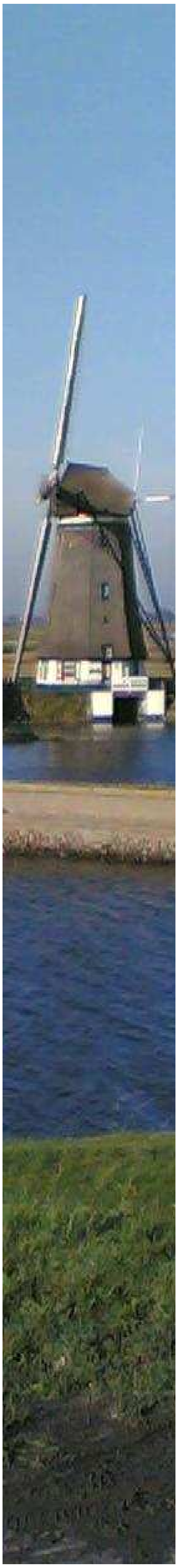

TU DELFT – FACULTY REAL ESTATE & HOUSING – URBAN AREA DEVELOPMENT

Case Study Westergouwe | Financial feasibility study of water-designs in lowland polders

What are the effects of different water-design concepts on the financial feasibility of urban development in lowland polders?

Date
29/10/2009

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Report Title
Case Study Westergouwe | Financial feasibility study of water-designs in lowland polders.

Research question
What are the effects of different water-design concepts on the financial feasibility of urban development in lowland polders?

Publication date
29/10/2009

Status of report
Definite version

Keywords
Urban Area Development, Climate Change, Lowland Polders, Flood risk

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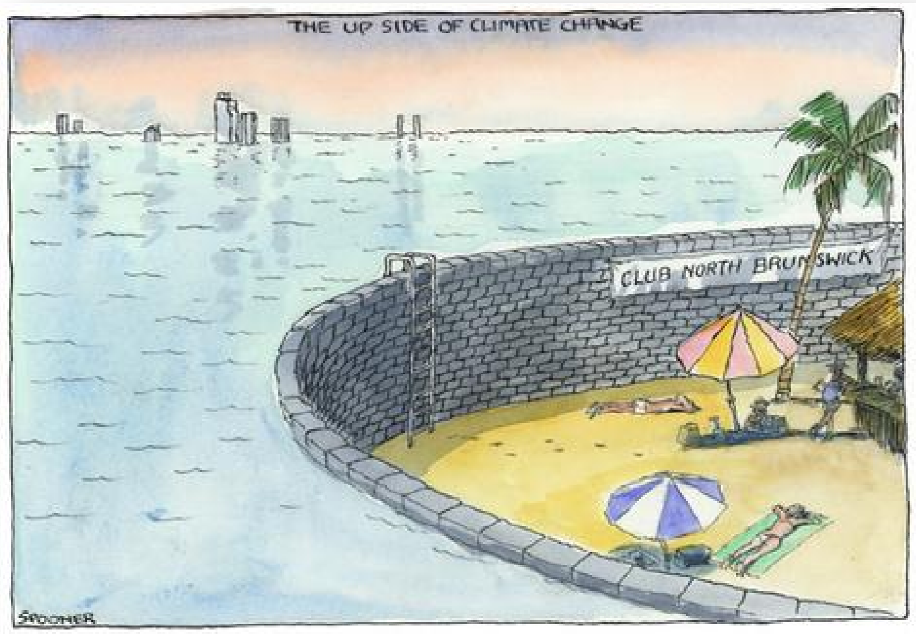
Of course "this can't be the answer"

'Upside' of climate change?



Preface

This graduation report is the finalisation of my research study at the Faculty of Architecture at the Delft University of Technology. My field of research is part of the Master-education Real Estate & Housing, with a specialisation in Urban Area Development. This report defines the process and contents of my thesis. My research is a financial feasibility study of water-designs in lowland polders and is based on a case study of the Westergouwe in the Netherlands.

Firstly I would like to thank my family and friends for your undoubted support and ever patients over the last few years.

Secondly I would like to thank my graduation company Dura Vermeer Business Development, for giving me a place and the opportunity to learn from their experiences and knowledge. My gratitude goes out to Johan van der Pol for taking up the role as my third mentor and for your time and effort in assisting in my research. In addition, I would like to thank Elton Boogaard from Dura Vermeer Bouw Leidschendam for helping me with input for my financial model.

Thirdly, this research could not have been made possible without the help and guidance of my first and second mentor. My thanks therefore go out to Wout van der Toorn Vrijthoff for your assistance during the past year and your expertise on urban area development and water management. I would also like to thank Sjoerd W. Bijleveld for your assistance and allowing me to implement your financial model, IGOMOD, in my research.

Finally, I would like to thank those who I did not mention by name but did help in the realisation of my research.

The Hague, October 2009

Ewout Holst

Abstract

Problem statement

Paragraph 1.3 p.8

Traditional strategy in the Netherlands on water management and control was to fight against the water and reduce the risk of flooding and water inconvenience, by keeping water where it belongs: behind the dykes, the last defence line. However, changing climate conditions and extreme weather has become a new reality. Two exceptional high-water levels occurred in 1993 and 1995, which resulted in the need for people to be evacuated en masse from their homes. Organizations and local government realized that continued traditional land use and water management will lead to problems. Hydrological options are beginning to dry up and damage to soil, infrastructure and property is becoming a realistic threat. Strong fluctuations in rainfall and drought can no longer be cushioned as further raising dykes and draining land could not cope with these ever higher water levels. There is furthermore, a growing demand for housing area which must now compete with the necessity of water storage in urban areas. As the supply of available building space is becoming increasingly limited, municipalities are forced to develop on alternative locations, such as lowland polders, where the risk from flooding and water inconvenience is even greater. This demands a new strategy in water management, which constitutes to two key challenges: multiple use of space (combining the demand for housing with water storage) and designing a spatial plan to incorporate water management.

The Water Policy and Management Plan for the 21st century, was then established to change the approach to water management and the use of space in the Netherlands. Investing in research and knowledge, developing water-resilient homes, amphibious- and floating homes, and reserving land for water storage are all part of this. The question is how much does this cost and to what consequential effects?

Research question

Paragraph 1.4 p.10

The problem statement defines two key challenges: combining the competing demand for housing with the necessity of water storage, and determining what the effects are of different water-designs on the financial feasibility of developing in lowland polders. This is translated into the following main research question:

What are the effects of different water-design concepts on the financial feasibility of urban development in lowland polders?

Method

Paragraph 2.2 p.19

This graduation project is a case study based research on the Westergouwe: part of the Zuidplaspolder, the lowest lying land in Europe. Literature study and data documentation was conducted to: understand the effects of climate change on urban development; determine the key stakeholders; determine what new technology has been developed in water innovation; and analyse the current development process of urban development and water management.

The current plan for Westergouwe serves as the referential design. In addition, three more water-designs have been developed to incorporate different methods for water management: raising land; creating cascade living areas; and filling Westergouwe with water. The financial model IGOMOD was used to translate those different spatial designs into financial value outcomes. The financial feasibility is calculated for

each variant, giving insight into the financial effects of different design choices and also implications and risks for stakeholders. Each design is then compared and further analysed using an analysis matrix, determining the 'best' variant for which sensitivity analysis is conducted, to determine the financial robustness against changes in financial parameters. Data analysis of each water-design is used to determine which factors in each design are most influential on the financial feasibility and how they relate to the stakeholder.

Paragraph 3.9 p.37

Results

Literature study and data documentation has shown:

- There are a number of contributing factors for new innovation in water management,
- New legislation and regulation has been developed as a result of climate change and extreme weather conditions,
- There are a number of key stakeholders in urban development and water management,
- New techniques in water management and housing have already been developed,
- There is much future potential in water- floating urban development,
- Water management and maintenance plans have been developed,
- There are a number of key aspects in the development process of lowland polders.

Paragraph 6.6 p.82

The financial model IGOMOD, has shown that: only the water-design has a positive balance in land use planning, all four variants have a positive outcome in real estate development, but only the cascade and water design have an overall positive financial end result.

Furthermore, financial models such as IGOMOD make it possible to predetermine financial consequences of design choices, and give insight into the implications and risks of each design for the stakeholders. Consequently, financial design studies during the initiative phase of development using mathematical models allow for possible cutbacks in costs, hence increasing the potential, probability and financial feasibility of complex innovative urban designs in lowland polders.

Paragraph 7.2 p.90

The following activity elements in water proofing measures are shown to constitute mostly in land use planning costs:

- Revetment costs,
- Soil consolidation,
- Construction ready costs of building site for traditional housing,
- Public facilities for amphibious and floating homes,
- Civil engineering costs,
- Water maintenance costs.

Paragraph 7.3 p.91

Results from data analysis have shown that the cascade design scores 'best' on aspects regarding spatial quality, water management, costs and risk. Furthermore, sensitivity analysis shows considerable robustness against financial changes in parameters, such as price and revenue increases, and phasing of activities.

Paragraph 8.1
p.100

Conclusion

The effects of water-design have a distinct effect on key design, cost and risk elements, as represented in the following:

- *Spatial design*: this includes the overall characteristics and quality of the variants, such as housing, program of requirements, and use of space.
- Water management: this includes all activities related to water proofing, water storage, water level fluctuations and water maintenance.
- *Costs & revenues*: this includes costs and revenues for land use planning activities and real estate development.
- *Financial feasibility*: this includes the end value of land use planning, real estate development and the combined financial outcome of each variant.
- *Risks*: this includes the risk of general phasing for land use planning and real estate development, the risk of the local housing market, risk from seepage pressure, and the risk with regard to future users.

The emphasis on new development of innovative forms of housing has to continue, because it is becoming increasingly difficult to build houses on good building land. This land simply no longer exists, because it is either already been used or reserved for water storage purposes. Certain locations less suitable for construction and less ideal in terms of water problems, such as the Westergouwe (The Zuidplaspolder), are becoming the next best alternative. Multiple functions (double use of space) have to be combined in one spatial plan such as living, working, recreation and water storage. Increasingly, different parties will be involved with water management: authorities, local governments, municipalities, constructions companies and real estate developers.

Of all four variants, the cascade design comes out as a potentially very feasible and possible solution for the competing requirements of water management and housing demands. It appears as the most financially robust and lowest risk design and as such offers interesting perspectives for a new approach to the challenges of climate change and urban development in lowland polders.

Paragraph 8.2
p.105

Recommendations

Although the approach and methods used in this research have made it possible to answer the research question, the following recommendations can be made:

- Broaden the field of research to include more case studies,
- Look into the cost effect of damages caused by water: to property, infrastructure and public facilities,
- Optimise each water-design further to determine the financial outcomes and possibilities,
- Improve further the application of the mathematical model IGOMOD.

Table of Contents

1.1 Introduction

The western part of the Netherlands, the Randstad, is driven by a growing demand for new urban development. Current open spaces therefore face the possibility of construction of new housing. Most of these areas are polder areas characterised by peat soil and bad ground conditions, making them unfit for development; part of the reason why these lowland polders are still uncultivated. However, new technological innovation, growing spatial demand and financial gain pushes municipalities to develop in such polders. Being the lowest parts of the Randstad, these lowland polders also face another threat, namely from flood risk and water inconveniences. Because of the low ground levels, these areas are more vulnerable to flooding and rivers overflowing. The impact and consequences of flooding are emphasised when these polders become urbanised. So why develop in these areas, and how can one manage the challenges of flood risk in urban areas? The importance and relevance of these challenges are induced by the following statements:

- *The 20th century saw the greatest increase in temperature of any century during the last thousand years, and the last decade was the warmest since records began. As the temperature rises, so does the sea level – with profound consequences for us all (source:* www.science.org, 2008*).*
- *Government should ban all development in lowland polder areas located below sea level (source:* www.jooinside.nl, 2008*)*

On a frequent basis we are confronted with reports on global warming and the changes in our climate. Scientists are predicting different scenarios with corresponding consequences for the near future. One fact is certain, the average temperature has gradually increased over the last century due to global warming, resulting in an increase in seawater levels. On average, it is expected that by 2100 sea levels will have risen in most places by around half a meter[1]. The impact on urbanised lowland polders with a higher risk of flooding and below seawater is undeniable and profound. This is also the case for the greater part of cities in The Netherlands, which has a long history of protecting itself against the threats by the sea. 27% of its area and 60% of its population is located below sea level (source: www.wikipedia.org, 2008). Over the years significant areas have been gained through land reclamation and persevered through polder systems and dykes. Urban development in these lowland polders, have a substantial risk of flooding. As a result some believe the government should ban development on such locations, primarily because it is unsafe and costly. Water- management and regulatory authorities also question that idea and are always looking for alternatives.

However, there is still the growing demand for new development, which is also the case for future developments in the Zuidplaspolder, located between Rotterdam, Gouda and Zoetermeer. The Zuidplaspolder is officially the lowest point in The Netherlands and Europe, measuring -6.76 meters below sea level. The city of Gouda

[1] Source: http://www.knmi.nl/klimaatscenarios/knmi06/samenvatting/index.html, 2009

has shown interest in the Zuidplaspolder, namely the location Westergouwe, for further expansion of its borders. The question arises whether or not one should develop on these grounds, taking the threat of flooding into consideration. Is it wise to invest in a project which is at risk of flooding? There are some who believe there is no future in these developments, because the benefits do not supersede the risks. However, there are also unique qualities of water in urban areas that could change that standpoint. The question is how to use those qualities to its advantage and integrate them into the project, hereby adding to the quality of living.

The Zuidplaspolder is a good example of the challenges facing water management and the demand for housing. Because it is the lowest point in The Netherlands, the Zuidplaspolder is also referred to as the “drain of Holland”. Studying the possibilities in the Westergouwe case could become an example of a successful project for future development. Analysing new innovative designs in water management and spatial plans will be necessary. This report will go into the challenges associated with such projects and hopefully give insight into the financial possibilities and consequences of urban development in lowland areas. The Westergouwe case in Gouda is used for this research.

Motivation

Motivation

As a master student of Real Estate & Housing at the Delft University of Technology, I have always had a fascination about water and how a country such as The Netherlands, with its many delta cities, copes with urban development and water management. Al Gore’s film, ‘An Inconvenient Truth’, has had great international impact and has inspired me to think about the challenges of urban development in lowland polders and climate change. Water-housing, water-resilient homes and polder developments are becoming increasingly popular. However, there are still only a few water related projects currently developed in the Netherlands. I found this to be strange, which drove me to analyse and understand the challenges of water-designs in polders. Aside from posing as possible solution to the effects of climate change and flood risk, I believe there can be a lucrative market for such homes. Water can form an additional unique quality which in turn adds to the value of real estate.

This idea fascinated me and pushed me to analyse different methods in water designs and determine its financial consequences. With my research I hope to add to future development of water designs.

1.2

1.2 Social relevance

Urban development in lowlands is especially vulnerable to flood risk and the effects of climate change, yet the demand and interest for living in these areas is growing rapidly. There is a friction between that demand and the risks involved in such projects. The Dutch water defence history has always focused on stopping the sea water at its borders, using dykes and natural dunes. During the Watersnoodramp in 1953 these defence lines have been upgraded and increased in height. However, in

New strategy in water management

the years '93-'95, rivers such as the Rhine could not cope with the huge amounts of water and overflowed, 200,000 people had to be evacuated (Hooimeijer & van der Toorn Vrijthoff, More Urban Water, 2007). This proposed a new problem in water management and a new strategy arose. The new idea was to give river water controlled space to allow for overflow in periods of high (peak) water. The same principle would be adopted for sea water fluctuations. This new strategy demanded a new policy and a new vision on urban area development and management.

More than ever is living on water and are floating, water-resilient homes the hot topic today. The scarcity of available land and the increased intensity of space usage have great influence on future developments. In addition climate is changing and so are weather conditions, showing increasingly extreme effects. In addition more and more land is given back and destined for water storage. These factors and many others illustrate the importance of treating water with the utmost respect and managing water in an optimal and durable way. Consequently individual living standards and living demands have changed, resulting in a demand for new and innovative solutions. This not only applies for homes on or near water, but also for entire living environments, where different functions need to be combined in one spatial program. Water is now the key element in that development. This brings forth new questions on how to deal with water. What role does water play in urban development, especially in lowland polders? What does such a program look like and how do water designs relate to financial feasibility? In addition the role and interests of each stakeholder adds to the complexity. Cooperative working methods and knowledge based development are becoming essential instruments in successful water-projects.

This research will go into the challenges of water designs and determine the results and financial consequences of different water designs in urban development in lowland polders. Consequently sensitivity analysis will determine the financial bandwidth in design specifications and stakeholder's interests. In conclusion this research will give insight into integrated spatial designs where water is the structural principle. Water will no longer be a threat but become a valuable quality in living.

Climate change & water-management

The current climate has undergone a huge transaction during the past decennia. The results are more wet winters and increased dry summers in combination with rising sea water. In addition, particular for The Netherlands, is the settlement of soil. To make matters worse, local economies are growing and with that the demand for urban space and new homes. The result is that more and more land is transformed to urban cities, taking away natural land and green areas. The total surface area for water reserves inland have therefore decreased. Those areas, which used to collect the excess water, have now drastically given way to housing, infrastructure and other facilities. This means that excess water cannot be transported back to the ground through natural saturation as before. As a result natural water reserves have decreased. This means that excess rain water, river water and potentially sea water will need to be transported by alternative means in order to prevent flooding in urban areas. Local government has taken action to integrate the spatial demands

Commissie Waterbeheer 21ste eeuw

with technical standards and the effects of climate change. The Commissie Waterbeheer 21ste eeuw was established by The State, provinces, municipalities and water regulatory authority, to investigate and manage which measures need to be taken in order to ensure a safe and liveable environment in The Netherlands for the coming years[2]. The key aspects of this agreement are[3]:

- Anticipate instead of react; the aim is to anticipate on future climate changes and ground settlement before they happen in order to combat future problems. This means taking precautionary measures for water reserves by reserving land in advance for future need.
- More space with technical competence; the idea is to make room for excess water before it finds its own space. This means that within cities there must be space to accommodate excess water in case of flooding. This controlled flooding could take shape in allowing for rivers to overflow in specially designed areas. The result could be temporary discomfort but the safety would be controlled and preserved. This idea is a new challenge in urban area development.
- Hold, store and discharge; for years the Dutch policy was to pump away as much excess water and as quickly as possible. A new three step strategy is being implemented that is founded on the idea that (excess) water should be maintained and collected where it occurs. This means that instead of pumping away the water, it will need to be housed. Water storage can help to assist in times of need and when that is not enough than excess water can and will be discharged.

Climate scenarios

IPCC

KNMI

In the international film, 'An inconvenient truth', Al Gore stresses the problems that could occur as a result of climate changes. This applies for all global cities within the next 50 years. The greater part of land could be washed away by violent seas. Weather or not his predictions hold true, the message is clear. The Netherlands as many other delta cities alike, cannot escape these new dangers and must prepare and take precautionary action. In 2007 the Intergovernmental Panel on Climate Change (IPCC) produced four reports on the world wide climate changes. These scenarios differ in predictions and address matters such as global warming, the rise of sea water and melting ice caps. There is no doubt among scientists that the consequences for highly populated delta cities will be profound and that measures will have to be undertaken. Al Gore's statements are supported by the National Dutch Weather Institute (KNMI) and show similar conclusions. The range in exact

[2] Source: http://www.grontmij.nl/site/nl-nl/Werkvelden/Water/Waterbeheer/Default.htm, 2008

[3] Source: Nederland leeft met Water

predictions and consequences do differ but the following holds true for The Netherlands[4]:

- Global warming is continuing with softer winters and warmer summers,
- More frequent and heavier rainfall during winter,
- Fewer rainfall during summer but more intense,
- Sea level is rising.

Water

The Dutch history on water risk and management has proven that the safety against flooding is crucial and must constantly be improved. Apart from sea level rising there is also the risk of extreme down poor, long dry spells and ground settlement. Combined with the low polder areas in The Netherlands it becomes clear that drastic change is needed in the way water is managed. This has consequences for future urban development projects in new areas. The Ministerie van VROM, LNV, VenW and EZ, have acknowledged this problem and issued that 'water' be a structural principle in integral spatial planning (www.VROM.nl, 2008). This has been laid out in the new Nota Ruimte, where water demands new restrictions on sustainable urban development. Spatial planning, integration, implementation and use will need to take into account the effects of water. This includes not only safety against flood risk, but also accounting for and preserving freshwater and enhancing the quality of ground and surface water. Consequently this could prove favourable in periods of drought and water shortage. The new role of water as structural principle therefore includes guaranteeing enough space for excess water but also the amount and quality of water in new urban development. This new principle means that different parties such as the municipality, private parties and water regulatory authority will need to cooperate. Especially in new large scale projects this will be a key issue but prove difficult. All parties play a crucial role in the development process, but also the management phase. This is usually done by the local water regulatory authority who manages the water system. Negotiations between all participants will need to start at an early stage in order to guarantee a successful project. Gathering new knowledge and sharing information between public and private parties will become essential.

1.3

1.3 Problem statement

The main problem of urban development in lowland areas is created by the demand for living space outside the city centres. This growing demand for living space pushes municipalities to look past their city borders and develop in lowland polder areas. Consequently, that demand, conflicts with the demand for surface water storage; most of those grounds meant for housing are also reserved for water storage (Samen Bouwen aan de Toekomst, 2007). Polder areas are green, spacious and full of water and The Netherlands has to protect itself from the sea and the impacts of climate change. This makes flood prone lowland areas even more at risk; causing friction

[4] Source: www.ipcc.ch, http://www.knmi.nl/kenniscentrum/ipcc_2007/zeespiegelstijging/, 2009

between a demand for living space, water storage and guaranteeing a safe living environment against flooding and water inconveniences. This is an increasing problem that puts strain on the social and financial feasibility of these projects.

Water management authorities

Because of the complexity of urban development, many different stakeholders are involved, resulting in cooperative working forms such as PPS. The role and interest of each stakeholder can add to the challenges. For the local government, this means investing in water protection through dikes but also having to take additional precautions for lowland areas. Rijkswaterstaat and water regulatory authorities will be responsible for maintenance of dikes and waterways. Municipalities, on the other hand, need to guarantee enough housing in a safe environment and upkeep social quality. In turn, investors will have to take a higher risk in developing in an uncertain housing market. Consequently future occupants and users will determine the success of water design projects.

Furthermore each polder is unique and has specific land characteristics. These characteristics strongly determine the possibilities of development and how to integrate water into the program. Certain housing typologies and water-prevention techniques may not be suitable or applicable. It is therefore essential to predetermine the success of development; cost-benefit analysis and financial feasibility studies are tools which can be used to assist in that matter.

In order to successfully develop in lowland polders and integrate water resilient aspects, much knowledge is needed and techniques further investigated. In cooperation with authorities, legislation and constraints will need to assist in future research. Because so little water projects are being realised, current knowledge is not being put into affect. In addition it is still unclear how specific water-design decisions and factors financially influence the feasibility of a project. Additional investments, costs and benefits, and the financial impact need to be weighed and calculated. Furthermore, these financial consequences have to be addressed per stakeholder.

Water management

Water management and control have always played an important role in urban development in The Netherlands. In the past it was mostly taken for granted when it came to integrated urban development. Nowadays however, with the rising sea water and climate changes, this has become an important problematical case. The Netherlands has to account for climate changes in spatial planning and urban development. Because of the long history of defence against the sea, Dutch citizens have become accustomed to flood risk and continued to live near the sea and in lowland polder areas. However, the demand for living space has increased over the years, stimulating development in lowlands. Due to the density of these urban areas, the risk of flooding has increased. Consequently the amount of possible damage caused by potential flooding has grown. This fact has not yet been sufficiently recognised.

Westergouwe

Specifically for the Westergouwe, there is the problem of too much water and too few. Being the lowest point in the area, there is the risk of flooding from surrounding polders, the Gouwe and the river Hollandse IJssel. In addition excess (rain) water from neighbouring areas, will be directed into the Westergouwe. Consequently Westergouwe faces the problem of seepage pressure; groundwater is pushed into the Westergouwe, keeping the soil wet and unfit for development. To add to the complexity of the Westergouwe, the ground structure is unstable and irregular when it comes to ground settlement. This is due to the ground characteristic, which is made up of peat soil. Draining the area would also result in irregular settlement, making it more difficult to maintain infrastructure and public areas. Long periods of drought can also have that effect, lowering the water level and causing foundations to rot. Therefore some sort of equilibrium is necessary.

'Article 12-status'

Finally the municipality of Gouda has an 'Article 12-status', meaning the government financially aids municipalities with financial difficulties with structural planning. In return for additional funds, the government gets financial insight in future planning. The financial implications of development in the Westergouwe will therefore play an important role in the decision making process.

Despite the complex challenges, local government and municipalities are setting out goals to further develop in a sustainable and durable way. Becoming environmentally proof is becoming a priority on local agenda's. However, there is a gap between those goals/visions and the number of realised projects. Part of the problem is a change in mindset and a change in process, where water is justified and becomes accepted not as a threat but as a foundation and unique quality within the program. Hence, water can become an added value; unfortunately there is still a long way to go.

1.4

1.4 Research question

The problem statement is divided into three categories: the aim of this graduation project, the main research question and sub-questions.

Aim of graduation project

Aim

This research aims to give insight into the challenges of combining housing with water storage in lowland polders, and to determine the financial feasibility of water-design concepts. In addition the strengths, weaknesses, opportunities and threats of each design will be related to the interests of the stakeholders and the effectiveness with regard to flood risk and water-management. For this research the Westergouwe case in Gouda will be analysed; in turn the research results can be implemented for future water-design projects in the Netherlands.

Main research question

According to the problem statement and aim of this research, the following main research question is formulated:

Main research question

What are the effects of different water-design concepts on the financial feasibility of urban development in lowland?

Sub research questions to be answered

In order to further investigate the field of research and consequently give answer to the main research question, the following sub-questions need to be addressed:

Sub research question

1. What are the effects/consequences of climate change on urban development and water-management in lowland polders; what new constraints/legislation has been adopted as a result?
2. Who are the key players/stakeholders and what is their role/interest in urban development in lowland polders?
3. What new techniques have been developed to cope with the consequences of flooding as mentioned in sub-question (1)?
4. How does the development process in lowland polders differ in relation to traditional urban development with regard to water management?
5. Which factors in water-designs are most influential and weigh the most on the consequences of the financial feasibility?
6. How do the different water-designs relate to the interests of the stakeholders, as mentioned in sub-question (2), and how do the designs relate to water management?

1.5

1.5 Conceptual model

Conceptual model

In order to visualise and clarify the problem statement and research question, the following conceptual model is derived. This is illustrated in the figure below. This is a schematic overview of the field of research and where the focus lies within the research design.

Main focus on product research

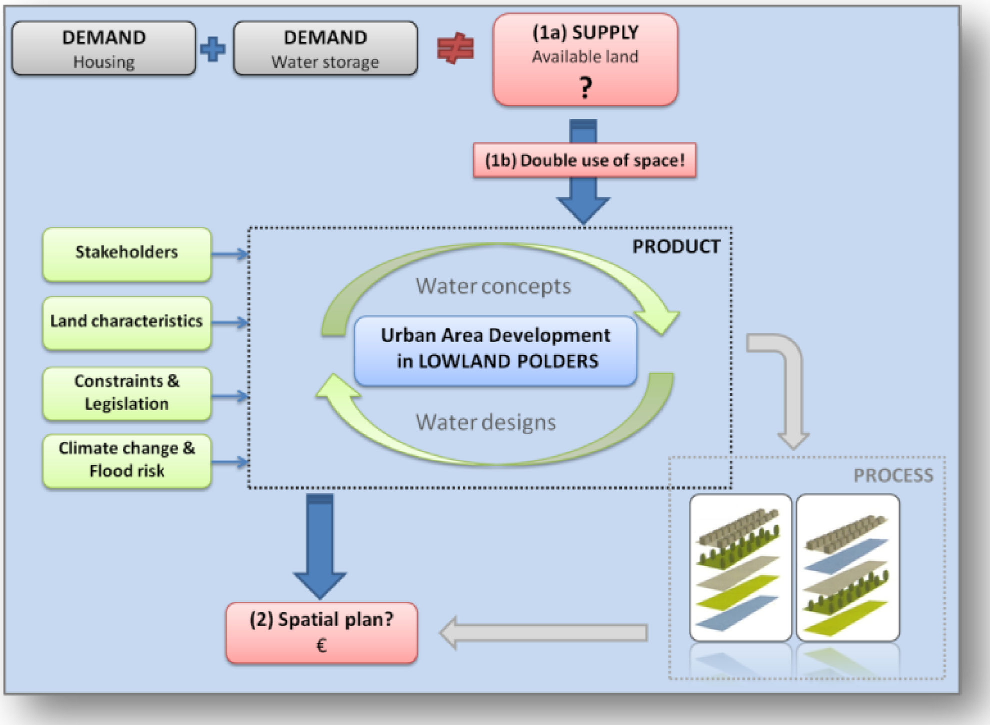


Figure 1: Conceptual model

Problem focus (1a+b)

The conceptual model can be interpreted in the following way. There are two main demands; the first is the people's demand for housing outside the city centres and secondly there is the social demand for water storage. Because there is a shortage in space and an increased intensity in space utilisation, the available supply of land is not sufficient to accommodate both programs. This mismatch (1a) forms the first major challenge; as a result double use of space and multiple purpose use of sites are needed (1b). This brings us to urban area development in lowland polder areas, where there are a number of key aspects directly involved with realising a spatial plan. On the one hand there are stakeholders involved with personal interests and goals, but there are also specific land characteristics that need to be incorporated into the program. In addition constraints and legislation with regard to water management have a great influence on possible development. This brings us to the following aspect of adapting a sustainable and durable solution to climate change and flood risk. The sum of these aspects forms the product-orientated approach to this research. Consequently these aspects need to be translated into a spatial program, but it is unclear how water designs and constraints translate into financial consequences. This forms the second major challenge; to quantify and translate innovative urban water designs into financial constraints (2). This research will address those challenges and use exploitation plans to give insight into different

Problem focus (2)

spatial designs and implications. These variants will represent an extreme perspective of different spatial plans of water plans.

Focus on product evaluation

Even though the main focus of this research lies with product evaluation/analysis, the process of achieving these goals (urban development in lowland polders) will also be addressed. This area is visualised in the bottom right part of the conceptual model. The two pictures represent the layer hierarchy; the traditional layer approach and the new hierarchy where water is the structural principle in urban development. The development process and cooperation between parties represents the process side of this research. The challenges, risks and problems will be described, but do not play a leading role in this research. In the conclusion of this report, recommendations will be made concerning the current process and how this research effects future developments in lowland polder areas.

1.6

1.6 Definitions

In order to further investigate the product- and process aspects of this research a few key definitions have been analysed. Defining these terms not only helps to understand certain terminology but also helps to outline the field of research and define research boundaries.

Water-design concepts and water-designs

These terms refer to spatial plans where water is a structural element within the program. The aim of water-designs is to be climate proof and water resilient. Because there are so few projects actually developed, the term 'concept' refers to the ideas and new instruments/techniques behind these designs. Water-designs are spatial plans where different water-design concepts have been realised.

Climate change

The effects of climate change are nowadays very noticeable and represent one of the greatest environmental, social and economic threats facing the world today. International organisations are working together in order to control climate change by taking precautionary actions. For this research climate change is referred to as:

Consequences of climate change

- The continual rise in sea level,
- Incidental rise in sea level caused by rivers overflowing in Delta areas,
- Concentrations of rainfall/sediment;
    - Short wet periods,
    - Long dry periods.

The Dutch government is taking precautionary measures by increasing the height of their dykes and allocating specific overflow (polder) areas in order to create a second defence line for the sea, thus creating buffer zones for excess river water. However, these measures alone are not full proof and could either fail or prove insufficient. In addition specific areas for water storage are needed including measures to guarantee safe urban living areas. Therefore the effects of climate change on lowland polder areas are increasing in intensity and will have a greater impact when combined with residential areas.

Relative rise in sea level = absolute rise in sea level + decrease in ground level

Rise in sea level

The rise in sea level can be distinguished by an absolute and relative rise. This is illustrated in the figure below, where the relative rise in sea level in any given point on land, is characterized by the sum of the increase in sea level (absolute sea level) and the local ground movements (www.knmi.nl). The rise in absolute sea level can be caused by a change in[5]:

- The total amount of water in the ocean (increase in mass),
- By the density of the present ocean water (increase in volume).

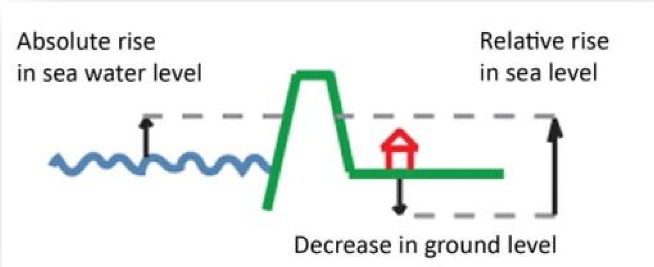


Figure 2: Rising sea level (source: www.knmi.nl, 2008)

Contributing factors for rise in sea level

An example of an increase in water mass can be caused by the melting of glaciers, ice caps and changes in river outflows. The major cause of increase in water volume is due to temperature changes, shrinking or expanding the ocean water. During the 20th century, the sea level worldwide has risen by approximately 1.8 millimetres a year, adding up to 10-20 centimetres in total[6]. The major contribution is caused by:

- The melting of the glacier and little ice caps,
- The expansion of the sea water,
- The melting of the Greenland ice cap,
- The calving of the Arctic ice cap.

The past few years the level of sea water has increased faster to approximately 3 millimetres per year. In addition, The Netherlands is currently undergoing a lowering in ground level due to soil subsidence. This is estimated to a few centimetres per century (www.knmi.nl). According to IPCC (Intergovernmental Panel on Climate Change) the sea level will rise by 18-59 centimetres worldwide during the 21st century, with an addition of 10-20 centimetres if the calving of the Greenland and Arctic ice cap continues (www.ipcc.ch). These happenings are not standard for every

[5] Source: http://www.knmi.nl/kenniscentrum/zeespiegelstijging/, 2008
[6] Source: http://www.knmi.nl/VinkCMS/explained_subject_detail.jsp?id=2621, 2008

location on earth. For The Netherlands, the KNMI estimates an increase in sea level of 35-85 centimetres by 2100 (KNMI Climate scenarios 2006). The major cause is influenced by the atmospheric temperature and the decrease in ground level. The changes in temperature and sea level, according to two scenarios are, illustrated in the table below.

Climate scenarios

Scenario (year)	Change in temperature	Rise in sea level
Moderate (2100)	+2 °C	35-60 cm
Warm (2100)	+4 °C	40-85 cm

Table 1: Climate scenarios for the rise in sea level (source: KNMI'06 summary, 2008)

Urban flooding

Flood prone areas

Aside from the threat of flooding caused by seawater, these potential urban areas also face the threat of urban flooding caused by rainfall overwhelming drainage capacity. In addition there is the chance of flooding caused by overflowing rivers. Flooding is a natural and recurring event for a river or stream; the result of heavy continuous rainfall exceeding the absorptive capacity of soil and the flow capacity of rivers, streams and coastal areas. This causes a watercourse to overflow its banks onto adjacent lands. Floodplains are therefore 'flood-prone' and are hazardous to development activities if the vulnerability of those activities exceeds an acceptable level. Acceptable risk criteria can help in distinguishing between different degrees of risk for different development activities and in evaluating constraints associated with potential investment projects. The chosen acceptable frequency of a particular flood event should be appropriate for the type of development activity. The consequences and impact of flooding can differ greatly, depending on the development project. Especially for urbanised areas the impact is high, because these areas are more densely populated and contain vital infrastructure. Continuing the development in flood-prone areas increases that risk. Consequently flooding is expected to happen more often in these areas.

For this research rise in sea level is a constant threat on polder areas, but the major threat of urban flooding is caused by rivers overflowing and extreme periods of rainfall. These aspects occur more frequent and have a more direct influence on urban areas.

NAP & Low elevation urban polder areas

NAP- average sea level

In the introduction it was already mentioned that 27% of the area in the Netherlands and 60% of its population is located below sea level. Figure 3, illustrates the different areas located either below or above 0 meter NAP. In The Netherlands NAP is a reference for the elevation height. This is roughly the same as the average sea level. If The Netherlands would do nothing to protect itself against the sea, then the greater part of the western cities would be submerged under the sea. It is also evident that The Netherlands cannot ignore the effects and impact of the rising sea level on future developments and structure of these lowland areas. The risk of flooding and the management of water will therefore play an important role in the organization of such projects. However, this also depends on the seriousness and level of risk we are prepared to tolerate and accept.

Elevation statistics in the Netherlands

Figure 3: Actual elevation statistics in The Netherlands (AHN), Above/below 0 NAP map (source: Adviesdienst Geo-Informatie en ICT Rijkswaterstaat, 2008)

Traditional development process

Water as structural principle in urban development

In the past integrating water, including water storage, in spatial planning never had a priority in the traditional development process. The main focus was always on ground and buildings, instead of water. The traditional process meant local grounds usually formed the basis for new development, followed by green, infrastructure, water (blue) and buildings (red). When water becomes the structural principle in area development, the organization of the spatial program becomes very different. This is illustrated in the new development process. A new challenge arises to think and design three dimensionally; combining water storage and buildings. As a result a different hierarchy in building stones is needed, where water becomes the primary layer for development. Figure 4 illustrates the shift in layer hierarchy in the development process.

Various pilot cases were conducted, such as the Haarlemmermeer polder, where this principle was adopted. Water formed the underlying basis for the structure of the spatial design. The other building stones were then integrated in the design in order to optimize the presence of surface water, water storage and possible excess water. The Haarlemmermeer polder is an example of an innovative water-design for future developments with water in lowland polder areas. In time this structural organization of layer hierarchy might become mandatory for future development.

A changing hierarchy in building layers

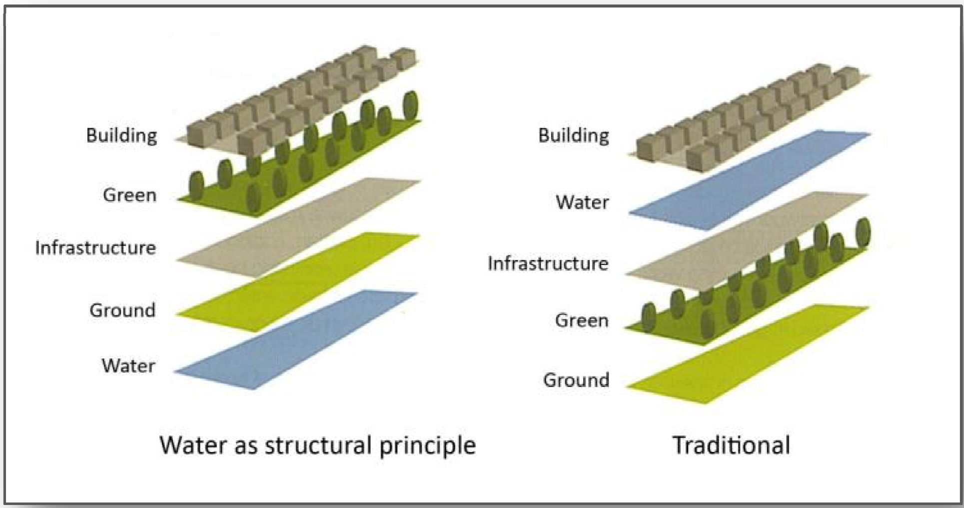


Figure 4: Hierarchy in building layers (source: Water Stedenbouw, Bouwen met Water, 2007)

1.7

1.7 Reader's guide

The structure of this report is as follows: in chapter 1 the research design is described; in chapter 2 the methodological approach and techniques used for this research are described; in chapter 3 the theoretical framework and literature study is reviewed; in chapter 4 the mathematical model (IGOMOD) for calculating the financial feasibility is described; in chapter 5 the context of the case study Westergouwe is analysed; in chapter 6 the different variants are described; in chapter 7 the data results are analysed and the different variants are compared followed by an analysis matrix and sensitivity analysis; and finally in chapter 8 conclusions are given with respect to the research questions, and recommendations are made for future implementation and further research.

The previous chapter was an introduction of this research and addressed the challenges of developing climate proof living areas with water storage in lowland polders. Consequently a conceptual model was described including key definitions. Chapter 2 will address the methodological approach including a research model and research methodology. Consequently the aim of each research method will be described including its relevance to the research (sub) questions.

2.1 Constructive research

This research is a practical analysis of current and future problems of urban development in lowland polders. Different instruments and techniques that can be implemented in water designs will be evaluated and financially quantified. This is done using literature study in a theoretical framework and case study in a practical framework. This research is closely related to constructive research, which develops solutions to a problem. The figure below illustrated a model of how it works.

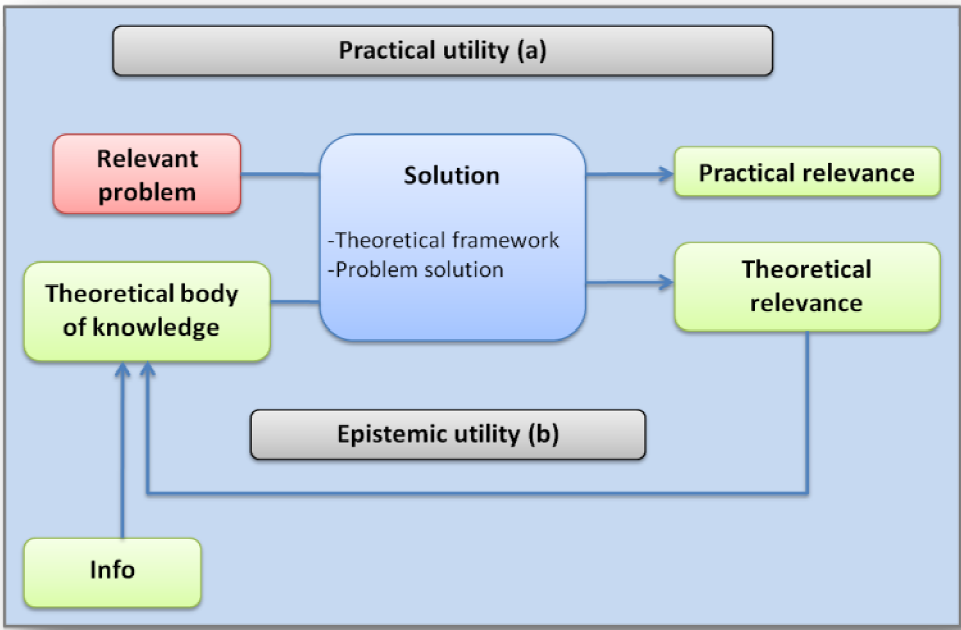


Figure 5: Constructive research (source: www.wikipedia.org)

The term 'construct' used in this context refers to new contributions being developed, being a theory or in this case a model to translate urban water designs into financial constraints. A solution must be acquired for the relevant problem using a predetermined method/instrument, thus giving answer to and having a practical and theoretical relevance. Practical relevance, referring to empirical knowledge offering final benefits, can be tested in practice/market, whereas theoretical relevance offers new theoretical knowledge which needs scientific acceptance. This is illustrated by the back arrow to the body of knowledge, which is combined with additional info including literature, articles, processes or experiences.

The steps being followed in this research are illustrated in (a) and (b). Practical utility (a) includes setting up objectives and tasks, identifying model, selecting case, running model, interpreting data results and giving feedback. Epistemic utility (b) includes constructive research, case research, qualitative- and quantitative research, theory creating and theory testing.

2.2

2.2 Research model

The figure below illustrates the research model. It is divided into five main phases: preliminary research, literature study, research framework, data analysis and conclusion & recommendations.

