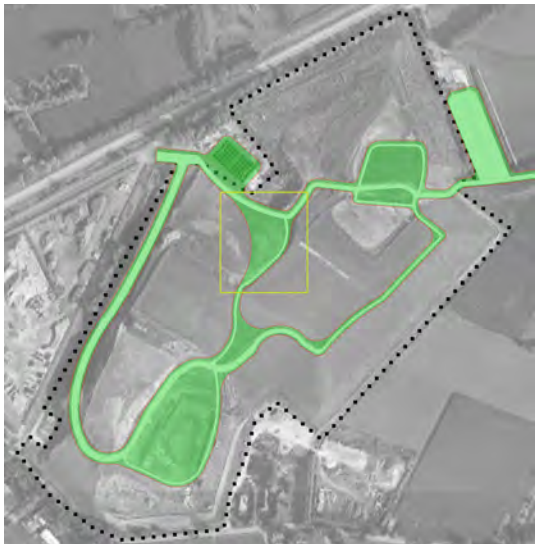


Figure 7.53 Location

Figure 7.54 Two different direction roads

Figure 7.55 Intention images about possible activities

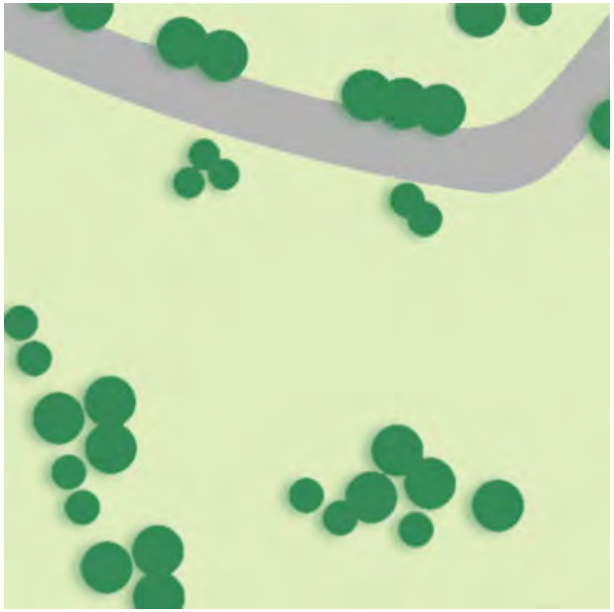


Figure 7.56 Stage one: vegetation restoration

Figure 7.57 Stage two: add roads and accessibility

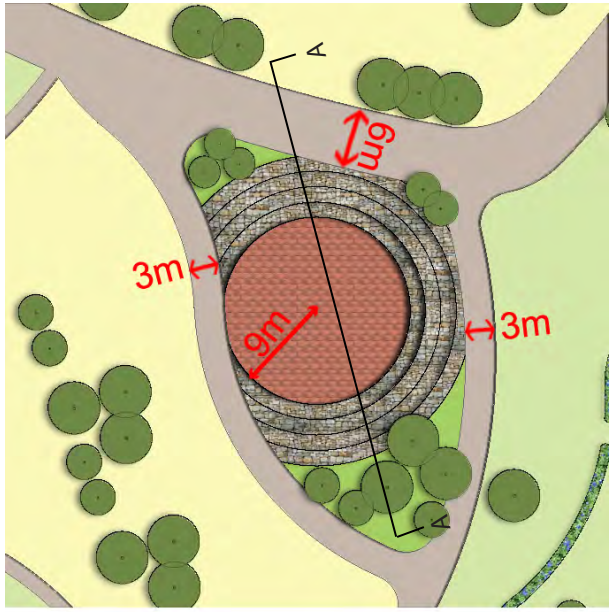


Figure 7.58 Stage three: nature theatre in 2050

- 3 years ***- 6 years***

Manufacturing soil and habitat ***Initiating access and activity***

- 10 years ***- 20 years***

Building spaces ***Diversifying ecologies and uses***

- 30 years

Growing new life

Figure 7.59 Section A-A

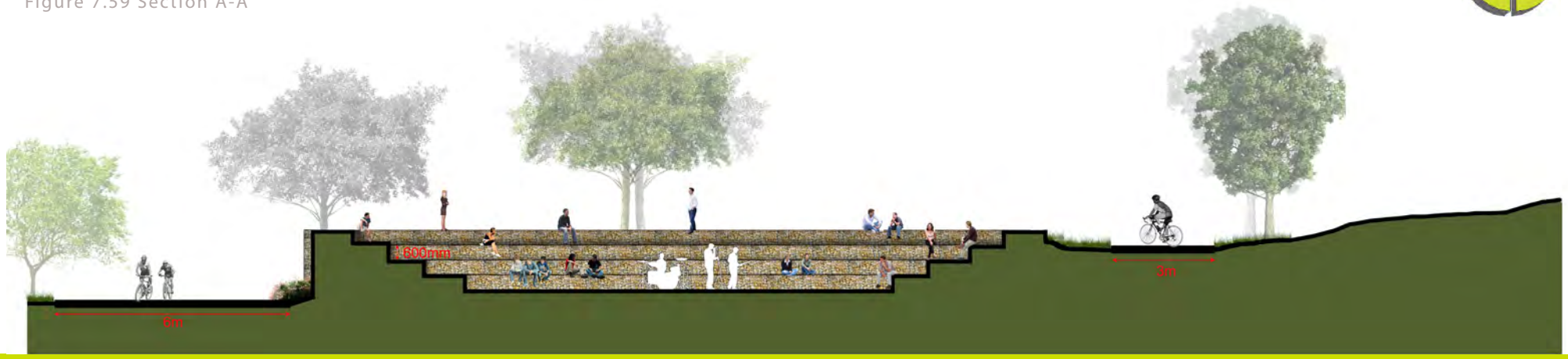


Figure 7.61 Image of natural theatre in 2050

Hybird Poplar

Chinese Glossy Privet

Bermuda Grass

Canada Fleablance

Ageratum Conyzoides L.

Figure 7.60 Plants selections

Brick

Gabion

Figure 7.62 Local materials

7.8 Detail design seven: hilltop open space

7.8.1 Site introduction

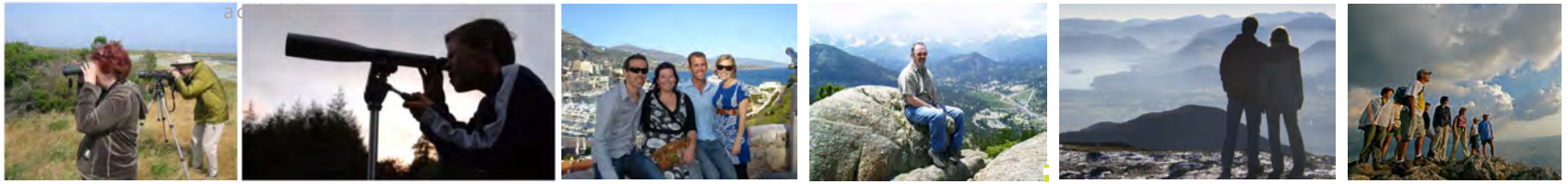