Research model

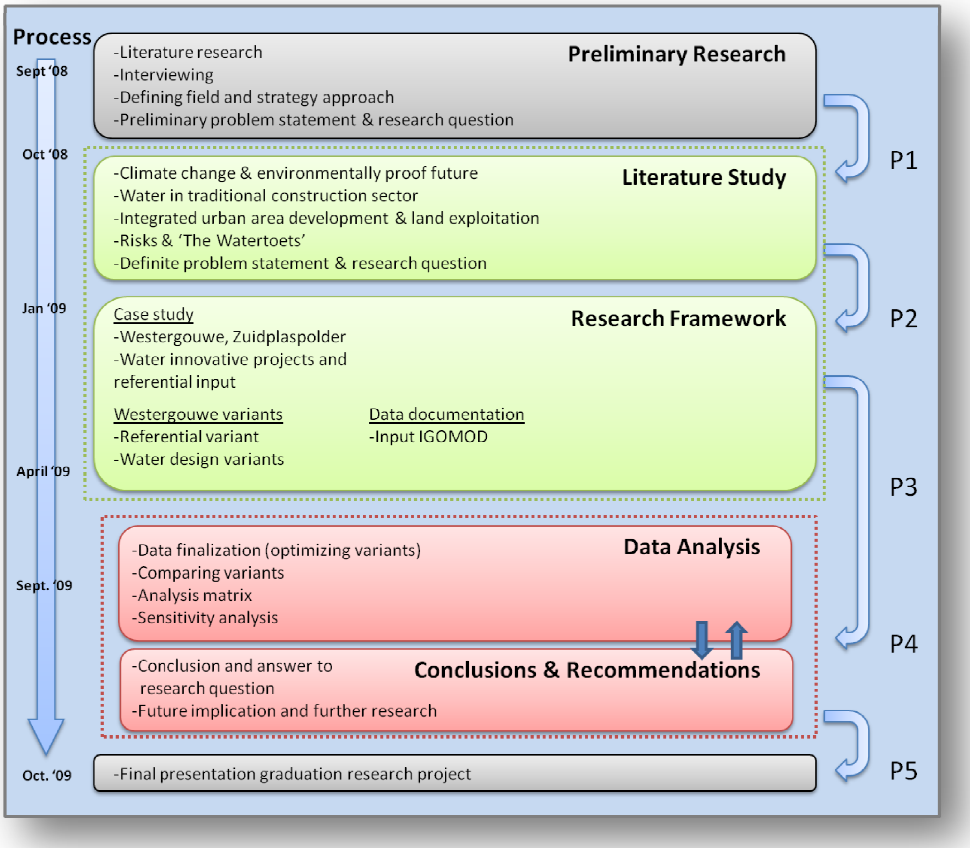


Figure 6: Research model

Phase 1

1. Preliminary research: conducting interviews, defining field of research and setting up preliminary problem statement and research questions;

Phase 2

2. Literature study: conducting background information and channel field of research to understand and analyse research topics, using literature study to answer sub-questions (1-4);

Phase 3

3. Research framework: analysing case Westergouwe, describing the referential (zero) variant and defining project alternatives/variants, defining the most influential effects of design variants in relation to the referential variant, translating specific factors in water-designs into social and financial effects;

Phase 4

4. Data analysis: the results from the different variants are analysed using an analysis matrix, followed by quantifying the results and translating them into

a bandwidth using sensitivity analysis, data analysis will be used to answer sub-questions (5-6);

Phase 5

5. Conclusion & recommendations: answer will be given to the main research question taking into account the conclusions of the sub-questions, recommendations will be made with regard to future implications and further research.

In the next paragraphs the different research methods will be described. This is done according to the different phases in the model above.

2.3

2.3 Literature study

Literature study is an account of what has been published on a certain topic by accredited scholars and other researchers. It is often used in essays and research reports to convey to a reader what knowledge and ideas have been established on a topic, and what their strengths and weaknesses are. Literature study is defined by a guiding concept, leading research or problem of discussion, helping to understand, support or argue a thesis. This form of study not only enlarges ones knowledge of the topic but also helps to define and critically analyse the topic. In principle literature study is: organised around and directly related to the thesis or research question; synthesis results into a summary of what is and is not known; and formulates questions or can give answer to research question.
In this research, literature study will be used to answer for the following sub-questions:

Sub-Q (1)

Sub-Q (2)

Sub-Q (3)

Sub-Q (4)

(1) What are the effects/consequences of climate change on urban development and water-management in lowland polders; what new constraints/legislation has been adopted as a result?

(2) Who are the key players/stakeholders and what is their role/interest in urban development in lowland polders?

(3) What new water-management techniques have been developed to cope with the consequences of flood risk as mentioned in sub-question (1)?

(4) How does the development process in lowland polders differ in relation to traditional urban development with regard to water- storage and management?

The results and answers of these questions are described in the conclusion of chapter 3, Theoretical Approach.

2.4

2.4 Case study

Case study was used for the practical part of this research. Case study is a specific strategy approach in research methodology. It is an intensive study, in-depth examination of a single event, case. This type of research is a systematic way of looking at specific events, collecting data, analysing information and reporting the results. It can be defined as a research strategy or empirical inquiry which investigates theories, information in real life context. Case study research can be single or multiple case studies, which can include quantitative evidence, relying on

multiple sources of evidence and benefits from prior development (www.wikipedia.org, 2009).
In this research case study was used to collect and document data from different cases consisting mostly of pilot cases and concepts. This was done to obtain valid data as input for IGOMOD; to get an understanding of various water-design concepts and methods; and to document different water housing typologies which have and are being developed. In addition an in-depth analysis was done on the case Westergouwe in Gouda. The spatial program of this case was then used to further asses various water-design variants and tests them on financial feasibility and resilience to flood risk and climate change. The aim of this methodology is to analyse the research results on a realistic project. Construction of the current plans for Westergouwe will start in 2011.

Characteristics of Westergouwe case

The Westergouwe case was chosen according to the following characteristics:

- Westergouwe is a lowland polder in the Zuidplaspolder and is the lowest point in Europe, -7 NAP,
- Clear structural plan with relevant accessible data,
- Not a pilot case but a realistic project construction date 2011,
- Urban development plan combined with water storage,
- A diverse housing program with commercial facilities,
- Unique structure of land with different levels in ground depths,
- Project Westergouwe is part of a larger region where water management and climate control is integrated in future developments.

The decisive reason why Westergouwe was chosen was based on the amount of accessible, reliable data, and the size of Westergouwe (approximate 170ha), making it applicable for IGOMOD; an important aspect and essential for data validity. Consequently this allowed for better variant comparison and the analysis of the research results.
Aside from the main research question, case study analysis will also help to answer sub-question 3:

Sub-Q (3)

> *(3) What new water-management techniques have been developed to cope with the consequences of flood risk as mentioned in sub-question (1)?*

The case Westergouwe is discussed in chapter 5, Context- Case study Westergouwe.

2.5

2.5 Data documentation

Aside from literature study and case study analysis, data documentation was also conducted during the phases: literature study, research framework and data analysis. This included data inquiry on costs and revenues related to input for IGOMOD: ground exploitation costs and revenues; real estate costs and revenues; and costs related to construction, landscaping and civil costs. In addition relevant projects were consulted on project phasing for the IGOMOD variants.
The aim of this research methodology is twofold: firstly to support the validity of data-input and secondly to enhance the credibility of the end results. This is essential in order to answer the main research question.

2.6

2.6 Financial feasibility study – IGOMOD

Feasibility

Feasibility study is a preliminary study to determine a project's viability or successful completion of specific project goals and objectives. It can also be referred to as feasibility analysis, which analyses the results of a study in order to determine if a certain project will be approved or become a success. It is an analysis of possible alternative solutions to a problem and a recommendation on the best alternative. If a project is seen to be feasible from the results of the study, the next logical step is to proceed with it. The research and information uncovered in the feasibility study will support the detailed planning and reduce the research time[7].

Economic/ financial feasibility study

There are many types of feasibility studies, but for this research the main area of focus will lie with economic (financial) feasibility. Because each water-design is unique and additional water related investments are unclear, it is important to determine the economic feasibility of such projects. In addition the level of impact of those design concepts on the whole project is still unclear. A feasibility study or cost/benefit analysis can help to give insight into those costs and potential benefits. Only then can the economic feasibility of such projects be determined. Consequently it can help to weigh the costs in relation to the benefits and give insight into the implementation of water constraints in a spatial plan. The question whether or not to develop in lowland polders can more easily be answered when the costs and benefits have been determined.

IGOMOD

Financial consequences of design decisions in urban development

Design decisions influence building costs and the economic feasibility of urban development projects. It is essential to understand how design decisions affect the project financially. Part of this research is to investigate the relationship between water design decisions and the financial consequences. Mathematical models such as IGOMOD are being developed to give insight into cost effects of different design decisions in an early stage of development. Consequently modeling and cost/quality management research can be used for real estate development. As a result the specific roles and interests of the various stakeholders in urban development can be aligned for better urban designs.

Mathematical model: design, financial land use planning and real estate development

In the case of urban development projects, it is crucial that the various stakeholders are able to gain insight in the 1) quality and 2) costs effects of changes in design and financial parameters. IGOMOD is a computer based mathematical model which relates three aspects of urban development in a comprehensive way in one instrument: design, financial land use planning and real estate development[8]. The various project designs and the effects of design changes can be made visible. In addition the financial outcome of land use planning and real estate development can be instantly calculated. The great advantage is that IGOMOD can assist at an early stage in the negotiations between stakeholders of urban development, thus adding

[7] Source: http://en.wikipedia.org/wiki/Feasibility_study#cite_note-2, 2009
[8] Source: http://www.bk.tudelft.nl/live/pagina.jsp?id=091ef03f-ebce-4326-96d2-bb8588da8c41&lang=en, 2009

to a more transparent development process. The possibility of IGOMOD to calculate directly the financial feasibility of design changes makes it a valuable tool in urban development. The model is implemented in Microsoft Excel and programmed in Visual Basic for Applications.

For this research IGOMOD will be used to calculate the financial feasibility of different water-design variants. The aim is to give insight into design decisions and water-design applications and translate those constraints into financial parameters. Consequently the results of IGOMOD can be used to determine which factors in water-designs are most influential with regard to cost-benefits and financial feasibility. Financial feasibility study and IGOMOD will be used to answer the main research question but also sub-questions (5 & 6):

Sub-Q (5)

Sub-Q (6)

(5) *Which factors in water-designs are most influential and weigh the most on the consequences of the financial feasibility?*
(6) *How do the different water-designs relate to the interests of the stakeholders, as mentioned in sub-question (2), and how do the designs relate to water management?*

2.7

2.7 Analysis-matrix

Different spatial designs can be cross analyzed with a list of criteria by use of an analysis matrix

Spatial designs can be analysed using different techniques and analysis methods, whereby the aim is to ascertain the projects unique qualities and opportunities, but also to establish where possible threats and risks may lie. In doing so, insight is given at an early stage of project development, into critical financial information and spatial qualities. The analysis-matrix is one such method, which cross analyses a list of criteria with spatial designs; in this research that would include the different variants for Westergouwe. This method is therefore especially useful in alliance type (PPS) cooperative working forms in urban area development. The most steering possibilities are during the initiative- and feasibility phase. During this phase the program is not yet defined and research can be done, in cooperation with other parties, on how to best facilitate and give content to an initial idea. Cross analysing each variant with a list of criteria will give insight into the projects risks for the stakeholders and possibly lead to a feasibly outcome in spatial design and financial result. Analysis-matrix will be used to answer the main research question and also sub-question (6):

Sub-Q (6)

(6) *How do the different water-designs relate to the interests of the stakeholders, as mentioned in sub-question (2), and how do the designs relate to water management?*

2.8

2.8 Sensitivity-analysis

A sensitivity analysis can be done to determine the financial effect (bandwidth) in an exploitation model. A land-exploitation calculation is based on estimations of costs and revenues and is therefore always ‘sensitive’ to changing circumstances, such as planning delays or increasing land prices. With the use of a sensitivity analysis, different changes in circumstances or design changes can be translated into financial

consequences and effects. A small change in program within a project could have a large financial affects. If for example a change in planning has a greater financial effect than an increase in land prices or other changes, then the financial effect (end result) is sensitive for changes in planning (phasing). It can be of great value to predetermine such financially sensitive aspects within the program and project. This in turn can assist in determining the best strategy with the least risks. With sensitivity analysis the influence of certain parameters on the financial end result are analysed. Apart from parameters such as rent level, inflation, land price and phasing, program specific parameters can also have a great effect on the end result. Such items can include housing typology, quantity, environmental aspects, water- and green distribution or maintenance costs.
A sensitivity analysis will give an overview of the largest financial opportunities and risks in relation to the land-exploitation. This in turn will give the initiative party or project coordinator insight into the 'financial strain' of the project and allow for potential necessary financial intervention. The sensitivity of the parameters indicates the bandwidth of the financial end result of a certain spatial design.

In addition to the results from IGOMOD, the analysis-matrix and sensitivity analysis will be used to answer sub question (5 & 6):

Sub-Q (5)

(5) *Which factors in water-designs are most influential and weigh the most on the consequences of the financial feasibility?*

Sub-Q (6)

(6) *How do the different water-designs relate to the interests of the stakeholders, as mentioned in sub-question (2), and how do the designs relate to water management?*

The results of the analysis-matrix and sensitivity analysis will play an important role in answering the main research question. Chapter 7 will go into the data analysis of the different design variants.

3. Theoretical approach

This chapter is a further investigation of certain aspects related to the research field, problem statement and research questions. This is done through literature study to give a better understanding of the different aspects associated with urban development and the complex challenges facing development in lowland polder areas. Consequently answer is given to the sub-questions mentioned in chapter one. The first paragraphs will address definitions and criteria, and the different parties involved with urban development and water management. This is followed by literature study on the current development process and water management instruments.

3.1 Climate-proof future

To develop a climate proof Netherlands is a new and demanding challenge. Also it is a growing business that is inevitable for our Dutch lowland landscape under a changing global climate. The Central Government has invested increasingly over the years in innovation and in the development of new knowledge on this subject. The successes of these investments strongly depend on the participation of local and central governments in projects related to environmental challenges. These projects require the cooperation between public and private parties together with the construction industry. A great deal of potential lies in the development and implementation of new sustainable concepts. In The Netherlands such projects include waterproof housing and urban areas that can store large amounts of rainwater or that can even cope with temporary flooding. D. van Well, member of the Board of Dura Vermeer, states that it is essential that experimentation is stimulated and that the government should proactively participate in such projects. He believes it is the only way to create a climate proof future (Samen Bouwen aan de Toekomst, 2007). New innovative concepts such as for the Haarlemmermeerpolder can breach the gap and perspectives between public and private parties in complex development projects. A positive outcome could stimulate the development of new concepts and knowledge on climate, construction and spatial development. In the end this could lead to the realization of future projects in practice.

Preparing The Netherlands to be climate proof is one of the most demanding spatial challenges of the century. Sea levels are rising, waves are crashing more violently on our coastlines, our rivers will have to cope with heavy rains and excess water and the weather will present more extremes; long dry spells and heavy rainfall. In addition the ground level, particularly in polder areas are decreasing due to soil settlement. In 2007 J. Cramer from VROM stated that “We must not wait any longer with investing in a climate proof Netherlands. The high unpredictability of climate change is an urgent problem of our nation” (Samen Bouwen aan de Toekomst, 2007). In order to face this challenge it is no longer a matter of battling against the water by increasing our dykes and dunes or increasing pumping out excess water but a matter of learning to live *with* water. Climate change is nowadays a factor that demands integral recognition when it comes to spatial organization, urban and rural projects and project development. Programs such as ‘Leven met Water’ and ‘Adaptatie Ruimte en Klimaat’ have been established to stimulate new concepts and knowledge in cooperation with delta technology institutes such as Deltares. In addition the State is

40% of land meant for new housing is reserved for water storage

investing €50 million in knowledge development on climate resistibility (Samen Bouwen aan de Toekomst, 2007). Naturally there are consequences for the traditional construction process. Water management and water reserves demand large amounts of space, usually in locations that are interesting or destined for housing or have economic development possibilities. It is estimated that 40% of housing that will be developed over the next 10 years will be on grounds reserved for water storage or on peat-soil (Samen Bouwen aan de Toekomst, 2007). This is also the case for the Zuidplaspolder and the Haarlemmermeerpolder. In the future building the traditional way will be less likely and thus the development in polder areas will demand a new approach. In addition the costs and benefits of developing in polder areas will need to be determined as will the maintenance costs, risks or damages caused by water inconveniences, or worse, flooding.

3.2

3.2 Groundwater-seepage and poldering-principles

There are various polder-techniques to cope with groundwater and seepage pressure. Ground- and river water from surrounding areas is pushed towards the surface, which is a frequent occurring problem in polder landscapes. The figure below illustrates this problem in polders and areas dealing with land reclamation.

Seepage pressure in lowland polders

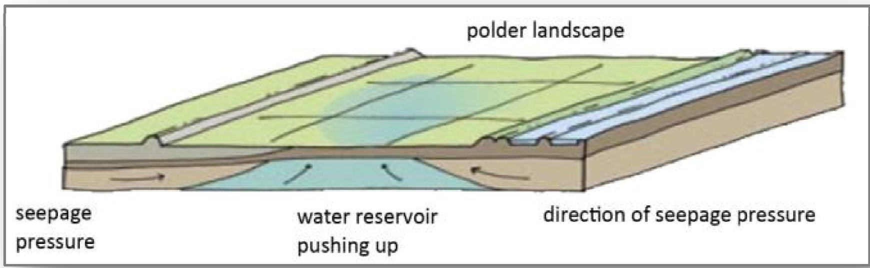


Figure 7: Current situation of seepage pressure in polders (source: Vista landscape and urban design, maart 2007)[9]

The figure illustrates a cross-section of a polder located a couple of meters below the surrounding area. The arrows in the ground layer show the direction of seepage pressure towards the middle of the polder. Directly beneath it a reservoir of freshwater is created pushing up on the surface. If nothing is done, the middle area will remain wet and unfit for development. One technique to cope with this problem is to load several layers of sand, thus forming a sturdy basis. This is illustrated in figure 8. It is now possible to develop on this area. A freshwater lens is formed in the sand layers, having the same effect as a pond or lake: the influx of ground water from surrounding areas and underneath is compensated.

[9] Source: Vista landscape and urban design, maart 2007, *Nieuwe Dorpen voor het Groene Hart, Duinwonen in de Droogmakerij*, InnovatieNetwerk, Utrecht. p, 14.

Inundation

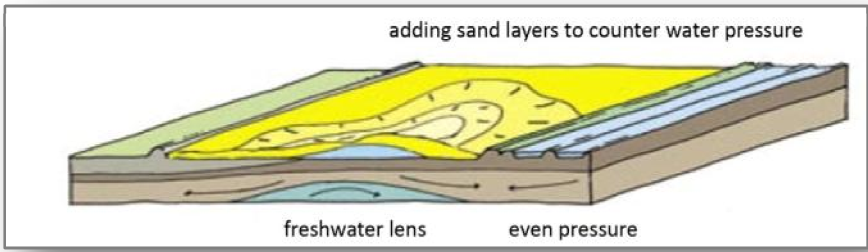


Figure 8: Adding layers of sand onto a polder (source: Vista landscape and urban design, maart 2007)

Another technique is inundation, whereby the difference in level height with surrounding area is cancelled out, thus solving the problem of inflowing water. As this technique applies counter pressure against seepage pressure of freshwater underneath. This is illustrated in figure 9. In this example the counter pressure is much larger than the seepage pressure, hereby pushing away the fresh groundwater.

Combination of new land and new water

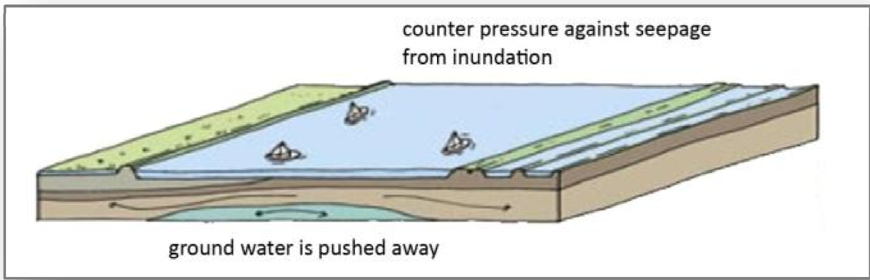


Figure 9: Inundation of polder (source: Vista landscape and urban design, maart 2007)

Lastly there is another technique which is a combination of creating new land and new water. This can be achieved by using dunes as embankment/dyke and separating the different level heights in the area. In addition it is possible to create islands within the newly created lake/pond. Instead of sand different soils such as clay, silt and other materials can be used to create these islands, because it is not necessary to store water in the sand layers. This method, illustrated in figure 10, is therefore useful for developing on these islands, while individually regulating water level heights.

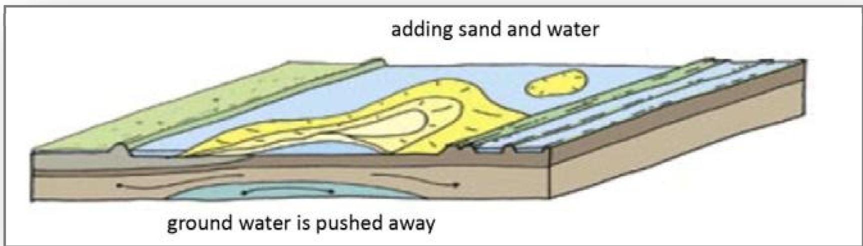


Figure 10: Combination of new land and water (source: Vista landscape and urban design, maart 2007)

3.3

3.3 Stakeholders

In integrated urban area development there are many different parties involved including public parties, private parties and users. Each participant has its own interests and role throughout the project. Specifically related to water management and the overall quality in the Netherlands, are Rijkswaterstaat and water regulatory authorities. Their key role is to protect the country from the threats of water including the maintenance and management of water.

Rijkswaterstaat

Rijkswater-staat is responsible for maintenance of waterways

Rijkswaterstaat is the executive branch of the Ministry of Transport, Public Works and Water Management and works to keep our country safe from the sea and also guarantee the availability of enough clean water. Rijkswaterstaat is responsible for the maintenance of the national water system (65.250 km^2) and the continual flow in water and the protection against flooding[10]. This organization is constantly growing in expertise and knowledge on water management, which is open for the public and private parties to use. In doing so Rijkswaterstaat is working more closely with other related organizations and companies in order to strengthen that position. Rijkswaterstaat has ten regional institutions, 36 districts and three project directories enabling her to function successfully in The Netherlands.

'Market unless'

The Netherlands has many large and small rivers, canals, creeks, water ditches and lakes. Each of these water typologies are interconnected either above or below ground. Rijkswaterstaat is responsible for the maintenance of these waterways and networks. In order to guarantee a safe future for our country, Rijkswaterstaat is constantly investing in new designs and projects in order to increase their knowledge and create a safe and livable environment. In order to achieve that, Rijkswaterstaat is realizing that it is essential to work in cooperative forms with public parties and the local market. Consequently they adopted a new principle called '*market unless*'[11]. This principle implies that the traditional tasks such as the construction, management and maintenance of water systems are assigned to the market. The guidelines and restrictions are still laid out by Rijkswaterstaat, but the design and solutions are left to the market. In complex projects including the cooperation of many different stakeholders, a cooperative working form between public and private parties becomes essential. Rijkswaterstaat often prefers cooperative forms between public and private parties because it can be beneficial for both:

Benefits of cooperative forms

- Cooperative forms speed up the development process and projects are more likely to remain within budget;
- In cooperative forms market parties are mutually responsible for the whole process. They are involved from the start of the project and can give valuable input for innovative solutions and concepts;
- By assigning construction and maintenance to one party, they become responsible for the projects' use. Their ideas therefore have to become innovative, user friendly and durable.

[10] Source: http://www.rijkswaterstaat.nl/organisatie, 2009
[11] Translated from '*markt opzjj*' source: http://www.rijkswaterstaat.nl/organisatie/pps, 2009

However, it isn't always the case that Rijkswaterstaat outsources their tasks to the local market. If a certain project costs more than €65 million for example, Rijkswaterstaat has to conduct an added value test in order to determine the best course of action[12]. This approach demands new tasks and responsibilities of each party. This also applies to Rijkswaterstaat, who is no longer responsible for execution but for the organization of the project.

Water Regulatory Authorities

Responsibility of Water Regulatory Authorities

There are multiple water regulatory authorities in The Netherlands each responsible for the water in the streams, lakes, pools, springs and near surface groundwater, in their specific region. These authorities must prevent flooding, guarantee clean water, ensure sufficient supply of water and manage groundwater. Water regulatory authorities also have to upkeep the safety of dykes/dunes and ensure safe living environments. On average water regulatory authorities manage a combined 260 km of dunes, 430 km of sea dykes and 1.430 km of river dykes[13]. The dykes require continual maintenance in order to prevent weak places. Recent tests have shown that there are approximately 150 weak places in our dykes today and that approximately 500 km of primary water defenses are in need of reinforcements. The remedial costs are estimated at €1.2 billion[14]. The water regulatory authorities manage the primary water defenses, whereas the Government is responsible for the original construction and necessary reinforcements. The yearly costs for maintenance of the dykes are approximately €550 million, which translates to around €40 per person per year[15]. The costs per household for the maintenance and management of our waterways are region specific. An overview of the yearly costs for each type of household is illustrated in appendix II, which is an example for the Hoogheemraadschap of Delfland for 2008. Water regulatory authorities work together with Rijkswaterstaat to regulate the water levels in each district. In times of drought excess water in one region can be redirected to another area. With regard to water management in new innovative lowland projects the initial costs of construction for the water system could be much higher. In addition the maintenance and management costs of new systems could also be higher. These costs will have a direct effect on the yearly costs per household for future users: how much will depend on the specific location and project. This also applies for any benefits that may result. The role of water regulatory authorities and Rijkswaterstaat in lowland polder development will need to be analyzed and determined.

Developers/investors

Reduce risks and increase revenues

These stakeholders are represented by any developing party, construction company or investor. The goal and interest of this stakeholder is to reduce development risks, reduce building costs and increase revenues. This is usually generated by high density development without costly additional investments; a reason why they can be hesitant to initiate and participate in innovative designs.

[12] Source: http://www.rijkswaterstaat.nl/organisatie/pps/ppsbijrws, 2009
[13] Source: http://www.waterschappen.nl/faq_waterschappen.html, 2009
[14] Source: http://www.waterschappen.nl/faq_waterschappen.html, 2009
[15] Source: http://www.waterschappen.nl/faq_waterschappen.html, 2009

Developing parties will want to reduce the construction period and sell off as many homes as soon as possible. Moreover they will want to have sold a majority of homes prior to development; allowing them an advance in payments with the reassurance of buyers. A good understanding and 'feeling' for the local housing market is essential. This risk factor is part of the role as developer, but can also result in large revenues.

Municipality

Municipality of Gouda

For this research the case study of Westergouwe was used. Therefore the stakeholder on behalf of the municipality is Gouda. The plans for Westergouwe are part of the RGZ-triangle: the location is located between the city of Rotterdam, Gouda and Zoetermeer. Due to a shortage in available space for new housing, Gouda conducted a number of studies for possible new locations; Westergouwe proved to be a valuable location with innovative possibilities. With this in mind and in cooperation with regional institutions, general constraints were developed with regard to spread-use of available space, a re-structural program for new development plans, urban spatial development plan (green, water, eco, recreation etc.), and accessibility. The municipality of Gouda is responsible for the further development of the structural plans, the housing program, integration of water and water related issues, traffic- aspects and requirements, and financial aspects[16].

3.4

3.4 Land-exploitation

Land-exploitation consists of accomplishing private-legislative actions to fulfil and realise public goals. In general, either a public or a private land-exploitation company will acquire the land and sign up an agreement with a contractor and project developer. In turn the latter party is responsible for readying the land for construction respectively to build, and either sell constructible land parcels or issue a leasehold-type contract. Public parties can include municipal land development companies whilst private parties can be included in PPS-type alliances. The aim of land-exploitation is to realise urban renewal or city upgrade plans, within politically issued boundaries and restrictions, with a most favourable end result. Independent of the question which party is responsible or who will execute a certain action, the following activities can be distinguished in land-exploitation[17]:

Activities in land-exploitation

- Obtaining ownership of or acquiring land (with or without stock),
- The operation/processing of land with all related aspects;
- public-juridical revision (change of designated land)
- civil-technical and/or culture-technical revision (reading for construction),
- The marketing of the product, including;
- sales of construction ready ('uitgeefbare') terrain
- issuing of leasehold type contracts for construction ready terrain
- delivery and transfer of the public space (to the municipality)

16

17 Vreke, J. et al (2005), Alterra-rapport 118: *De (on)geschreven regels van het spel, De positie van groen in rode projecten,* Alterra, Wageningen, p39.

In essence, with land-exploitation the total costs, at minimum, need to be covered by the generated revenues. The total costs include purchasing of real estate, construction ready costs, upper-ground facility costs, financing costs, management costs and administrative costs. The generated revenues include income from land distribution (via selling and/or leasehold) and income from subsidies.

Instead of the municipal development company executing a land-exploitation, nowadays it is more frequent that this is performed by a development company consisting of an alliance between public and private parties. This cooperative working form allows parties to work closer together and safeguard overall goals and personal interests. One of the advantages of performing a land-exploitation is to test and evaluate the financial feasibility of certain plans in advance (Witpaard-partners, April 2008)[18].

Residual land price

Residual land price method

Before distribution of land can take place, the land value for the total area needs to be determined and each land-plot needs to be calculated. The residual land price method is one such method often used to estimate land value in urban area development. This method is based on the market value of the land and the costs to develop the housing and buildings, including the costs to ready the land for construction. With new plans for urban area development a land-exploitation plan is essential, weighing the costs with the revenues; often referred to as a cost-benefit analysis. As mentioned above, the total costs are directly related to the costs of production and development. Not all upper-ground facility costs can at times be included in the total plan costs, because in some cases other areas or neighbourhoods can also benefit from these new developments. Part of those costs can then be distributed out.

Land-exploitation risks

Risk categories in land exploitation

Due to the complexity of construction projects, the many different parties involved and the relatively long period of realisation with urban development plans, certain decisions can be forced to be reconsidered. Amongst other things the land-exploitation is exposed to a number of risks. With regard to these risks, three main categories can be distinguished[19];

- *Environment risks* - concerning political, administrative and social developments, economic developments, changes in financial parameters and law- and juridical legislation, and problems in cooperation,
- *Project risks* - these may also include complications in cooperation between parties, conflicting interests and inadequacies in agreements. In addition the overall quality of the plan can be insufficient and setbacks can occur during development,

[18] Witpaard –partners, april 2008, Bestemmingsplan Westergouwe, gemeente Gouda, p.19.
[19] Vreke, J. et al (2005), Alterra-rapport 118: *De (on)geschreven regels van het spel, De positie van groen in rode projecten,* Alterra, Wageningen, p49.

Focus of risk during different phases of development

- *Organisational risks* - concerning mostly the structure of the cooperation (task distribution, rights and responsibilities) and internal processes such as administration, communication, planning and project management.

The following figure illustrates the focus of each risk during the various phases in development.

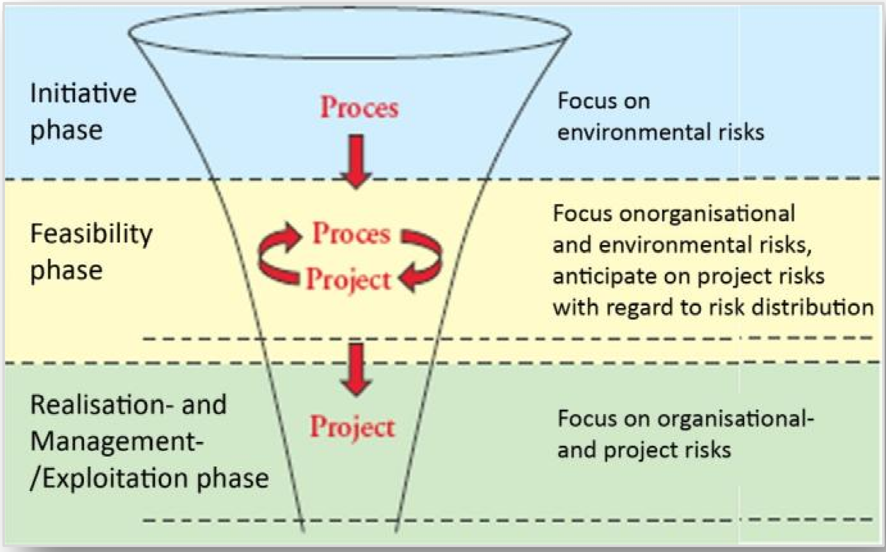


Figure 11: Phasing in relation to risks (translated from dutch to english, source: B & G, maart 2004)[20]

During the feasibility phase the main effects of the risks are on the project as well as the process. The focus lies on organisational and environmental risks. The aim is to anticipate instead of act and (re)distribute the different project risks. The following table 3 gives an overview of the different risks, their main typologies and indicators.

[20] B & G, maart 2004, *Goed risicomanagement bij PPS-gebiedsontwikkelingvoorkomt tegenvallers*, p. 5.)

Major land exploitation risks and indicators

Major risks	Risk typology	Risk indicator
Environment risks	Political/administrative/ social	Basis, political enforcement, different governments, social resistance, complex procedures
	Economic	Market developments, price developments, financial possibilities, bankruptcy private parties
	Laws and regulation	Objection procedures, claims, authorisation, procurement, environmental and expropriation law, integration planning
	Financial parameters	Rent and inflation, price increase (building costs), planning deviation
	Cooperation	Absence of commitment, turnover staff
Project risks	Cooperation	Conflict of interest, inadequate agreement
	Quality of plan	Insufficient and consequences in cost-benefit
	Plan development	Time planning (too tight), plan development costs (too high), disappointing quality designer
	Land-exploitation	Processing fees higher, furnishing of public space, technical (program of requirements), spatial (accessibility, soil quality, groundwater etc.)
Organisational risks	Structure/processes	Adjustment, planning, procedures
	Culture/staff	Corporate culture, quality/capacity of staff

Table 2: Overview major land-exploitation risks (source: Vreke, J. et al., 2005, Alterra-rapport 118, p. 50.)

Shift from environmental risk to organizational risk as process continues

The key idea behind the different risks during the whole development process is, that as the process continues (from initiative- to management phase) the accent shifts from environment risks to organizational risks. The level of risk of project- and organizational risk increases as more (public and private) parties become involved in the land-exploitation. This can be reduced by setting up strict and clear boundaries, tasks, responsibilities and financial implications. In order to guarantee smooth cooperation between public and private parties, a clear action plan is essential.

3.5

Focus on process in urban development

3.5 Traditional construction sector

Even though construction companies are aware of the consequences of climate change and the need for adaptation, they are hesitant to participate in related research and development projects. They do however recognise the significance of such innovative concepts. 'Bouwend Nederland', for example does actively stimulate innovative water projects, but there are still too many private companies that are reticent to participate. The main reasons for that are:

Private companies are reticent to participate

Major land exploitation risks and indicators

- Firstly, construction companies are hesitant about the consequences that such projects may pose for future tendering, especially for knowledge based development projects. The information that a construction company may acquire during the research phase may be considered unfair during the tendering procedure. It is still unclear for public and private parties what the actual consequences are for participating in knowledge based research for later tendering of the project.
- Secondly, construction companies do not create any revenues in the short term when participating in knowledge based projects that include the cooperation between public parties, institutes and potential competing companies. It is only in the long run that a construction company can create revenues and then there is always the risk that another competing company gets the project after tendering.
- Lastly, construction companies don't feel the direct urge to participate in innovative and risky projects. The current market (before the economic downturn) is very strong and there are enough outstanding projects, suppressing the need for risky, innovative projects. It would appear that climate adaptation has never been a priority for construction companies, making it difficult to change this trend.

In order to get all participants to participate proactively in new innovative developments in polder areas it is imperative that a change in the traditional construction sector occurs. This also includes all public and private parties, making the development process more transparent and measurable. This leads to an integrated development approach.

3.6

3.6 Integrated urban area development

Integrated approach linking all aspects of development in one project

Complex innovative projects, conflict in interest

One of the key criteria in urban area development is the combination of different functions in one specific area. That combination of integrating different real estate and infrastructure has become an important aspect in future development. The functionality, architectural quality and real estate is aimed to increase in value over time. This is strongly dependant on the location characteristics. The location must comply with the demands and restrictions of local economy, social standards, spatial organization, legislation and environmental control. This requires that all functions such as dwellings, business, facilities, infrastructure, water and green are taken into account. An integral development approach is often used in order to link and connect these aspects within one project. This requires the cooperation of all parties and stakeholders. Different cooperative working forms are implemented to ensure the synergy of all functions in one area in order to achieve the best quality in living, spatial quality, and social- and economic prosperity. An integral urban area development approach is needed to develop an area in agreement with the different spatial functions and climate change issues. This requires the cooperation of multiple parties and stakeholders. The different parties each have their own agenda, personal interests and expectations. These indifferences between public and private parties often complicate the realization of complex innovative projects. Public parties are driven by social interests, whereas private parties and users have commercial interests. This friction must be adjusted to align the goals. This in turn requires the cooperation between public and private parties. This is one of the key aspects in order to achieve mutual goals and guarantee success. The cooperation of different parties whilst complying with new environmental legislation easily increases the complexity of large scale urban development projects.

Knowledge based projects

Public and private knowledge based projects are a unique instrument to realize innovations on climate adaptation and water management. In such projects a solution must be acquired for multiple challenges such as the water problems, housing and infrastructure. A multidisciplinary approach is needed with different participants and stakeholders. Cooperation is crucial throughout the development cycle but also the management phase. Only through working together will it be possible to give insight into the challenges and align the differences in interests in order to realize new projects.

3.7

3.7 Knowledge development & development project

In 'Samen Bouwen aan de Toekomst' a distinction is made between the practical development project and knowledge development. The development project is the realization of a certain project, divided into the initiative, design, realization and management phase (management phase not included in the figure). For each of the phases research is needed to analyze the local situation with different designs and solutions. This is usually performed during the whole process, but it is also possible to establish a separate research project including not only the directly involved parties but also knowledge institutes, companies, engineering consultancy firms or other construction businesses. This is a separate knowledge project consisting of public and private parties that are not directly associated with the development project but can give input and valuable insight. See also figure 12. The idea behind this concept is that such knowledge development can introduce key guidelines and instruments to help and assist in research and project development. This was initiated by PSI Bouw, called 'Aanbesteding na Onderzoek', which is a program that investigates the influences and results of this approach in the construction chain, contributing to added social value, value for the client, sustainable performance in the construction sector and improved knowledge infrastructure[21].

PSI Bouw, 'Aanbesteding na Onderzoek'

[21] Source: http://www.psibouw.nl/projectenpagina.asp?id=12259, 2009

Knowledge development versus development project

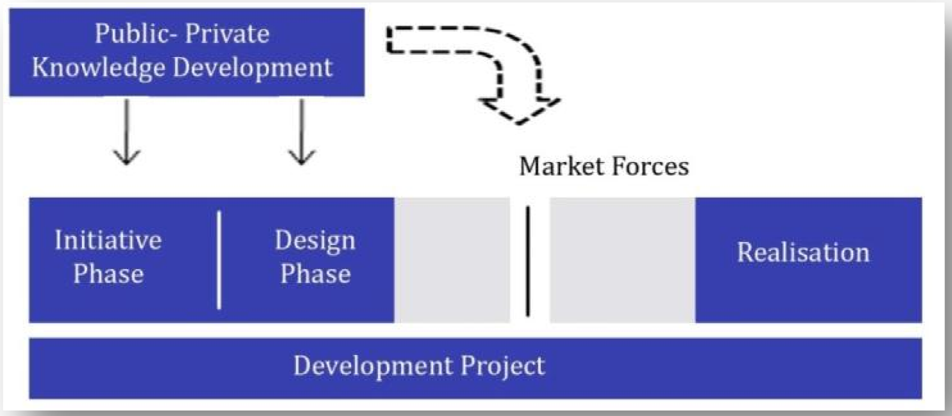


Figure 12: Schematic overview of knowledge development versus development project (source: Samen Bouwen aan de Toekomst, 2007)

Part of the success of this platform is to determine and quantify the different measures that need to be taken in innovative polder developments. The boundary conditions set up by local governments and the State need to be determined and calculated for such projects. By doing so it will become clearer what the initial costs can be and what party is responsible for that investment. In addition the benefits of those investments need to be calculated throughout the developing process but also during the management phase. Only then is it possible to determine whether or not innovative projects such as the Haarlemmermeerpolder and the Zuidplaspolder are feasible.

3.8

'Vijfde Nota Ruimtelijke Ordening en de Startovereen-komst Waterbeleid 21ste eeuw'

3.8 The 'Watertoets'

The 'Watertoets' originated from the Government's standpoint 'Anders omgaan met water'. This is part of the 'Vijfde Nota Ruimtelijke Ordening en de Startovereenkomst Waterbeleid 21ste eeuw'. The Watertoets was adopted as an important instrument in the coordination between the policy on water and spatial planning. It was first implemented in 2001, but was only legally binding as off 2003 with regard to the 'Wet op de Ruimtelijke Ordening'[22].

The Watertoets is an instrument designed to take into account and guarantee the interests of water management within spatial planning and decision-making process. It is not so much a testing method performed after completion of a project but rather a process to get the initiator of a certain spatial plan together with the water management organization at an early stage. The aim is to incorporate water issues into the spatial plan as soon as possible. This requires that both parties are involved right from the start in order to actively combine water management with spatial

[22] Source: http://www.rijkswaterstaat.nl/themas/bescherming_tegen_het_water/veilig_tegen_hoogwater/de_veiligheidsnorm/watertoets/index.aspx, 2009

Water management requirements

planning and decision making. The Watertoets is applied to all water management related spatial plans and decisions. The water management related issues include[23]:

- Safety;
- All forms of water regional and private, including surface and ground water;
- Threat of flooding from lakes, rivers and sea;
- Water inconvenience caused by rainfall or groundwater, quality of water, salting or drying out.

Five Phases of the Watertoets

The Watertoets process is divided into five phases:

Five phases of the Watertoets

1. Concept;
2. Initiative;
3. Development;
4. Decision making;
5. Realization.

In each phase both the initiator and the water management party have to play their part, whereby the latter party is mostly involved during the initiative, development and decision making phase. It is however expected that the water management party is proactively involved because that ensures that their interests are realized. It can be the case that the initiator is the government, represented by the municipality, province or state. The water management party can consist of The Water Authority, Rijkswaterstaat, or whoever is responsible for the water management of that project. An overview of the different phases is illustrated in Appendix II.

The success of the Watertoets is based on mutual commitment between both parties. Early and mutual involvement between initiator and water management is needed to lead to a successful water-advice from the water management and to incorporate the water issues in the spatial plan.

3.9

3.9 Outcome of literature study

Contributing factors for new innovation (subQ-1)

There are four underlying factors contributing to new innovation and the challenges of water management:

Answer to subQ-1

1. The first factor is the problem of water-management in the Netherlands, where the Dutch construction industry does not sufficiently take into account water, as a threat but also as an opportunity. Climate change and with that, water, are becoming structural issues within our society and environment. Local governments, planners, developers and investors, have little experience with water related developments. Furthermore there is another water problem related to groundwater, which is a frequent problem in most polder type landscapes.

[23] Source: http://www.helpdeskwater.nl/water_en_ruimte/watertoetsproces/, 2009

2. The second factor is an insufficient supply of suitable and available land for future development. Urbanization is increasing, Vinex-locations are gradually reaching their implementation, while the demand for new land continues to increase. As a result new alternative locations for development will need to be found.
3. The third factor is multiple use of land, which is becoming increasingly interesting. The combination of different functions can contribute to the overall attractiveness of the locations, such as combining nature, recreation, living and working. Consequently consumer market research has indicated a growing demand for quality homes next to or on water.
4. The fourth factor is law and regulations. Due to the growing interest and necessity of water management, new laws and regulations have been developed such as: the New Water-law, the New Guideline Water, and the Guideline Water.