The seven detail design is located in the top of the hill, 20 meters high. (fig.7.65) This area is an empty open space, with existing roads. (fig.7.63)

7.8.2 Proposal

To use the topography to provide unique experience for tourists. The hilltop can provide a nice open view for tourists to overlook the rural area in Barneveld naturally, which they cannot experience this in other place. (fig.7.64) The hilltop open space can be accessed through the multi-use paths provided by other detail designs. Several platforms will be built up based on the slope, for people to sit or stand. (fig.4.66) Plants should be mainly shrubs and grass in order to not block the view.

Figure 7.63 Empty space, photo by author

Figure 7.64 Intention images for possible hilltop activities



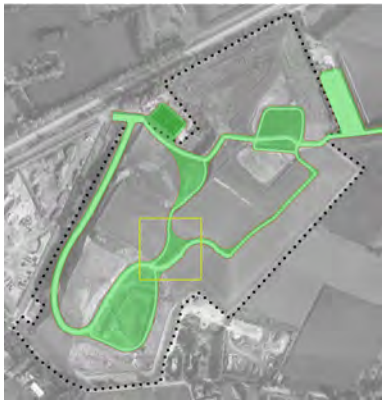


Figure 7.65 Location

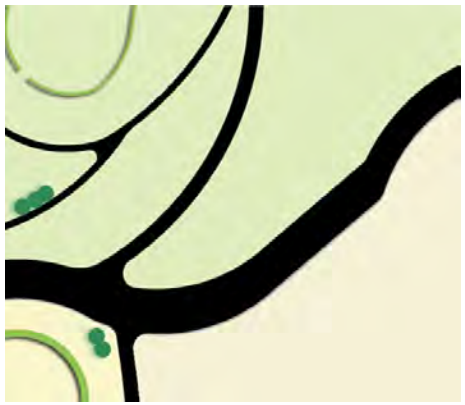


Figure 7.66 Provide accessibility

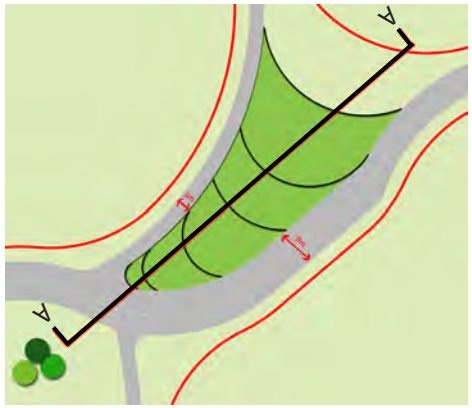


Figure 7.67 Final master plan in 2025

- Today ***- 3 years*** ***- 6 years*** ***- 10 years*** ***- 20 years*** ***- 30 years***