Law and regulations

Answer to subQ-1

Due to the changing climate and strong fluctuations in water levels, new laws and regulations have been developed. Mostly they focus on spatial designs, development in 'wet' areas, and different forms of water storage. For the latter, a distinction is made between inner- and outer- dike areas. For inner dike areas this includes: peak storage, seasonal storage, calamity storage, and groundwater seepage. For outer dike areas this applies for high water levels. For both areas law and regulation applies to spatial design as well as construction.
With regard to new development in 'wet' areas, the following laws apply (waterbestendigbouwen.nl)[24]:

Laws and regulations with regard to water management

- The 'Watertoets' (Province, VROM and municipality): The aim is to pre-evaluate, inform, advise, consider and judge water management related aspects in spatial planning and decision making process.
- 'Wet beheer rijkswaterstaatswerken' (State): The aim is to protect, upkeep, and manage all water civil-technical installations such as dikes, waterways, bridges and embankments.
- 'Wet op de waterkering' (State): This law includes general regulations to enforce the safety of dikes against flooding from outside water.
- 'Wet op de ruimtelijke ordeing' (municipality): This law is also adapted for new development of homes in 'wet' areas, with regard to planning, spatial design, and typologies.
- 'Wet op de waterhuishouding' (water regulatoy authority): The aim of this law is to uphold and coordinate water management and water regulations. In addition this law controls quantity-management of surface water.

[24] Source: www.waterbestendigbouwen.nl/6%20juridische%20en%20gebruikersaspecten/juridische%en%20gebruikersaspecten.htm

- ‘Wet verontreiniging oppervlakte water’ (Provincie of Rijk): The aim of this law is to control and prevent pollution of surface water with regard to the different types of functions that water fulfills within the community.

Key players & stakeholders (subQ-2)

Answer to subQ-2

Independent to other development plans, in the initiative phase there are multiple parties involved; government, province, municipality, construction company, investors, developers, users etc. The main difference lies in individual interests; they are dependent on task, responsibility, risk, and investment; and vary between social and financial gain. Naturally this also applies to urban development in polders. But whenever water management is concerned and there is a threat of flooding, water authorities become more heavily involved. A distinction is made between location, inner and outer dike areas and the risk of flooding with regard to the future program.

Main stakeholders with regard to water in new development plans

Rijkswaterstaat and water regulatory authorities have developed tools to help determine a suitable location and thus reduce the risks at hand (the Watertoets). Furthermore they set up new constraints and uphold new legislation. Consequently they are responsible for the construction and maintenance of all waterways and defense lines.

New techniques in water innovation (sub-Q3)

Answer to subQ-3

It is ‘slowly’ becoming evident, that simply heightening the dikes and dunes, is not the solution to a changing climate or flood management, nor is the option not to build in flood-prone areas or to ignore the risks. As a result new methods, tools and techniques have been developed:

- Adopting new constraints and legislation,
- Three-step strategy in water policy (hold, store and discharge),
- Knowledge development and cooperative working alliances,
- Changing the traditional development process,
- Testing suitable locations thus reducing risks (Watertoets),
- Taking ground characteristics into account within new plans,
- Water as principle structure in new development plans.

When it comes to new innovation in water homes there are seven different typologies:

Water home typologies

1. Wet proof housing
2. Dry proof housing
3. Embankment housing
4. Column (pole) housing
5. Floating housing
6. Amphibious housing
7. Minimal drainage housing

Each housing example tackles water inconvenience in a different way. The extent of effectiveness against water strongly depends on the location and type of water inconvenience. This can be heavy rainfall, seepage pressure, river flooding, drainage from surrounding areas, drought, water storage etc. For a complete overview of each typology with illustration and short description, see appendix IV.

Water- floating urban development

Advantages of water design concepts

Developing floating neighbourhoods and water resilient homes have much future potential and benefits compared to traditional development. The following advantages of water floating concepts not only support the concept of water designs but also stimulate innovative and sustainable development[25]:

- Implements multiple use of space, urbanisation and water storage;
- *'No problems'* with flooding;
- Enables flexibility in urban development;
- No need for delivery of sand for readying land for construction. This reduces development time;
- No additional costs for repairs with regard to soil settlement;
- International recognition.

Advantages in sustainability as a result of development on water

Apart from these advantages, developing on water also has advantages when viewed from different sustainable perspectives. Floating urbanisation can therefore have multiple potentials on different 'sustainability grounds'. The following distinction can be made[26]:

- Physical sustainability: energy saving, multiple integrated use of space, sustainable and durable materials, climate proof;
- Economic sustainability: payable, safe, reliable, international recognition and market demand;
- Social sustainability: enjoyable living environment, water as binding factor in living environment;
- Cultural sustainability: cultural history, diversity.

Water- management and maintenance

Three main categories of maintenance in water management

There are three main categories in maintenance that can also be applied for water management and maintenance with regard to natural vegetation and embankments. These are[27]:

1. *Daily maintenance*; this refers to daily related maintenance and repair on a minor level. Specifically this implies maintaining a safe environment and controlling the specified water quality. This can and is usually performed by users and occupants of the neighbourhood concerned. This type of maintenance is difficult to predict and greatly depends on the participation of the local community. Maintenance can also be outsourced; payments will then be integrated in the local association of owners. Examples of such

[25] Source: Urgenda, (oct 2008), *de Drijvende Stad, benutten van zee van ruimte*, p4.
[26] Source: Urgenda, (oct 2008), *de Drijvende Stad, benutten van zee van ruimte,* p7.
[27] Information used from: Stadsbeheer Zoetermeer, Bureau Beleid en Programmering, (sept. 2008), *Basisinrichting en Beheervisie Openbare Ruimte onderdeel: Beheervisie Openbare Ruimte 2009-2020.*

maintenance can include, planting natural vegetation, cutting vegetation or cleaning embankments.

2. *Periodic maintenance*; in contrast to daily maintenance, this type of maintenance is predetermined and periodically executed. A contract type plan including standards and regulations must guarantee safety and water quality. Periodic maintenance not only aims to upkeep the existing quality but must also guarantees durability. Examples include: examining embankments and checking for stability, controlling water levels or controlling water quality.
3. *Large scale maintenance*; large scale maintenance occurs at the end of a certain life expectancy or duration. This can include large scale replacement of vegetation, controlling dykes/dunes or regulating water quality. The essence of this maintenance type is to improve fundamentally the quality of the surroundings and water. This scale of maintenance is done in cooperation with inhabitants and executed by the local municipality.

It is important to integrate water management and issue a maintenance plan for urban water development projects. This not only controls current quality and safety but must also guarantee sustainability and durability.

Environmental - management law & decontamination law of surface water

With regard to water and sewage management, this is done by the local municipality, based on the environmental-management law (Wet Milieubeheer). In addition the law "decontamination of surface water" (Wet verontreiniging oppervlaktewater) is issued to prevent surface/storage water from possible decontamination. That is why during maintenance bridges and other civil constructions must be checked and necessary measures need to be taken to prevent that from happening.

The local water regulatory authority is responsible for issuing regulation for maintenance of waterways and embankments. This is written in the 'Keur en het Peilbesluit' (Stadsbeheer Zoetermeer, Bureau Beleid en Programmering, sept. 2008, p18). Consequently, water regulations with regard to water systems and water storage capacities are mentioned in the 'Nationaal Bestuursakkoord Water'. The aim is to not only regulate water quality but also water level and storage capacity in the Netherlands.

'De Kaderrichtlijn Water'

Finally there is also 'De Kaderrichtlijn Water', with the main goal to achieve good ecological quality and control of all surface water by 2015 in the Netherlands (Stadsbeheer Zoetermeer, Bureau Beleid en Programmering, sept. 2008, p.23). Applying natural embankments is an important instrument in achieving that goal. This idea is supported by the Waterplan 2002.

Development process of lowland polders (subQ-4)

Answer to subq-4

The following key aspects are relevant with regard to the development process in lowland polders: the traditional development process; knowledge development and tendering phase; ground characteristics and development delays; the housing market and willingness to pay.

Developing in lowland polders requires a change in the traditional process, where the focus needs to lie on integrating water within structural plans, hence becoming the primary layer. In turn future plans must accommodate for enough space for water, in

Integrated approach required during initiative phase

times of drought as well as flooding. Consequently this will influence the spatial design, introducing new structural and legal challenges while negotiating with multiple stakeholders. As a result new knowledge is required with these complex development plans, requiring an integrated approach where knowledge is shared between different parties and stakeholders. This must be done during the initial phase of new projects. Because there are increased risks and much knowledge is unknown, the latter becomes a problem during the tendering phase. Construction companies are hesitant to invest and share information without the reassurance of a stake in the project and subsequent revenue income and return. Local government and water management authorities will need to invest and cooperate with developing companies to stimulate knowledge development.

Development delays due to soil characteristics

Furthermore ground characteristics of polders can form a major problem and cause long development delays. The unstable peat soil layers require costly soil sanitation and long ground settlement. Consequently this postpones housing development, resulting in high financial investments without return.

Finally from a commercial point of view, there is an added risk of developing water resilient homes and not selling them on the housing market. Future users will have to be willing to pay for water homes and additional costs of water-proofing. During the initiative phase of development it is therefore important to asses the local market and determine whether the demand for water-resilient homes is sufficient to cover potential added costs.

Sharing knowledge

Again it becomes clear that the development process in lowland polders is complex and requires an integrated approach where key players work closely together and new knowledge is shared.

4.1 Introduction

This chapter describes how the mathematical model IGOMOD is used to design and analyze different variants for the Westergouwe. This is done based on three elements of urban development: design, financial land use planning and real estate development. In addition planning and cost phasing in IGOMID will be addressed and a list of indices is given. The indices give an overview of all input used for the Westergouwe case.
IGOMOD uses a drawing application which makes it possible to quickly design different variants of spatial designs. This may include changes in program, housing typologies, functions, phasing etc. The direct financial result is then calculated illustrating not only the cost-quality affect but also illustrating the difference in and quality of design changes. The ability to design in variants is a unique quality and specific characteristic of IGOMOD.

4.2 Design

A unique design feature of IGOMOD is the visual representation of the structural plan for an area. Actual drawing into the designated area is directly translated into a financial outcome. This can be done in three different ways: drawing building masses *(bouwmassa)*, designing areas to house a certain function *(functiegebied of vlek toekennen)* or inputting predesigned plots *(stempels)*. Building in masses and predesigned plots, have an added value, making it possible to visualize a certain area in 3D, showing buildings within their direct environment. For this research a combination is used of drawing building masses and allocating areas to house a certain function. The first technique is used because some housing typologies are not yet included in IGOMOD and must therefore be (designed) drawn separately. A useful advantage of using the second technique is that IGOMOD automatically optimizes construction in the available building space. Green (public and private 'grass/garden' areas), parking, pavement and roads are all included in the design of each housing typology. Consequently it is possible to adjust all input for each typology, making IGOMOD a very effective and useful tool in designing.

Working method

For this research four different variants are graphically constructed using IGOMOD. The functional program, area dimensions and related data from the current plan for Westergouwe are used as primary input of each variant. This will not only allow for valid data input, but will also make it possible to cross-analyze and compare each variant, as are the financial outcomes of each variant: therefore the same calculations and fixed unit-indices for the calculation of the costs and revenues are used. A complete list of indices is described in the following paragraph.

IGOMOD uses the residual value method, which is the sum remaining from value of the completed property, measured in terms of net development value, after deduction of the costs of creating the development, the total development costs, and the developer's minimum profit requirement (Real Estate Financial Limited, June

2008)[28]. To populate the calculation, estimates are required for each of the different component factors. These can include houses for example, which will be specified to each developer, and will reflect their individual views about their vision for the project (in terms of uses, density mix, quality etc.). Other factors include delivery timings and costs (phasing), rate of return, risk assessment, financing ability etc. For the variants in IGOMOD referential data will be used from similar projects, current economy and local market characteristics.

4.3

4.3 Financial land use planning

Financial land use planning: costs and revenues generated by land use

The financial value for the spatial design, drawn in IGOMOD, is then calculated into two categories; financial land use planning and real estate development. For financial land use planning the calculation of costs and revenues generated by land use is included encompassing all activities needed to ready the land for construction, environmental costs, clean-up and demolition costs, indirect costs, and additional area-specific interventions. The latter costs are due to specific interventions such as dykes, back-filling, excavation, edge trim of embankments, maintenance costs or water regulatory systems. This list can be unique for each variant depending on the structural plan. The specific plan details are described in the following chapter. The costs and revenues are included in the indices and are the same for all variants.

The revenues for land use are divided into rent and owner occupied. For each object the corresponding amount, unit index and price per unit is calculated from the design. It is possible to change any value in IGOMOD to suit the characteristics of any plan or location.
IGOMOD has a wide list of housing typologies pre-included in its library, but there is also the possibility to add new objects.

4.4

4.4 Real estate development

As part of land-exploitation the costs and revenues of real estate development are also calculated in IGOMOD. This is done in the same way as described in the previous paragraph on land use planning. Specific for real estate development is the addition of Gross Initial Yield for housing, offices and companies. This is the gross rent income for depreciation and owner charges as a percentage of the total acquisition price (Heijer et al, 2002)[29]. The GIY reflects the relationship between the operating income expectancy in the first year of occupancy and the total property price including buyer's costs. Furthermore the constructed area, gross space area, floor space index, opens space ratio and the ground space index is calculated for the total area. This will give insight into the different relationships between constructed land/area, density and non constructed land.

Gross Initial Yield = expected rent income 1st year/total costs

Closing land-use balance

Residual end value

Finally the total costs of land use planning and real estate development are totaled to calculate an end value. Firstly the final balance of total land use planning is

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[28] Source: www.re-financial.co.uk, Real Estate Financial Solutions Limited, 25/06/2008, p.2.
[29] Source: Heijer, ir. A.C. et al, juni 2002, *Vastgoed in Cijfers*, 2002 Bouwmangement & Vastgoedbeheer, TU Delft, p.179.

determined, to see if the revenues are sufficient and the costs do not supersede the revenues; in other words a closing land-use balance. This is of importance for land exploitation-parties. Secondly, the residual end value is calculated by adding to the final land-use outcomes the costs and revenues of real estate development, but deducting the revenues of land exploitation. The latter is done because in most cases revenues for land use planning are considered costs for developing parties. In other words the residual end value is determined after deducting all costs. In overview the end result is calculated according to the following (the same corresponding letter-coding is used as in IGOMOD):

Financial outcome

Costs land use planning:	-(A)	
Revenues land use planning:	(B)	+
End result financial land use planning:	(-A+B)	

Costs real estate development:	-(C)	
Revenues real estate development:	(D)	+
End result real estate development:	(-C+D)	

Final residual end value = (-C+D)-(B)

This residual end value, calculated according to the phasing, represents the financial outcome and gives insight into the financial feasibility. Consequently it shows the end balance for land exploitation-parties and investors. The final result will help different parties to interpret the cost-quality of the overall plan and determine financial risk. In case of negative land-use planning outcomes, it is also possible to shift certain elements in the balance sheet. This can be achieved by raising land revenues or leveling out the costs with the revenues, in order to compensate for negative results. This is often done in the construction industry; also known as financial settlement (leveling out). The aim is to achieve a closing land-use balance while keeping investors out of the red.

Financial settlement/ leveling out

IGOMOD makes it possible to adjust and change any value or design; consequently determining the financial bandwidth. The financial implication and end result is then instantly calculated, giving planners, designers and investors a transparent view of the financial outcome of different variants.

4.5

4.5 Phasing

Phasing can have a profound influence on the financial feasibility of a plan and is therefore of great importance. Because each variant is different in design, so is planning and cost phasing. The initial start and total duration of the project, however, will remain the same for all variants. This is based on the current plans for Westergouwe, starting in 2009 and finishing in 2023: total duration of construction is 15 years.

Dynamic end value method

The influence and effects of rent, price-increase and revenue-increase are also included in the financial calculation of IGOMOD. All calculations are based on the dynamic end-value-method. This method determines the end value at the end of the construction period (15 years), taking into account all costs and revenues, inflation, *Delays in development can have a large financial impact*

rent, and price- and revenue increase. The end value is calculated according to the current monetary time frame, in this case the value of the euro in 2009. This technique makes it possible to compare different projects.

Phasing is of great importance in urban development, because it has a great impact on the logistics and different financial outcomes of projects. When projects are put to a halt because of economic downturn situations for example, rent costs on previously made investments can lead into the millions. In worst case scenarios, bankruptcy can occur or cancellation of development. Therefore a tight time frame is of the essence and investments should preferably generate income as soon as possible. In IGOMOD it is easily possible to alter and adjust phasing to optimize development or achieve a more favorable financial outcome.

The time line of the phasing of each object is shown behind each object. It is possible to adjust and specify each phase per object (housing or activity). Within each variant it is important to take into account the different activities with corresponding process duration and required implementer time.

4.6

4.6 Indices

For referential purposes the same input for all objects and values are adopted in the analysis of the Westergouwe. The sources for input come from referential projects, literature reviews, data reviews and assumptions. A relative comparison approach in data is used for all variants, thus reducing the risk of invalid data or wrongly interpreted values. The tables, values and sources are divided accordingly and for a complete overview see Appendix V. The following table illustrates the sources used. In the following figures the numbers correspond with the source. A full review of all sources can be found in the literature list or Appendix V.:

List of sources for IGOMOD

Ref. NR.	Name & Date source
1	Ymere et al, 2008
2	Innovatie Netwerk, maart 2007
3	Boogaard, E, 2009
4	Gouda.nl, 2009
5	Nota Grondprijzen, 2008-2009
6	Nota Grondprijzen, 2009
7	Prospectus Drijvende Stad
8	Nota Fonds Bovenwijkse Voorzieningen, mei 2008
9	Nota Bovenwijkse Voorzieningen gemeente Rijnwoude, juli 2008
10	DTZ Zadelhoff, 2009
11	Bestemmingsplan gemeente Gouda, april 2008
12	vindjeeigenhuis.nl, 2009
13	DVBD
14	Veldkamp, G.J., 2008
15	Funda.nl, 2009

Table 3: Sources used for indices with reference numbers

Assumptions for land price

For the land price the following is assumed:

- The land price is according to the local market and based on referential prices from 2009,
- The land price is based on the to be realized function,
- The residual value method is used in IGOMOD for calculating the land price,
- The land prices are indications and based on the program, location, area and the characteristics of the financial market.

Residual value method

The residual value method is the commercial value (for new homes the V.O.N. price) of the, to be developed real estate, minus the investments needed for the realization of the building costs (and additional costs). The investments are therefore exclusive of the land costs (ground costs). Exception of this rule applies for the following:

- Land prices per m^2 plot for free plots ('vrije kavels'),
- Land prices for non-profit facilities ('voorzieningen'),
- Land prices for businesses, offices and recreation.

IGOMOD applied

IGOMOD applied for Westergouwe

The assumed starting date of construction is 2009 with a total development period of 15 years; final building phase will end in 2023. It is unclear if land acquisition or land preparation has taken place prior to this date with possible delays, resulting in high rent costs from previous investments. In this research that is omitted for all variants. Price levels are that of 2009. The total area of development land is approximately 1.700.000m^2.

Phasing in IGOMOD- five phases

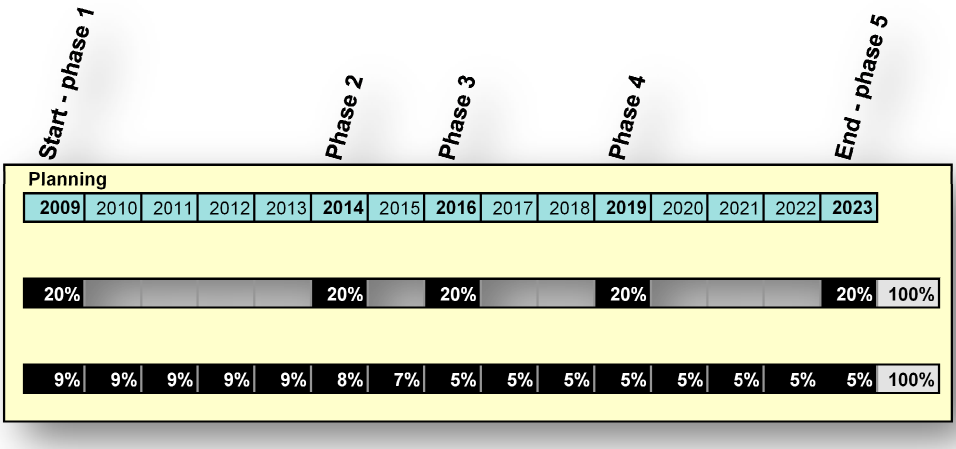


Figure 13: Illustration of phasing in IGOMOD

Figure 13 illustrates an example of phasing in IGOMOD. The total duration of development is divided into five phases, starting with phase 1 in 2009 and continuing until 2023, final phase 5. Per activity it is possible to determine the initial starting date and finalization date of construction. This is done by stating the percentage of completion per activity/object per year. The sum of all percentages must equal 100%, illustrates at the end of the horizontal bar. As mentioned in the previous paragraph, it is important to carefully manage the phasing, to reduce unnecessary costs and to optimize return. For each variant the phasing of land development will be different. The phasing of real estate development will be kept relatively the same for all variants, in order to simulate the phasing set up in the current plan for Westergouwe.

With the actualization of the different prices and possible future fluctuations, financial/economic changes have been taken into account. This is done for the following:

Price indexation and economic situation

Pricing	Value		Source
Rent level	5.0	%	(3)
Increase in costs	2.5	%	(1)
Increase in revenues	0	%	(3)
BAR- homes	5.54	%	(10)
BAR- social services	8.03	%	(10)
BAR- shops	8.97	%	(10)
BAR- businesses	6.47	%	(10)

Table 4: Price indexation and current economic situation

In PPS-type cooperative working forms, it is possible for municipalities to actively participate in projects and thus share in development costs. A financial benefit is municipalities can loan money against a lower rent price, for example 3%. For this research, however, that possibility is omitted and a current rent level of 5.0% is used. This value is slightly higher and representative for private development parties. Due to the current economic- downturn and instability the increase in revenues is set to zero to simulate current conditions. This means no increase in revenue prices while cost prices do increase, thus influencing the financial end result.

Land development costs

The following tables refer to all land development costs; related to ground interventions, land construction and/or management operations for the location Westergouwe.

General costs for land development

General	Unit	Price/unit	Item sum	Source
Land acquisition	m^2	€ 36.20	€ 61,533,000	(11)
Temporary management of land	m^2	€ 0.10	-	(2)
Clean up and demolition of land	Po	-	€ 265,000	(11)
Environmental costs soil sanitation	m^2	€ 0.28	€ 481,000	(11)

Table 5: Land-exploitation costs - General costs

Table 6 includes all activities related to acquiring the land, managing and maintaining its current state, and cleaning the land; keeping it free from hazardous conditions or polluted grounds. The column 'Item sum' is a value from referential data and converted (recalculated) for the Westergouwe case into a price per unit, for example €/m^2. This is done for land acquisition and soil sanitation costs. In the structural (zoning) plan of Gouda a sum of € 61,533,000 was reserved; divided by the total area 1,700,000m^2, this gives a unit price of € 36.20/m^2. The same was done for environmental costs.

Activities related to preparing the site for construction

Preparation of building site	Unit	Price/unit	Item sum	Source
Ready for building (Type A)	m^2	€ 55.55	€ 26,479,000	(3)
Ready for building (Type B)	m^2	€ 35.00	-	(3)
Ready for building (Type C)	m^2	€ 15.00	-	(3)
Water	m^2	€ 2.00	-	(2)
Civil engineering constructions	Po	-	€ 6,000,000	(1)
Main infrastructure	m^2	€ 11.87	€ 20,187,000	(11)
Cables & piping	Po	-	€ 499,000	(11)
Additional costs for setting up public utilities and sewer connections				
Amphibious homes	Po	-	€ 5,000	(14)
Floating homes	Po	-	€ 10,000	(14)

Table 6: Land-exploitation costs - Preparation of building site

Distinct difference in readying land for construction for water homes

All activities needed to ready the building site for construction are listed in table 7. For this research a distinction was made with regard to readying the land for building. This was done because there is a difference in costs when this is done the traditional way, readying land as potential flood-area, or readying water. The latter refers to the development on water for floating homes, which is very limited to only the construction of a (floating) pontoon[30]. Amphibious homes can be developed in areas with the possibility of flooding; therefore readying land for construction is limited to constructing slots or grooves in the ground for the (floating) pontoon. Again an item sum of Westergouwe was used to calculate the unit price. In consultation with project developer E. Boogaard from Dura Vermeer Bouw Leidschendam BV, the following costs for type B and C were derived. Groundwork, infrastructure, piping, and temporary facilities are activities included in readying land for building.

Civil engineering constructions include bridges, waterway systems and water regulatory systems. These costs are bundled into one item post and included in various variants depending on the design.

Additional costs for water homes

The costs for water relate to the activities needed to supply, prepare or clean water and make it suitable to build and live on. Because the development of water resilient homes is still new, certain additional costs are necessary to set up public utilities and sewer connections. This is a cost item per dwelling type (amphibious or floating) and will be multiplied by the amount of homes for each variant.

Preparation of living area

Preparation of living area	Unit	Price/unit	Item sum	Source
Paving	m^2	€ 90	-	(1)
'Green' area, parks/buffers	m^2	€ 65	-	(1)
Public 'green' area, landscaping	m^2	€ 65	-	(1)

Table 7: Land-exploitation costs - Preparation of living area

Preparing land for living area include paving, green-facilities, water facilities, public lighting, public space, landscaping and public furnishings. The unit prices from similar referential projects were used for the Westergouwe. Table 8 shows a list of all items.

[30] For more information on the foundation of floating homes: http://www.wonenopwater.info/pages/nl/het_concept/bouwkundige_aspecten

Structural plan costs

Structural plan costs	Unit	Price/unit	Item sum	Source
VAT-costs	Po	-	€ 24,349,000	(11)
Funds top-district facilities	Po	-	€ 2,464,000	(11)
Planning costs	Po	-	€ 6,702,000	(11)
Unforeseen	po	-	€ 13,041,000	(11)

Table 8: Land-exploitation costs - Structural plan costs

Table 9 shows the list of activities related to structural plan costs. These activities include preparation costs, administrative costs, supervision and engineering costs. Data from the structural plan from Gouda was used to determine the funds, planning costs and unforeseen costs. The latter are costs reserved for additional unforeseen circumstances. The values are the same for all variants.

Additional costs per activity incorporated in specific variant designs

Additional costs	Unit	Price/unit	Item sum	Source
Construction of dikes/ring-dike	m	€ 150	-	(1)
Land improvement/soil consolidation and land raising	m^3	€27.09	-	(3)
Ground excavation	m^3	€ 7.40	-	(14)
Digging out canals/waterways	m^2	€ 3.25	-	(1)
Revetment of banks type A	m	€ 800	-	(1)
Revetment of banks type B	m	€ 15	-	Assumption
Construction of quays	m	€ 700	-	(1)
Water facilities	Po	-	€ 157,000	(14)
Additional maintenance water quality	m^2	-	€ 3.00	(14)
Expropriation	Po	-	€ 2,500,000	Assumption

Table 9: Land-exploitation costs - Additional costs

Revetment of banks type A and B

Because each variant is unique, certain structural plans require additional investments with added costs. These are strongly dependent on the layout and design of each variant. The list of items is shown in table 10. The construction of dikes is there to protect the Westergouwe from possible flooding from the river and surrounding areas. This is calculated per meter length and includes the structural construction of the dike. The amount of sand needed to acquire the necessary height of the dike is calculated in cubic meters; land improvement/soil consolidation and land-raising. The sand and peat soil from ground excavation, digging out canals and waterways, can be reused for part of the dikes. Deepening the canals is done to enhance the quality of the water, guarantee the life of underwater organisms and allow water plants to grow. The depth is approximately 2.5m. The revetment of banks for the canals is done with natural plants and scrubs (type B). The revetment of banks for dikes is made up of inner sand cores, dump stones as outer shell and reed planting (type A). For the living areas quays will be constructed to guard against water and waves. These are constructed in wooden sheet pilings.

Expropriation of property

Furthermore, special water facilities are needed to regulate the quality of the water to maintain the prescribed quality levels. Keeping the water in circulation to avoid mosquitoes and rubbish piling up, and controlling the water levels is essential. These facilities and additional water maintenance are calculated per 10.000m^2 surface

Indirect costs

water area, for a total period of the next 30 years.
Furthermore expropriation is necessary in some variants, because unlike the referential variant, certain spatial designs require the development of the total area in the Westergouwe. An assumption for the expropriation costs was made based on the current property value in Gouda.

Indirect costs

Indirect	Unit	Item sum	Source
Preparation- and counseling costs	10.0	%	(3)
Contribution and funds	6.0	%	(3)
Unforeseen	7.0	%	(3)

Table 10: Land-exploitation costs - Indirect costs

Finally there are indirect costs which are calculated as a percentage of the land development costs. These costs are related to the land costs, building costs and design costs. These include: charges, insurance, start-up costs, financing costs, risk assessment costs, compensation costs, maintenance costs of building site and sales taxes. Table 11 lists the percentages used in this research.

Revenues land allocation

Revenues from land allocation

The revenues generated by land allocation are divided into two parts: rental objects and objects for sale. For each variant a 20-80% distribution was adopted for rent and for sale homes, respectively. The different objects include public facilities, homes in social- and free sectors, and special functions. Each typology differs in size and is calculated according to the current economic value and multiplied by its plot size. This is indicated in table 12. No distinction was made in land price between objects for rent or for sale. The special functions were added to accommodate new water home typologies: amphibious homes and floating homes.

Real estate development

Real estate development costs & revenues

This paragraph includes an overview of both costs and revenues of real estate development, interpreted for Westergouwe in IGOMOD; referring to tables 13 and 14. This is done in the same way as with land development, where rent and sale prices are separately calculated. Specifically added for 'special functions' is the additional cost per dwelling for dry-proofing. This activity includes precautionary measurements to protect certain homes against a rise in water level and thus reduce any damages to the dwelling. This measure is effective up to 30 cm in water level height. This added precaution is a special coating for exterior walls, a slight rise in ground (living) level or a barrier around the perimeter of certain plots.
The revenues for rental objects are calculated in rent price per year. The costs and revenues for amphibious and floating homes were calculated according to current market prices in Gouda of similar objects in size.

Revenues land allocation. Divided in two parts: rental objects and objects for sale

Owner occupied homes

Revenues land allocation	Unit	Price/ unit	Plot size (m^2)	Source
<u>Rent</u>				
Social facilities	m^2 uitg	€ 300		(6)
Shops	m^2 gfa	€ 450		(5)
Businesses	m^2 uitg	€ 450		(5)
Recreation	m^2 gfa	€ 300		(6)
<u>Homes social sector</u>				
Single family homes	Obj.	€ 22,772	121	(13)
Bebo-home narrow	Obj.	€ 20,871	111	(13)
<u>Homes free sector</u>				
Single family homes	Obj.	€ 30,317	161	(13)
Semi detached homes	Obj.	€ 66,682	275	(13)
Free standing expensive	Obj.	€ 111,541	460	(13)
Appartment building expensive	Obj.	€ 31,486	130	(13)
Closed building block traditional	Obj.	€ 32,445	4130	(13)
Free plot (app.)	Obj.	€ 86,728	460	(13)
Appartment building middle priced	Obj.	€ 19,618	104	(13)
Urban villa	Obj.	€ 98,597	407	(13)
<u>Special functions</u>				
Free-2 (amphibious home)	m^2 gfa	€ 455	190	(14)
Free-3 (floating homes)	m^2 gfa	€ 898	155	(14)
Parking garage	m^2 gfa	€ 500		Assumption
<u>Owner occupied</u>				
<u>Homes free sector</u>				
Single family homes	Obj.	€ 30,317	161	(13)
Semi detached homes	Obj.	€ 66,682	275	(13)
Free standing expensive	Obj.	€ 111,541	460	(13)
Appartment building expensive	Obj.	€ 31,486	130	(13)
Closed building block traditional	Obj.	€ 32,445	4130	(13)
Free plot (app.)	Obj.	€ 86,728	460	(13)
Appartment building middle priced	Obj.	€ 19,618	104	(13)
Urban villa	Obj.	€ 98,597	407	(13)
<u>Special functions</u>				
Free-2 (amphibious home)	m^2 gfa	€ 455	190	(14)
Free-3 (floating homes)	m^2 gfa	€ 898	155	(14)

Table 11: Land-exploitation costs- Revenues land allocation

Real estate development costs

Costs real estate development	Unit	Price/ unit	GFA (m^2)	Source
Rent				
Social facilities	m^2 uitg	€ 1,800		(1)
Shops	m^2 gfa	€ 1,200		(1)
Business	m^2 uitg	€ 1,500		(1)
Homes social sector				
Single family homes	Obj.	€ 45,000	97	Assumption
Homes free sector				
Single family homes	Obj.	€ 60,418	132	Assumption
Semi detached homes	Obj.	€ 162,000	180	(7)
Free standing expensive	Obj.	€ 243,000	203	(7)
Appartment building expensive	Obj.	€ 99,344	112	Assumption
Closed building block traditional	Obj.	€ 77,169	87	Assumption
Appartment building middle priced	Obj.	€ 80,052	84	(7)
Urban villa	Obj.	€ 83,368	88	(7)
Special functions				
Free-1 (dry-proofing)	Obj.	9,700		(13)
Free-2 (amphibious home)	m^2 gfa	€ 562	180	(13)
Free-3 (floating homes)	m^2 gfa	€ 506	240	(13)
Parking garage	m^2 gfa	€ 900		Assumption
Owner occupied				
Homes free sector				
Single family homes	Obj.	€ 60,418	132	Assumption
Semi detached homes	Obj.	€ 162,000	180	(7)
Free standing expensive	Obj.	€ 243,000	203	(7)
Appartment building expensive	Obj.	€ 99,344	112	Assumption
Closed building block traditional	Obj.	€ 77,169	87	Assumption
Free plots	Obj.	€ 182,250	203	Assumption
Appartment building middle priced	Obj.	€ 80,052	84	(7)
Urban villa	Obj.	€ 83,368	88	(7)
Special functions				
Free-1 (dry-proofing)	Obj.	9,700		(13)
Free-2 (amphibious home)	m^2 gfa	€ 562	180	(13)
Free-3 (floating homes)	m^2 gfa	€ 506	240	(13)

Table 12: Real estate development- Costs real estate

Real estate development revenues

Revenues real estate development	Unit	Price/ unit	GFA (m^2)	Source
Rent				
Social facilities	m^2 uitg	€ 150		(1)
Shops	m^2 gfa	€ 225		(1)
Business	m^2 uitg	€ 225		(1)
Homes social sector				
Single family homes	Rent/year	€ 6,424	97	(6)
Bebo-home narrow	Rent/year	€ 6,709	102	(6)
Appartment building	Rent/year	€ 5,552	84	(6)
Homes free sector				
Single family homes	Rent/year	€ 13,200	132	(15)
Mansion/town house	Rent/year	€ 24,000	204	(15)
Semi detached homes	Rent/year	€ 15,000	180	(15)
Free standing expensive	Rent/year	€ 16,872	203	(15)
Appartment building expensive	Rent/year	€ 13,200	112	(15)
Closed building block traditional	Rent/year	€ 9,600	87	(15)
Free plot	Rent/year	€ 6,000	203	(15)
Appartment building middle priced	Rent/year	€ 11,400	84	(15)
Urban villa	Rent/year	€ 12,000	88	(15)
Special functions				(15)
Free-2 (amphibious home)	m^2 gfa	€ 83	180	Assumption
Free-3 (floating homes)	m^2 gfa	€ 88	240	Assumptioin
Parking garage	m^2 gfa	€ 75		Assumption
Owner occupied				
Homes social sector				
Single family homes	Obj.	€ 174,000	97	(6)
Bebo-home narrow	Obj.	€ 200,000	102	(6)
Appartment building	Obj.	€ 232,000	84	(6)
Homes free sector				
Single family homes	Obj.	€ 255,500	132	(6)
Semi detached homes	Obj.	€ 432,000	180	(7)
Free standing expensive	Obj.	€ 648,000	203	(7)
Appartment building expensive	Obj.	€ 246,400	112	(13)
Closed building block traditional	Obj.	€ 156,600	87	Assumption
Free plot (app.)	Obj.	€ 556,875	203	(7)
Appartment building middle priced	Obj.	€ 161,354	84	(12)
Urab villa	Obj.	€ 211,614	88	(7)
Special functions				
Free-2 (amphibious home)	m^2 gfa	€ 2,400	180	Assumption
Free-3 (floating homes)	m^2 gfa	€ 2,700	240	Assumptioin

Table 13: Real estate development- Revenues real estate

5.1 Introduction

This chapter focuses on the Westergouwe case in the Zuidplaspolder. This includes the original characteristics of the land, the location with regard to water risks, the new program and the approved future spatial design. The constraints set up by the municipality of Gouda are also included, which will be used in the further study of different variants for the Westergouwe.

Westergouwe is an area which is part of the RZG Zuidplas (Rotterdam, Zoetermeer and Gouda). This triangular shaped area is strategically located in relation to the Randstad. According to local governments involved with/in the region, this area is the last remaining area in the Randstad where, as of 2010, there is still enough 'free' space for large scale transformation (zuidplas.nl, 2009)[31]. Many different parties are working together, to successfully and safely manage future plans and control the need for space in that area. This project is known as project 'driehoek Rotterdam-Zoetermeer-Gouda' (RZG) Zuidplas.
The need for new development is stimulated by the growing demand from the Randstad for living areas, business/work areas, nature and recreation; each program fighting for attention and recognition within new plans. The sums of all aspects do not equal the available free space, not to mention new requirements for nature and water storage. As a result the Zuidplas faces tough challenges when it comes to integrating all requirements in future plans, while incorporating water management.

5.2 Water-Risk map

The water-risk map is a map of the Netherlands, illustrating where the flooding can occur and to what level the water could then rise. The current version does not state the absolute risk of flooding, but does illustrate the locations at risk of flooding. In general flooding is referred to as a state whereby large quantities of water stream uncontrollably land inwards, either from the sea, rivers, or other streams and waterways. 'Nature' obviously plays an important role whenever dykes break, water level rises or there is heavy rainfall. Besides this flooding, the more natural phenomenon of heavy rainfall induced flooding is referred to as water-inconvenience. With regard to Westergouwe and parts of the city of Gouda, the following two figures illustrate these areas. Figure 14 shows that the Westergouwe lies within the flood-prone area (marked by the light blue striped lines), whereas figure 15 illustrates the water level height (marked by blue colour shades). For the Westergouwe this lies between 2.0-5.0 meters, whereby the latter number represents the worst case scenario. The added risk of water flowing into Westergouwe is the cause of its low ground level compared to the surrounding area. This also means rainwater and groundwater from surrounding waterways seep into the polder area. The risk of structural failure of dykes in the direct area, and thus letting in seawater, is a lesser risk but may not be excluded in future plans.

[31] Source: www.zuidplas.nl/driehoekrzg/pagina.asp?pagnaam=project, 2009

Risk map – flooding area Westergouwe

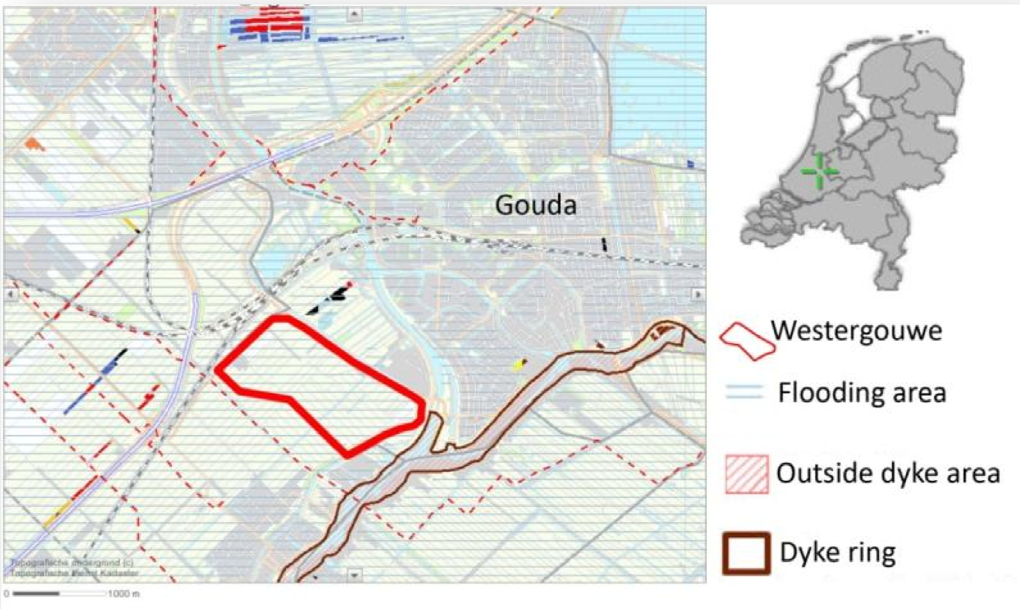


Figure 14: Risk map - Flooding area Westergouwe (source: Nederland.risicokaart.nl, 2009)[32]
The vast majority of the area near Gouda lies far beneath NAP, therefore the area of flooding risk is so large. This map shows the entire area is included, with the exception of certain parts of Gouda center.

Risk map – Flood depth Westergouwe

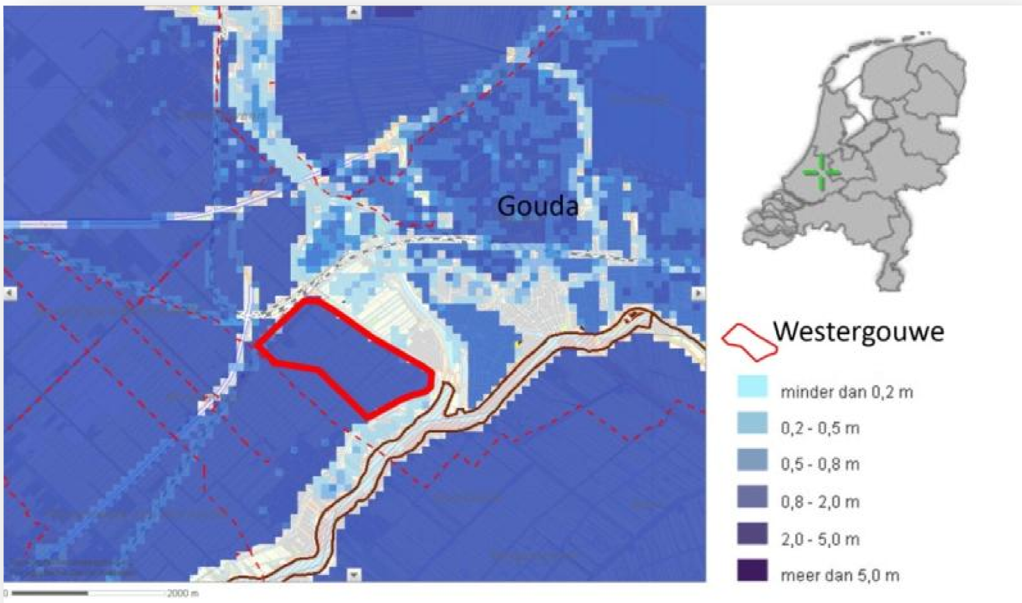


Figure 15: Risk map - Flooding depth Westergouwe (source: Nederland.risicokaart.nl, 2009)
Water levels can rise to almost 5.0 meter for the greater part of Gouda and surrounding neighborhoods.

[32] Maps edited from original.
Source: http://nederland.risicokaart.nl/risicokaart.html?prv=utrecht

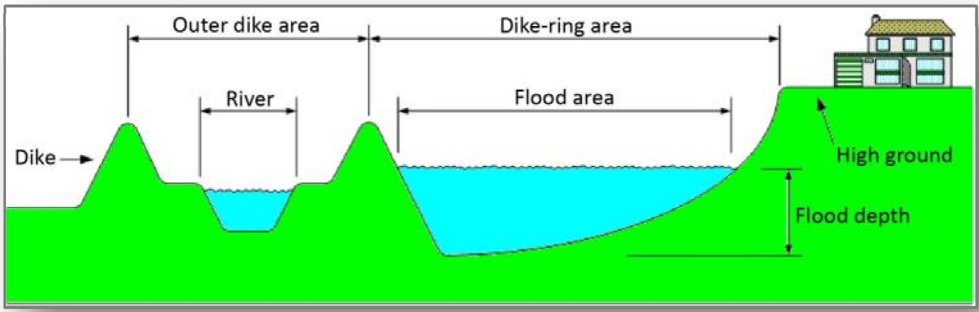


Figure 16: Illustration of dike with flood area (source: nederland.risicokaart.nl, 2009)[33]

Flood areas

The figure above is a visual representation of a river with a dyke and what area would be flooded in certain extreme situations. In case of a rise in river water the outer dyke area would be flooded first. If the outer dyke does not hold or water levels continue to rise, the dyke-ring area will flood. This is called the flood area; the flood depth or height is the distance from ground level to water level. In the Netherlands many homes are built within the dyke-ring area and are therefore in the risk zone. The level of precaution and requirements for the area within the dyke ring including the dyke itself, are legally stipulated in the 'Wet op de Waterkering'. In the Zuidplas there isn't much 'high ground' available and therefore alternative precautionary measures need to be taken.

5.3

5.3 Westergouwe, Zuidplaspolder

3W-deliberation: Workgroup Water management Westergouwe

The future program of the municipality of Gouda includes plans for new housing development in Westergouwe, a specific region within the Zuidplaspolder. Because the Zuidplaspolder is located far beneath sea level, the minister of Housing, Spatial Planning and the Environment has requested the municipality of Gouda to include water management and water risk control as part of the new program. This new urban area must become a water-friendly and sustainable area. In order to accomplish these goals a task group was developed called *Workgroup Water-management Westergouwe* (3W-deliberation). This group includes all major parties involved: the province of South-Holland, the ministries of Traffic and Water and Housing, Spatial Planning and Environmental management, and the Water Regulatory Authority of Schieland. The building location Westergouwe lies in the south-eastern part of the Zuidplaspolder.

Since the '90 it has become clear that water management in the Netherlands is under pressure due to climate change, rise in sea level and soil subsidence. Extreme periods of rainfall with increasing frequency of occurrence are serious threats. The almost flood disasters of the Rijn and Maas (1993, 1995) and the repeated water inconveniences in West-Netherlands (1999, 2001) are constant reminders of these challenges. Traditional solutions such as heightening dykes and pumping out water are no longer sufficient. In 2001, the Commission Water management 21st century (WB21) introduced new advice/protocols on how to tackle and anticipate these

[33] Translated into English from original. Source:
http://nederland.risicokaart.nl/risicokaart/legendauitleg_pub/nl/overstroming.html, 2009

challenges. The basic principle is not to avert excess water but to first hold, then store and finally discharge excess water. Future spatial developments will need to account for this principle, allowing for enough space for water and becoming a structural principle in future plans.

The initial spatial plans dating back to the early '90s, for the Westergouwe was developed far before the introduction of these new protocols and visions. As a result during the decision making process of looking for a suitable location for development, the interest of water management according to the WB21 was never incorporated. In addition water regulatory authorities were excluded from this process. Therefore the District Water Control Board of Schiedam was initially against the new plans of the Westergouwe and issued a negative advice for the choice of location for housing development in the Westergouwe. In order to revise the plans for the Westergouwe, in 2004 the 3W deliberation group started with re-analysing the plans for the Westergouwe. In accordance with the principles of WB21, the workgroup ISV RZG-Zuidplas (Interregionale Structuurvisie 2010-2030, Rotterdam Zoetermeer Gouda) was also included in the study. The latter party is mostly involved with development after 2010 but strongly supports the interests of spatial planning in Westergouwe and future developments in the Zuidplaspolder. The general aim of this collaboration is to regulate the quantity of water (water level management), guarantee water safety and uphold the quality of water in the area.

ISV RZG-Zuidplas

Figure 17: Area map of RZG-Zuidplas and Westergouwe (source: www.driehoekrzg.nl)

Current situation

The Westergouwe has a differentiated orthogonal structure. During land reclamation the polder was systematically divided into a grid like pattern of north-south and east-west orientated ditches and canals. The canals are evenly spaced by 400m and between them run smaller waterways at intervals of approximately 40m. Within the grid like structure systematic line plots have taken shape.

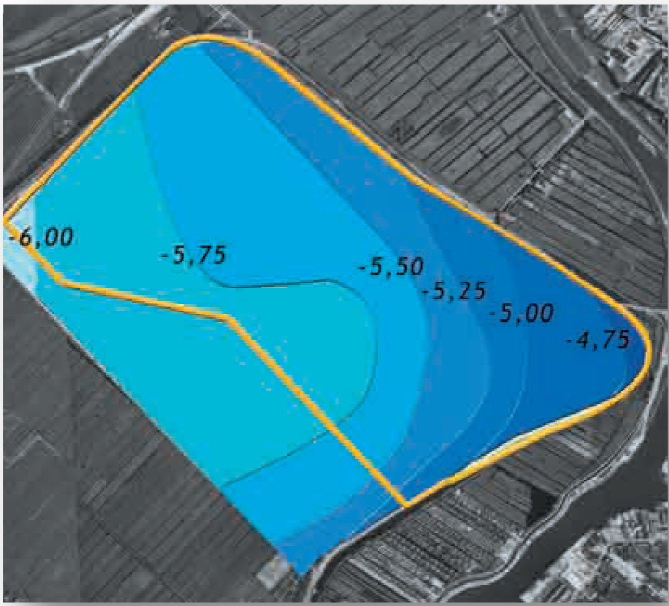


Figure 18: Seepage pressure levels in Westergouwe (source: Waterstad Westergouwe Masterplan, 03 2005)

Peat soil

Westergouwe soil originated during the forming process in peat. A thick layer has formed differing in thickness from 6 to 8 meters. Unlike other areas such as the Haarlemmermeerpolder, the underlying structure is not sand and is therefore sensitive to setting.

The Zuidplaspolder is officially the lowest polder in Europe with -6.76 meters below NAP. The ground level in Westergouwe varies between -5.60 to -6.13 meters below NAP. In relation to its surroundings, Westergouwe is also located low; groundwater therefore flows from out of the region and into the polder. As a result seepage pressure is relatively high (groundwater that is pushed to the surface due to underground pressures). This seepage pressure is a direct result from surrounding waterways, the Krimpenerwaard (-2.40 m NAP), the Ringvaart (-2.00 m NAP) and the Gouwe (-0.60 m NAP).

Constraints

Constraints for Westergouwe

In order to guarantee a successful and safe water management system and the implementation of water as a structural principle in the spatial development plan, the water authorities have issued a list of constraints for the future plans of Westergouwe. The District Water Control Board of Schieland has set up the following constraints[34]:

- No construction or vegetation on or near the embankment due to safety measures,
- The location remains functional as part of the current water level plane,

[34] Constraints established 16 July 2002 by District Water Control Board Schieland established: *De Waterstaatkundige inpasbaarheid van een woonwijk in Westergouwe, bevindingen van de Werkgroep Wateropgave Westergouwe*, 1 september 2004

- Adequate water storage reserves need to be included in the location for the location for the residential area but also surrounding polders (rough estimate of at least 15% surface water),
- A system allowing for water fluctuations in seasonal and peak periods with a natural conservation of rainwater,
- Accounting for and incorporating future climate changes (scenarios developed by WB21 and KNMI),
- The construction level must be sufficient to account for an increase in water level by 1 meter without damages,
- All public shores (banks) must be constructed with nature-friendly and natural materials/plants,
- The quality of water must be in agreement with MTR standards and the ecological quality of water must be kept.

5.4

5.4 Master plan Westergouwe

The master plan is set up by the municipality of Gouda. Westergouwe will be developed to incorporate the demand for new housing in the Gouda district. The housing program will include sufficient homes for starters, elderly people, families and upper class (more expensive) homes for a wealthier group. Westergouwe must become a water rich environment with much space and high quality. New homes will be developed in all price ranges including owner occupied as well as rental. The majority of houses will be in the higher price range, including floating homes and water resilient houses. These housing typologies and rural type homes alongside water fronts will form an important esthetical look which will be characteristic for Westergouwe. The program will also include urban- and town like areas.

Westergouwe is located 10 minutes biking distance from the historical centre of Gouda and a few minutes away from the interstate A20. The eastern part of Westergouwe is located alongside the existing city, whilst the north-west part is located near the newly developed station area. The north and south side lies in the green hart of Oostpolder and Krimpenerwaard.

The table below shows the facts and figures for the new development in Westergouwe[35]:

Facts and figures for plan Westergouwe

Facts and figures

Location	Between Gouda and Moordrecht
Area location	170 ha
New housing	Approximately 3800
Facilities	Shops, schools, medical- and social-cultural facilities
Infrastructure	Good connection with centre and region
Nature	Respect for flora and fauna
First pole	Beginning 2012
Delivery first homes	End 2012

Table 14: Facts and figures Westergouwe (source: www.gouda.nl)

[35] Source: www.gouda.nl/content.jsp?objectid=45617

Approximately 3800 homes

Naturally an area such as Westergouwe will need its own facilities. The approximately 3,800 homes will be predominately owner occupied instead of rental homes as a study has shown that there is a higher demand for owner occupied high quality homes than social rental homes. The living area must include nature, water and a wide range in recreational facilities. Safety, water storage capacity and quality in living are key aspects for Westergouwe with an optimal balance between technical solutions and innovative designs with financial- and commercial feasibility.
These criterion and constraints have led to the following structural plan for Westergouwe:

Representa-tion of structural plan Westergouwe

Figure 19: Spatial plan Westergouwe (source: www.gouda.nl)

Living areas

Living areas[36]

'Canal houses'

Canal area

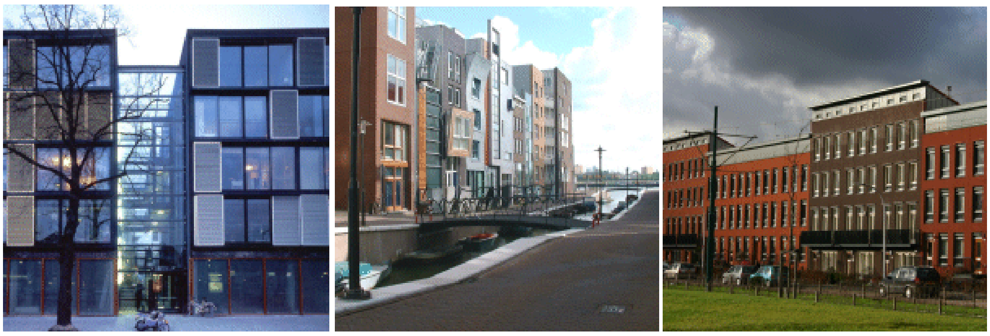


Figure 20: Examples of canal houses (source: www.gouda.nl)

The western part of Westergouwe (light orange in figure 19) will be represented by canal type houses. The existing waterways will be kept, giving room for the

[36] Illustrations of housing typologies (source: www.gouda.nl/content.jsp?objectid=45619)

development of canal houses in a variety of styles. This includes modern type houses as well as the more traditional types, in an urban like neighbourhood. Pedestrians and visitors can sit near the waterways and enjoy the environment. Traffic will run alongside the canals. The outer rim near the Provincial road will house single family homes and apartments with a maximum of 6 floors. The area nearer to the centre will have approximately 4 floors and also predominately single family homes.

Gardens area

'Gardens'

Figure 21: Examples of garden houses (source: www.gouda.nl)

The living area 'gardens' (yellow in figure 19) will house mostly single family homes orientated parallel to each other with the gardens alongside the road. This neighbourhood strongly reflects and emphasises the orthogonal structures of the polder landscape. A wide variety of homes will be developed, creating a town like environment with wide views across the polder. Trees, plants and natural vegetation are important elements in this green living area. At the edge of this area, near the Provincial road larger apartment type buildings will be constructed, thus reducing the noise from the road. Care facilities will also be developed in this area.

Stronghold area

'Stronghold'

Figure 22: Examples of stronghold houses (source: www.gouda.nl)

'Stronghold' living area (3 islands in figure 19) is the right area alongside the Ring dike. This neighbourhood consists of three main cores separates by water and internal squares. Each main core houses approximately 250 homes and is surrounded by water. Owners and visitors will park in underground garages thus reducing traffic in the living area. As a result there is an abundance of public space which can be used for recreational purposes. The homes will consist of luxury apartments, penthouses and family houses with gardens.

'Rural living'

Rural area

Figure 23: Examples of rural type houses (source: www.gouda.nl)

The rural living area (green in figure 19) lies directly next to the green-blue zone. This area is a beautiful natural developed area which will be preserved. The rural type homes will benefit from the spacious green surroundings and the houses will lie amidst the water. The housing typology is mostly free standing homes but will also include semi-detached houses with a vivid and diverse architecture. The homes will be in the higher price range and parking will occur on own property.

'Water homes'

Water area

Figure 24: Examples of water homes (source: www.gouda.nl)

The 'water homes' (little red blocks in figure 19) are houses on the water. These large and spacious water villas will be the eye catcher of Westergouwe. Each house will have its own pier allowing for occupants to moor their boot and enjoy various water based activities.

'Centre'

Centre area

The centre of Westergouwe will house a variety of facilities to accommodate and facilitate the needs of the neighbourhood. This includes: shops, schools, and medical- and social-cultural facilities.

'Green-blue zone'

Ecological area

The green-blue zone refers to the nature and water area in the polder. This area will be developed in the south part of Westergouwe in and beneath the rural living area. This area will become a nature reserve area where people can enjoy the environment but can also recreate, cycle or walk. The natural landscape will include creeks, low bushes, grass, vegetation etc. Cycle routes and footpaths will be developed including a food- and beverage facility.

6.1 Introduction

This chapter describes the case study of Westergouwe variants for the Zuidplaspolder. The current plan for Westergouwe, approved by the municipality of Gouda, will form the referential variant. In total, four variants have been made, each plan with a different approach and water design. The financial result and implication of all variants are included. The different variants are:

1. *Referential variant:* current plan of Gouda,
2. *Land-raising variant:* part of the area in the referential variant will be heightened,
3. *Cascade variant*: using the existing ground structure to create different layers with specific housing typologies,
4. *Water variant:* maximise water storage and floating housing.

The variants illustrate a different approach in water management, applying a different water-design concept to deal with flood risk and water inconveniences. This in turn is translated into a spatial plan where design-choices in development of the Westergouwe differ from one another. For comparison reasons the program is kept the same for all variants, but they can differ in the following:

- Surface water area/storage (seasonal and peak),
- Building typologies,
- Ground-, street- and water level,
- Dykes/civil objects and landscape operations,
- Phasing

These aspects have a significant effect on the structural layout of the plan, design choices and financial consequences in the exploitation plan.

6.2 Referential variant

The referential variant is modelled after the master plan, constructed by the municipality of Gouda as described in the previous chapter. The different constraints and living areas have been translated into IGOMOD. Each housing typology and environment is matched as closely as possible in accordance with the plan. This model will form the basis with which the other variants can be evaluated. A graphical representation of the plan in IGOMOD is illustrated in figure 25. The colour codes in IGOMOD represent the various housing typologies, public areas, water and other remaining functions. The white areas in IGOMOD represent dykes or are not applicable.

In the referential variant, the water level is -6.3m NAP and street level is at -5.3m NAP; in accordance with the prescribed constraints of safely allowing 1 meter in water fluctuations. In order to achieve this, the total constructed building area is heightened by 0.5 meter, while the area housing water is excavated by 1.5 meter. The different canals/waterways are excavated to a depth of 1.5 meters, to allow for clear passageways and to maintain water quality. The dyke-ring is heightened by 6 meters to just above 0 NAP. The same is done for the islands in the water areas (stronghold). Two types of revetments for banks are implemented; one for the ring-dyke (type A) and the other for the living areas (type B). This is done to maintain the safety of the waterways and embankments. Finally water facility systems are used for maintaining the water quality, ensuring the flow of water, and safely regulating water levels.

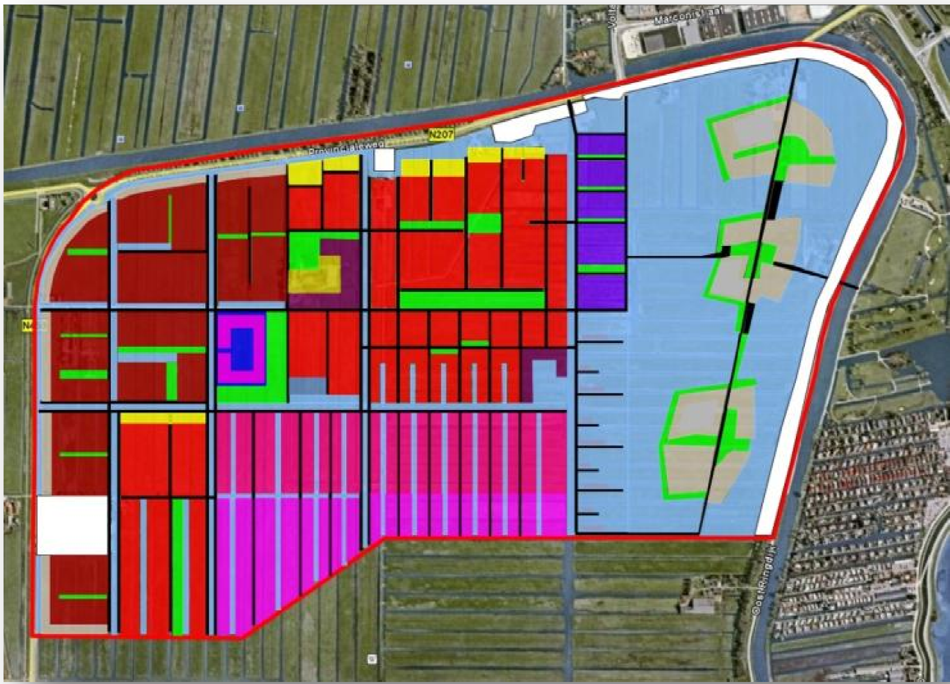


Figure 25: Referential variant in IGOMOD

For an overview of investments/costs, the different housing typologies, living areas etc, see Appendix VI. Readying the land for construction was done in two ways: type A is the traditional way for traditional homes, whereas type C was done for floating homes. For the referential variant this only applies for 38 homes. The following tables show an overview of the number of houses and the total area of facilities.

Total number of homes

Rent	682	Homes	18%
Owner occupied	3,118	Homes	82%
Total	**3,800**	**Homes**	

Table 15: Overview of amount of homes - Referential variant

Other facilities

Public/social facilities	1,000 m^2 gfa
Shops	18,748 m^2 gfa
Business	7,950 m^2 gfa
Parking garages	12,979 m^2 gfa

Table 16: Overview of Gross Floor Area of facilities - Referential variant

The following tables show an overview of the costs and revenues generated for land use planning and real estate development, resulting in an end calculation (see description in chapter 4.4). The *general costs* in land use planning, consists of: land acquisition, temporary management, clean-up and demolition, and environmental costs for soil sanitation.

Financial end result land use planning -€551.99

Costs & Revenues land use planning	Activity	(million €)
Costs	General costs	-109.15
	Preparation of building site	-202.18
	Preparation of living area	-102.32
	Structural plan costs	-83.53
	Additional costs	-128.73
	Indirect costs	-142.52
Total		**-768.43**
Revenues	Rental objects	54.03
	Owner occupied objects	162.41
Total		**216.44**
Total	Costs	-768.43
	Revenues	216.44
	End result	**-551.99**

Table 17: costs & revenues land use planning - Referential variant

The revenues in land use planning are added as costs in real estate development, in order to calculate the total costs (described in chapter 4.4).

Financial end result of real estate development €483.07

Costs & Revenues real estate development	Activity	(million €)
Costs	Rental objects	-185.98
	Owner occupied objects	-403.32
	Land use costs	-216.44
Total		**-805.74**
Revenues	Rental objects	288.41
	Owner occupied objects	1.000.40
Total		**1,288.81**
Total	Costs (including land use)	-805.74
	Revenues	1,288.81
	End result	**483.07**

Table 18: Costs & revenues real estate development - Referential variant

The financial outcome for land use planning is -€551.99, for real estate development €1,288.81 and the final end result is €483.07.

Land use planning cost activities

Phasing & financial overview

For land use planning, the total duration of 15 years is divided into five phases with distinct end dates: beginning in 2009, 2014, 2016, 2019 and ending in 2023. General activities associated with land acquisition are evenly divided in 20% intervals. The activities of readying land for construction and living take place the year after acquisition and preparation: these costs are realised in incremental steps ranging from 10-20%. Costs for structural planning activities are evenly spread over 15 years, as these costs are generated throughout the total developing process. The phasing of the additional activities varies per activity; starting in 2010, whereby the construction of dykes, soil consolidation and excavation finish earlier (2016) so that further completion of the living areas can take place. The remaining activities last until 2023. The indirect costs are calculated in the same years as the overall phasing, 20% each year.

Revenues of land use planning are generated by selling or renting the various land plots, which occurs the year after the land has been prepared for construction. This is done in 20% increments per typology in the following years: 2011, 2014, 2016, 2019 and 2023. The prepared land is now ready for real estate development. The costs of real estate development, which incorporate building costs, begin as soon as the land has been bought. The phasing is evenly distributed from 2011 until 2022. Revenues of real estate development are generated when buildings have been completed and can be sold or rented on the local housing market, starting as soon as the first buildings are completed, namely in 2012 (a year later than real estate costs) and are evenly distributed until 2023, when the last houses have been constructed.

Figure 26 shows a financial overview of land use planning and real estate development calculated per year (2009-2023). The blue histogram represents the sum of land use planning costs and revenues over the years. The same is applied for the sum of real estate development costs and revenues, represented by the green histogram.

Because of a uniform distribution in real estate development the histogram shows a constant rise in revenues

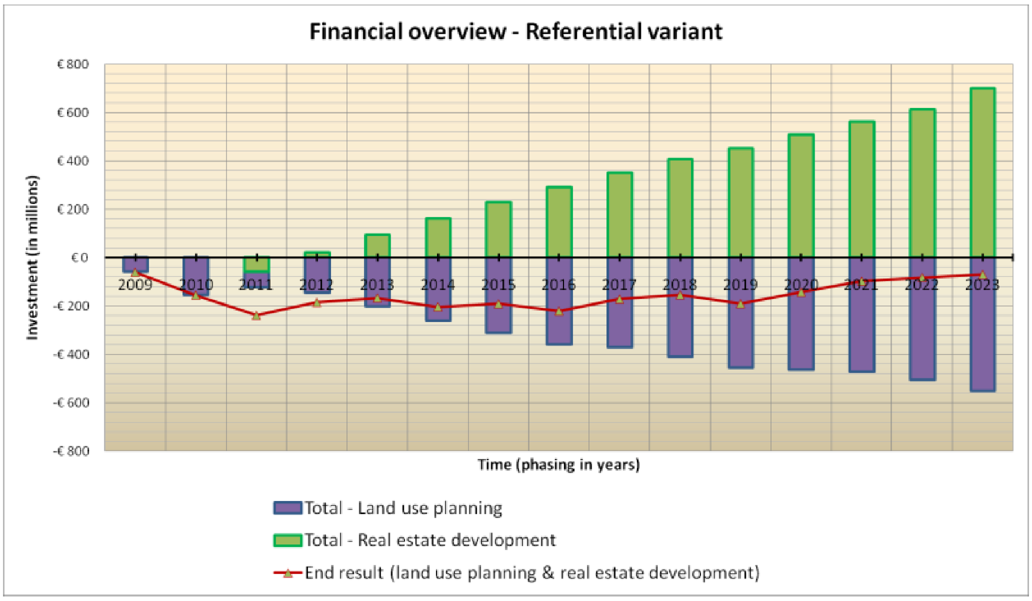


Figure 26: Financial overview of referential variant, end value is -€68.92.

The red line is the combined sum of land use planning and real estate development, where the financial end result visualising the phasing. This line remains below the horizontal €0-axis, meaning the outcome has a negative result, -€68.92. The biggest financial dip occurs in 2011 when land use costs are added with initial costs for real estate development. It is also visible to see when indirect costs are made, showing a slight drop in years 2014, 2016 and 2019. As of 2020 revenues from real estate development strongly rise, resulting in a slight rise of the red line.

Financial settlement

Tables 18 and 19 show the financial end result of land use planning having a negative value; the costs supersede the revenues. In order to try to compensate for this deficit, it is possible to cover part of these costs with the result from real estate development. This method illustrates the possible 'financial room' within a project to see whether a closing land use balance can be achieved. This is illustrated in figure 27.

After financial settlement the end value remains negative, -€69

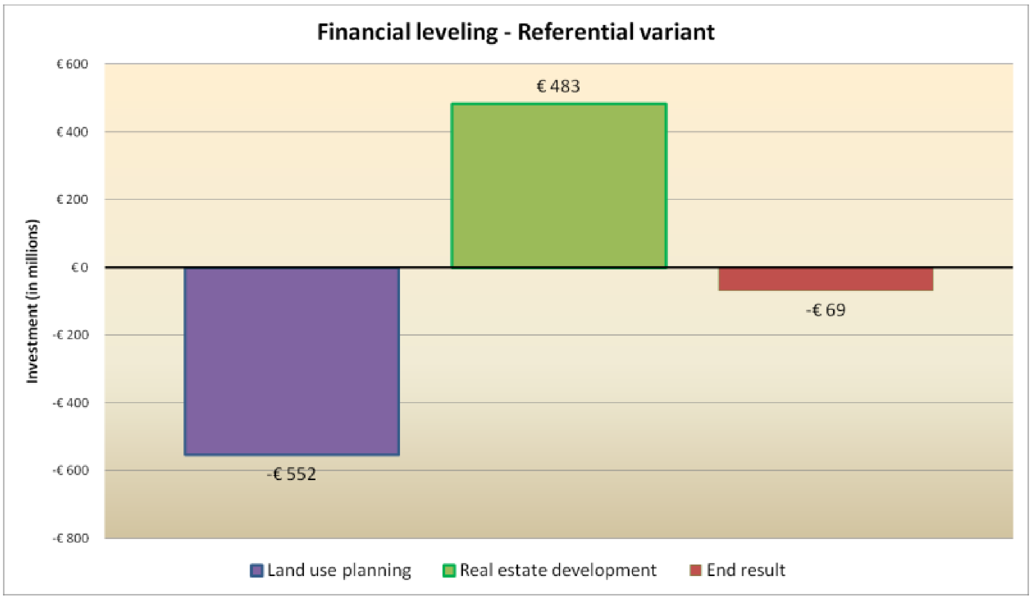


Figure 27: Financial leveling of land use costs with real estate development revenues

It is clear from the both figure 26 and 27 that the profit generated by real estate development is insufficient to cover the costs of land use planning. The newly calculated end result is -€68.92.The unique quality the financial model IGOMOD makes it possible to determine the paying proposition in the end balance, and weather or not there is enough financial room for cost reduction and revenue distribution. When the end balance equals zero, this does not imply real estate developers have no rate of return; in IGOMOD this is already included in the prices. Therefore, even though the end value is -€69, the outcome does imply there is enough potential to make this variant financially feasible.

6.3

6.3 Land-raising variant

This variant is similar to the referential variant, except the living area (in the west) is heightened to 0 m NAP. Consequently street level is now equal to 0 NAP; an increase of approximately 6 meters. Water level is at -4.5m NAP. The difference in street- and water level is now 4.5m, instead of 1m as mentioned in previous variant. As a result this variant can withstand a larger increase in water level without inconveniences. To ensure the safety of the dykes, additional revetment is needed around the water area in the east. The described precautions have been taken into account and calculated in IGOMOD.

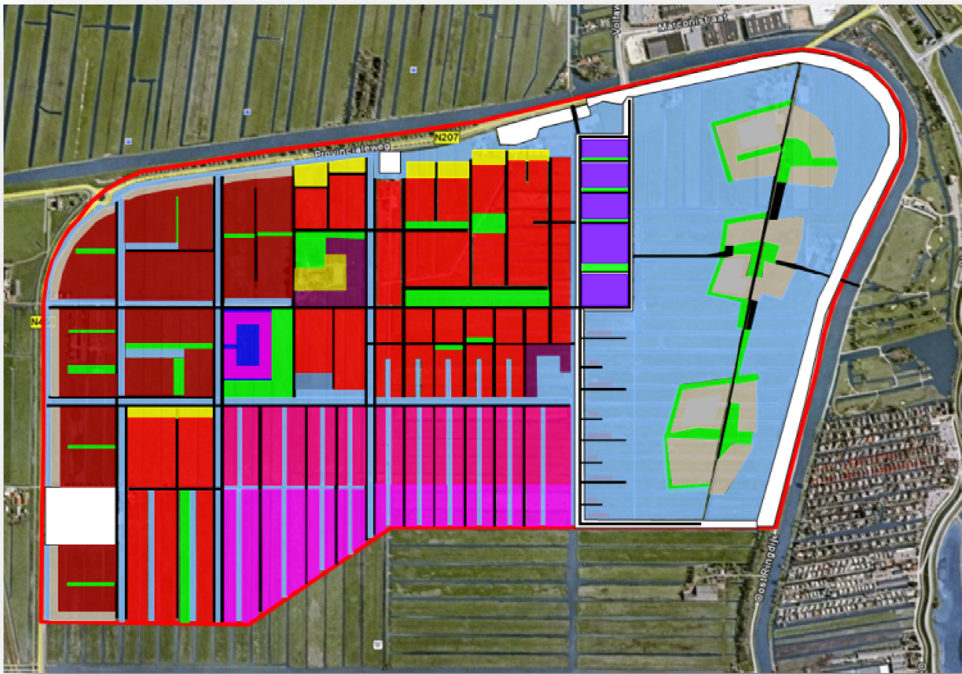


Figure 28: Land raising variant in IGOMOD

Figure 28 shows a graphical representation of the variant. In this illustration, the visual difference is minimal; however there is a large financial difference. Housing, public facilities and remaining program are kept the same as in the referential variant. For a full overview of the program, investments/costs, living areas etc, see Appendix VII.

Total number of homes

Rent	682	Homes	18%
Owner occupied	3,118	Homes	82%
Total	**3,800**	**Homes**	

Table 19: Overview of amount of homes - Land raising variant

Other facilities

Public/social facilities	1,000 m^2 gfa
Shops	18,748 m^2 gfa
Business	7,950 m^2 gfa
Parking garages	12,979 m^2 gfa

Table 20: Overview of Gross Floor Area of facilities - Land raising variant

The following tables show an overview of the costs and revenues generated for land use planning and real estate development. Consequently the end result is calculated.

Financial end result land use planning -€699.01

Costs & Revenues land use planning	Activity	(million €)
Costs	General costs	-109.15
	Preparation of building site	-192.22
	Preparation of living area	-97.21
	Structural plan costs	-83.53
	Additional costs	-243.29
	Indirect costs	-166.94
Total		**-892.33**
Revenues	Rental objects	48.26
	Owner occupied objects	145.06
Total		**193.32**
Total	Costs	-892.33
	Revenues	193.32
	End result	**-699.01**

Table 21: Costs & revenues land use planning - Land raising variant

The following table shows the costs and revenues for real estate development. All calculations are done in the same way as the previous variant.

Financial end result of real estate development €459.19

Costs & Revenues real estate development	Activity	(million €)
Costs	Rental objects	-177.71
	Owner occupied objects	-366.99
	Land use costs	-193.32
Total		**-738.02**
Revenues	Rental objects	267.91
	Owner occupied objects	929.31
Total		**1,197.22**
Total	Costs (including land use)	-738.02
	Revenues	1,197.22
	End result	**459.19**

Table 22: Costs & revenues real estate development - Land raising variant

4 years needed for soil settlement

Real estate sales are increased to 11% per year

The large financial drop up to 2014 is the result of soil settlement

Phasing & financial overview

The design choice of raising the Westergouwe to 0 NAP influences the phasing of this variant. As with the referential variant the five phases of general land use planning activities remain the same. The difference lies with readying land for construction and living, which starts in 2013, 3-4 years later than the previous variant. Raising such a large quantity of land to that height takes multiple years for soil to settle. As a result revenues from land sales and real estate development are also postponed. Because the total area is raised, it is impossible to develop certain areas earlier. Therefore revenues from land sales start in 2014, continuing in 2016, 2017, 2019 and finally 2023. Construction of real estate is evenly distributed at 10% per year starting 2014 until 2023. A year after real estate construction starts the first houses can be put on the market; starting in 2015 and ending 2023. In order to finish within the proposed project time period of 15 years, 11% of housing will need to be sold a year; 3% more than with the referential variant. This accounts to around 418 homes a year.

Figure 29 shows the financial overview of land use planning and real estate development calculated per year (2009-2023). The blue histogram represents the sum of land use planning costs and revenues over the years. The same is applied for the sum of real estate development costs and revenues, represented by the green histogram.

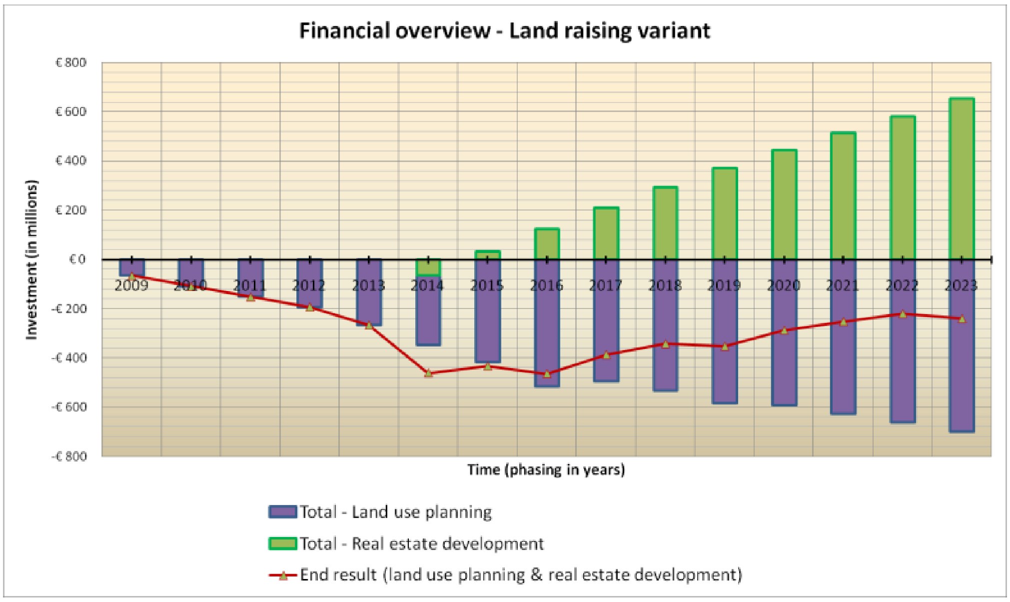


Figure 29: Financial overview of land raising variant, end value is -€239.81

The red line is the sum of land use planning and real estate development, where the financial end result can be seen with regard to the phasing. As with the previous variant the red line remains below the horizontal €0-axis, meaning the outcome has a negative result, -€239.81. The graph shows a strong financial drop up to 2014, which is the result of the additional costs for raising the Westergouwe. It is by 2016 that real estate sales pick up and the red line shows a slight rise. A shorter real estate development phase is the reason why the slope of the red line is steeper towards the end. However, the blue histogram clearly shows increasing land use costs due to an increase in traditional housing development towards the end of the project.

Financial settlement

It is clear from the tables above and figure 29 that the profit generated by real estate development is insufficient to cover the negative costs of land use planning. The calculated end result is -€239.81. This was to be expected considering the negative financial outcome of the referential variant. Compared to the previous variant, development delays have increased final costs of raising Westergouwe by approximately €170.

Long development delays due to raising Westergouwe have increased costs by approximately €170 with regard to the referential variant

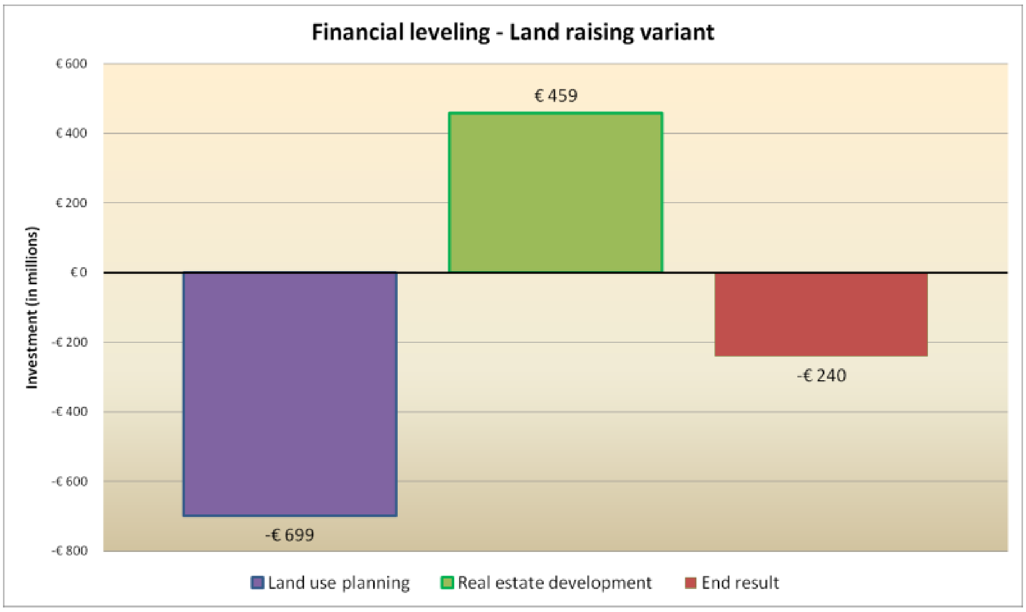


Figure 30: Financial leveling of land use costs with real estate development revenues

The large financial imbalance of the land raising variant implies the possibilities of compensating €240 are very slim. Unlike the referential variant the difference is too large.

6.4

6.4 Cascade variant

This variant is constructed in accordance with the varying ground levels, making it ideal for constructing cascades. Four different street levels range from 0m NAP (top right corner) to -6.3m NAP (bottom left area). See Appendix IX for more information on each living area. As a result four different living areas are created with a step-like character. The first two areas are at 0m NAP with the intention of being flood free. Flood-proofing precautions have been implemented for the homes in area two. All the homes in living area three are amphibious homes, whereas area four houses floating homes. More amphibious homes and parking garages have been constructed on the embankments (dykes).

Figure 31: Cascade variant in IGOMOD

A number of dyke rings have to be constructed to safeguard the different living areas and manage the flow of water. Rain- and surface water can naturally flow from the higher living areas into the water area. In times of extreme water conditions, the total living area housing the amphibious homes can be submerged. Consequently high water fluctuations can safely take place. Figure 32 shows a visual representation of how certain areas can overflow in times of high water conditions. Furthermore this variant includes all three types of readying land for construction; see Appendix IX for a full overview of the program, costs and revenues).

Total number of homes

Rent	773	Homes	20.3%
Owner occupied	3,027	Homes	79.7%
Total	**3,800**	**Homes**	

Table 23: Overview amount of homes - Cascade variant

Example of safely letting certain areas to overflow, thus controlling the risk and potential damages

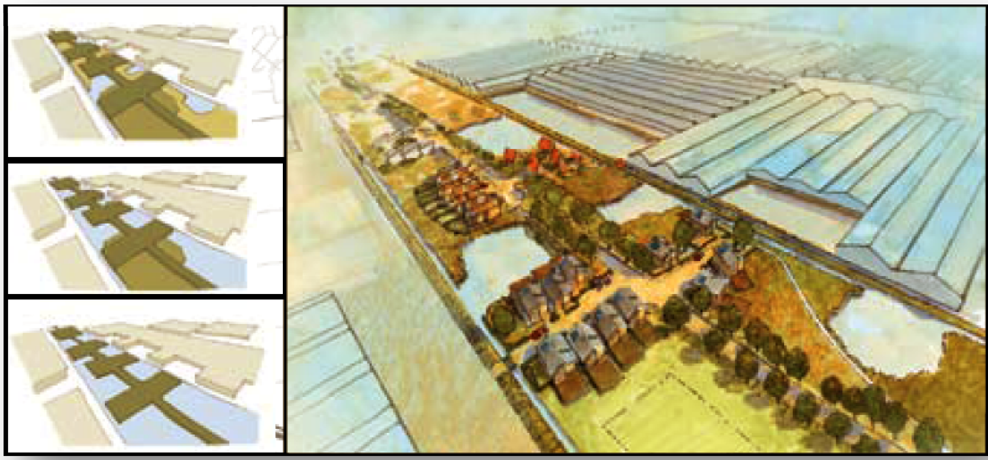


Figure 32: Overflow areas for excess water (source: Placemat, 2008)

Other facilities

Public/social facilities	1,512 m^2 gfa
Shops	11,996 m^2 gfa
Business	6,360 m^2 gfa
Parking garages	12,499 m^2 gfa

Table 24: Overview of Gross Floor Area of facilities - Cascade variant

The following tables show an overview of the costs and revenues generated for land use planning and real estate development. Consequently the end result is calculated.

Financial end result land use planning -€239.15

Costs & Revenues land use planning	Activity	(million €)
Costs	General costs	-110.51
	Preparation of building site	-176.91
	Preparation of living area	-121.14
	Structural plan costs	-83.53
	Additional costs	-90.19
	Indirect costs	-133.15
Total		**-715.43**
Revenues	Rental objects	133.27
	Owner occupied objects	343.00
Total		**476.27**
Total	Costs	-715.43
	Revenues	476.27
	End result	**-239.15**

Table 25: Costa & revenues land use planning - Cascade variant

The following table shows the costs and revenues for real estate development.

Financial end result of real estate development €448.37

Costs & Revenues real estate development	Activity	(million €)
Costs	Rental objects	-228.07
	Owner occupied objects	-507.43
	Land use costs	-476.27
Total		**-1,211.77**
Revenues	Rental objects	328.67
	Owner occupied objects	1,331.48
Total		**1,660.14**
Total	Costs (including land use)	-1,211.77
	Revenues	1,660.14
	End result	**448.37**

Table 26: Costs & revenues real estate development - Cascade variant

Phasing & cash flows

The total project duration remains the same for all variants and is therefore 15 years. The same five phase distribution at 20% is therefore also applied for the cascade variant, as well as for the structural plan costs and indirect costs. In this variant the whole Westergouwe is reconstructed, therefore certain areas have to be expropriated before construction or land preparations can begin. At has been assumed this will take place in steps of 25% each year starting in 2009 until 2012. The cascade design divides the Westergouwe in four different living areas with different ground levels (see also appendix IX for spatial design overview). Therefore certain areas are slightly raised or excavated to house the various housing typologies. As a result all three methods of readying the land for construction are used and vary in phasing. For the (3rd) area housing the amphibious homes need only be raised by 0.45m and is therefore constructed first, starting in 2010. Areas 1 and 2 are raised between 4.75-5.00m respectively and therefore require 3 years for soil to settle; land construction starts in 2012, distributed by 10% a year until 2023. Readying the land for construction for the fourth (water) area starts in 2013. This structural delay is due to waiting time for the area to fill with rainwater.