Spatial planning ***Manufacturing soil and habitat*** ***Initiating access and activity*** ***Building spaces*** ***Diversifying ecologies and uses*** ***Growing new life***

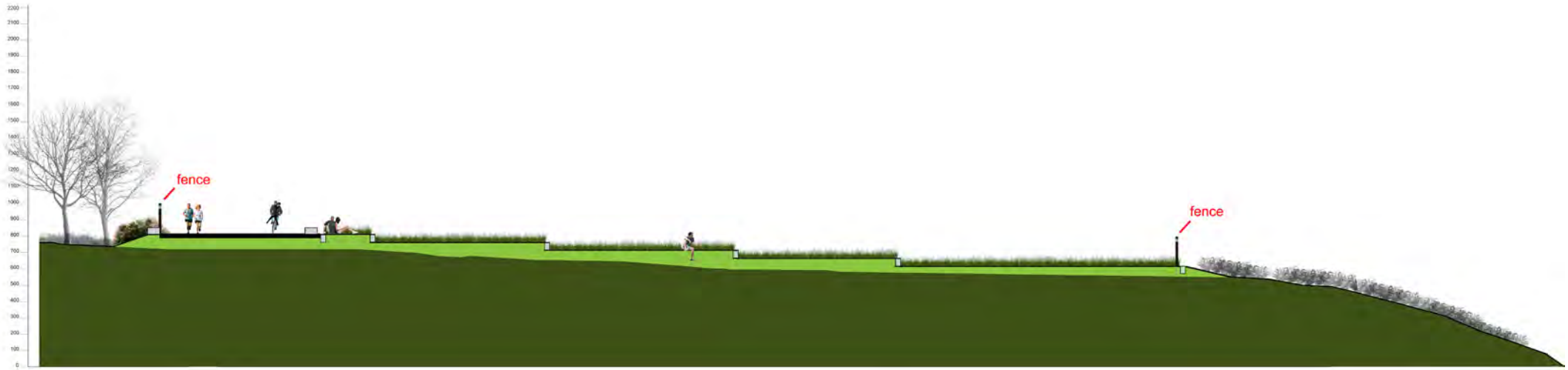


Figure 7.68 Section A-A

Figure 7.69 Images of hilltop open space at 2025

7.9 Detail design eight: play area

7.9.1 Site introduction

My last detail design is located in the south part of the landfill hill, in between the detail design "multi-use paths" and "hilltop open space". (fig.7.70) It is a gentle slope, 5% gradient. The existing road is at the edge of the hill, 3 meters width.

7.9.2 Proposal

After vegetation restoration, this place can be designed to provide park-like experience for people. By design routes inside the plants, using plants to create enclosure and open space, adding seating area and playing area for people. (see chapter 4.4 public space) The playing elements will be constructed in abandoned materials in the site. (fig.7.71) Various activities suiting for different group can be happened in this place. (fig.7.73)

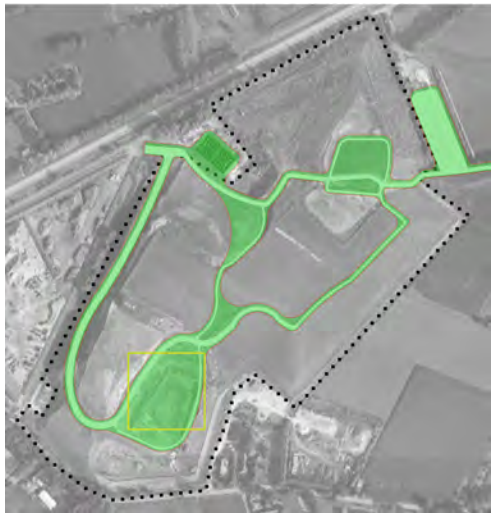


Figure 7.70 Location

Figure 7.71 Abandoned materials

Figure 7.72 Plants species selection

Figure 7.73 Intention images about possible activities

Figure 7.74 Image of play area in 2025

Figure 7.75 Vegetation restoration

Figure 7.76 Final master plan in 2025

- Today ***- 3 years*** ***- 6 years*** ***- 10 years*** ***- 20 years***

Spatial planning ***Manufacturing soil and habitat*** ***Initiating access and activity*** ***Building spaces*** ***Diversifying ecologies and uses***