Three different methods of land preparation, therefore three different phasing dates

Depending on the housing program and area, land use planning revenues are generated starting in 2011-2013 and up to 2023. Land sales for amphibious homes will begin in 2011, followed by traditional housing and finally floating homes in 2013. Because of the structural design of this variant, real estate development costs and revenues show the same even distribution as with land use planning. Real estate development costs for amphibious homes are phased 7-8% a year starting in 2007, 9% for traditional homes in 2013 and 10% for floating homes in 2014. Revenues from real estate sales begin a year after construction, with distributed income ranging between 2012 and 2015 respectively. Between 8-11% of housing is developed on the housing market.

Figure 33 shows the financial overview of land use planning and real estate development calculated for each year (2009-2023). Again, the blue histogram represents the sum of land use planning costs and revenues, whereas the green histogram represents the sum of real estate development costs and revenues.

Figure 33 shows initial land use costs steadily rising during the first 6 years, before land sales and real estate development picks up in 2015. Positive financial turnaround is reached in 2018-2019

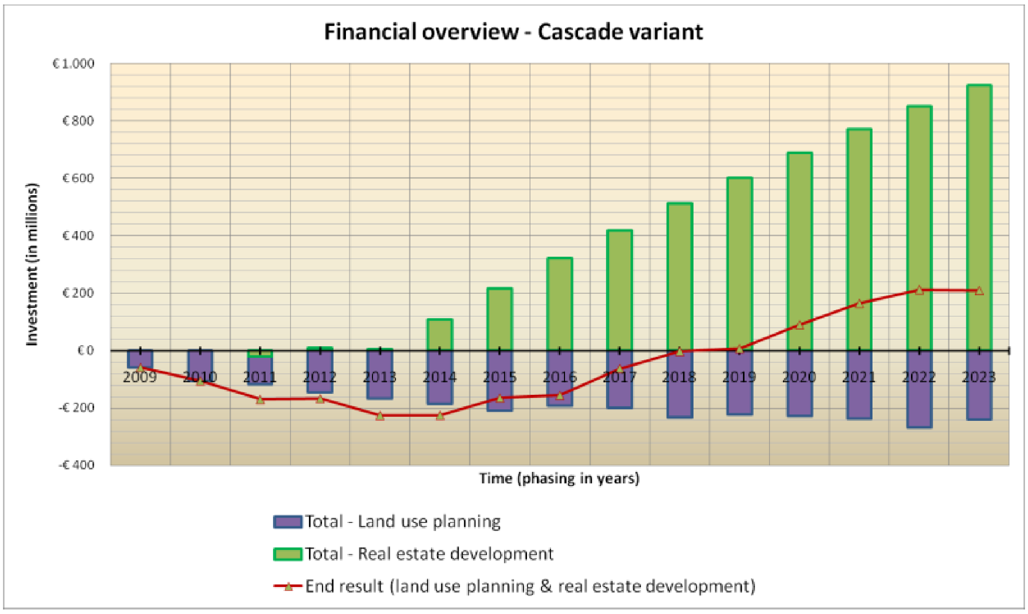


Figure 33: Financial overview for cascade variant, end value is €209.21

Figure 33 shows a lower and much more even distribution of land use costs. This can be explained by fewer costs in readying land for construction for non-traditional housing. Initial land use costs are similar to previous variants, but as the project progresses, so does the development of water resistant (floating) homes, and with the afore mentioned lower land preparation costs. As a result, land use planning costs do not increase but remain steady. The green histogram shows the gradual increase in housing development, starting in 2011. A financial turn around is evident between the years 2018 and 2019, when real estate revenues supersede total costs. The end value is €209.21.

Financial settlement

Land use balance is -€239 but can be leveled with real estate development

An important difference is that, unlike the previous two variants, the cascade variant shows a positive financial outcome. This is partially due to lower land use planning costs. However, the final balance of land use planning has a negative value, namely -€239. Only when financial levelling is done, can this negative outcome be compensated. The result is an end value of approximately €209, illustrated in figure 34. Further design optimisation and financial analysis can be done to reduce this surplus, since real estate revenues remain high after levelling.

Financial leveling shows a positive outcome of approximately €209

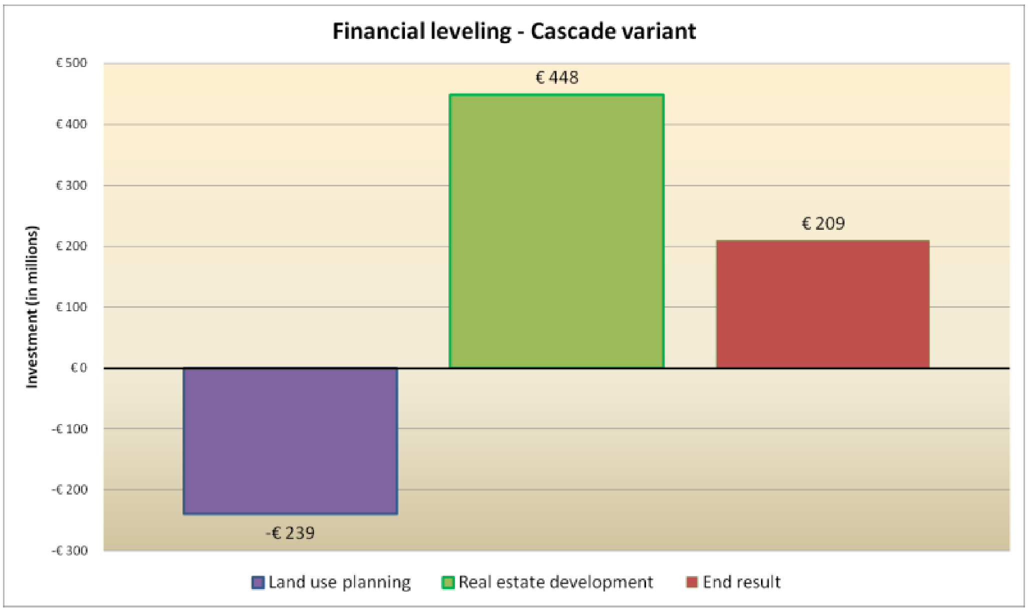


Figure 34: Financial leveling of land use costs with real estate development revenues

Figure 34 shows the cascade variant has enough 'financial room' for further design alterations and finance optimisation. The positive financial end value is caused by the combination of lower land use planning costs and relatively high revenues from real estate sales. The large profits for real estate development are caused by the shortened development phase of real estate.

6.5

6.5 Water variant

In the water variant, the whole area is transformed into one large lake, with a ring dyke running around the borders. Six islands have been constructed in order to facilitate infrastructure, public facilities, parking garages, business and other programs. The floating homes are situated alongside floating piers, which are in turn connected to the islands. The floating homes include detached homes, semi detached houses and row houses. Amphibious homes are built alongside the dykes and on the islands. Water proofing precautions have been taken for the public area and buildings. Figure 35 shows the spatial design in IGOMOD.

- border line
- water
- green
- infrastructure
- urban villa, apartm.
- apartm. building
- urban villa
- single family homes
- semi detached homes
- free standing homes
- public/social facilities
- shops
- businesses
- free plots
- parking garage
- free 2 - owner occupied
- free 2 - rent
- free 3 - owner occupied
- free 3 - rent

Figure 35: Water variant in IGOMOD

The amphibious homes have a gfa of 180 m^2 and the floating homes of 240m^2; both spacious family homes. The total area includes parking space, pier and private space. The principle idea is based on the housing typologies in figure 36. More examples of water homes can be found in Appendix X.

Total number of homes

Rent	3,034	Homes	20.2%
Owner occupied	766	Homes	79.8%
Total	**3,800**	**Homes**	

Table 27: Overview of amount of homes - Water variant

Other facilities

Public/social facilities	1,000 m^2 gfa
Shops	18,758 m^2 gfa
Business	7,950 m^2 gfa
Parking garages	47,442 m^2 gfa

Table 28: Overview of Gross Floor Area of facilities for the Water variant

Examples of different concepts of water resilient homes, developed by Dura Vermeer

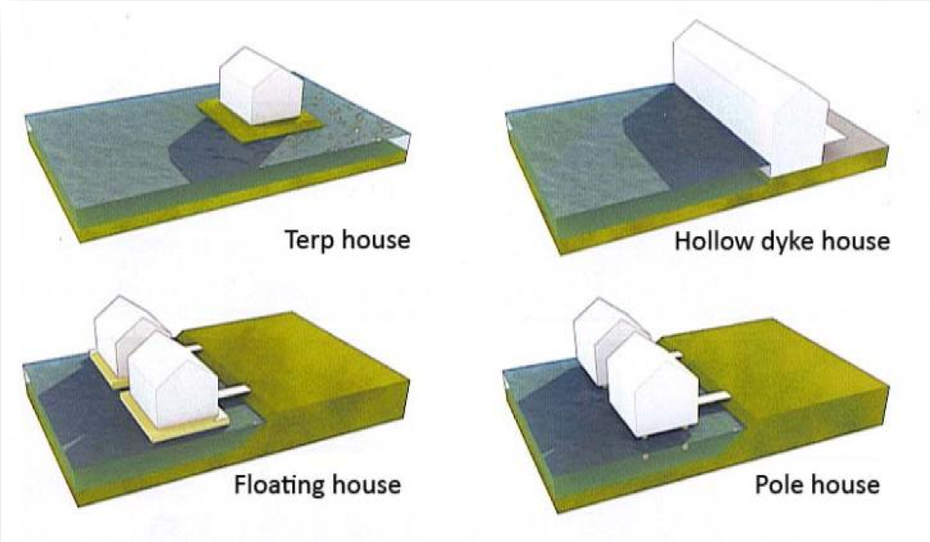


Figure 36: Housing typology developed by Dura Vermeer (translated to English, source: Water Stedenbouw *Bouwen met Water*, 2007)

The following tables show an overview of the costs and revenues generated for land use planning and real estate development. Consequently the end result is calculated.

Costs & Revenues land use planning	Activity	(million €)
Costs	General costs	-110.50
	Preparation of building site	-140.63
	Preparation of living area	-45.75
	Structural plan costs	-83.53
	Additional costs	-107.90
	Indirect costs	-112.96
Total		**-601.27**
Revenues	Rental objects	187.09
	Owner occupied objects	741.30
Total		**928.39**
Total	Costs	-601.27
	Revenues	928.39
	End result	**327.12**

Table 29: Costs & revenues land use planning - Water variant

Financial end result land use planning is positive, €327.12

Table 31 shows the costs and revenues for real estate development. For the first time, this variant shows a positive financial end result in land use planning, €327. This is caused by a combination of lower land use costs with high revenues from land sales. It is therefore not necessary to apply financial settlement for the water variant.

Costs & Revenues real estate development		Activity	(million €)
Costs		Rental objects	-371.29
		Owner occupied objects	-651.47
		Land use costs	-928.39
	Total		**-1.951.15**
Revenues		Rental objects	374.46
		Owner occupied objects	1,610.88
	Total		**1,985.34**
Total		Costs (including land use)	-1,951.15
		Revenues	1,985.34
		End result	**34.30**

Table 30: Costs & revenues real estate development - Water variant

Financial end result of real estate development €34.30

Phasing & cash flows

The water variant poses similar structural design implications as in the cascade variant, because of the amount of surface water and housing typology. However, it is a more extreme design, whereby the Westergouwe is fully filled with water, with predominately floating homes and the remainder amphibious homes. Public facilities such as shops, businesses and parking garages are built on six islands, which are to be raised to 0m NAP. The remaining area is excavated by approximately 0.5m to create an even water depth, making it fit for water recreational purposes. Additional time is needed for the creation of the six islands and for the large quantity of water needed to fill Westergouwe. Again, 4 years are reserved for soil settlement and the greater part of Westergouwe to fill with rain water which is enough to initiate further development. Readying land for construction therefore starts in 2013 with 10% completed year by year with a steadily growing rate as work progresses.

A minimum of 4 years are reserved for Westergouwe to fill with rainwater

With this variant it is important that additional activities such as the construction of the dyke and revetment of banks are completed as soon as possible in order to guarantee a safe working and living environment. These activities will therefore start immediately in 2010 and should be competed by 2016. Expropriation of certain areas is also needed similar to the cascade variant, and starting in 2009 until 2012. The remaining land use planning activities follow the same phasing as in the previously described variants.

Revenues from land sales are divided in five phases starting in 2014 with 20%, followed by 25% in 2016, 20% in 2019, and 35% in 2023. Real estate development costs start to be incurred in 2014 and are evenly distributed by 10% until 2023. As from 2015 revenues from real estate sales start in increments of 11% per year until 2023.

Figure 37 shows the phasing and yearly result of land use planning costs and revenues. The red line shows the combined financial outcome of total costs and revenues over the total 15 years. Unlike the previous three variants, here we have a positive balance for land use planning.

Unlike the previous three variants, the water design shows a positive financial outcome in land use planning of €327.12

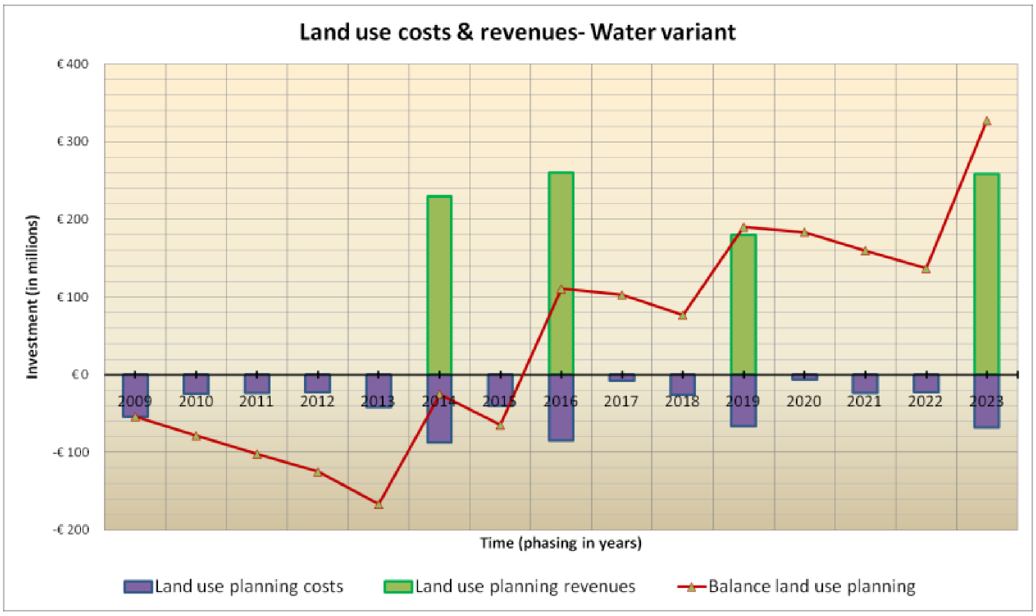


Figure 37: Overview of land use planning costs and revenues of water variant, end result is €327.12

Between 2015 and 2016, land use planning generates a positive financial turnaround

Before analyzing the overall phasing and financial outcome of the water variant it is important to note that the balance of land use planning is positive, unlike the previous three variants. The end value is €327.12. Figure 37 shows the financial overview of land use planning costs, represented by the blue histogram, and land use planning revenues, represented by the green histogram. The balance per year is illustrated by the red line, which shows the expected positive turnaround in 2015. The combination of relatively low land preparation costs with land sales are the reason why this variant scores positively. The initial steep decline of the red line illustrates the growing costs of settlement delays. In 2014 land sales begin and the financial outcome starts to rise. This is continued up to 2023.

Financial turnover happens in 2020 with an end value of €34 for the water variant

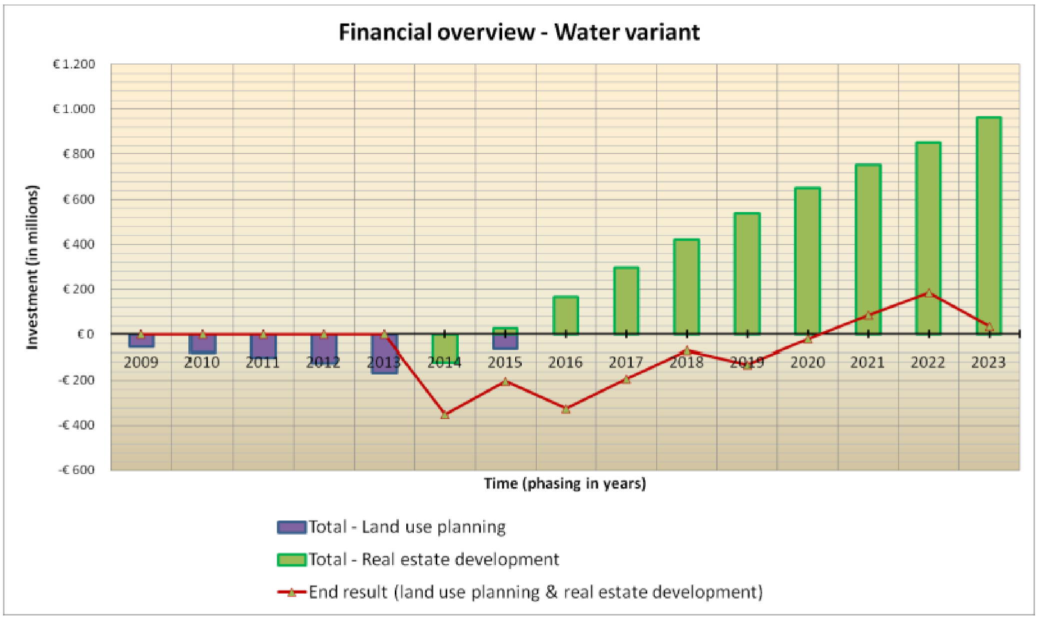


Figure 38: Financial overview of water variant, end result is €34

Figure 38 clearly shows the difference in project phasing between land use planning and real estate development activities. The activities follow in almost consecutive order, whereby initial costs in land preparations are made, until in 2014, when development in real estate starts. The strong financial drop in 2014 illustrates the addition of real estate costs to land use costs. From there on, real estate sales increase with an end result of approximately €34.30. The last dip of the red line between 2022 and 2023 is caused by indirect costs and costs from real estate. As was previously mentioned, the water variant does not need to undergo any from of financial levelling.

6.6

Activities in land use planning greatly determine the phasing for the remaining activities

6.6 Review

This chapter has shown there is a great difference in planning and financial outcome of each variant, which is the direct result of the essential design choices. The program of public facilities and number of houses is kept relatively equal for each variant, whereas housing typologies vary greatly. The same can be said about land intervention and landscaping activities, which determines the project's phasing in land use planning. Other than for the referential and cascade variant, real estate development is delayed up to 4 years. As a result investments are increased while revenues are postponed. Apart from the water design with an outcome of €327, the balance in land use planning is negative for the other three variants, ranging between -€699 and -€239. For all variants the balance in real estate development is positive. This can be explained by the relatively short and optimistic phasing of real estate sales. In order to compensate for high land use planning costs, financial settlement is conducted. However, this study has shown this remains insufficient for both the referential as well as for the land raising. Due to longer development delays and high soil consolidation costs, after financial levelling, the end value for the land raising variant is substantially lower than the referential variant; a difference of approximately €170. Both the cascade and the water variant score positively, €209 and €34, respectively.

A uniform distribution in real estate development for all variants

Furthermore, there is a noticeable difference in total land use planning costs between each variant. The referential and land raising variant show considerable higher costs and a steeper rise, whereas the cascade and water variant show a much lower and more equal distribution over the total project duration. The costs for readying land for construction largely contribute to this phenomenon. For real estate development, the graphs show similar patterns for all designs. This is because real estate development is equally distributed over the remaining years up to 2023. There is only a slight difference in the percentage of phasing, ranging between 8-11% market costs and sales. Because the total project time is kept the same, longer delays in land use planning means shorter real estate development time, resulting in a more favourable financial outcome.

In the following chapter, further data analysis will be done on the individual costs and revenues of certain design choices between each variant.

7.1 Introduction

In this chapter the four variants are further analysed. First the variants are interrelated and compared with the referential variant, illustrating how the plans differ in spatial design, water management related aspects and cost/benefits. This is followed by an analysis matrix, containing a list of criteria, on which each variant is assessed. The analysis matrix determines how well each variant scores with regard to the different criteria. The conclusion of the analysis matrix will determine a most favourable and strongest variant. The chosen variant is then subjected to sensitivity analysis to give insight into the sensitivity of various parameters. The aim is to determine the economic feasibility, financial weight and consequences within the design.

7.2 Variant comparison

The variants are analysed for the following aspects[37]:

- Street- and water level
- Area ratio distribution
- Overview general program
- Real estate development
- Cost & revenue overview
    - Land use planning costs
    - Construction ready costs
    - Water proofing costs

<u>Street- and water level</u>

Table 32 illustrates an overview of the different street and water levels of each variant. Consequently the possible rise in water level is shown. This is the allowed rise in height without damages and within the limitations of each design. In accordance with the constraints for Westergouwe, each plan has the possibility of water rising safely by at least 1 meter. For the referential variant this is the limitation, whereas for the land raising variant water can rise by 4.5m. The cascade variant has the highest value, because of the high difference in living areas. There are two scenarios: the first being 1m up to the area housing amphibious homes; the second is a maximum rise of 6.3m. It is technically possible for amphibious homes to rise by 5.3m, but increasing that further would compromise safety.

Levels	Referential	Land raising	Cascade	Water
Street level	-5.3m	0m NAP	0m NAP, -5.3m, and -6.3m	0m NAP, -1m, and -2.7m
Water level	-6.3m	-4.5m	-6.3m	-2.7m
Rise in water level	1m	4.5m	1-6.3m	1.7-2.7m

Table 31: Street- and water levels with regard to NAP

Similar to the cascade variant, the water design has different street levels: 0m for the islands, -1m for the amphibious homes and -2.7 for the floating homes. Unlike the

[37] See also Appendix XI for additional tables and information on data comparisons

previous variant the water depth in this design is increased for water recreational purposes. Therefore in extreme conditions water level can safely rise up to 2.7m. Although this is less than the land raising- and cascade variant, the total surface area is much higher, thus having a larger volume of water. This becomes clearer when reviewing area distribution and the possibilities for water storage/water fluctuations.

Area ratio distribution

For each variant a distinction is made between the following functions: water, land/green area, paving, and constructed building area. This is illustrated in Appendix XI, showing the percentage and ratio with regard to the total area. This is made visible by use of various tables and pie-charts.

There is little difference between the referential variant and the land raising variant, except for a slight rise in constructed building area, which is the result of building additional dykes and construction of embankments. As a result there is only a minor difference in above ratios. Water area, constructed area and paving make up the largest proportion within both variants, approximately 29%, 34-38%, and 31%, respectively. Land/green areas make up somewhat over 9% for both variants. In relation to the cascade variant this is very different, whereby water and land/green area make up the largest proportion, between 34% and 32% of the total area. Paving and constructed area are reduced to approximately 22% and 19%, respectively. These characteristics can be explained by the unusually large proportion of land destined for amphibious homes; reducing the need for paving and reducing constructed building area. A unique quality of the cascade variant is the ability to overflow the area housing the amphibious homes. As a result the ratio distribution shifts even more, to a total water area increasing by almost 23%, from 34% to 57%. Finally, as can be expected, the water variant has the highest percentage in water area, approximately 69%. Because the majority of housing is floating homes, the need for paving is at a minimum, only 2%. Total constructed building area is relatively similar to the referential variant, namely 39%, whereas land/green area is 22%. Furthermore, the total area of water storage in each variant is higher than the prescribed minimum of 15% as mentioned in the constraints for Westergouwe.

The water variant has the largest area in water storage, followed by the cascade variant. As the number of floating homes increases, the need for paving decreases

What is interesting to see when reviewing the total area distribution, is the use of space in each design. In the problem statement it is mentioned that double use of space is necessary in order to fulfil the demand for housing and water storage. This becomes evident when reviewing the following table:

Variants	% of total area
Referential	105%
Land raising	108%
Cascade	106%, and 129%
Water	132%

Table 32: Use of space as percentage of total area

A score above 100% implies multiple use of space

Table 35 shows the total sum of water, land/green, paving and constructed building area, as a percentage of the total area of Westergouwe. In doing so, the use of space in each variant is calculated; scoring above 100% implies multiple use of space. The referential and land raising variant score between 105-108%, which is the result of

With the cascade variant, multiple use of space increase from 106% to 132% when part of Westergouwe is flooded

combining water storage with floating homes. However, the use of water homes in both variants is limited. This is not the case for the cascade and water variant, where the majority of housing is either amphibious or floating. This is reflected in the use of space, where the cascades design scores 106% in 'normal' conditions but can rise up to 129% when certain areas are flooded. The cascade variant not only combines water storage with floating homes, but also combines land and green areas with seasonal/peak water storage. The amphibious homes then rise with the tide, without structural damage. Finally, the water variant scores highest with 132%, which can be explained by the large quantity in surface water combined with floating homes and amphibious homes.

Overview general program

Table 34 shows an overview of the housing typologies, whereby a distinction is made between traditional, amphibious, and floating homes. The number and percentage are added to illustrate the diversity between each variant. The referential and water variant form the extreme opposites; the water design having no traditional homes, apart from public facilities and buildings and the referential having only traditional homes. The referential (and land raising) variant have only 1% floating homes, whereas the water design has up to 70%. The cascade variant has a much larger and more spread diversity in housing typology, with the majority still in traditional homes at 50%.

Overview of housing typology and percentage

Typology	Referential	Land raising	Cascade	Water
Traditional	3,762 – (99%)	3,762 – (99%)	1,910 – (50%)	-
Amphibious	-	-	1,072 – (28%)	1,098 – (30%)
Floating	38 – (1%)	38 – (1%)	818 – (22%)	2,703 – (70%)

Table 33: Housing typologies; traditional versus water resilient (amount and percentage)

Design choices in housing typology influence the financial outcome and feasibility of each design, with key constructional implications and financial consequences. This will become clearer when the difference in land use planning costs are compared; see following paragraph on cost & revenue distribution.

The design characteristics of the variants help to better understand the layout of each design. Table 35 illustrates a number of characteristics.

	Referential	Land raising	Cascade	Water
FSI	0.82	0.82	0.6	0.51
OSR	0.8	0.75	1.34	1.19
GSI	0.34	0.38	0.19	0.39
Gfa/'bbo'	2.4	2.2	3.2	1.3

Table 34: Statistics per variant

Firstly, the floor space index (FSI) is calculated, which is the gross floor area divided by the total plan area. The higher this value, the more floor area there is per plot. The FSI value for the cascade and water variant is considerably lower than for the referential variant. This can be explained by the increased amount of amphibious and floating homes, which need less open space/green area. The homes are more compact and moreover have terraces instead of large gardens.

Secondly, the open space ratio[38] (OSR) calculates how 'open' a certain plan is; the higher this value the more 'open' the plan. The cascade and water variant both score higher and are thus more open. This is because of two reasons: the first being that the total plan area is slightly larger due to expropriation; and the second because total constructed building area is less. This is especially the case for the cascade variant, which therefore has the highest OSR.

Thirdly, the ground space index (GSI) is calculated, which determines the ratio between constructed building area and total plan area. The nearer that value is to 1, the more constructed the plot is. With the exception of the cascade variant, the other three score relatively similar, whereas the cascade design scores lowest. This is due to the large (land) area for amphibious homes, which consequently also functions as green/public area in IGOMOD. As a result constructed area is lower and thus the GSI is lower.

Finally, an indication is given of the number of building layers in each design. This is calculated by dividing the gross floor area by total constructed area. The referential and land raising variant score an average of approximately 2.3 layers, whereas the cascade variant obviously scores highest with 3.2 building layers. The large amount of detached and semi detached floating homes, means the average in building layers is reduced. Therefore it can be expected the water variant has the least layers, 1.3.

Real estate development

In previous paragraphs, the phasing of land use planning and real estate development, was described for each variant. However, for developing parties it is also important to see how many homes will need to be constructed and eventually put onto the housing market, giving insight into development risks.

Phasing of housing development per year

The line is the same for the referential and cascade variant, and for the land raising and water variant

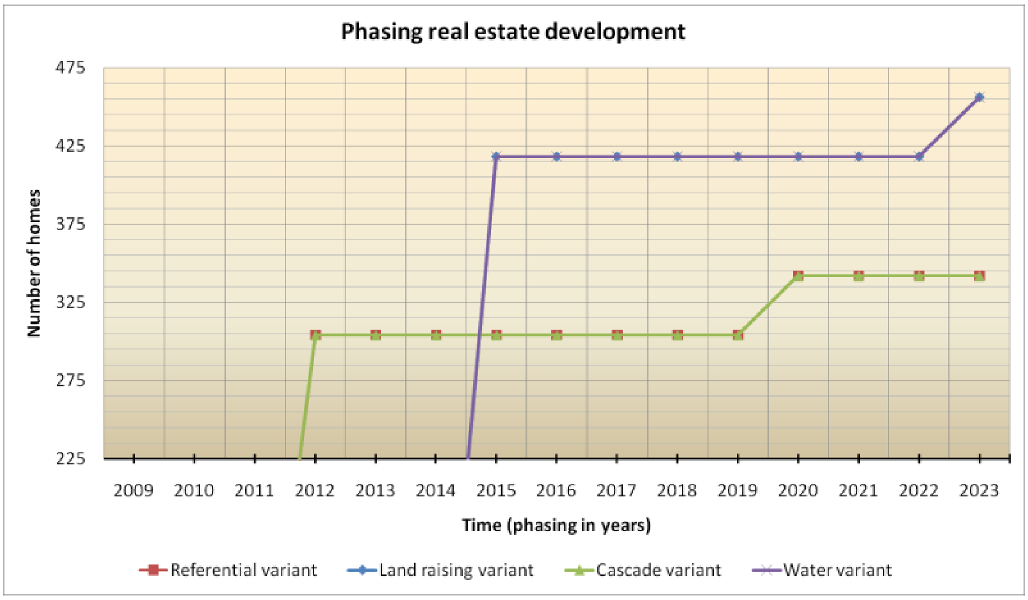


Figure 39: Number of homes developed per year per variant; the lines overlap each other

[38] (total plan area - constructed building area)/gross floor area

Figure 39 shows the distribution for each variant, of the total amount of homes that are to be developed and put on the market per year. This will give developing parties an indication of the risks of real estate development in the housing market and when they can expect their rate of return. As was mentioned earlier, the phasing per year for real estate was evenly spread over the years. This explains the uniform flow of the lines. Furthermore, the four lines are the sum of all housing typologies added together per variant, and give a general (average) indication of real estate development. As a consequence similar patterns are visible in phasing; the phasing for the referential and cascade variant are the same, as is the case for the land raising and water variants. This is largely due to planning in land use activities. The delays caused by soil settlement and water needed for the floating homes explains why real estate development starts 3-4 years later for the land raising and water variants. Even though the cascade variant also has soil and water related activities, it is still possible to develop the traditional housing first. Therefore, development starts in 2012 for the referential and cascade variant, whereas 2015 is the starting date for the land raising and water variant. For the first two variants the average number of homes to be put on the housing market is approximately 300, rising up to 340 towards 2020. For the land raising and water variant, this is approximately 380 homes a year. The greatest risk for real estate developers is overshooting the local housing market[39]. Moreover a certain percentage of homes are sold prior to development, thus ensuring revenues and reducing the risk on the housing market. That risk is increased with new, high-priced, innovative housing, such as water resilient homes. Therefore developers will prefer to spread that risk and aim for diversity in housing typologies.

Approximately 300 homes are to be developed per year for the referential and cascade variant; 380 for the land raising and water variant

Cost & revenue overview

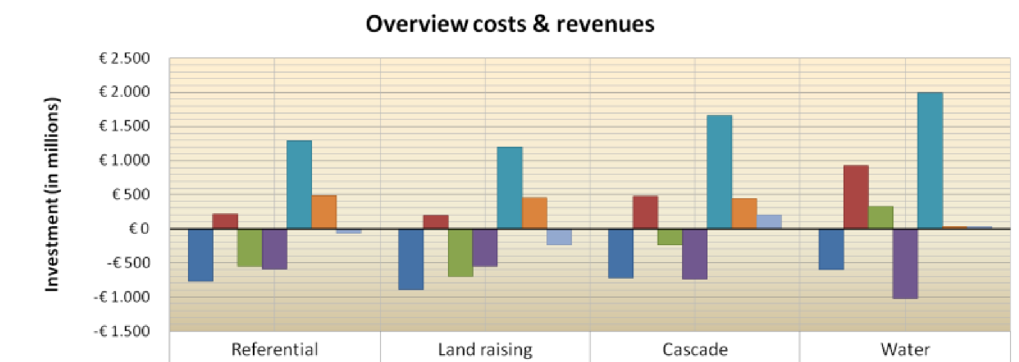
In figure 40 the differences in costs and revenues between each variant is more clearly visible. The land raising variant scores highest on land use planning costs due to the large financial outlay of raising the Westergouwe, whereas the water variant scores lowest. Revenues from land use planning are higher for the cascade variant and highest for the water variant, in relation to the referential and land raising variant. This has to do with the housing typology and land sales for amphibious and floating homes, which are calculated per gross floor area. Furthermore, the plot sizes are lower than for traditional houses, allowing for more homes to fit in the area. In addition, the plots are destined for either detached or semi detached homes (high market segment), making it possible to demand more for the land. Consequently this increases the revenue from land sales. However, the positive balance of land use planning implies the cost per plot could be reduced.

Another aspect which draws attention is the mutual growth in real estate costs and revenues for amphibious and floating homes. It is more expensive to develop water resilient homes but they also generate more revenues. This is strongly dependant on the local housing market. This is illustrated by the purple and light blue histogram in

[39] 'Overshooting' the housing market: the relatively short period in which costs and house sales take place combined with economic downturn and price increases, causing RE costs to rise while rate of return is delayed

figure 40, representing real estate costs and real estate revenues, respectively. Real estate costs are higher for both the cascade and water variant, but so are the revenues. In conclusion, lower land use planning costs for water resilient homes combined with higher real estate revenues, makes the difference between a positive or negative financial outcome. The cascade and water variants are prone to be financially feasible.

Overview of total costs and revenues for land use planning and real estate development. Only the cascade and the water variant have a positive end value



	Referential	Land raising	Cascade	Water
L.u.p. costs	€ 768-	€ 892-	€ 715-	€ 601-
L.u.p.-revenues	€ 216	€ 193	€ 476	€ 928
L.u.p. balance	€ 552-	€ 699-	€ 239-	€ 327
RE-costs	€ 589-	€ 545-	€ 736-	€ 1.023-
RE-revenues	€ 1.289	€ 1.197	€ 1.660	€ 1.985
RE-balance	€ 483	€ 459	€ 448	€ 34
End result	€ 69-	€ 240-	€ 209	€ 34

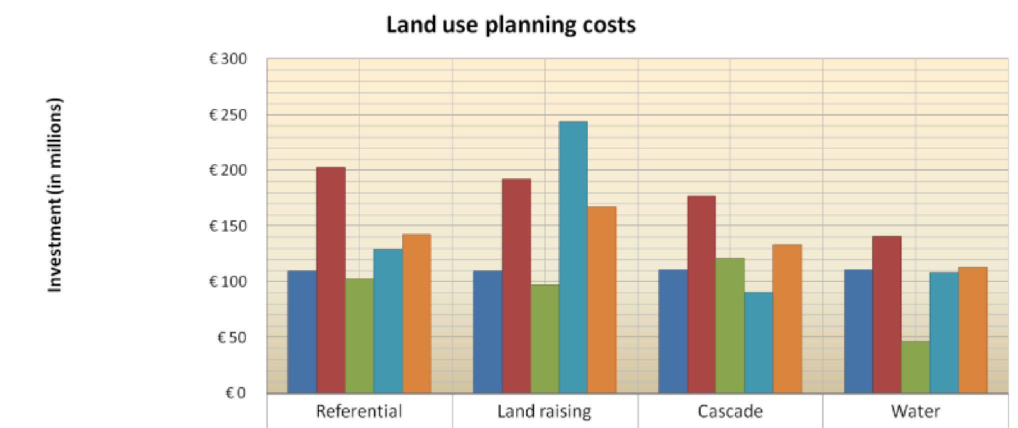
Figure 40: Overview of total costs and revenues for land use planning and real estate development (L.u.p. = Land use planning, RE = Real estate)

Land use planning costs

It is becoming increasingly evident from data analysis, that land use planning activities have a profound impact on the financial outcome and consequently on the end balance of land use planning; three out of four variants score negative. It is therefore interesting to determine what activities contribute most, and how this varies between each variant. This is illustrated in figure 41, which shows the different land use planning activities and costs per variant. The structural plan costs are the same for all variants and are therefore not included in figure 40. These costs are a fixed item sum within land use planning; comparison is therefore irrelevant for this analysis. When reviewing the different activities, the light blue histogram representing additional costs, are extremely high for the land raising variant; more so than for the other variants. This is caused by raising Westergouwe to 0m NAP. Consequently indirect costs are higher too, which is calculated as a percentage of total costs. It can be expected with such a difficult and complex procedure, that complications and unforeseen circumstances can occur and costs can suddenly increase. Raising such a large quantity therefore poses many risks for land developing parties and/or municipality.

Additional costs are highest for the land raising variant

Land use planning activities have a large financial impact. Figure 41 shows the costs per activity for each variant



	Referential	Land raising	Cascade	Water
General	€ 109	€ 109	€ 111	€ 111
Preparation of building site	€ 202	€ 192	€ 177	€ 141
Preparation of living area	€ 102	€ 97	€ 121	€ 46
Additional costs	€ 129	€ 243	€ 90	€ 108
Indirect costs	€ 143	€ 167	€ 133	€ 113

Figure 41: Overview of land use planning costs per activity

Floating homes need little to none preparation to the land

The following activity scoring high for all variants is preparation of building site, whereby these costs are higher for the referential and land raising variant. The foremost reason for this is the construction ready costs for traditional housing (this will be explained more in depth in the following paragraph). Another noticeable difference is the relatively low cost for preparation of living area for the water variant. This is due to the large number of floating homes, needing little to no preparation of land. On the other hand, there are additional costs for water proofing, which applies to both the water and cascade variant. The water variant, with only water resilient homes, scores higher than the cascade variant. The cost distribution of water proofing activities will be addressed in the following paragraph.

Construction ready costs[40]

In previous paragraph it was noted that costs for preparation of building site are highest in land use planning, whereby the construction ready type is a large contributing factor. This paragraph will give insight into the reason why.

Construction ready costs for traditional housing account for the high costs with the referential and land raising variant

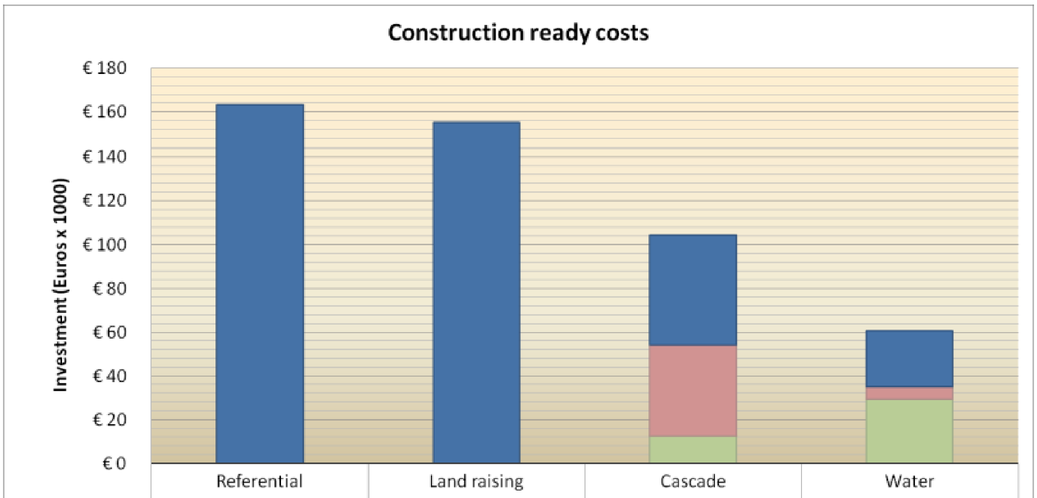
In IGOMOD three different types in readying land for construction were used: preparing land for traditional development, amphibious housing and for floating housing. However, there is a substantial difference in unit price, which in turn greatly influences total costs of preparation of building site. This is illustrated in figure 42, which shows the construction ready costs per type for each variant. It is evident that the costs for the referential and land raising variant are considerably higher, while keeping in mind that each variant houses the same number of homes (3,800). The blue histogram represents the traditional method which accounts for almost all costs for the referential and land raising variant. The cascade variant on the other hand shows a more equal distribution of types; as a result total costs are considerably lower. The same applies for the water variant, whereby the construction ready type

[40] In IGOMOD the following types were used: Traditional (type A), Amphibious (type B) and Floating (type C)

for floating homes is highest.

Construction ready costs account for more than half and up to 80% of preparation of building site costs

The relative weight of these costs becomes clear, when these costs are put as a percentage of total ‘preparation of building site’ and ‘land use planning’ costs. Construction ready costs for the referential variant make up almost 81% of ‘preparation of building site’ costs and 21% of total ‘land use development’ costs. For the land raising, cascade and water variant, this is: 81% and 17%; 59% and 15%; 43% and 10%, respectively. In other words, construction ready costs weigh substantially in the total costs for preparation of building site; from more than half to 80%. It is therefore less costly to prepare the building site for amphibious and floating homes than it is for the traditional variant. These costs compensate for the added costs of water proofing and landscaping activities.



	Referential	Land raising	Cascade	Water
Traditional	€ 163.137	€ 154.987	€ 50.194	€ 25.578
Amphibious	€ 0	€ 0	€ 41.681	€ 5.426
Floating	€ 236	€ 224	€ 12.616	€ 29.659

Figure 42: Construction ready costs per type for each variant (Euros x 1000)

Water proofing costs

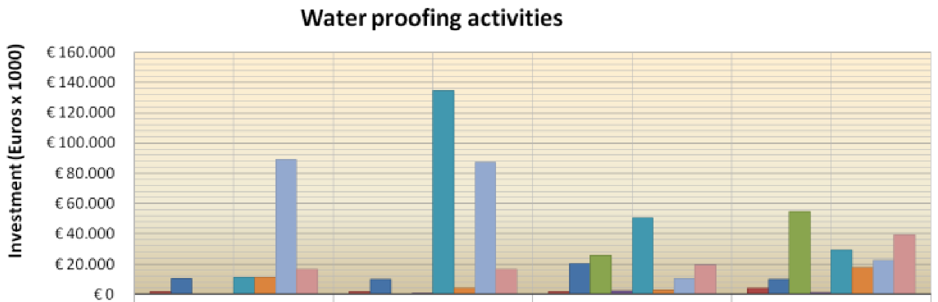
For each variant all activities related to water proofing are listed, including total costs. The activities include: water; civil engineering construction; addition of public facilities specifically for amphibious and floating homes; construction of dykes; soil consolidation; excavation of both land and waterways; revetments of dykes and quays; and water facilities and maintenance. This will give insight into the cost distribution of each activity and how they financially relate with regard to each design. This is illustrated in figure 43 (the name of some activities have been shortened to fit the table).

Revetment costs are high for the referential and land raising variant

Again it is evident that soil consolidation costs are very high for the land raising variant, and to some degree for the cascade variant. An interesting aspect is revetment costs for dykes, embankments, and quays. As the amount of surface water area and canals/waterways increases, so do the costs for the construction of revetments. The use of pre-existing waterways in the referential and land raising variant are the cause of this. Furthermore, the water variant shows two peaks in activities: additional costs for public facilities for water resilient homes; and water facilities and maintenance. These are higher than for the other variants, which can be

Overview of activities related to water proofing. The water variant shows higher costs for public facilities and water maintenance

explained by the number of amphibious and floating homes. In addition costs for excavation are also slightly higher. However, in reviewing land use planning costs, the costs of additional water proofing precautions do not supersede the revenues. This is not the case for the referential and land raising variant. For the referential variant, revetment costs are highest; for the land raising variant, both soil consolidation and revetment stand out; for the cascade variant, these are public facilities and soil consolidation; and for the water variant, these are public facilities, and water facilities and water maintenance.



	Referential	Land raising	Cascade	Water
Water	€ 1.769	€ 1.653	€ 1.945	€ 3.955
Civil constr.	€ 10.593	€ 10.064	€ 20.128	€ 10.064
Public facilities	€ 670	€ 637	€ 25.849	€ 54.538
Dykes	€ 494	€ 747	€ 2.361	€ 1.548
Soil consolidation	€ 11.212	€ 134.543	€ 50.605	€ 29.449
Excavation	€ 11.146	€ 4.142	€ 2.528	€ 17.799
Revetments	€ 89.099	€ 87.125	€ 10.221	€ 22.595
Water facil. & maint.	€ 16.781	€ 16.736	€ 19.458	€ 39.300

Figure 43: Water proofing activities and cost overview per variant

7.3

7.3 Analysis matrix

This part of the data analysis, combines the knowledge gained from literature study with the case study of different variants for Westergouwe, whereby the data analysis is used to further asses the variants on a number of crucial topics related to this research. The role and implications with regard to the various stakeholders are also taken into account. This is done by way of an analysis matrix. The analysis matrix is divided into five categories; in turn each category consists of a number of criteria related to that subject. A short description/evaluation is given for each variant. This can include specific characteristics, but also positive as well as negative aspects, depending on the design and criterion. The different categories are:

The analysis matrix is divided into five main categories. Each category consists of a number of criteria

- *Spatial design*: this includes the overall characteristics and quality of the variants, such as housing, overall program, and use of space.
- Water management: this includes all activities related to water proofing, water storage, water level fluctuations and water maintenance.
- *Costs & revenues*: this includes costs and revenues for land use planning activities and real estate development.

Points are awarded to the variant that scores best per criterion

- *Financial feasibility*: this includes the end value of land use planning, real estate development and the overall financial outcome of each variant.
- *Risks*: this includes the risk of general phasing for land use planning and real estate development, the risk of the local housing market, risk from seepage pressure, and the risk with regard to future users.

Answer to subQ-6 in Table 35

Table 35 shows the analysis matrix. For each criterion a point is awarded to that variant that scores, either: strongest; has the lowest costs, and/or has the highest revenues; is most flexible in housing program; has the fewest risks; is most feasible, etc. It is also possible no points are awarded when there is no difference in characteristics or that criterion applies to all variants. The points are visualised by an asterisk (*) and are highlighted in the matrix. The total score per category is totalled and the end score is given. The variant with the highest score is subjected to sensitivity analysis. This is described in the following paragraph.

Analysis matrix

	Referential variant	Land raising variant	Cascade variant	Water variant
Spatial design		*	***	**
Re-use of polder landscape characteristics	*Part of the original waterways and canals are kept*	*Part of the original waterways and canals are kept*	***The natural ground levels are reused to create different layers. Some original waterways are reused.***	*None*
Area distribution	*Constructed building area (34%) and paving (31%) make up the largest proportion, followed by water (30%)*	*Constructed building area (38%) and paving (31%) make up the largest proportion, followed by water (29%)*	*Land/green area makes up the largest proportion. In case of flooding, water area is increased by 23% to a total of 57%*	***69% of the area is water. This area can be used for water storage but can also have recreational purposes.***
Housing typology (traditional vs. water resilient)	*99% traditional housing, 1% floating homes; one-sided typology*	*99% traditional housing, 1% floating homes; one-sided typology*	***50% traditional housing, 28% amphibious and 12% floating homes; strong mix in typologies. There is an added need for parking garages for amphibious homes, due to limited space on plots and in case of flooding.***	*30% amphibious and 70% floating homes; good mix in water resilient homes, but none in traditional housing. The need for parking garages with floating homes is greater, since parking is limited.*
Space ratio & housing density	*The average number of building layers is 2.4.*	***The average number of building layers is 2.2.***	*The area housing amphibious homes (mostly detached) is more densely populated than area housing traditional homes. As a result traditional housing includes more storey buildings, average of 3.2.*	*Because floating homes are mostly detached and semi detached, the water area is densely populated, thus reducing privacy and water space for recreation, average of 1.3 layers.*
Project innovation (research development)	*Little to none; mostly traditional development as we know it.*	*New knowledge can be gained on soil settlement techniques, aiming to reduce time and reduce soil instability.*	***Possibilities for research development for water regulatory authorities and construction industry on water resilient homes. This also accounts for soil settlement techniques.***	*Possibilities for research development for water regulatory authorities and construction industry on water resilient homes*
Multiple use of space (water storage and housing)	*105% use of space*	*108% use of space*	*106% and when partially flooded 129% use of space*	***132% use of space***
Water management	*			**
Water storage	*30% of area is water; more than required in constraints, also due to many waterway. Requirements in constraints states at least 15% water storage.*	*29% of area is water; more than required in constraints, also due to many waterways*	*A maximum of 57% water area can be reached, 23% under normal conditions; more than required in constraints*	***More than half, 69%, is water area. This large area is ideal for water storage and considerably higher than required in constraints.***
Water level fluctuation & water inconvenience (see also Appendix XI Data analysis – variant comparison)	*≤1m; according to the minimum requirements listed in constraints. Excess (rain) water can flow into the canals and waterways and be directed to the larger water area, thus taking away water inconvenience.*	*≤4.5m; due to raising the land to 0m NAP. Excess (rain) water can flow into the canals and waterways and be directed to the larger water area, thus taking away water inconvenience.*	*≤1 and ≤6.3m; the layered ground levels allow for the highest rise in water level without property damages. Excess (rain) water can flow down the step-like structure and into the water area.*	***≤1.7 and ≤2.7m; not as much as the cascade variant, but the large area of water means more water capacity. Excess (rain) water can easily be collected in the Westergouwe.***
Water maintenance	***A constant flow of water is needed to reduce formation of blue algae, debris, and or inconvenience from insects. Water regulatory authorities are responsible for maintenance and quality control.***	*A constant flow of water is needed to reduce formation of blue algae, debris, and or inconvenience from insects. Water regulatory authorities are responsible for maintenance and quality control.*	*A constant flow of water is needed to reduce formation of blue algae, debris, and or inconvenience from insects. Constant maintenance is needed, especially after the land with amphibious homes dries up again, after flooding. Water regulatory authorities and users are responsible for maintenance.*	*A constant flow of water is needed to reduce formation of blue algae, debris, and or inconvenience from insects. Water regulatory authorities and users are responsible for maintenance and quality control.*

Analysis matrix

	Referential variant	Land raising variant	Cascade variant	Water variant
Costs & revenues			***	*
Land use planning	*The costs for preparation of building site are the highest item sum in land use planning.*	*Costs for soil settlement are the largest financial sum in land use planning, in addition to costs for preparation of building site.*	*The costs for preparation of building site and indirect costs are highest for land use planning.*	***There is a more even cost distribution of activities in land use planning. Preparation of building site, however, is still highest. Preparation of living costs is lowest of all variants.***
Construction ready costs (types)	*Construction ready costs account for 21% of total land use planning. The high costs are due to traditional methods of readying building site.*	*Construction ready costs account for 17% of total land use planning. Traditional method of readying building site is the leading cause.*	***Construction ready costs account for 15% of total land use planning. All three types of readying building site for construction are used; traditional, amphibious, and floating homes. Consequently reducing overall costs for preparation of building site.***	*Construction ready costs account for 10% of total land use planning. Both methods for amphibious and floating homes are used. Consequently reducing overall costs for preparation of building site.*
Real estate development	*Approximately 300 homes per year are put on the housing market. Sales start a year after construction, which is potentially a tight and relative optimistic planning.*	*Approximately 380 homes per year are put on the housing market. Sales start a year after construction, which is potentially a tight and relative optimistic planning.*	***Approximately 300 homes per year are put on the housing market. Sales start a year after construction, which is potentially a tight and relative optimistic planning.***	*Approximately 380 homes per year are put on the housing market. Sales start a year after construction, which is potentially a tight and relative optimistic planning.*
Water proofing activities	*Costs for the construction of revetments are highest with regard to water proofing activities.*	*Costs for soil consolidation and the construction of revetments are highest with regard to water proofing activities. This variant has the highest costs for water proofing precautions.*	***Costs for soil consolidation, public facilities for amphibious and floating homes, and civil engineering are higher with regard to the other water proofing activities. This variant has the lowest total costs for water proofing precautions.***	*Costs for public facilities, water facilities and maintenance, are highest for this variant. This is caused by the large quantity of water and the number of floating homes.*
Financial feasibility	*		*	*
Balance in land use planning (million €)	*Negative: -€552*	*Negative: -€699*	*Negative:-€239*	***Positive, land use revenues supersede the costs: €327***
Balance in real estate development (million €)	***€483; the majority of homes are detached and high priced, resulting in a positive and favorable financial outcome of RE development.***	*€459; the tight and relative short development phase of housing constitutes to the positive end value. The shortened RE phase is caused by delays in land use planning.*	*€448; the tight and relative short development phase of housing constitutes to the positive end value. The shortened RE phase is caused by delays in land use planning.*	*€34; even though developing water resilient homes have added costs, the end result remains positive.*
Financial end result (financial room & financial leveling)	*Negative land use planning costs could not be leveled by real estate revenues; -€69. However, the deficit is relatively 'minor' and financial cut backs could bring the value closer to 0.*	*Negative land use planning costs could not be leveled by real estate revenues; -€240. The large deficit does not suggest there is enough room for further financial compensation.*	***After leveling the financial outcome is positive; €209. The financial outcome becomes more optimistic, when total time of real estate development is reduced. The surplus in end value implies there is financial room for further optimization.***	*Financial leveling was not needed for this variant, due to low land use planning costs and high real estate sales.*

	Referential variant	Land raising variant	Cascade variant	Water variant
Risks	*		***	
Phasing in land use planning	***The peat soil conditions of Westergouwe, means the ground is unstable and unfit for development. As a result soil consolidation is required. This increases the risk for land development parties.**	*Complications in soil settlement can easily delay further planning, driving up costs and increasing investments. This increases the risk for land development parties.*	*Complications in soil settlement and water needed to fill Westergouwe, could delay further planning, driving up costs and increasing investments. This increases the risk for land development parties.*	*Complications in water needed to fill Westergouwe, could delay further planning, driving up costs and increasing investments.*
Phasing in real estate development	*The current phasing for real estate development differs one year between construction and sales. This could easily change for the worse if local economy is in downturn. Furthermore, real estate delays combined with a rise in rent levels can be devastating for developing companies, increasing development risks.*	*The current phasing for real estate development differs one year between construction and sales. This could easily change for the worse if local economy is in downturn. Furthermore, real estate delays combined with a rise in rent levels can be devastating for developing companies, increasing development risks.*	*The current phasing for real estate development differs one year between construction and sales. This could easily change for the worse if local economy is in downturn. Furthermore, real estate delays combined with a rise in rent levels can be devastating for developing companies, increasing development risks.*	*The current phasing for real estate development differs one year between construction and sales. This could easily change for the worse if local economy is in downturn. Furthermore, real estate delays combined with a rise in rent levels can be devastating for developing companies, increasing development risks.*
Housing market	*This variant offers predominately traditional non water resilient homes, with the exception of 38 floating houses. There is a wide choice in housing typology and price range, making it attractive for a larger target group; reducing the risk for developers on the housing market.*	*Also this variant offers predominately traditional homes, but built above water level. The wide choice in housing typology and price range makes it attractive for a large target group; reducing the risk for developing parties.*	***This variant offers all housing typologies, traditional and water resilient. The risk on the housing market is therefore more spread out. Consequently there is not only a wide choice in typology but also in price range.**	*For real estate developers, the greatest risk is overshooting the local housing market with amphibious homes and floating homes. The demand and high housing price are therefore crucial factors.*
Seepage pressure	*Seepage pressure remains and water from surrounding areas can push into Westergouwe.*	*The added sand pack reduces the risk of seepage from surrounding areas.*	***The combination of added sand pack and large water area reduces the risk of seepage into Westergouwe. Seepage into the water area does not pose a threat.**	*The large water area means seepage from neighboring areas is no threat to this design and can naturally occur.*
Users (willingness to pay)	*Future users/inhabitants may find the risk of property damages from water inconveniences too great and choose not to live in Westergouwe, and in the Zuidplaspolder.*	*Property damages from flooding or water inconvenience is drastically reduced, however, the question remains if future users are willing to pay for additional water precautions and activities.*	***As with the land raising variant, the success of this variant depends on the people's demand for water resilient houses. In turn they must be prepared to invest in more expensive homes, but with the knowledge of being safe from water inconvenience. The floating homes and amphibious homes offer a unique living experience when water levels rise. Living on and near water can be an added quality in living.**	*The water variant poses similar risks as the cascade variant when the demand for floating homes is concerned. This variant does however offer the added quality of living near and on water. Consequently this variant offers the possibility of water sports and recreation.*
Total score	*3*	*1*	***10***	*6*

Table 35: Analysis matrix

Variant choice

The end score shows the cascade variant has the most points, 10 out of 20 possible points. To a certain degree, this outcome was to be expected. The cascade variant for Westergouwe is a mix of all variants whereby the spatial designs incorporates innovative techniques in water management, as well as a wide range in housing typology; both traditional and water resilient houses are implemented. As a result the cascade variants benefits from the positive and unique qualities of each variant, but with fewer complications and fewer (or spread) risks. Although the balance for land use planning is negative the financial end result is positive. Consequently, the combination of fewer risks and a favourable financial outcome makes this variant appealing to the stakeholders.

7.4

7.4 Sensitivity-analysis

The aim and focus of this sensitivity analysis is not to optimise the cascade variant to generate, for example, the most revenues or reduce costs to a minimum, but to determine how sensitive the cascade design is to changes in financial parameters. Data analysis has shown the cascade variant does not have a closing land use planning balance and that real estate revenues are relatively high. Furthermore, in the analysis matrix it was stated that phasing of planning activities can have great financial effects on the financial outcome and pose a potential risk for the main stakeholders. The aim is therefore to achieve a closing financial outcome in land use planning and real estate development, by influencing different parameters. In addition, a 'bad weather' scenario is conducted, whereby planning is delayed. Sensitivity analysis will determine the design's sensitivity to those changes. The main parameters that have a determining effect on the outcome are: fluctuating (land) prices; rent levels and percentages; and delays or changes in phasing. The following aspects will be analysed for the cascade variant:

The sensitivity of the financial outcome for the cascade design is analyzed with regard to three aspects

- Closing land use balance
- Closing financial end value
- 'Bad weather' scenario

Closing land use balance

The current financial outcome of land use planning for the cascade variant is approximately -€239 million. For this analysis, the 'Goal Seek' function in Excel is used to set the outcome in land use planning to 0, by changing either primarily the value of rent level, cost increase percentage and revenue increase percentage. Study has shown the outcome was only sensitive to changes in revenue increase, changing it from 0% to 4.9%. As a result land use planning has a closing balance, but the financial end value is now increased from €209 to €853 million, a difference of €644 million.

Revenue increase percentage of 4.9% is needed

Another parameter that can be influenced, in order to achieve a closing balance in land use planning, is land prices. For this, the 'land quote method[41]' is used, which is calculated by dividing land costs by housing price (v.o.n. price[42]) to give a percentage, or land quote. When revenues from land sales are recalculated according to this method (in IGOMOD), the land quote for the current situation is approximately 26%. When the 'goals seek' function is used again, land quote increases to 40%, a difference of 14%. The newly calculated land prices are shifted to the high end price range; low priced homes up to 14%, middle priced homes between 14-28%, high priced homes between 28-35% and up[43]. The financial end result is now €209 million. Appendix XII shows an overview of newly calculated land prices.

Land quotes method; a rise of 13% is needed to close the balance of land use planning

[41] Grond quote berekening
[42] V.o.n. price ='vrij op naam prijs' in Dutch
[43] Source: http://www.zwolle.nl/cms/resources_users.nsf/Lookup/Grondprijzencurve_2009_projectmatige_woningbouw/$file/Grondprijzencurve_2009_projectmatige_woningbouw.pdf

In the analysis matrix it is mentioned that the phasing of land use planning activities already follows a tight and potentially optimistic schedule. It is therefore not likely that phasing in land use activities can be shortened, in order to reduce costs. In fact, the opposite is more likely and would only increase the deficit in land use planning.

Closing financial end value

An increase of 2.8% in costs is sufficient to achieve a closing balance in end value

The end value for the cascade variant after financial levelling is €209 million. Research has shown that it is impossible to achieve a closing end value by changing the BAR percentage of housing, offices, or businesses. The end value is only sensitive to changes in the percentage of cost increase. This in turn increases the costs of land use planning and real estate development. The goal seek function has shown that an increase of 2.8% (from 2.5% to 5.3%) is enough. As a result: land use planning costs increase by €146; and real estate development costs increase by €63 which reduce real estate revenues accordingly.

A change in phasing of real estate development also has a profound effect on the financial outcome. This sensitivity analysis will be further analysed in the 'bad weather' scenario.

'Bad weather' scenario

Project duration is increased to 19 years

Risk of overshooting the housing market

For the 'bad weather' scenario, real estate planning is delayed, to determine the financial sensitivity and consequences. Two different scenarios are investigated. The first extends the duration of real estate development by 4 years, the time it takes for soil to settle and Westergouwe to fill with water. This means the project duration is extended to 19 years. The second scenario further investigates what the financial consequences are when the first scenario is combined with the risk of overshooting the housing market. For both scenarios, a new overview of the financial implications is included.

Figure 44 shows the financial consequences of the first bad weather scenario. Total project duration is now 19 years and real estate development continues until 2027; 4 years longer than the original planning of the cascade variant. The same even distribution in real estate development is used. This means approximately 260 homes are developed per year; 40 homes less than the original design. Phasing for land use planning is kept the same. The figure shows the end result for both land use planning and real estate development. In addition to the newly calculated end result, (represented by the red line) the end result from the original cascade design is also included (represented by the blue line). The figure shows a gradual increase in total costs, whereby financial turnaround occurs in 2025, and approximately 7 years later than the original design. Table 36 shows the changes in financial outcomes. The new financial end result is dropped by €82 million, but still remains positive.

The end result is €82 million less than the original cascade variant

	Original design	New scenario
Balance land use planning	-€239	-€291
Balance RE development	€448	€418
End result	€209	€127

Table 36: Change in financial outcomes (Euros in millions)

Financial overview of new scenario; the end value is approximately €127 million

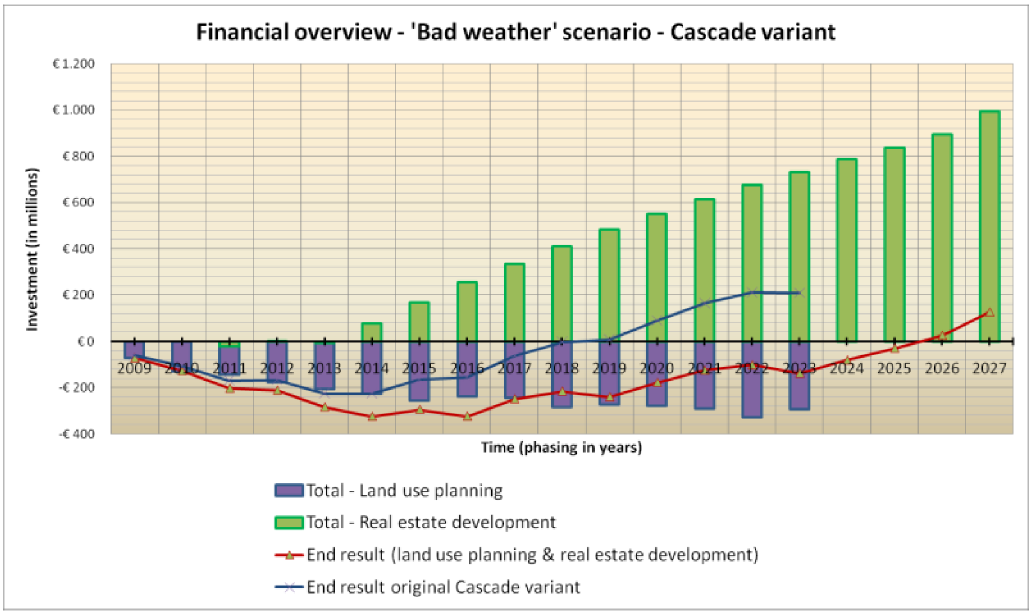


Figure 44: Financial overview of 'bad weather' scenario 1 for the cascade variant

The second scenario includes the same extension of 4 years in project time, but also takes into account the risk of the local housing market. This is interpreted in the following way: during the initial years construction of real estate is high, but gradually diminishes as the local housing market takes a downturn and becomes less attractive. People are hesitant to live in Westergouwe and are unwilling to pay for additional housing costs. As a result real estate costs keep increasing over the years and real estate sales fall behind. This is illustrated in figure 45, by the strong decline in the red line. After a number of years, however, people become accustomed to the idea of water management; real estate sales gradually pick up and more houses are sold over the remaining years.

Financial overview of second scenario; the end value is now negative, -€24 million

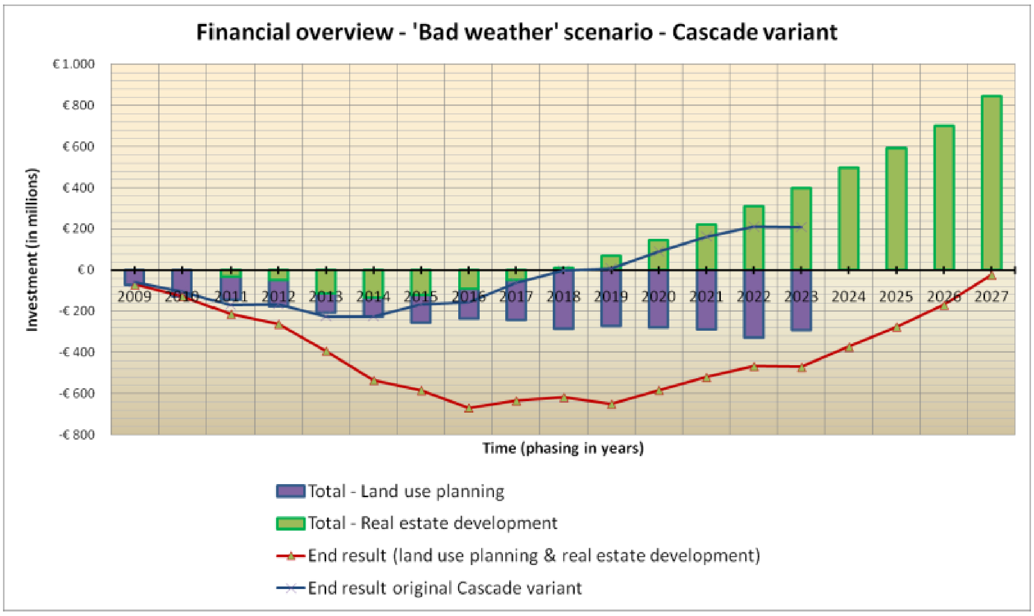


Figure 45: Financial overview of 'bad weather' scenario 2 for the cascade variant

The end result is -€24 million

The rising slope of the green histogram visualises the increase in sales. The difference in pattern between the red line and the (original end value) blue line is clearly visible. Unlike the positive financial outcome of the original variant, this scenario shows a negative balance of -€24 million. Table 37 shows the changes in financial outcomes for the original variant, the first scenario and the second scenario.

	Original design	Scenario 1	Scenario 2
Balance land use planning	-€239	-€291	-€291
Balance RE development	€448	€418	€267
End result	€209	€127	-€24

Table 37: Changes in financial outcomes (Euros in millions)

Answer to SubQ-5

The cascade variant is most sensitive to changes in phasing and increases in revenue prices, land prices and cost prices

<u>Review</u>

Sensitivity analysis was conducted from various perspectives with the aim to study how variations in certain key parameters affect the financial outcome of the cascade variant. The first analysis of land use planning results determined which parameter can bring forth a closing balance. Both an increase in revenue prices and an increase in overall land prices had the desired effect. This provides important information for both land developing parties and municipalities, who prefer to achieve a closing balance.

The second analysis investigated the financial effects on the variant's end value. Research has shown that a closing balance can be achieved by raising the percentage of costs increase by 2.8%. As a result, overall costs of land use planning and real estate development rose, and revenues from real estate development dropped. The third analysis of the 'bad weather' scenarios proved that phasing has a profound impact on the financial outcome for land use planning and real estate development. Phasing variances pose an important financial risk for not only investors but also developing parties. Economic downturn and negative changes on the local housing market can easily effect sales and delay revenues, while costs keep rising. For the cascade variant, both scenarios drastically increased real estate costs and reduced real estate revenues. In the first scenario the end value was still positive, but for the second scenario the outcome was negative at -€24 million.

The cascade variant shows considerable financial robustness

Although the second 'bad weather' scenario results in a negative overall end value, it is noteworthy that -€24 million constitutes 'near balance', in the worst of economic and financial assumptions. The cascade variant can therefore also been concluded to provide considerable robustness.

The aim of this research project is to give a conclusive answer to the main research question:

What are the effects of different water-design concepts on the financial feasibility of urban development in lowland polders?

The research methodology used in this graduation project has made it possible to come to conclusive insights in the key parameters which determine the financial and risk dimensions of the constituent parts of the resulting land use planning and real estate development values for the four different designs.
This chapter includes: the conclusion of this study research followed by my recommendations for Westergouwe, recommendations on further research and use of the financial model IGOMOD, and an epilogue.

8.1 Conclusion

Four different concepts in water-designs have been analysed on their financial feasibility and spatial program for the Westergouwe, three represent a different approach and method in water management. These water-design concepts are reflected in the following variants:

(1) *The referential variant:* building the traditional way ,
(2) *The land raising variant:* raising land to 0m NAP,
(3) *The cascade variant:* using structural land characteristics to create different step-like living areas ranging in street level heights, combined with water storage,
(4) *The water variant:* filling Westergouwe with water to form a large lake.

In this research, the cascade variant proves to be the 'strongest' and most financially robust design for Westergouwe, and shows great potential for future development in lowland polders.

Research conditions

This research has been based on a number of conditions which have to be taken into account when reviewing the conclusions.
(a) When developing in Westergouwe, the following ground interventions should be considered with regard to construction ready activities on peat soil:

- Keeping land raising to a necessary minimum to prevent unnecessary costs and ground instability;
- Large scale soil consolidation increases the stability of construction on peat soil;
- Reducing soil settlement time by implementing innovative techniques and soils, including a surplus in raised height to include setting, and taking into account the minimum required time for soil to settle in project phasing of activities;
- Using light weight materials in construction will reduce the load and stresses on the peat soil.

(b) Developing in Westergouwe and raising part of the land, will take away the problem of seepage pressure, but could direct this problem to surrounding areas. If this poses to be a threat, either necessary precautions must be taken or a more suitable alternative location must be found. In the case of Westergouwe this is not a problem, seepage pressure is directed into the Hollandse IJssel and Vijfde Tocht.
(c) Real estate development in the water design only includes high market segment housing, whereas for the other variants social housing is included. As a result of this, real estate revenues are considerably higher for the water variant, posing a more favourable financial outcome.
(d) In the future, water storage capacity for neighbouring areas and water displacement in times of dry spells, can have financial benefits. These possible revenues however, are not yet defined and were therefore not admitted in this study research.
(e) Flood risk from a dike burst is not the real threat for the Westergouwe, whereas water inconvenience from extreme weather conditions is. If the Hollandse IIssel or Ringvaartkade were to break, water will rise to -4.82m NAP (Werkgroep Wateropgave Westergouwe, 2004, p. 21). Under those circumstances only the referential design for Westergouwe will be insufficient to cope with such a rise.

Key effects of water-design concepts

Each water-design concept has a distinct effect on key design aspects, cost and risk elements, as represented in the following five categories:

<u>Spatial design</u>

The referential and cascade design have shown that implementing the original polder landscape characteristics of Westergouwe, can bring forth a unique quality in living area. In the referential design the existing waterways are re-used, whereas in the cascade design, the different ground levels are used to full potential to create different step-like living areas.
The minimum requirement of 15% reserved for water storage, setup in the constraints for Westergouwe, was achieved in each design, whereby the water design scores highest with 69% and the referential design the lowest with 30%. In order to incorporate both the housing demand and water storage, double use of space is needed. The large number in floating homes combined with the large quantity of water storage, means the water design scores highest on multiple use of space, at 132%. Building the traditional way makes this impossible, therefore the referential design score lowest. The unique feature of the cascade design means 106% in use of space is achieved in ‘normal’ conditions, but when flooded, multiple use of space rises to 132%.
A distinction is made in housing typologies: traditional, amphibious and floating homes. For both the referential and land raising design, 99% in housing typology are traditional built homes. The cascade design has an even distribution between traditional and water resilient homes (28% amphibious, 12% floating), whereas the water variant only has water homes (30% amphibious, 70% floating).
The difference in housing typologies combined with water storage facilities, means both the cascade and water design present the possibility and also need for research

development and cooperation between water regulatory authorities, municipalities and the construction industry.

Water management

In each water design it was possible to realise the minimum requirement in water storage. In fact, all variants exceeded the minimum requirement, making it possible for Westergouwe to hold, store, and discharge extra water from surrounding areas. In time this could lead to financial revenues. The downturn for water regulatory authorities lies in: additional costs of water regulatory systems, additional maintenance of water and embankments, more complex maintenance plans and increased organisational costs.

Although the referential design has more than the minimum required area for water storage, water level can only rise by 1 meter without structural damages or inconveniences. Heightening the Westergouwe ground level means water level can safely rise up to 4.5 meters for the land raising design. For the water design this is 2.7 meters, whereas the cascades design score highest as the water level can safely rise up to 6.3 meters. However, large quantities in water area require water maintenance: to reduce the formation of blue algae, debris, and to keep insects away. Water regulatory authorities are responsible for maintaining the water quality and water levels.

In the cascade and water design, water also has a recreational purpose apart from solely functioning as water buffer and storage, thus adding to a unique, newly achievable quality of living on/near water.

Costs & revenues

This study showed there is a considerable difference in cost distribution in land use planning costs for each design. Three types in readying building site for construction were used: preparing for traditional, amphibious, and floating homes. Construction ready costs of building site make up the largest sum in land use planning for the referential and land raising variant, up to 21% and 17%, respectively. This was noticeably lower for the cascade and water design, which is the result of lower construction ready costs for amphibious and floating housing.

With regard to water proofing costs, revetments make up the largest sum for the referential and land raising design; soil consolidation costs also make a large proportion for the land raising design. For the cascade design, costs for public facilities of water homes, combined with civil engineering costs make up the largest sum; however, overall this design has the lowest costs for waterproofing. For the water design, maintenance and public facilities are high investments in land use planning.

In this model the phasing of real estate for the referential and cascade design means approximately 300 homes are developed per year. Due to a four year shorter real estate development period, approximately 380 homes are developed for the land raising and water design. Shorter periods in real estate development, results in lower construction costs and in a quicker rate of return. As a consequence real estate revenues are higher.

Financial feasibility

The financial feasibility looks at the financial end balance in land use planning and real estate development, as well as the total financial end value of each design. The balance in land use planning for the referential, land raising and cascade design is negative, whereas the water design proved to be the only design with a positive outcome in land use planning. This can be explained by the low construction ready costs of land destined for amphibious and floating homes in the water design. The high costs of soil consolidation means the land raising design has a considerable lower end value than the referential or cascade design.

The end balance in real estate development for all four designs is positive, showing minor difference in outcome, with the exception of the water design, which showed a much lower end result. This is caused by additional water proofing costs of amphibious and floating homes, increasing real estate costs.

Financial levelling between land use planning costs and revenues from real estate development showed a negative financial end value for the referential and land raising design. However, the slight negative outcome of the referential design could be compensated by further cutbacks in costs. This cannot be said for the land raising design, whereby the total negative outcome is relatively high compared to total costs. The cascade design proves to have a positive financial outcome. For the water design financial levelling was not needed; both land the balance in land use planning and real estate development was positive.

Risks

The peat soil of Westergouwe makes the ground unstable and unfit for housing development. As a result soil consolidation is required; this predetermines and strongly influences phasing of land use planning activities. Soil settlement delays can take up to 4 years as is the case for the land raising and cascade design, increasing land use planning costs. Furthermore, peat soil is sensitive to further setting over time. Therefore, when raising the Westergouwe ground level a surplus in elevated height is needed to incorporate future setting. Excavated land from Westergouwe can be reused to raise other parts. This was done for the cascade and water design. Filling the Westergouwe with (rain) water also results in planning delays of multiple years, which constitutes to high land use planning costs for the cascade and water design. For land developers and municipalities, delays in phasing of land use planning activities can form a considerable financial risk.

Both raising land and filling part of Westergouwe with water, prove to be an effective method against the risk of seepage pressure from surrounding polder areas.

For real estate developers there is the risk of overshooting the local housing market, due to a one-sided housing typology of water homes. This can be a problem for the water and to a lesser degree for the cascade design, when future users may be unwilling and hesitant to invest in more expensive, innovative water resilient homes. For developers, phasing of real estate activities is crucial. A potentially too short phasing between real estate construction and sales, can give a too optimistic rate of return. The uncertainty of local economy, land prices, and the local housing demand has to be taken into account.

Personal reflection on water-designs for Westergouwe

Raising land to a substantial height has proven to be too costly and therefore the land raising design is not a functional alternative for our future challenges. Furthermore when implementing such spatial designs, special thought must be given to connecting neighbouring areas with the newly raised land. There can be a large difference in elevation height. Partial land-raising as with the cascade design is a more suitable alternative: the Hollandse IJssel and the dike ring already separates Westergouwe from Gouda, therefore the difference in ground heights will not pose a problem for this location.

Unfortunately, due to the high real estate risk, the water design looks currently too extreme for Westergouwe. Hopefully over time, when the demand for water resilient housing has grown, this design can be realised.

In this research study, the cascade variant is a mix of all four variant, incorporating the different water-design concepts into one spatial plan for Westergouwe. Therefore, the cascade design benefits from the unique qualities each variant has to offer, but because it is a less extreme design, the risks are more spread and lower. The unique diversity in living areas, housing typologies and price, makes it an attractive design for not only future users, but also the stakeholders. The innovative cascade design offers great possibilities for knowledge development and future cooperation between governments, water regulatory authorities, and the construction industry. The high multiple use of space means that the competing demands for housing and water storage are met. The cascade design not only proves to be financially feasible, but also shows considerable robustness under sensitivity analysis.

The majority of peat soil grounds in the Netherlands are situated in the Randstad area and in the North. It is in these areas that the growing demand for new housing is greatest. By 2040 approximately 200,000 new homes are to be realised in the Randstad (Gelderlander.nl)[44]. Furthermore, these areas are located below NAP; therefore the necessity for further research and development on peat soil is of the essence. A cascade design, where the polder-land characteristics are used fully can provide an answer to the growing demand for new homes in the future and subsequently address the challenges of water management and the need for water storage.

The referential design shows little innovation on water resilient housing and limited flexibility to future climate change and water management.

I therefore believe that the cascade design proves to be the strongest variant for future lowland polder design projects: combining the potential for meeting mutually competing demands and providing a new and unique quality for living in lowland polders.

[44] Source: http://www.gelderlander.nl/algemeen/dgbinnenland/3666792/In-2040-meer-woningen-en-groen-in-Randstad.ece

8.2 Recommendations

Recommendations for further research

- This research was a specific analysis of one case study. Although the challenges facing water management are generic, the problems for Westergouwe in program and spatial design remain specific and unique for that location. Analysing more cases will help to broaden the scope on challenges facing water management and can subsequently lead to alternative solutions for water management. Furthermore, the financial data input used in IGOMOD, is unique for the Westergouwe case. The validity and reliability of the financial outcome is therefore specific for this case.
- For future research it is interesting to calculate the risk and financial consequences of potential damages to property, infrastructure, public facilities and housing. This will give financial insight into the choice between investing in water proofing precautions and potentially having to 'pay the price' when flooding occurs.
- For this research the decision was made not to further analyse all four designs, but only the cascade variant. For future research it can be interesting to optimise each variant and determine the financial possibilities of each specific design.

Recommendations with regard to IGOMOD

Drawing application:

- To make it possible for the drawing application to take place without the need each time to, having calculate the overall outcome in the model. This would drastically reduce the intensity of the workspace and therefore reduce the time needed to draw up or alter a spatial plan;
- To make it possible to alter an element, switching between 'stempels', 'functie vlek' and 'bouwmassa'.
- To make it possible to select more than one element at the same time to either delete, copy or move different elements.
- To make it possible to copy one or more elements from one Excel-design to another without loosing information.

Phasing:

- To integrate different (sub) phases in one spatial design, making it possible to divide a spatial design into multiple separate areas with individual phasing of activities. Not only will this result in more realistic planning but it will also help to calculate a more accurate financial end value.

'Costs & Revenues' model:

- To have an activation key to allow for IGOMOD to start calculating the spatial design. Again this will reduce the time needed to design the correct plan and adjust the list of activities within the spatial design without having to wait for the model to finish calculating the end value.

IGOMOD overall:

- To make it possible to select one region within a spatial design and let IGOMOD calculate the optimal mix between different functions. The mix in functions could be a list of requirements from the initiating party which can be imputed into IGOMOD. This method is helpful in preliminary phase of designing. In turn this can give an overall view of what is possible in a certain area.
- To make it possible to see the total external margins in the spatial design. This will give an idea of the quality in use of space.
- Update the version to Office 2007; newer version of Office makes it easier to draw graphs, figures etc.
- Allow for [Del] button to function.

8.3 Epilogue

The situation in Westergouwe is a good example of the nationwide dilemma on water management. As Lenie Dwarshuis-van de Beek, Member of the South Holland Provincial Executive, clearly states: "The threat is certainly real, with rising sea levels, bigger waves, higher water levels in rivers, and a lot more rainfall…we must find a solution for this if we want to continue living here…it is an extremely expensive affair…the public is not sufficiently aware, as yet, that it will ultimately have to pay for this" (quote from interview with Lenie Dwarshuis-van de Beek in *Gouda Waterproof)*[45]. And furthermore as Toine Smits says: "unfortunately with the current plans not all new approaches have been used fully, homes are to be built in classical fashion, a direct effect of predetermined agreements, costs and decision making; the whole decision-making process was already too far advanced for the plan to be adjusted to accommodate a much more innovative approach" (quote from interview with Toine Smits in *Gouda Waterproof*)[46]. According to John Steegh, a director on the Rijnland dyke board, the technological possibilities for dealing with water management are multiple: the question is "at what price and are we so aware of the dangers that we are prepared to pay extra to keep our feet dry and our water clean" (quote from interview with John Steegh in *Gouda Waterproof*)[47].

[45] Gemeente Gouda, june 2005, Gouda Waterproof, Afdeling Communicatie en Persvoorlichting Gouda, gemeente Gouda, p. 44.
[46] Gemeente Gouda, june 2005, Gouda Waterproof, Afdeling Communicatie en Persvoorlichting Gouda, gemeente Gouda, p. 29.
[47] Gemeente Gouda, june 2005, Gouda Waterproof, Afdeling Communicatie en Persvoorlichting Gouda, gemeente Gouda, p. 9.

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- www.bk.tudelft.nl
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- www.climatecrisis.net
- www.driehoekrzg.nl
- www.duravermeer.nl
- www.gouda.nl
- www.grontmij.nl
- www.helpdeskwater.nl/
- www.hhdelfland.nl/
- www.ipcc.ch
- www.jooinside.nl
- www.klimaatbestendig.nl
- www.knmi.nl
- www.mkbainderegio.nl/
- www.nederlandbovenwater.nl
- www.nederlandleeftmetwater.nl/
- www.obr.rotterdam.nl
- www.parkzestienhoven.nl/
- www.psibouw.nl
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Appendix I Glossary

The following glossary was adopted for this research to clarify certain translations from Dutch into English. Some terms were difficult to translate, hence short description were used.

English	Dutch
Association of owners	*VVE (Vereniging Van Eigenaren)*
Back filling	*Ophoging*
Constructed building area	*Bbo (bebouwd oppervlakte)*
District Water Control Board	*Hoogheemraadschap*
Edge trim of embankment	*Oeverbekleding*
Green (parks, public area, grass area)	*Groen*
Influx	*Toestroom van water*
Land development	*Grondexploitatie*
Level height	*Peilhoogte*
Level plane	*Peilvlak*
Operating costs	*Exploitatiekosten*
Revenues land exploitation	*Opbrengsten gronduitgifte*
Seepage pressure	*Kweldruk*
Setting of soil	*Inklinken*
Settlement (financial)	*Verevening (financieel)*
Sheet piling	*Damwand*
Social services	*Maatschappelijke voorzieningen*
Soil subsidence	*Bodemdaling*
Structural (zoning) plan	*Bestemmingsplan*
The Department of Waterways and Public Works	*Rijkswaterstaat*
The Water Policy and Management Plan for the 21st century	*Commissie Water Beheer 21ste eeuw*
Water level management	*Peilbeheer*
Water management	*Waterbeheer*
Water regulatory authority	*Waterschap*

Table 38: Glossary (English-Dutch)

Appendix II Water Regulatory Authority yearly costs for Hoogheemraadschap of Delftland 2008

Tarieven 2008 en begroting

De tarieven en de begroting voor 2008 zijn op 22 november 2007 vastgesteld door de verenigde vergadering van Delfland.

Delfland zorgt voor het juiste waterpeil in sloten en vaarten, voor stevige dijken en kaden en voor het zuiveren van afvalwater. Daarom betaalt u belasting aan Delfland. Ook voor 2008 heeft Delfland uitgerekend wat het kost om dat werk uit te kunnen voeren. Op basis van het totaalbedrag zijn onderstaande belastingtarieven berekend.

Gebruikersbelastingen:	**tarief**	**eenheid**
Verontreinigingsheffing	70,18 euro	per vervuilingseenheid
Ingezetenenomslag waterkering	11,72 euro	per huishouden
Ingezetenenomslag waterbeheersing	32,24 euro	per huishouden

Eigenarenbelastingen:	**tarief**	**eenheid**
Waterkeringsomslag gebouwd	0,10 euro	per 2500 euro WOZ-waarde*
Waterbeheersingsomslag gebouwd	0,39 euro	per 2500 euro WOZ-waarde*
Waterkeringsomslag ongebouwd	14,46 euro	per hectare
Waterbeheersingsomslag ongebouwd	59,65 euro	per hectare

* De WOZ-waarde is de door de gemeente vastgestelde waarde van uw onroerende zaak.

Ter verduidelijking van het het totaal te betalen bedrag, volgen hieronder een aantal voorbeelden.

Gezin met een koophuis	**Gezin met een huurhuis**
Ingezetenenomslag 43,96 euro	Ingezetenenomslag 43,96 euro
Verontreinigingsheffing 210,54 euro	Verontreinigingsheffing 210,54 euro
Waterschapsomslag** 49,00 euro	

Alleenwonende met een koophuis	**Alleenwonende met een huurhuis**
Ingezetenenomslag 43,96 euro	Ingezetenenomslag 43,96 euro
Verontreinigingsheffing 70,18 euro	Verontreinigingsheffing 70,18 euro
Waterschapsomslag** 39,20 euro	

De verontreinigingsheffing is gebaseerd op vervuilingseenheden. Eén persoon betaalt één vervuilingseenheid (70,18 euro).Twee of meer personen betalen drie vervuilingseenheden (3 x 70,18 euro = 210,54 euro).
Voor tweepersoonshuishoudens is geen apart tarief. In de Tweede Kamer is hierover uitvoerig gesproken, maar dit is uiteindelijk in de wet niet gewijzigd.

**De waterschapsomslag van een koopwoning is voor een gezin gebaseerd op een economische waarde van 250.000 euro en voor een alleenwonende op een economische waarde van 200.000 euro. Een huurder betaalt geen waterschapsomslag.