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8 Evaluation & conclusion

Figure 8.1 An artificial lake in Tilburg landfill restoration project, photo by author

- People's demands

Good landscape & spatial quality	Vegetation restoration adn road system renew	★★★
Unique experience	Various topography and activities	★★★
Meanings of landscape	Museum, exhibition about knowledge, identity and history	★★

- Environmental Benefits

Protection of groundwater, soil condition and air	Landfill maintaining and vegetation restoration	★★★
Protection of biodiversity and ecodiversity	Introduce new native species attracting insects and birds	★★
Protection of surrounding environment	?	

- Social Benefits

Improving people's recycling behavior	Create waste exhibition and building recycle activities	★★
Reduction of people's negative perspective on waste	Decrease negative impacts by landscape design	★★
Providing various activities to the community	Satisfy different people's demands	★★★

- Economic Benefits

Attractive to outsiders and lead to more economic incomes	Create waste exhibition and building recycle activities	★★
Increase land value by improving landscape quality	?	
Get incomes quickly and support long term construction	Develop different activities based on timeline	★★

Figure 8.2 Evaluation table

★ hard meets the needs ★★ cover the basic needs ★★★ completely satisfy the needs

8.1 Evaluation

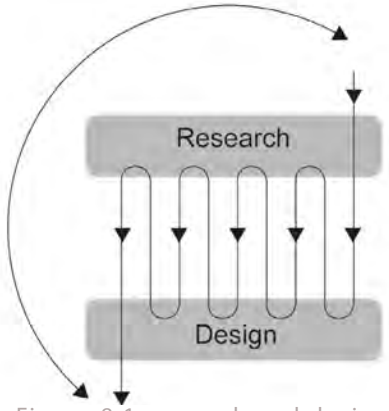

Figure 8.1 research and design
Source: Zeisel, 2006

Due to my methodology map and design process, after a period of research for design about Barneveld landfill redevelopment, I need to look back of my research questions and hypothesis to analyze the design I have done to rectify mistakes, and more information or make clear directions for next steps. (fig. 8.1)

As I said in the chapter of introduction, my hypothesis is " A well-designed landfill redevelopment should have the possibilities to have not only ecology values but also educative meanings, also a feasible integrating approach could be applied in the future landfill treatment in other projects." By checking my planning and design, I considered both ecology values and educative meanings into my design, and using the integrating approach to design various functions in the former landfill site.

My research question is "How can my studying area be developed into a sustainable and attractive site, where negative impacts from landfill are decreased, and various landscape functions be developed and integrated in a sustainable and educative way?" after the research and design, I would like to answer this question in two "***P***" keywords: "***protect***" and "***provide***".

- Protecting and improve environment

- Protecting necessary landfill infrastructure
- Protecting existing road system
- Providing landscape and wild life
- Providing accessibility and local network
- Providing spatial quality and multiuse road
- Providing attractions and activities
- Providing educative meanings

By achieving those "protecting" and "providing", Barneveld landfill will become a sustainable and attractive, and negative impacts from both environment and people's perspectives will decreased in the future.

Although I have come back to check if my design is fitted in my hypothesis and research question, it is still necessary to evaluate my design with specific criteria so that I could get more clear information about the advantages and disadvantages about my design.

The evaluation criteria are built up due to my problem statement and SWOT analysis. I divided them into four parts: people's demands, environmental benefits, social benefits and economic benefits. (fig. 8.2)

8.2 Conclusion and future discussion

From the evaluation we can see that the design can satisfy people's demands preferably, more research on the meaning of landfill's landscape should be studied cooperating with artists and other experts. In the environmental part, the design will protect the landfill site's environment and ecosystem in the future, but the influence of surrounding area need future research and analysis. For social aspects, the design can provide various outdoor activities to the community and also increasing people's awareness about waste related issues. Due to the time schedule and my ability, the design still contains some limitations and uncertain expectations. Because lack of database, I use indicator plants as an alternative solution to analysis the soil condition. This approach may not accurate enough for a more constructive design. Also, the samples of my interview are too small to be convincing. These two limitations need my future research and analysis to find better solution. Last but not least, the economic benefits is the weakness of the design, the value of the land in the future is unknown at this moment. And due to the long construction period, incomes cannot be got quickly. More investigation and interview should be done in the future to get to know:

Is there any negative influence of Barneveld landfill to surrounding environment?

What is people's perspective and behavior of waste and landfill?

In the end, my research and design are not just a plan for one landfill site. It can be also used and applied to many former landfill in the Netherlands, and contributing to the global issues of waste and recycling.

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