Figure 46: Overview of yearly costs for Delfland in 2008 (source: www.hhdelfland.nl, 2009)[48]

[48] Source: http://www.hhdelfland.nl/aspx/get.aspx?xdl=/views/Delfland_internet/xdl/page&ItmIdt=45249&SitIdt=2&VarIdt=1, 2009

Appendix III The 'Watertoets' process in steps

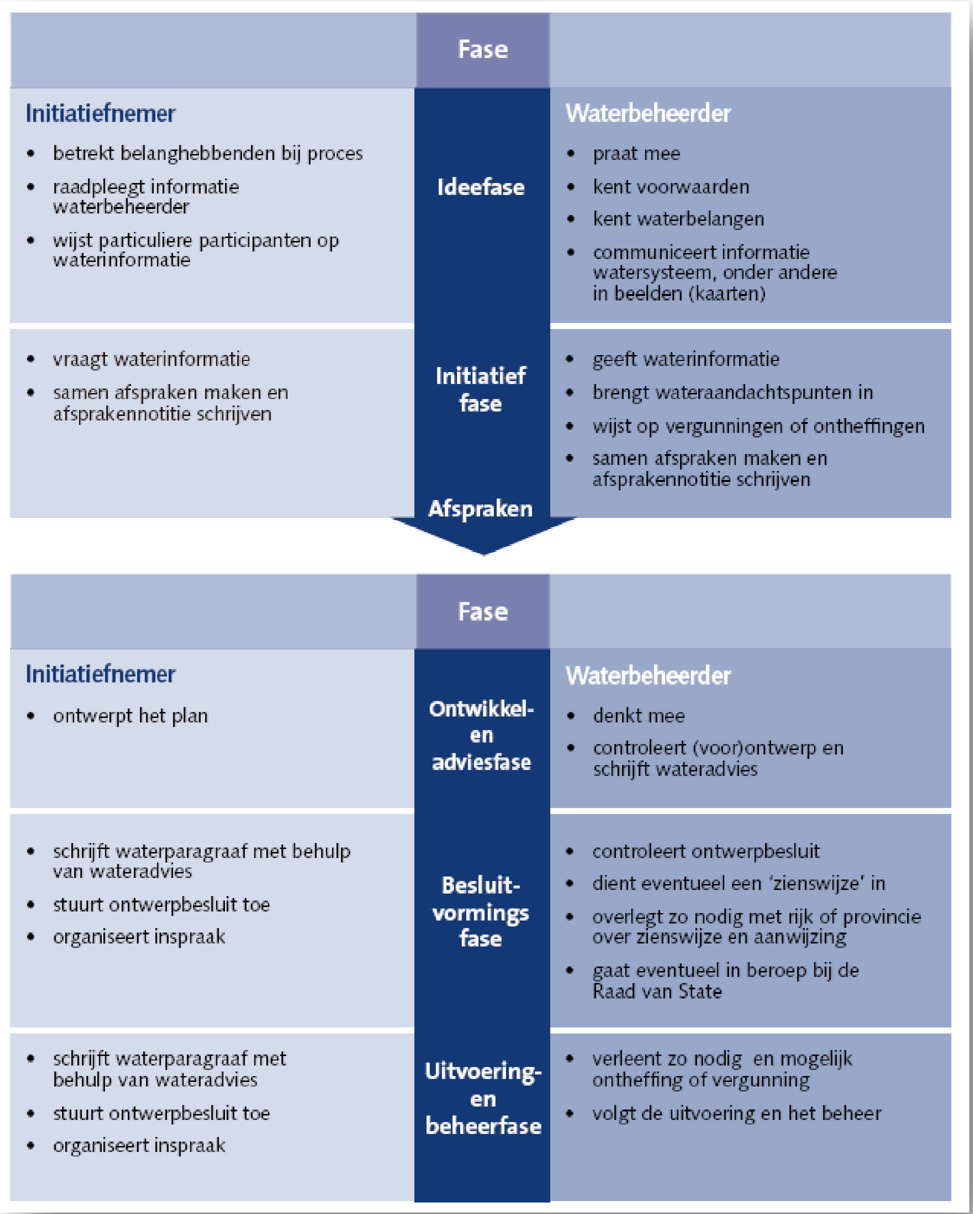


Figure 47: The ' Watertoets' (source: www.helpdeskwater.nl, 2009[49])

[49] Source: www.helpdeskwater.nl/water_en_ruimte/watertoetsproces/processtappen, 2009

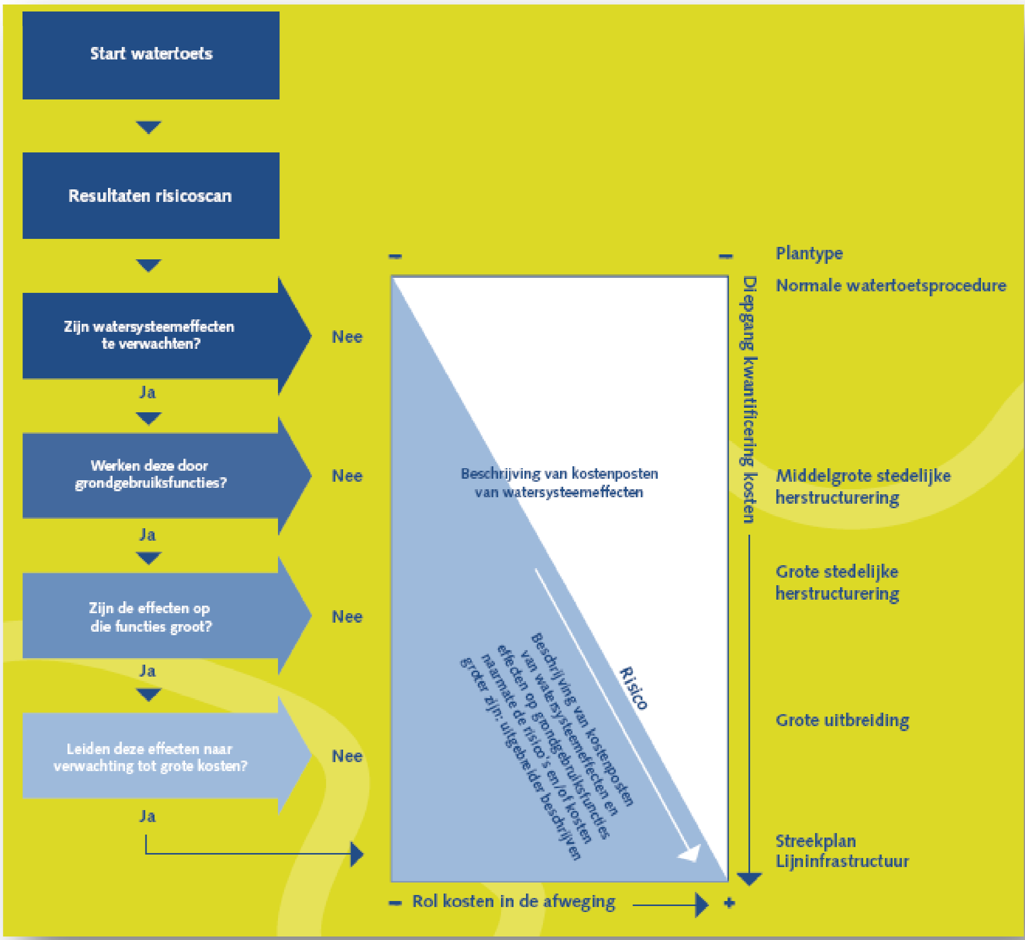


Figure 48: Risk-Costs Analyses Scheme (Source: Nederland leeft met water, *Risico's en kosten in de Watertoets*, mei 2007)

Appendix IV Different water-home typologies

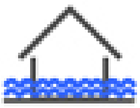
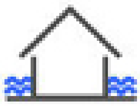
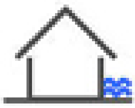
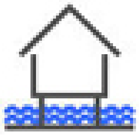
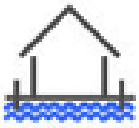
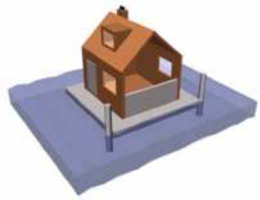
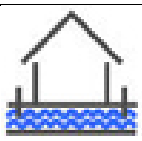
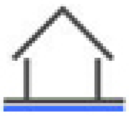
Housing typology	Description	Illustration
 **Wet proof housing**	In extreme weather conditions, this typology can withstand a rise of 1.5m in water level with minimal damages. Water resilient materials are used and fittings are constructed above 1.5m.	
 **Dry proof housing**	The floor and façade of this housing typology is water resilient u to 0.9m. In times when necessary, boarders can be manually put into place in front of openings, thus keeping out water.	
 **Embankment housing**	Similar to the previous house, this typology is water resilient on one façade, facing the water side. A rise of 1.5m is acceptable. The entrance is on the other side opposite the waterfront.	
 **Column (pole) housing**	This housing typology is built on poles which are mounted on the foundation. It can withstand a rise of 3m in water level fluctuations without any water inconveniences.	
 **Floating housing**	Floating homes are fixed to poles but can fluctuate in height with water levels. There is no restriction in water level height. A traditional foundation is not necessary as it lies on water.	
 **Amphibious housing**	This typology is similar to the previous example, but only floats in times of high water levels. Its foundation is built to float and is adaptable to any rise in height.	
 **Minimal drainage housing**	This last example is built to withstand a rise in ground water. The basement and ground floor are built with water resilient materials to withstand ground water and upward water pressures.	No example

Table 39: Examples of water resilient homes (source: waterbestendigbouwen.nl, 2009)[50]

[50] Source: www.waterbestendigbouwen.nl/3%20woningtypen.htm, 2009

Appendix V Indices IGOMOD

GRONDEXPLOITATIE

			Bron	Beschrijving
rente gemeente	3,0	%	Boogaard, E, 2009	Participatie van gemeente
rente private partij	5,0	%	Boogaard, E, 2009	Gehele lening van private partij
kostenstijging	2,5	%	Ymere et al, 2008	
opbrengstenstijging	0,0	%	Boogaard, E, 2009	agv huidige economie

Kosten	Eenheid	Prijs/eenheid	Stelpost	Bron	Beschrijving
Algemeen					
Verwerving exploitatiegebied	m2	€ 36,20	€ 61.533.000	Bestemmingsplan gemeente Gouda, april 2008	teruggerekend vanuit stelpost
Tijdelijk beheer exploitatiegebied	m2	€ 0,10		Innovatie Netwerk, maart 2007	
Opruimig en sloop exploitatiegebied	po		€ 265.000	Bestemmingsplan gemeente Gouda, april 2008	teruggerekend vanuit stelpost
Milieukosten bodemsanering	m2	€ 0,28	€ 481.000	Bestemmingsplan gemeente Gouda, april 2008	teruggerekend vanuit stelpost
Bouwrijpmaken					
Bouwrijp maken (Type A)	m2	€ 55,00	€ 26.479.000	Boogaard, E, 2009	bouwrijp maken traditioneel
Bouwrijp maken (Type B)	m2	€ 35,00		Boogaard, E, 2009	bouwrijp maken overstroomgebied
Bouwrijp maken (Type C)	m2	€ 15,00		Boogaard, E, 2009	bouwrijp maken water
Water	m2	€ 2,00		Innovatie Netwerk, maart 2007	inrichting natuur en water
Civiel technische kunstwerken	po		€ 6.000.000	Ymere et al, 2008	per object
Hoofd infrastructuur	m2	€ 11,87	€ 20.187.000	Bestemmingsplan gemeente Gouda, april 2008	teruggerekend vanuit stelpost
Kabels & leidingen	po		€ 499.000	Bestemmingsplan gemeente Gouda, april 2008	
Extra kosten aansluiten nuts en riolering					
Amfibische woning	po		€ 5.000	Veldkamp, G.J., 2008	per woning, variant afhankelijk
Drijvende woning	po		€ 10.000	Veldkamp, G.J., 2008	per woning, variant afhankelijk
Woonrijpmaken					
Verharding	m2	€ 90		Ymere et al, 2008	
Groen (parkachtig/buffer)	m2	€ 65		Ymere et al, 2008	
Openbaar groen	m2	€ 65		Ymere et al, 2008	
Planstructurele kosten					
VAT-kosten	po		€ 24.349.000	Bestemmingsplan gemeente Gouda, april 2008	gelijk voor alle varianten
Fonds bovenwijkse voorzieningen	po		€ 2.464.000	Bestemmingsplan gemeente Gouda, april 2008	gelijk voor alle varianten
Plankosten	po		€ 6.702.000	Bestemmingsplan gemeente Gouda, april 2008	gelijk voor alle varianten
Onvoorzien	po		€ 13.041.000	Bestemmingsplan gemeente Gouda, april 2008	gelijk voor alle varianten
Meerkosten					
Aanleg dijken/dijkring	m1	€ 150		Ymere et al, 2008	
Grondverbetering/ophoging	m3	€ 7,00		Innovatie Netwerk, maart 2007	dmv zand. Veengrond niet geschikt
Afgraving grond	m3	€ 7,40		Veldkamp, G.J., 2008	extra ontgraven gebied
Ontgraving sloten	m2	€ 3,25		Ymere et al, 2008	1,25 euro per m3
Oeverbekleding type A	m1	€ 800		Ymere et al, 2008	dijkring ed
Oeverbekleding type B	m1	€ 15		aanname	natuurlijke begroeiing langs kaden
Aanleg kaden	m1	€ 700		Ymere et al, 2008	houtbeschot tegen waterslag in woonmilieus
Watervoorzieningen	po		€ 157.000	Veldkamp, G.J., 2008	per object per 10 hectare water
Extra onderhoud tbv waterkwaliteit	m2		€ 3,00	Veldkamp, G.J., 2008	per hectare wateropp. Voor termijn van 30 jaar
Onteigening	po		€ 2.500.000	aanname	aanname, variant afhankelijk
Indirect					
Voorbereiding en begeleiding		10,0 %		Boogaard, E, 2009	
Bijdragen en fondsen		6,0 %		Boogaard, E, 2009	
Onvoorzien		7,0 %		Boogaard, E, 2009	

			Bron	Beschrijving
startdatum project	2009		Gouda.nl, 2009	start bouwrijp: 1ste fase Westergouwe
looptijd project	15	jaar	Gouda.nl, 2009	eind 2023: laatste 5de fasebouwen aan de wijk
plangebied	1.700.000	m2	Gouda.nl, 2009	170 ha volgens bestemmingsplan
exploitatiegebied	1.700.000	m2	Gouda.nl, 2009	170 ha volgens bestemmingsplan
prijspeil	2009			van huidig jaar

Opbrengsten gronduitgifte	Eenheid	Prijs/eenheid	kavel in m2	kavelprijs/m2	Bron	Beschrijving
Huur						
maatschappelijke voorzieningen	m2 uitg	€ 300			Nota Grondprijzen, 2009	
winkels	m2 bvo	€ 450			Nota Grondprijzen 2008-2009	
bedrijven	m2 uitg	€ 450			Nota Grondprijzen 2008-2009	
recreatie	m2 bvo	€ 300			Nota Grondprijzen, 2009	
woningen sociale sector						
eengezinswoning	st	€ 22.772	120,78	€ 188,54	DVBD	
Bebo-woning smal	st	€ 20.871	110,70	€ 188,54	DVBD	2 objecten per kavel
woningen vrije sector						
eengezinswoning	st	€ 30.317	160,80	€ 188,54	DVBD	
twee onder één kap	st	€ 66.682	275,00	€ 242,48	DVBD	
vrijstaand duur	st	€ 111.541	460,00	€ 242,48	DVBD	
appartementsgebouw duur	st	€ 31.486	129,85	€ 242,48	DVBD	4 objecten per kavel
gesloten bouwblok traditioneel	st	€ 32.445	172,08	€ 188,54	DVBD	120 objecten per kavel
vrije kavel	st	€ 86.728	460,00	€ 188,54	DVBD	
appartementsgebouw middelduur	st	€ 19.618	104,05	€ 188,54	DVBD	4 objecten per kavel
urban villa	st	€ 98.597	406,62	€ 242,48	DVBD	21 objecten per kavel
speciale functies						
vrij-1 (dry-proof)	m2 bvo					
vrij-2 (amf. Woning)	m2 bvo	€ 455	190,00	€ 480,00	Veldkamp, G.J., 2008	omgerekend van kavel naar m2 bvo prijs
vrij 3 (drijv. Woning)	m2 bvo	€ 898	155,00	€ 580,00	Veldkamp, G.J., 2008	omgerekend van kavel naar m2 bvo prijs
parkeergarage('s)	m2 bvo	€ 500		€ -	aanname	m2 prijs

Opbrengsten gronduitgifte	Eenheid	Prijs/eenheid	kavel in m2	arktwaarde/m	Bron	Beschrijving
Koop						
woningen sociale sector						
eengezinswoning	st		120,78	€ -		2 objecten per kavel
Bebo-woning smal	st		110,70	€ -		4 objecten per kavel
appartementsgebouw	st		104,05	€ -		
woningen vrije sector						
eengezinswoning	st	€ 30.317	160,80	€ 188,54	DVBD	
twee onder één kap	st	€ 66.682	275,00	€ 242,48	DVBD	
vrijstaand duur	st	€ 111.541	460,00	€ 242,48	DVBD	4 objecten per kavel
appartementsgebouw duur	st	€ 31.486	129,85	€ 242,48	DVBD	120 objecten per kavel
gesloten bouwblok traditioneel	st	€ 32.445	172,08	€ 188,54	DVBD	
vrije kavel	st	€ 86.728	460,00	€ 188,54	DVBD	2 objecten per kavel
appartementsgbeouw middelduur	st	€ 19.618	104,05	€ 188,54	DVBD	21 objecten per kavel
urban villa	st	€ 98.597	406,62	€ 242,48	DVBD	225 objecten per kavel
speciale functies						
vrij-1 (dry-proof)	m2 bvo					
vrij-2 (amf. Woning)	m2 bvo	€ 455	190,00	€ 480,00	Veldkamp, G.J., 2008	omgerekend van kavel naar m2 bvo prijs
vrij 3 (drijv. Woning)	m2 bvo	€ 898	155,00	€ 580,00	Veldkamp, G.J., 2008	omgerekend van kavel naar m2 bvo prijs

VASTGOEDEXPLOITATIE

				Bron
BAR woningen	5.54	%	dtz.nl, 2009	
BAR maatschappelijke vzn.	8,03	% aanname gebaseerd op BAR kantoren	dtz.nl, 2009	
BAR winkels	8,97	%	dtz.nl, 2009	
BAR bedrijven	6,47	%	dtz.nl, 2009	

			Beschrijving
bbo		m2	bbo is exclusief oppervlakte parkeergarage
bvo		m2	bvo is exclusief oppervlakte parkeergarage
vvo/bvo			
bvo/bbo			indicatie van het gemiddeld aantal lagen
FSI			bvo/oppervlak plangebied; hoe hoger de waarde des te meer vloeroppervlak kavel
OSR			(opp. plangebied-bbo)/bvo; hoe hoger de waarde des te "opener" het plan
GSI			bbo/opp. plangebied; hoe dichter de waarde bij 1, des te meer bebouwing op kavel

Kosten	Eenheid	Prijs/eenheid	bvo in m2	bouwkosten/m2	Bron	Beschrijving
Huur						
maatschappelijke voorzieningen	m2 uitg	€ 1.800			Ymere et al, 2008	
winkels	m2 bvo	€ 1.200			Ymere et al, 2008	
bedrijven	m2 uitg	€ 1.500			Ymere et al, 2008	
woningen sociale sector						
eengezinswoning	st	€ 45.000	97,20	€ 463	aanname	
Bebo-woning smal	st	€ -	101,52			
appartementsgebouw	st	€ -	84,00			
woningen vrije sector						
eengezinswoning	st	€ 60.418	132,00	€ 458	aanname	
twee onder één kap	st	€ 162.000	180,00	€ 900	Prospectus Drijvende Stad	
vrijstaand duur	st	€ 243.000	202,50	€ 1.200	Prospectus Drijvende Stad	
appartementsgebouw duur	st	€ 99.344	112,00	€ 887	aanname	
gesloten bouwblok traditioneel	st	€ 77.169	87,00	€ 887	aanname	
vrije kavel	st	€ 182.250	202,50	€ 900	aanname	
appartementsgebouw middelduur	st	€ 80.052	84,00	€ 953	Prospectus Drijvende Stad	
urban villa	st	€ 83.368	87,48	€ 953	Prospectus Drijvende Stad	
speciale functies						
vrij-1 (dry-proofing)	m2 bvo	€ -		€ 9.700	meerkosten bovenop prijs	DVBD
vrij-2 (amf. Woning)	m2 bvo	€ 144.000	180,00	€ 800		DVBD
vrij 3 (drijv. Woning)	m2 bvo	€ 168.000	240,00	€ 700		DVBD
parkeergarage('s)	m2 bvo	€ 1.600			aanname	
Koop						
woningen sociale sector						
eengezinswoning	st	€ -	97,20			
Bebo-woning smal	st	€ -	101,52			
appartementsgebouw	st	€ -	84,00			
woningen vrije sector						
eengezinswoning	st	€ 60.418	132,00	€ 458	aanname	
herenhuis	st	€ -	204,00			
twee onder één kap	st	€ 162.000	180,00	€ 900	Prospectus Drijvende Stad	
vrijstaand duur	st	€ 243.000	202,50	€ 1.200	Prospectus Drijvende Stad	
appartementsgebouw duur	st	€ 99.344	112,00	€ 887	aanname	
gesloten bouwblok traditioneel	st	€ 77.169	87,00	€ 887	aanname	
vrije kavel	st	€ 182.250	202,50	€ 900	aanname	
appartementsgbeouw middelduur	st	€ 80.052	84,00	€ 953	Prospectus Drijvende Stad	
urban villa	st	€ 83.368	87,48	€ 953	Prospectus Drijvende Stad	
speciale functies						
vrij-1 (dry-proofing)	m2 bvo	€ -		€ 9.700	meerkosten bovenop prijs	DVBD
vrij-2 (amf. Woning)	m2 bvo	€ 144.000	180,00	€ 800		DVBD
vrij 3 (drijv. Woning)	m2 bvo	€ 168.000	240,00	€ 700		DVBD

Opbrengsten	Eenheid	Prijs/eenheid	bvo in m2	marktwaarde/m2	Bron	Beschrijving
Huur						
maatschappelijke voorzieningen	m2 uitg	€ 150			Ymere et al, 2008	
winkels	m2 bvo	€ 225			Ymere et al, 2008	
bedrijven	m2 uitg	€ 225			Ymere et al, 2008	
woningen sociale sector						
eengezinswoning	huur/jaar	€ 6.424	97,20	€ 66	Nota Grondprijzen, 2009	Sociale huur
Bebo-woning smal	huur/jaar	€ 6.709	101,52		Nota Grondprijzen, 2009	Sociale huur
appartementsgebouw	huur/jaar	€ 5.552	84,00		Nota Grondprijzen, 2009	Sociale huur
woningen vrije sector						
eengezinswoning	huur/jaar	€ 13.200	132,00	€ 1.100	Funda.nl, 2009	Gemiddelde huurprijs
twee onder één kap	huur/jaar	€ 15.000	180,00	€ 1.250	Funda.nl, 2009	Gemiddelde huurprijs
vrijstaand duur	huur/jaar	€ 16.872	202,50	€ 1.406	Funda.nl, 2009	Gemiddelde huurprijs
appartementsgebouw duur	huur/jaar	€ 13.200	112,00	€ 1.100	Funda.nl, 2009	Gemiddelde huurprijs
gesloten bouwblok traditioneel	huur/jaar	€ 9.600	87,00	€ 800	Funda.nl, 2009	Gemiddelde huurprijs
vrije kavel	huur/jaar	€ 6.000	202,50	€ 500	Funda.nl, 2009	Gemiddelde huurprijs
appartementsgebouw middelduur	huur/jaar	€ 11.400	84,00	€ 950	Funda.nl, 2009	Gemiddelde huurprijs
urban villa	huur/jaar	€ 12.000	87,48	€ 1.000	Funda.nl, 2009	Gemiddelde huurprijs
speciale functies						
vrij-1 (dry-proofing)	m2 bvo	€ -		€ -		
vrij-2 (amf. Woning)	m2 bvo	€ 83	180,00	€ 15.000	aanname gebaseerd op vergelijkbare woningen op Funda	
vrij 3 (drijv. Woning)	m2 bvo	€ 88	240,00	€ 21.000	aanname gebaseerd op vergelijkbare woningen op Funda	
parkeergarage('s)	m2 bvo	€ 75		€ -	aanname	
Koop						
woningen sociale sector						
eengezinswoning	st	€ 174.000	97,20	€ 1.790	Nota Grondprijzen, 2009	Sociale koop
Bebo-woning smal	st	€ 200.000	101,52	€ 1.970	Nota Grondprijzen, 2009	Bereikbare koop
appartementsgebouw	st	€ 232.000	84,00	€ 2.762	Nota Grondprijzen, 2009	Middeldure koop
woningen vrije sector						
eengezinswoning	st	€ 255.500	132,00	€ 1.936	Nota Grondprijzen, 2009	Middeldure koop
herenhuis	st	€ -	204,00			
twee onder één kap	st	€ 432.000	180,00	€ 2.400	Prospectus Drijvende Stad	VON prijs
vrijstaand duur	st	€ 648.000	202,50	€ 3.200	Prospectus Drijvende Stad	VON prijs
appartementsgebouw duur	st	€ 246.400	112,00	€ 2.200	DVBD	VON prijs
gesloten bouwblok traditioneel	st	€ 156.600	87,00	€ 1.800	aanname	
vrije kavel	st	€ 556.875	202,50	€ 2.750	Prospectus Drijvende Stad	VON prijs
appartementsgbeouw middelduur	st	€ 161.354	84,00	€ 1.921	vindjeeigenhuis.nl, 2009	VON prijs
urban villa	st	€ 211.614	87,48	€ 2.419	Prospectus Drijvende Stad	VON prijs
speciale functies						
vrij-1 (dry-proofing)	m2 bvo	€ -				
vrij-2 (amf. Woning)	m2 bvo	€ 1.944	180,00	€ 350.000	aanname	VON prijs
vrij 3 (drijv. Woning)	m2 bvo	€ 1.800	240,00	€ 432.000	aanname	VON prijs

Source references used for indices

	Name & Date	Source	Comments	Link/email address
1	Ymere et al, 2008	Ymere et al, 2008, *PURMER-MEER, ontwerpen aan de Purmer als bundelingsbeleid in het Nationaal Laag*		
2	Innovatie Netwerk, maart 2007	Innovatie Netwerk, maart 2007, *Nieuwe Dorpen voor het Groene Hart, Duinwonen in*		
3	Boogaard, E, 2009	Dura Vermeer Bouw Leidschendam BV	*N.a.v. gesprek met projectontwikkelaar afdeling*	e.boogaard@duravermeer.nl
4	Gouda.nl, 2009	www.gouda.nl	*Algemene informatie site plan*	www.gouda.nl/content.jsp?objectid=45617
5	Nota Grondprijzen, 2008-2009	Nota Grondprijzen, 2008-2009, *Gemeente*	*Vastgesteld door de raad in de*	
6	Nota Grondprijzen, 2009	Nota Grondprijzen, 10 feb 2009, *Afdeling Planontwikkeling Team Grondzaken*	*Vastgesteld door College van B&W op 10 Feb 2009*	
7	Prospectus Drijvende Stad			
8	Nota Fonds Bovenwijkse Voorzieningen, mei 2008	Actualitsatie Nota Fond Bovenwijkse Voorzieningen, *Gemeente Helden*, mei 2008,	*voor gemeente Helden*	www.helden.nl/upload/cieEO/EO08052811notaFBV.doc
9	Nota Bovenwijkse Voorzieningen gemeente	Nota Bovenwijkse Voorzieningen *gemeente Rijnwoude*, juli 2008		
10	DTZ Zadelhoff, 2009	DTZ Zadelhoff, *Bruto*	*BAR voor diverse typologien*	www.dtz.nl/page.asp?id=61950
11	Bestemmingsplan gemeente			
12	vindjeeigenhuis.nl, 2009	vindjeeigenhuis, 2008	*internetsite for gemiddelde koopsom (aantal) in 2008 van*	www.vindjeeigenhuis.nl/vindjeeigenhuis/
13	DVBD	Dura Vermeer Business Development	*aanname vanuit interne*	
14	Veldkamp, G.J., 2008	Veldkamp, G.J., 13 mei 2008, *Op het water wonen in Emmeloord*, ChristenUnie-SGP	*planvoorstel op innititatief van ChristenUnie-SGPaan gemeenteraad*	
15	Funda.nl, 2009	www.funda.nl, 2009	*Gemiddelde huurprijs berekening*	www.funda.nl

Appendix VI Overview data Referential variant

Grondexploitatie

rente	5.0%	plangebied	1,688,901	m2	startdatum project	2009	
kostenstijging	2.5%	exploitatiegebied	1,688,901	m2	looptijd project	15	jaar
opbrengstenstijging		prijspeil	2009				

Kosten

activiteit	hvld	eh	prijs/eh		kosten	contante waarde	eindwaarde
Verwerving				€	**61,138,216**	**-€ 51,732,387**	**-€ 107,547,918**
exploitatiegebied	1,688,901	m2	36.20	€	61,138,216	-€ 51,732,387	-€ 107,547,918
Tijdelijk beheer				€	**168,890**	**-€ 147,209**	**-€ 306,036**
exploitatiegebied	1,688,901	m2	0.10	€	168,890	-€ 147,209	-€ 306,036
Opruiming en sloop				€	**265,000**	**-€ 224,231**	**-€ 466,160**
exploitatiegebied		po	265,000	€	265,000	-€ 224,231	-€ 466,160
Milieukosten bodemsanering				€	**472,892**	**-€ 400,140**	**-€ 831,862**
exploitatiegebied	1,688,901	m2	0.28	€	472,892	-€ 400,140	-€ 831,862
Bouwrijpmaken				€	**114,512,802**	**-€ 97,252,597**	**-€ 202,181,164**
Bouwrijp maken (Type A)	1,679,979	m2	55	€	92,398,845	-€ 78,471,817	-€ 163,137,272
Bouwrijp maken (Type B)		m2	35.00	€	-		
Bouwrijp maken (Type C)	8,922	m2	15.00	€	133,830	-€ 113,658	-€ 236,287
Water	501,093	m2	2.00	€	1,002,186	-€ 851,129	-€ 1,769,437
Civiel technische kunstwerken	1	po	6,000,000	€	6,000,000	-€ 5,095,636	-€ 10,593,462
Hoofd infrastructuur	1,187,808	m2	11.87	€	14,099,281	-€ 11,974,134	-€ 24,893,366
Kabels & leidingen		po	499,000	€	499,000	-€ 423,787	-€ 881,023
Extra kosten nuts/riool (amf. Won)		po	5,000	€	-		
Extra kosten nuts/riool (drijv. Won)	38	po	10,000	€	379,660	-€ 322,435	-€ 670,318
Woonrijpmaken				€	**57,950,843**	**-€ 49,216,069**	**-€ 102,316,673**
Verharding	528,842	m2	90.00	€	47,595,758	-€ 40,421,778	-€ 84,033,974
Groen (parkachtig/buffer)	85,005	m2	65.00	€	5,525,325	-€ 4,692,508	-€ 9,755,387
Openbaar groen	74,304	m2	65.00	€	4,829,760	-€ 4,101,783	-€ 8,527,313
Planstructurele kosten				€	**46,556,000**	**-€ 40,177,400**	**-€ 83,525,928**
VAT-kosten		po	24,349,000	€	24,349,000	-€ 21,012,963	-€ 43,684,441
Fonds voor bovenwijkse voorziengen		po	2,464,000	€	2,464,000	-€ 2,126,409	-€ 4,420,652
Plankosten		po	6,702,000	€	6,702,000	-€ 5,783,764	-€ 12,024,031
Onvoorzien		po	13,041,000	€	13,041,000	-€ 11,254,263	-€ 23,396,804
Meerkosten				€	**71,194,543**	**-€ 61,922,457**	**-€ 128,732,342**
Aanleg dijken/dijkring	1,737	m1	150	€	260,550	-€ 237,722	-€ 494,206
Grondverbetering/ophoging	844,432	m3	7.00	€	5,911,021	-€ 5,393,121	-€ 11,211,911
Afgraving grond	751,640	m3	7.40	€	5,562,132	-€ 4,977,457	-€ 10,347,776
Ontgraving sloten	136,925	m2	3.25	€	445,006	-€ 384,036	-€ 798,384
Oeverbekleding type A (buitenrand)	33,091	m1	800	€	26,472,800	-€ 22,845,783	-€ 47,494,742
Oeverbekleding type B (woonmilieu)	1,737	m1	15	€	26,055	-€ 22,485	-€ 46,745
Aanleg kaden	33,091	m1	700	€	23,163,700	-€ 19,990,060	-€ 41,557,899
Watervoorzieningen	50	po	157,000	€	7,850,000	-€ 6,774,478	-€ 14,083,653
Extra onderhoud tbv waterkwaliteit	501,093	m2	3.00	€	1,503,279	-€ 1,297,316	-€ 2,697,027
Indirect				€	***81,019,613***	**-€ 68,555,124**	**-€ 142,521,180**
Voorbereiding en begeleiding	10.0%			€	35,225,919	-€ 29,806,576	-€ 61,965,730
Bijdragen en fondsen	6.0%			€	21,135,551	-€ 17,883,945	-€ 37,179,438
Onvoorzien	7.0%			€	24,658,143	-€ 20,864,603	-€ 43,376,011
			totaal (A)	€	**433,278,799**	**-€ 369,627,614**	**-€ 768,429,263**

Planning

activiteit	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	
Verwerving – exploitatiegebied	20%					20%		20%			20%				20%	100%
Tijdelijk beheer – exploitatiegebied	9%	9%	9%	9%	9%	8%	7%	5%	5%	5%	5%	5%	5%	5%	5%	100%
Opruiming en sloop – exploitatiegebied	20%					20%		20%			20%				20%	100%
Milieukosten bodemsanering – exploitatiegebied	20%					20%		20%			20%				20%	100%
Bouwrijp maken (Type A)		20%			10%	10%	10%	10%		10%	10%			10%	10%	100%
Bouwrijp maken (Type B)																
Bouwrijp maken (Type C)		20%			10%	10%	10%	10%		10%	10%			10%	10%	100%
Water		20%			10%	10%	10%	10%		10%	10%			10%	10%	100%
Civiel technische kunstwerken		20%			10%	10%	10%	10%		10%	10%			10%	10%	100%
Hoofd infrastructuur		20%			10%	10%	10%	10%		10%	10%			10%	10%	100%
Kabels & leidingen		20%			10%	10%	10%	10%		10%	10%			10%	10%	100%
Extra kosten nuts/riool (amf. Won)																
Extra kosten nuts/riool (drijv. Won)		20%			10%	10%	10%	10%		10%	10%			10%	10%	100%
Verharding		20%			10%	10%	10%	10%		10%	10%			10%	10%	100%
Groen (parkachtig/buffer)		20%			10%	10%	10%	10%		10%	10%			10%	10%	100%
Openbaar groen		20%			10%	10%	10%	10%		10%	10%			10%	10%	100%
VAT-kosten		10%	10%	10%	10%	10%	10%	5%	5%	5%	5%	5%	5%	5%	5%	100%
Fonds voor bovenwijkse voorziengen		10%	10%	10%	10%	10%	10%	5%	5%	5%	5%	5%	5%	5%	5%	100%
Plankosten		10%	10%	10%	10%	10%	10%	5%	5%	5%	5%	5%	5%	5%	5%	100%
Onvoorzien		10%	10%	10%	10%	10%	10%	5%	5%	5%	5%	5%	5%	5%	5%	100%
Aanleg dijken/dijkring		15%	15%	15%	15%	15%	15%	10%								100%
Grondverbetering/ophoging		15%	15%	15%	15%	15%	15%	10%								100%
Afgraving grond		15%	15%	10%	10%	10%	10%	10%	10%	5%	5%					100%
Ontgraving sloten		10%	10%	10%	10%	10%	10%	5%	5%	5%	5%	5%	5%	5%	5%	100%
Oeverbekleding type A (buitenrand)		10%	10%	10%	10%	10%	10%	5%	5%	5%	5%	5%	5%	5%	5%	100%
Oeverbekleding type B (woonmilieu)		10%	10%	10%	10%	10%	10%	5%	5%	5%	5%	5%	5%	5%	5%	100%
Aanleg kaden		10%	10%	10%	10%	10%	10%	5%	5%	5%	5%	5%	5%	5%	5%	100%
Watervoorzieningen		10%	10%	10%	10%	10%	10%	5%	5%	5%	5%	5%	5%	5%	5%	100%
Extra onderhoud tbv waterkwaliteit		10%	10%	10%	10%	10%	10%	5%	5%	5%	5%	5%	5%	5%	5%	100%
Voorbereiding en begeleiding	20%					20%		20%			20%				20%	100%
Bijdragen en fondsen	20%					20%		20%			20%				20%	100%
Onvoorzien	20%					20%		20%			20%				20%	100%

Opbrengsten gronduitgifte

object	hvld	eh	prijs/eh	opbrengsten	contante waarde	eindwaarde	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	
Huur				**€ 30,424,896**	**€ 25,989,346**	**€ 54,029,983**																
maatschappelijke voorzieningen	1000	m2 bvo	300	€ 300,000	€ 211,213	€ 439,097			20%			20%		20%			20%				20%	100%
winkels	18748	m2 bvo	450	€ 8,436,600	€ 5,939,735	€ 12,348,282			20%			20%		20%			20%				20%	100%
bedrijven	7950	m2 bvo	450	€ 3,577,500	€ 2,518,716	€ 5,236,230			20%			20%		20%			20%				20%	100%
woningen sociale sector	**22**	stuks																				
eengezinswoning	22	stuks	22,772	€ 500,984	€ 352,715	€ 733,268			20%			20%		20%			20%				20%	100%
woningen vrije sector	**660**	stuks																				
eengezinswoning	148	stuks	30,317	€ 4,486,916	€ 3,158,985	€ 6,567,302			20%			20%		20%			20%				20%	100%
gesloten bouwblok traditioneel	240	stuks	32,445	€ 7,786,800	€ 5,482,247	€ 11,397,198			20%			20%		20%			20%				20%	100%
appartementsgebouw middelduur	272	stuks	19,618	€ 5,336,096	€ 3,756,844	€ 7,810,210			20%			20%		20%			20%				20%	100%
speciale functies																						
parkeergarage('s)	12979	m2 bvo	500	€ 6,489,500	€ 4,568,891	€ 9,498,397			20%			20%		20%			20%				20%	100%
Koop				**€ 8,011,956**	**€ 78,120,716**	**€ 162,407,357**																
woningen sociale sector		stuks																				
woningen vrije sector	**3,080**	stuks																				
eengezinswoning	654	stuks	30,317	€ 19,827,318	€ 13,959,297	€ 29,020,376			20%			20%		20%			20%				20%	100%
twee onder één kap	120	stuks	66,682	€ 8,001,840	€ 5,633,645	€ 11,711,942			20%			20%		20%			20%				20%	100%
vrijstaand duur	50	stuks	111,541	€ 5,577,050	€ 3,926,487	€ 8,162,884			20%			20%		20%			20%				20%	100%
appartementsgebouw duur	888	stuks	31,486	€ 27,959,568	€ 19,684,756	€ 40,923,194			20%			20%		20%			20%				20%	100%
vrije kavel	22	stuks	86,728	€ 1,908,016	€ 1,343,327	€ 2,792,679			20%			20%		20%			20%				20%	100%
appartementsgbeouw middelduur	1178	stuks	19,618	€ 23,110,004	€ 16,270,451	€ 33,825,100			20%			20%		20%			20%				20%	100%
urban villa	168	stuks	98,597	€ 16,564,296	€ 11,661,987	€ 24,244,434			20%			20%		20%			20%				20%	100%
speciale functies																						
vrij 3	8922	m2 bvo	898	€ 8,011,956	€ 5,640,767	€ 11,726,749			20%			20%		20%			20%				20%	100%
			totaal (B)	**€ 38,436,852**	**€ 104,110,061**	**€ 216,437,340**																
			resultaat (A+B)		**-€ 265,517,553**	**-€ 551,991,923**																

Overview data – Referential Variant

Vastgoedexploitatie

BAR woningen	5.54%	bbo	577,655	m2	FSI	0.82	GSI	0.342
BAR maatschappelijke vzn.	8.03%							
BAR winkels	8.97%	bvo	1,385,015	m2	OSR	0.802		
BAR bedrijven	6.47%	vvo/bvo	0.8		bvo/bbo	2.398		

Kosten

object	hvld	eh	prijs/eh	kosten	contante waarde	eindwaarde
Huur				**€ 105,415,568**	**-€ 89,458,275**	**-€ 185,977,328**
maatschappelijke voorzieningen	1000	m2 bvo	1,800	€ 1,800,000	-€ 1,501,880	-€ 3,122,300
winkels	18748	m2 bvo	1,200	€ 22,497,600	-€ 18,771,495	-€ 39,024,590
bedrijven	7950	m2 bvo	1,500	€ 11,925,000	-€ 9,949,954	-€ 20,685,239
woningen sociale sector						
eengezinswoning	22	stuks	45,000	€ 990,000	-€ 826,034	-€ 1,717,265
woningen vrije sector						
eengezinswoning	148	stuks	60,418	€ 8,941,864	-€ 7,460,892	-€ 15,510,658
gesloten bouwblok traditioneel	240	stuks	77,169	€ 18,520,560	-€ 15,453,142	-€ 32,125,971
appartementsgebouw middelduur	272	stuks	80,052	€ 21,774,144	-€ 18,167,859	-€ 37,769,675
speciale functies						
parkeergarage('s)	12979	m2 bvo	1,600	€ 20,766,400	-€ 17,327,020	-€ 36,021,631
Koop				**€ 6,245,400**	**-€ 194,004,693**	**-€ 403,321,823**
woningen sociale sector						
woningen vrije sector						
eengezinswoning	654	stuks	60,418	€ 39,513,372	-€ 27,586,374	-€ 57,350,091
twee onder één kap	120	stuks	162,000	€ 19,440,000	-€ 13,572,092	-€ 28,215,404
vrijstaand duur	50	stuks	243,000	€ 12,150,000	-€ 8,482,557	-€ 17,634,628
appartementsgebouw duur	888	stuks	99,344	€ 88,217,472	-€ 61,589,282	-€ 128,039,693
vrije kavel	22	stuks	182,250	€ 4,009,500	-€ 2,799,244	-€ 5,819,427
appartementsgbeouw middelduur	1178	stuks	80,052	€ 94,301,256	-€ 65,836,693	-€ 136,869,756
urban villa	168	stuks	83,368	€ 14,005,824	-€ 9,778,206	-€ 20,328,189
speciale functies						
vrij 3	8922	m2 bvo	700	€ 6,245,400	-€ 4,360,244	-€ 9,064,634
			totaal (C)	**€ 111,660,968**	**-€ 283,462,967**	**-€ 589,299,151**

Planning

object	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	
maatschappelijke voorzieningen			8%	8%	8%	8%	8%	8%	8%	8%	9%	9%	9%	9%		100%
winkels			8%	8%	8%	8%	8%	8%	8%	8%	9%	9%	9%	9%		100%
bedrijven			8%	8%	8%	8%	8%	8%	8%	8%	9%	9%	9%	9%		100%
eengezinswoning (sociale sector, huur)			8%	8%	8%	8%	8%	8%	8%	8%	9%	9%	9%	9%		100%
eengezinswoning (vrije sector, huur)			8%	8%	8%	8%	8%	8%	8%	8%	9%	9%	9%	9%		100%
gesloten bouwblok traditioneel			8%	8%	8%	8%	8%	8%	8%	8%	9%	9%	9%	9%		100%
appartementsgebouw middelduur			8%	8%	8%	8%	8%	8%	8%	8%	9%	9%	9%	9%		100%
parkeergarage('s)			8%	8%	8%	8%	8%	8%	8%	8%	9%	9%	9%	9%		100%
eengezinswoning (vrije sector, koop)			8%	8%	8%	8%	8%	8%	8%	8%	9%	9%	9%	9%		100%
twee onder één kap			8%	8%	8%	8%	8%	8%	8%	8%	9%	9%	9%	9%		100%
vrijstaand duur			8%	8%	8%	8%	8%	8%	8%	8%	9%	9%	9%	9%		100%
appartementsgebouw duur			8%	8%	8%	8%	8%	8%	8%	8%	9%	9%	9%	9%		100%
vrije kavel			8%	8%	8%	8%	8%	8%	8%	8%	9%	9%	9%	9%		100%
appartementsgbeouw middelduur			8%	8%	8%	8%	8%	8%	8%	8%	9%	9%	9%	9%		100%
urban villa			8%	8%	8%	8%	8%	8%	8%	8%	9%	9%	9%	9%		100%
vrij 3			8%	8%	8%	8%	8%	8%	8%	8%	9%	9%	9%	9%		100%

Opbrengsten

object	hvld	eh	prijs/eh		opbrengsten	contante waarde	eindwaarde
Huur				**€**	**196,607,418**	**€ 138,728,684**	**€ 288,406,971**
maatschappelijke voorzieningen	800	m2 vvo	150	€	1,494,396	€ 993,635	€ 2,065,696
winkels	14998	m2 vvo	225	€	37,621,405	€ 25,014,754	€ 52,003,877
bedrijven	6360	m2 vvo	225	€	22,117,465	€ 14,706,069	€ 30,572,860
woningen sociale sector							
eengezinswoning	22	stuks	6,424	€	2,551,047	€ 1,696,210	€ 3,526,299
woningen vrije sector							
eengezinswoning	148	stuks	13,200	€	35,263,538	€ 23,446,991	€ 48,744,610
gesloten bouwblok traditioneel	240	stuks	9,600	€	41,588,448	€ 27,652,471	€ 57,487,501
appartementsgebouw middelduur	272	stuks	11,400	€	55,971,119	€ 37,215,617	€ 77,368,595
speciale functies							
parkeergarage('s)	10383	m2 vvo	75	€	12,036,167	€ 8,002,938	€ 16,637,533
Koop				**€**	**16,059,600**	**€ 481,208,196**	**€ 1,000,397,278**
woningen sociale sector							
woningen vrije sector							
eengezinswoning	654	stuks	255,500	€	167,097,000	€ 111,104,049	€ 230,977,338
twee onder één kap	120	stuks	432,000	€	51,840,000	€ 34,468,805	€ 71,658,170
vrijstaand duur	50	stuks	648,000	€	32,400,000	€ 21,543,003	€ 44,786,356
appartementsgebouw duur	888	stuks	246,000	€	218,448,000	€ 145,247,714	€ 301,959,565
vrije kavel	22	stuks	556,875	€	12,251,250	€ 8,145,948	€ 16,934,841
appartementsgebouw middelduur	1178	stuks	161,354	€	190,075,012	€ 126,382,301	€ 262,739,727
urban villa	168	stuks	211,614	€	35,551,152	€ 23,638,228	€ 49,142,178
speciale functies							
vrij 3	8922	m2 bvo	1,800	€	16,059,600	€ 10,678,149	€ 22,199,104
			totaal (D)	**€**	**212,667,018**	**€ 619,936,880**	**€ 1,288,804,249**
			resultaat (C+D)			**€ 336,473,913**	**€ 699,505,098**
			resultaat (B)			**-€ 104,110,061**	**-€ 216,437,340**
			resultaat (C+D+B)			**€ 232,363,851**	**€ 483,067,758**

object	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	
maatschappelijke voorzieningen				8%	8%	8%	8%	8%	8%	8%	8%	9%	9%	9%	9%	100%
winkels				8%	8%	8%	8%	8%	8%	8%	8%	9%	9%	9%	9%	100%
bedrijven				8%	8%	8%	8%	8%	8%	8%	8%	9%	9%	9%	9%	100%
eengezinswoning (sociale sector, huur)				8%	8%	8%	8%	8%	8%	8%	8%	9%	9%	9%	9%	100%
eengezinswoning (vrije sector, huur)				8%	8%	8%	8%	8%	8%	8%	8%	9%	9%	9%	9%	100%
gesloten bouwblok traditioneel				8%	8%	8%	8%	8%	8%	8%	8%	9%	9%	9%	9%	100%
appartementsgebouw middelduur (huur)				8%	8%	8%	8%	8%	8%	8%	8%	9%	9%	9%	9%	100%
parkeergarage('s)				8%	8%	8%	8%	8%	8%	8%	8%	9%	9%	9%	9%	100%
eengezinswoning (koop)				8%	8%	8%	8%	8%	8%	8%	8%	9%	9%	9%	9%	100%
twee onder één kap				8%	8%	8%	8%	8%	8%	8%	8%	9%	9%	9%	9%	100%
vrijstaand duur				8%	8%	8%	8%	8%	8%	8%	8%	9%	9%	9%	9%	100%
appartementsgebouw duur				8%	8%	8%	8%	8%	8%	8%	8%	9%	9%	9%	9%	100%
vrije kavel				8%	8%	8%	8%	8%	8%	8%	8%	9%	9%	9%	9%	100%
appartementsgebouw middelduur (koop)				8%	8%	8%	8%	8%	8%	8%	8%	9%	9%	9%	9%	100%
urban villa				8%	8%	8%	8%	8%	8%	8%	8%	9%	9%	9%	9%	100%
vrij 3				8%	8%	8%	8%	8%	8%	8%	8%	9%	9%	9%	9%	100%

Referential Variant

Referential variant

Overview of living areas and housing typologies:

Facilities

Social/public facilities	1,000	m^2
shops	18,748	m^2
business	7,950	m^2
Total	**27,698**	**m^2**

Canal area

Apartment, middle priced, owner occupied	1,178	Homes
Apartment, middle priced, rent	272	Homes
Apartment, expensive, owner occupied	138	Homes
Total	**1,588**	**Homes**

Garden area

Urban villa, owner occupied	168	Homes
Single family home, middle priced, owner occupied	654	Homes
Single family home, middle priced, rent	148	Homes
Single family home, social, rent	22	Homes
Total	**992**	**Homes**

Rural area

Free standing, expensive, owner occupied	50	Homes
Semi detached, owner occupied	120	Homes
Total	**170**	**Homes**

Water area

Free-3, floating homes, owner occupied	8,922	m^2 gfa
Total	**38**	**Homes**

Stronghold area

Apartment, expensive, owner occupied	750	Homes
Parking in garage	12,979	m^2 gfa
Total	**750**	**Homes**

Remaining area

Closed building block, traditional, free plot, owner occupied	22	Homes
BEBO home, small traditional, rent	240	Homes
Total	**262**	**Homes**

Referential Variant

Total amount of homes

Rent	682	Homes	18%
Owner occupied	3,118	Homes	82%
Total	**3,800**	**Homes**	

<u>Overview of landscaping activities:</u>

Area	Referential	(%)
Water	501,093 m^2	29.7 %
Land/green	159,309 m^2	9.4 %
Paving	528,842 m^2	31.3 %
Constructed building area	577,655 m^2	34.2 %
Total	**1,688,901 m^2**	**104.7 %**

Revetment embankments

Type A: ring dyke	1,737 m
Type B: living areas	14, 482 m

Construction of quays

Total	**33,091 m**

Water facility system

Total	**1**

Heightening constructed building ground

Area	1,688,863 m^2
Height	0.5 m
Total	**844,432 m^3**

Street level at -5.3m NAP

Excavation

Area	501,093 m^2
Height	1.5 m
Total	**751,640 m^3**

Water level at -6.3m NAP

Excavation of waterways/canals

Total	**136,925 m2**

Heightening ground

Dyke ring east	Area	48,857 m^2	Length	1,737 m
Total	Height	6 m	Cubic meters	293,142 m^3
Dyke ring west and south	Area	16,883 m^2	Length	890 m
Total	Height	6 m	Cubic meters	101,298 m^3
Living area 'rectangle'	Area	51,023 m^2	Circumference	29,456 m
Total	Height	6 m	Cubic meters	306,138 m^3
Living areas islands	Area	121,680 m^2	Circumference	2,745 m
Total	Height	6 m	Cubic meters	730,080 m^3
Total			**Cubic meters**	**1,430,658 m^3**

Overview data – Land raising Variant

Appendix VII Overview data Land raising variant

Grondexploitatie

rente	5.0%	plangebied	1,688,901	m2	startdatum project	2009		
kostenstijging	2.5%	exploitatiegebied	1,688,901	m2	looptijd project	15	jaar	
opbrengstenstijging		prijspeil	2009					

Kosten / **Planning**

activiteit	hvld	eh	prijs/eh		kosten	contante waarde	eindwaarde	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	
Verwerving				€	**61,138,216**	**-€ 51,732,387**	**-€ 107,547,918**																
exploitatiegebied	1,688,901	m2	36.20	€	61,138,216	-€ 51,732,387	-€ 107,547,918	20%					20%		20%			20%				20%	100%
Tijdelijk beheer				€	**168,890**	**-€ 147,209**	**-€ 306,036**																
exploitatiegebied	1,688,901	m2	0.10	€	168,890	-€ 147,209	-€ 306,036	9%	9%	9%	9%	9%	8%	7%	5%	5%	5%	5%	5%	5%	5%	5%	100%
Opruiming en sloop				€	**265,000**	**-€ 224,231**	**-€ 466,160**																
exploitatiegebied		po	265,000	€	265,000	-€ 224,231	-€ 466,160	20%					20%		20%			20%				20%	100%
Milieukosten bodemsanering				€	**472,892**	**-€ 400,140**	**-€ 831,862**																
exploitatiegebied	1,688,901	m2	0.28	€	472,892	-€ 400,140	-€ 831,862	20%					20%		20%			20%				20%	100%
Bouwrijpmaken				€	**114,594,713**	**-€ 92,460,088**	**-€ 192,217,883**																
Bouwrijp maken (Type A)	1,679,979	m2	55	€	92,398,845	-€ 74,551,480	-€ 154,987,172					10%	10%	10%	15%		10%	10%		10%	10%	15%	100%
Bouwrijp maken (Type C)	8,922	m2	15.00	€	133,830	-€ 107,980	-€ 224,483					10%	10%	10%	15%		10%	10%		10%	10%	15%	100%
Water	492,794	m2	2.00	€	985,588	-€ 795,216	-€ 1,653,197					10%	10%	10%	15%		10%	10%		10%	10%	15%	100%
Civiel technische kunstwerken	1	po	6,000,000	€	6,000,000	-€ 4,841,066	-€ 10,064,228					10%	10%	10%	15%		10%	10%		10%	10%	15%	100%
Hoofd infrastructuur	1,196,107	m2	11.87	€	14,197,790	-€ 11,455,406	-€ 23,814,966					10%	10%	10%	15%		10%	10%		10%	10%	15%	100%
Kabels & leidingen		po	499,000	€	499,000	-€ 402,615	-€ 837,008					10%	10%	10%	15%		10%	10%		10%	10%	15%	100%
Extra kosten nuts/riool (drijv. Won)	38	po	10,000	€	379,660	-€ 306,326	-€ 636,830					10%	10%	10%	15%		10%	10%		10%	10%	15%	100%
Woonrijpmaken				€	**57,950,843**	**-€ 46,757,306**	**-€ 97,205,082**																
Verharding	528,842	m2	90.00	€	47,595,758	-€ 38,402,365	-€ 79,835,759					10%	10%	10%	15%		10%	10%		10%	10%	15%	100%
Groen (parkachtig/buffer)	85,005	m2	65.00	€	5,525,325	-€ 4,458,077	-€ 9,268,022					10%	10%	10%	15%		10%	10%		10%	10%	15%	100%
Openbaar groen	74,304	m2	65.00	€	4,829,760	-€ 3,896,864	-€ 8,101,301					10%	10%	10%	15%		10%	10%		10%	10%	15%	100%
Planstructurele kosten				€	**46,556,000**	**-€ 40,177,400**	**-€ 83,525,928**																
VAT-kosten		po	24,349,000	€	24,349,000	-€ 21,012,963	-€ 43,684,441		10%	10%	10%	10%	10%	10%	5%	5%	5%	5%	5%	5%	5%	5%	100%
Fonds voor bovenwijkse voorziengen		po	2,464,000	€	2,464,000	-€ 2,126,409	-€ 4,420,652		10%	10%	10%	10%	10%	10%	5%	5%	5%	5%	5%	5%	5%	5%	100%
Plankosten		po	6,702,000	€	6,702,000	-€ 5,783,764	-€ 12,024,031		10%	10%	10%	10%	10%	10%	5%	5%	5%	5%	5%	5%	5%	5%	100%
Onvoorzien		po	13,041,000	€	13,041,000	-€ 11,254,263	-€ 23,396,804		10%	10%	10%	10%	10%	10%	5%	5%	5%	5%	5%	5%	5%	5%	100%
Meerkosten				€	**131,457,877**	**-€ 117,028,123**	**-€ 243,293,063**																
Aanleg dijken/dijkring	2,627	m1	150	€	394,050	-€ 359,525	-€ 747,426		15%	15%	15%	15%	15%	15%	10%								100%
Grondverbetering/ophoging	10,133,178	m3	7.00	€	70,932,247	-€ 64,717,448	-€ 134,542,927		15%	15%	15%	15%	15%	15%	10%								100%
Afgraving grond	246,397	m3	7.40	€	1,823,338	-€ 1,631,674	-€ 3,392,133		15%	15%	10%	10%	10%	10%	10%	10%	5%	5%					100%
Ontgraving sloten	128,626	m2	3.25	€	418,035	-€ 360,760	-€ 749,994		10%	10%	10%	10%	10%	10%	5%	5%	5%	5%	5%	5%	5%	5%	100%
Oeverbekleding type A (buitenrand)	32,201	m1	800	€	25,760,800	-€ 22,231,333	-€ 46,217,345		10%	10%	10%	10%	10%	10%	5%	5%	5%	5%	5%	5%	5%	5%	100%
Oeverbekleding type B (woonmilieu)	17,355	m1	15	€	260,325	-€ 224,658	-€ 467,048		10%	10%	10%	10%	10%	10%	5%	5%	5%	5%	5%	5%	5%	5%	100%
Aanleg kaden	32,201	m1	700	€	22,540,700	-€ 19,452,417	-€ 40,440,177		10%	10%	10%	10%	10%	10%	5%	5%	5%	5%	5%	5%	5%	5%	100%
Watervoorzieningen	50	po	157,000	€	7,850,000	-€ 6,774,478	-€ 14,083,653		10%	10%	10%	10%	10%	10%	5%	5%	5%	5%	5%	5%	5%	5%	100%
Extra onderhoud tbv waterkwaliteit	492,794	m2	3.00	€	1,478,382	-€ 1,275,830	-€ 2,652,359		10%	10%	10%	10%	10%	10%	5%	5%	5%	5%	5%	5%	5%	5%	100%
Indirect				€	***94,899,019***	**-€ 80,299,249**	**-€ 166,936,371**																
Voorbereiding en begeleiding	10.0%			€	41,260,443	-€ 34,912,717	-€ 72,581,031	20%					20%		20%			20%				20%	100%
Bijdragen en fondsen	6.0%			€	24,756,266	-€ 20,947,630	-€ 43,548,618	20%					20%		20%			20%				20%	100%
Onvoorzien	7.0%			€	28,882,310	-€ 24,438,902	-€ 50,806,722	20%					20%		20%			20%				20%	100%
			totaal (A)	**€**	**507,503,450**	**-€ 429,226,133**	**-€ 892,330,304**																

Opbrengsten gronduitgifte

object	hvld	eh	prijs/eh		opbrengsten	contante waarde	eindwaarde
Huur				**€**	**30,424,896**	**€ 23,213,829**	**€ 48,259,882**
maatschappelijke voorzieningen	1000	m2 bvo	300	€	300,000	€ 188,657	€ 392,204
winkels	18748	m2 bvo	450	€	8,436,600	€ 5,305,404	€ 11,029,554
bedrijven	7950	m2 bvo	450	€	3,577,500	€ 2,249,731	€ 4,677,030
woningen sociale sector	**22**	stuks					
eengezinswoning	22	stuks	22,772	€	500,984	€ 315,047	€ 654,959
woningen vrije sector	**660**	stuks					
eengezinswoning	148	stuks	30,317	€	4,486,916	€ 2,821,623	€ 5,865,951
gesloten bouwblok traditioneel	240	stuks	32,445	€	7,786,800	€ 4,896,774	€ 10,180,041
appartementsgebouw middelduur	272	stuks	19,618	€	5,336,096	€ 3,355,634	€ 6,976,123
speciale functies							
parkeergarage('s)	12979	m2 bvo	500	€	6,489,500	€ 4,080,959	€ 8,484,021
Koop				**€**	**8,011,956**	**€ 69,777,859**	**€ 145,063,158**
woningen sociale sector		stuks					
woningen vrije sector	**3,080**	stuks					
eengezinswoning	654	stuks	30,317	€	19,827,318	€ 12,468,522	€ 25,921,162
twee onder één kap	120	stuks	66,682	€	8,001,840	€ 5,032,003	€ 10,461,172
vrijstaand duur	50	stuks	111,541	€	5,577,050	€ 3,507,160	€ 7,291,133
appartementsgebouw duur	888	stuks	31,486	€	27,959,568	€ 17,582,534	€ 36,552,825
vrije kavel	22	stuks	86,728	€	1,908,016	€ 1,199,867	€ 2,494,437
appartementsgbeouw middelduur	1178	stuks	19,618	€	23,110,004	€ 14,532,858	€ 30,212,768
urban villa	168	stuks	98,597	€	16,564,296	€ 10,416,552	€ 21,655,264
speciale functies							
vrij 3	8922	m2 bvo	898	€	8,011,956	€ 5,038,364	€ 10,474,397
			totaal (B)	**€**	**38,436,852**	**€ 92,991,688**	**€ 193,323,040**
			resultaat (A+B)			**-€ 336,234,445**	**-€ 699,007,264**

object	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	
maatschappelijke voorzieningen						20%		10%	15%		20%				35%	100%
winkels						20%		10%	15%		20%				35%	100%
bedrijven						20%		10%	15%		20%				35%	100%
eengezinswoning						20%		10%	15%		20%				35%	100%
eengezinswoning						20%		10%	15%		20%				35%	100%
gesloten bouwblok traditioneel						20%		10%	15%		20%				35%	100%
appartementsgebouw middelduur						20%		10%	15%		20%				35%	100%
parkeergarage('s)						20%		10%	15%		20%				35%	100%
eengezinswoning						20%		10%	15%		20%				35%	100%
twee onder één kap						20%		10%	15%		20%				35%	100%
vrijstaand duur						20%		10%	15%		20%				35%	100%
appartementsgebouw duur						20%		10%	15%		20%				35%	100%
vrije kavel						20%		10%	15%		20%				35%	100%
appartementsgbeouw middelduur						20%		10%	15%		20%				35%	100%
urban villa						20%		10%	15%		20%				35%	100%
vrij 3						20%		10%	15%		20%				35%	100%

Vastgoedexploitatie

BAR woningen	5.54%	bbo	646,123 m2	FSI 0.82	GSI 0.383
BAR maatschappelijke vzn.	8.03%				
BAR winkels	8.97%	bvo	1,385,015 m2	OSR 0.753	
BAR bedrijven	6.47%	vvo/bvo	0.8	bvo/bbo 2.144	

Kosten

object	hvld	eh	prijs/eh	kosten	contante waarde	eindwaarde
Huur				**€ 105,415,568**	**-€ 85,482,263**	**-€ 177,711,486**
maatschappelijke voorzieningen	1000	m2 bvo	1,800	€ 1,800,000	-€ 1,435,128	-€ 2,983,528
winkels	18748	m2 bvo	1,200	€ 22,497,600	-€ 17,937,188	-€ 37,290,125
bedrijven	7950	m2 bvo	1,500	€ 11,925,000	-€ 9,507,724	-€ 19,765,875
woningen sociale sector						
eengezinswoning	22	stuks	45,000	€ 990,000	-€ 789,320	-€ 1,640,941
woningen vrije sector						
eengezinswoning	148	stuks	60,418	€ 8,941,864	-€ 7,129,289	-€ 14,821,280
gesloten bouwblok traditioneel	240	stuks	77,169	€ 18,520,560	-€ 14,766,320	-€ 30,698,119
appartementsgebouw middelduur	272	stuks	80,052	€ 21,774,144	-€ 17,360,381	-€ 36,090,985
speciale functies						
parkeergarage('s)	12979	m2 bvo	1,600	€ 20,766,400	-€ 16,556,913	-€ 34,420,634
Koop				**€ 6,245,400**	**-€ 176,530,356**	**-€ 366,993,931**
woningen sociale sector						
woningen vrije sector						
eengezinswoning	654	stuks	60,418	€ 39,513,372	-€ 25,101,622	-€ 52,184,469
twee onder één kap	120	stuks	162,000	€ 19,440,000	-€ 12,349,630	-€ 25,673,994
vrijstaand duur	50	stuks	243,000	€ 12,150,000	-€ 7,718,519	-€ 16,046,246
appartementsgebouw duur	888	stuks	99,344	€ 88,217,472	-€ 56,041,829	-€ 116,506,938
vrije kavel	22	stuks	182,250	€ 4,009,500	-€ 2,547,111	-€ 5,295,261
appartementsgbeouw middelduur	1178	stuks	80,052	€ 94,301,256	-€ 59,906,669	-€ 124,541,662
urban villa	168	stuks	83,368	€ 14,005,824	-€ 8,897,466	-€ 18,497,194
speciale functies						
vrij 3	8922	m2 bvo	700	€ 6,245,400	-€ 3,967,509	-€ 8,248,167
			totaal (C)	**€ 111,660,968**	**-€ 262,012,619**	**-€ 544,705,417**

Planning

object	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	
maatschappelijke voorzieningen						10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	100%
winkels						10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	100%
bedrijven						10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	100%
eengezinswoning (sociale sector)						10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	100%
eengezinswoning (vrije sector)						10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	100%
gesloten bouwblok traditioneel						10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	100%
appartementsgebouw middelduur						10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	100%
parkeergarage('s)						10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	100%
eengezinswoning (koop)						10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	100%
twee onder één kap						10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	100%
vrijstaand duur						10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	100%
appartementsgebouw duur						10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	100%
vrije kavel						10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	100%
appartementsgbeouw middelduur						10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	100%
urban villa						10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	100%
vrij 3						10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	100%

Overview data – Land raising Variant

Opbrengsten

object	hvld	eh	prijs/eh		opbrengsten	contante waarde	eindwaarde
Huur				€	196,607,418	€ 128,870,535	€ 267,912,588
maatschappelijke voorzieningen	800	m2 vvo	150	€	1,494,396	€ 923,027	€ 1,918,906
winkels	14998	m2 vvo	225	€	37,621,405	€ 23,237,190	€ 48,308,449
bedrijven	6360	m2 vvo	225	€	22,117,465	€ 13,661,046	€ 28,400,333
woningen sociale sector							
eengezinswoning	22	stuks	6,424	€	2,551,047	€ 1,575,676	€ 3,275,718
woningen vrije sector							
eengezinswoning	148	stuks	13,200	€	35,263,538	€ 21,780,833	€ 45,280,787
gesloten bouwblok traditioneel	240	stuks	9,600	€	41,588,448	€ 25,687,469	€ 53,402,402
appartementsgebouw middelduur	272	stuks	11,400	€	55,971,119	€ 34,571,051	€ 71,870,733
speciale functies							
parkeergarage('s)	10383	m2 vvo	75	€	12,036,167	€ 7,434,244	€ 15,455,259
Koop				€	16,059,600	€ 488,952,016	€ 929,308,409
woningen sociale sector							
woningen vrije sector							
eengezinswoning	654	stuks	255,500	€	167,097,000	€ 103,208,924	€ 214,563,940
twee onder één kap	120	stuks	432,000	€	51,840,000	€ 32,019,430	€ 66,566,094
vrijstaand duur	50	stuks	648,000	€	32,400,000	€ 20,012,143	€ 41,603,809
appartementsgebouw duur	888	stuks	246,000	€	218,448,000	€ 134,926,318	€ 280,502,126
vrije kavel	22	stuks	556,875	€	12,251,250	€ 7,567,092	€ 15,731,440
appartementsgbeouw middelduur	1178	stuks	161,354	€	190,075,012	€ 117,401,494	€ 244,069,275
urban villa	168	stuks	211,614	€	35,551,152	€ 21,958,480	€ 45,650,103
speciale functies							
vrij 3	8922	m2 bvo	1,800	€	16,059,600	€ 9,919,352	€ 20,621,621
			totaal (D)	€	**212,667,018**	**€ 617,822,551**	**€ 1,197,220,996**
			resultaat (C+D)			**€ 355,809,932**	**€ 652,515,579**
			resultaat (B)			**-€ 92,991,688**	**-€ 193,323,040**
			resultaat (C+D+B)			**€ 262,818,245**	**€ 459,192,539**

object	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	
maatschappelijke voorzieningen							11%	11%	11%	11%	11%	11%	11%	11%	12%	100%
winkels							11%	11%	11%	11%	11%	11%	11%	11%	12%	100%
bedrijven							11%	11%	11%	11%	11%	11%	11%	11%	12%	100%
eengezinswoning (sociale sector, huur)							11%	11%	11%	11%	11%	11%	11%	11%	12%	100%
eengezinswoning (vrije sector, huur)							11%	11%	11%	11%	11%	11%	11%	11%	12%	100%
gesloten bouwblok traditioneel							11%	11%	11%	11%	11%	11%	11%	11%	12%	100%
appartementsgebouw middelduur							11%	11%	11%	11%	11%	11%	11%	11%	12%	100%
parkeergarage('s)							11%	11%	11%	11%	11%	11%	11%	11%	12%	100%
eengezinswoning (koop)							11%	11%	11%	11%	11%	11%	11%	11%	12%	100%
twee onder één kap							11%	11%	11%	11%	11%	11%	11%	11%	12%	100%
vrijstaand duur							11%	11%	11%	11%	11%	11%	11%	11%	12%	100%
appartementsgebouw duur							11%	11%	11%	11%	11%	11%	11%	11%	12%	100%
vrije kavel							11%	11%	11%	11%	11%	11%	11%	11%	12%	100%
appartementsgbeouw middelduur							11%	11%	11%	11%	11%	11%	11%	11%	12%	100%
urban villa							11%	11%	11%	11%	11%	11%	11%	11%	12%	100%
vrij 3							11%	11%	11%	11%	11%	11%	11%	11%	12%	100%

Land raising variant

Overview of living areas and housing typologies:

Facilities

Social/public facilities	1,000	m^2
shops	18,748	m^2
business	7,950	m^2
Total	**27,698**	**m^2**

Canal area

Apartment, middle priced, owner occupied	1,178	Homes
Apartment, middle priced, rent	272	Homes
Apartment, expensive, owner occupied	138	Homes
Total	**1,588**	**Homes**

Garden area

Urban villa, owner occupied	168	Homes
Single family home, middle priced, owner occupied	654	Homes
Single family home, middle priced, rent	148	Homes
Single family home, social, rent	22	Homes
Total	**992**	**Homes**

Rural area

Free standing, expensive, owner occupied	50	Homes
Semi detached, owner occupied	120	Homes
Total	**170**	**Homes**

Water area

Free-3, floating homes, owner occupied	8,922	m^2 gfa
Total	**38**	**Homes**

Stronghold area

Apartment, expensive, owner occupied	750	Homes
Parking in garage	12,979	m^2 gfa
Total	**750**	**Homes**

Remaining area

Closed building block, traditional, free plot, owner occupied	22	Homes
BEBO home, small traditional, rent	240	Homes
Total	**262**	**Homes**

Land raising Variant

Total amount of homes

Rent	682	Homes	18%
Owner occupied	3,118	Homes	82%
Total	**3,800**	**Homes**	

Overview of landscaping activities:

Area	Referential	(%)
Water	492,794 m^2	29.2 %
Land/green	159,309 m^2	9.4 %
Paving	528,842 m^2	31.3 %
Constructed building area	646,123 m^2	38.3 %
Total	**1,688,901 m^2**	**108.2 %**

Revetment embankments

Type A: ring dyke	17,355 m
Type B: living areas	44, 828 m

Construction of quays

Total	**32,201 m**

Water facility system

Total	**1**

Heightening constructed building ground

Area	1,688,863 m^2
Height	6.0 m
Total	**10,133,178 m^3**

Street level at 0 m NAP

Excavation

Area	492,794 m^2
Height	0.5 m
Total	**246,397 m^3**

Water level at -4.5 m NAP

Excavation of waterways/canals

Total	**128,626 m2**

Heightening ground

Dyke ring east	Area	48,857 m^2	Length	1,737 m
Total	Height	6 m	Cubic meters	293,142 m^3
Dyke ring west and south	Area	16,883 m^2	Length	890 m
Total	Height	6 m	Cubic meters	101,298 m^3
Living area 'rectangle'	Area	51,023 m^2	Circumference	29,456 m
Total	Height	6 m	Cubic meters	306,138 m^3
Living areas islands	Area	121,680 m^2	Circumference	2,745 m
Total	Height	6 m	Cubic meters	730,080 m^3
Total			**Cubic meters**	**1,430,658 m^3**

Appendix VIII Referential images of water homes

Referential images of water housing typologies and island variations.

source: rapport duinwonen

Referential images of water homes

Source: www.waterbestendigbouwen.nl/3%20woningtypen/woningtypen.htm, 2009

Source: www.Wonenopwater.nu, 2009

source:
www.godevaert.nl/news/item/Superspecial_Wonen_aan_het_water/228?mid=100013, 2009

Source: www.goudenkust.nl/verkoop/buitendijks3.htm

source: www.arkenbouw.nl/fotoalbum/2/2, 2009

Appendix IX Overview data Cascade variant

Grondexploitatie

rente	5.0%	plangebied	1,709,901	m2	startdatum project	2009	
kostenstijging	2.5%	exploitatiegebied	1,709,901	m2	looptijd project	15	jaar
opbrengstenstijging		prijspeil	2009				

Kosten / **Planning**

activiteit	hvld	eh	prijs/eh		kosten	contante waarde	eindwaarde	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	
Verwerving				€	**61,898,416**	**-€ 52,375,634**	**-€ 108,885,182**																
exploitatiegebied	1,709,901	m2	36.20	€	61,898,416	-€ 52,375,634	-€ 108,885,182	20%					20%		20%			20%				20%	100%
Tijdelijk beheer				€	**170,990**	**-€ 149,039**	**-€ 309,842**																
exploitatiegebied	1,709,901	m2	0.10	€	170,990	-€ 149,039	-€ 309,842	9%	9%	9%	9%	9%	8%	7%	5%	5%	5%	5%	5%	5%	5%	5%	100%
Opruiming en sloop				€	**265,000**	**-€ 224,231**	**-€ 466,160**																
exploitatiegebied		po	265,000.00	€	265,000	-€ 224,231	-€ 466,160	20%					20%		20%			20%				20%	100%
Milieukosten				€	**478,772**	**-€ 405,115**	**-€ 842,206**																
exploitatiegebied	1,709,901	m2	0.28	€	478,772	-€ 405,115	-€ 842,206	20%					20%		20%			20%				20%	100%
Bouwrijpmaken				€	**102,600,632**	**-€ 85,096,931**	**-€ 176,910,408**																
Bouwrijp maken (Type A)	532,120	m2	55.00	€	29,266,600	-€ 24,144,409	-€ 50,194,493				10%	10%	10%	10%	15%		10%	10%			10%	15%	100%
Bouwrijp maken (Type B)	676,348	m2	35.00	€	23,672,180	-€ 20,049,116	-€ 41,680,672		10%	10%		10%	10%	10%	10%		10%	10%			10%	10%	100%
Bouwrijp maken (Type C)	501,433	m2	15.00	€	7,521,495	-€ 6,068,675	-€ 12,616,340					10%	10%	10%	15%		10%	10%		10%	10%	15%	100%
Water	579,884	m2	2.00	€	1,159,768	-€ 935,752	-€ 1,945,362					10%	10%	10%	15%		10%	10%		10%	10%	15%	100%
Civiel technische kunstwerken	2	po	6,000,000	€	12,000,000	-€ 9,682,131	-€ 20,128,456					10%	10%	10%	15%		10%	10%		10%	10%	15%	100%
Hoofd infrastructuur	1,130,017	m2	11.87	€	13,413,302	-€ 11,360,375	-€ 23,617,404		10%	10%		10%	10%	10%	10%		10%	10%			10%	10%	100%
Kabels & leidingen		po	499,000	€	499,000	-€ 422,627	-€ 878,612		10%	10%		10%	10%	10%	10%		10%	10%			10%	10%	100%
Extra kosten nuts/riool (amf. Won)	1,377	po	5,000	€	6,884,162	-€ 5,830,530	-€ 12,121,254		10%	10%		10%	10%	10%	10%		10%	10%			10%	10%	100%
Extra kosten nuts/riool (drijv. Won)	818	po	10,000	€	8,184,125	-€ 6,603,314	-€ 13,727,816					10%	10%	10%	15%		10%	10%		10%	10%	15%	100%
Woonrijpmaken				€	**68,802,724**	**-€ 58,272,360**	**-€ 121,144,051**																
Verharding	368,924	m2	90.00	€	33,203,199	-€ 28,121,398	-€ 58,462,366		10%	10%		10%	10%	10%	10%		10%	10%			10%	10%	100%
Groen (parkachtig/buffer)	527,571	m2	65.00	€	34,292,115	-€ 29,043,653	-€ 60,379,669		10%	10%		10%	10%	10%	10%		10%	10%			10%	10%	100%
Openbaar groen	20,114	m2	65.00	€	1,307,410	-€ 1,107,309	-€ 2,302,016		10%	10%		10%	10%	10%	10%		10%	10%			10%	10%	100%
Planstructurele kosten				€	**46,556,000**	**-€ 40,177,400**	**-€ 83,525,928**																
VAT-kosten		po	24,349,000	€	24,349,000	-€ 21,012,963	-€ 43,684,441		10%	10%	10%	10%	10%	10%	5%	5%	5%	5%	5%	5%	5%	5%	100%
Fonds voor bovenwijkse voorzieningen		po	2,464,000	€	2,464,000	-€ 2,126,409	-€ 4,420,652		10%	10%	10%	10%	10%	10%	5%	5%	5%	5%	5%	5%	5%	5%	100%
Plankosten		po	6,702,000	€	6,702,000	-€ 5,783,764	-€ 12,024,031		10%	10%	10%	10%	10%	10%	5%	5%	5%	5%	5%	5%	5%	5%	100%
Onvoorzien		po	13,041,000	€	13,041,000	-€ 11,254,263	-€ 23,396,804		10%	10%	10%	10%	10%	10%	5%	5%	5%	5%	5%	5%	5%	5%	100%
Meerkosten				€	**48,335,603**	**-€ 43,382,612**	**-€ 90,189,334**																
Aanleg dijken/dijkring	8,300	m1	150	€	1,245,000	-€ 1,135,918	-€ 2,361,492		15%	15%	15%	15%	15%	15%	10%								100%
Grondverbetering/ophoging	3,811,365	m3	7.00	€	26,679,554	-€ 24,341,998	-€ 50,605,266		15%	15%	15%	15%	15%	15%	10%								100%
Afgraving grond	150,430	m3	7.40	€	1,113,181	-€ 996,167	-€ 2,070,959		15%	15%	10%	10%	10%	10%	10%	10%	5%	5%					100%
Ontgraving sloten	78,451	m2	3.25	€	254,966	-€ 220,033	-€ 457,433		10%	10%	10%	10%	10%	10%	5%	5%	5%	5%	5%	5%	5%	5%	100%
Oeverbekleding type A (buitenrand)	3,450	m1	800	€	2,760,000	-€ 2,381,855	-€ 4,951,705		10%	10%	10%	10%	10%	10%	5%	5%	5%	5%	5%	5%	5%	5%	100%
Oeverbekleding type B (woonmilieu)	2,150	m1	15	€	32,250	-€ 27,831	-€ 57,860		10%	10%	10%	10%	10%	10%	5%	5%	5%	5%	5%	5%	5%	5%	100%
Aanleg kaden	4,150	m1	700	€	2,905,000	-€ 2,506,988	-€ 5,211,849		10%	10%	10%	10%	10%	10%	5%	5%	5%	5%	5%	5%	5%	5%	100%
Watervoorzieningen	58	po	157,000	€	9,106,000	-€ 7,858,394	-€ 16,337,037		10%	10%	10%	10%	10%	10%	5%	5%	5%	5%	5%	5%	5%	5%	100%
Extra onderhoud tbv waterkwaliteit	579,884	m2	3.00	€	1,739,652	-€ 1,501,304	-€ 3,121,102		10%	10%	10%	10%	10%	10%	5%	5%	5%	5%	5%	5%	5%	5%	100%
Onteigening		po	2,500,000	€	2,500,000	-€ 2,412,123	-€ 5,014,631	25%	25%	25%	25%												100%
Indirect				€	***75,694,872***	**-€ 64,049,569**	**-€ 133,154,455**																
Voorbereiding en begeleiding	10.0%			€	32,910,814	-€ 27,847,639	-€ 57,893,241	20%					20%		20%			20%				20%	100%
Bijdragen en fondsen	6.0%			€	19,746,488	-€ 16,708,583	-€ 34,735,945	20%					20%		20%			20%				20%	100%
Onvoorzien	7.0%			€	23,037,570	-€ 19,493,347	-€ 40,525,269	20%					20%		20%			20%				20%	100%
			totaal (A)	€	**404,803,009**	**-€ 344,132,892**	**-€ 715,427,566**																

Opbrengsten gronduitgifte

object	hvld	eh	prijs/eh		opbrengsten	contante waarde	eindwaarde
Huur				**€**	**92,023,036**	**€ 64,105,383**	**€ 133,270,487**
maatschappelijke voorzieningen	1512	m2 uitg	300	€	453,600	€ 303,656	€ 631,279
winkels	11996	m2 bvo	450	€	5,398,200	€ 3,613,746	€ 7,512,719
bedrijven	6360	m2 uitg	450	€	2,862,000	€ 1,915,924	€ 3,983,069
woningen sociale sector		stuks					
woningen vrije sector	**305**	stuks					
eengezinswoning	305	stuks	30,317	€	9,246,685	€ 6,190,058	€ 12,868,687
speciale functies							
vrij-2	29709	m2 bvo	455	€	13,517,595	€ 9,516,977	€ 19,785,111
vrij 3	67422	m2 bvo	898	€	60,544,956	€ 38,381,385	€ 79,792,143
parkeergarage('s)	12499	m2 bvo	500	€	6,249,500	€ 4,183,637	€ 8,697,480
Koop				**€**	**188,319,441**	**€ 164,989,929**	**€ 343,002,212**
woningen sociale sector		stuks					
woningen vrije sector	**1,605**	stuks					
eengezinswoning	661	stuks	30,317	€	20,039,537	€ 13,415,176	€ 27,889,187
twee onder één kap	178	stuks	66,682	€	11,869,396	€ 7,945,794	€ 16,518,735
vrijstaand duur	86	stuks	111,541	€	9,592,526	€ 6,421,577	€ 13,349,997
appartementsgebouw duur	480	stuks	31,486	€	15,113,280	€ 10,117,365	€ 21,033,275
appartementsgbeouw middelduur	200	stuks	19,618	€	3,923,600	€ 2,626,597	€ 5,460,506
speciale functies							
vrij 2	159297	m2 bvo	455	€	72,480,135	€ 51,029,178	€ 106,085,996
vrij 3	128997	m2 bvo	898	€	115,839,306	€ 73,434,243	€ 152,664,517
			totaal (B)	**€**	**280,342,477**	**€ 229,095,312**	**€ 476,272,699**
			resultaat (A+B)			**-€ 115,037,580**	**-€ 239,154,867**

object	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	
maatschappelijke voorzieningen					20%		20%	15%			20%				25%	100%
winkels					20%		20%	15%			20%				25%	100%
bedrijven					20%		20%	15%			20%				25%	100%
eengezinswoning (huur)					20%		20%	15%			20%				25%	100%
vrij-2			20%			20%		20%			20%				20%	100%
vrij 3						20%		25%			20%				35%	100%
parkeergarage('s)					20%		20%	15%			20%				25%	100%
eengezinswoning (koop)					20%		20%	15%			20%				25%	100%
twee onder één kap					20%		20%	15%			20%				25%	100%
vrijstaand duur					20%		20%	15%			20%				25%	100%
appartementsgebouw duur					20%		20%	15%			20%				25%	100%
appartementsgbeouw middelduur					20%		20%	15%			20%				25%	100%
vrij 2			20%			20%		20%			20%				20%	100%
vrij 3						20%		25%			20%				35%	100%

Vastgoedexploitatie

BAR woningen	5.54%	bbo	322,917	m2	FSI	0.605	GSI	0.189
BAR maatschappelijke vzn.	8.03%							
BAR winkels	8.97%	bvo	1,033,651	m2	OSR	1.342		
BAR bedrijven	6.47%	vvo/bvo	0.8		bvo/bbo	3.201		

Kosten

object	hvld	eh	prijs/eh		kosten	contante waarde	eindwaarde
Huur				**€**	**133,323,690**	**-€ 109,706,015**	**-€ 228,070,925**
maatschappelijke voorzieningen	1512	m2 uitg	1,800	€	2,721,600	-€ 2,194,781	-€ 4,562,792
winkels	11996	m2 bvo	1,200	€	14,395,200	-€ 11,608,727	-€ 24,133,709
bedrijven	6360	m2 uitg	1,500	€	9,540,000	-€ 7,693,346	-€ 15,993,914
woningen sociale sector							
woningen vrije sector							
eengezinswoning	305	stuks	60,418	€	18,427,490	-€ 14,860,488	-€ 30,893,887
speciale functies							
vrij-2	29709	m2 bvo	800	€	23,767,200	-€ 19,592,775	-€ 40,731,973
vrij 3	67422	m2 bvo	700	€	47,195,400	-€ 37,628,580	-€ 78,227,116
parkeergarage('s)	12499	m2 bvo	1,600	€	19,998,400	-€ 16,127,317	-€ 33,527,535
Koop				**€**	**217,735,500**	**-€ 244,082,965**	**-€ 507,430,954**
woningen sociale sector							
woningen vrije sector							
eengezinswoning	661	stuks	60,418	€	39,936,298	-€ 25,991,982	-€ 54,035,464
twee onder één kap	178	stuks	162,000	€	28,836,000	-€ 18,767,508	-€ 39,016,301
vrijstaand duur	86	stuks	243,000	€	20,898,000	-€ 13,601,172	-€ 28,275,859
appartementsgebouw duur	480	stuks	99,344	€	47,685,120	-€ 31,035,195	-€ 64,519,941
appartementsgebeouw middelduur	200	stuks	80,052	€	16,010,400	-€ 10,420,145	-€ 21,662,734
speciale functies							
vrij 2	159297	m2 bvo	800	€	127,437,600	-€ 86,903,502	-€ 180,666,140
vrij 3	128997	m2 bvo	700	€	90,297,900	-€ 57,363,461	-€ 119,254,515
			totaal (C)	**€**	**351,059,190**	**-€ 353,788,980**	**-€ 735,501,879**

Planning

object	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	
maatschappelijke voorzieningen					9%	9%	9%	9%	9%	9%	9%	9%	9%	9%	10%	100%
winkels					9%	9%	9%	9%	9%	9%	9%	9%	9%	9%	10%	100%
bedrijven					9%	9%	9%	9%	9%	9%	9%	9%	9%	9%	10%	100%
eengezinswoning (huur)					9%	9%	9%	9%	9%	9%	9%	9%	9%	9%	10%	100%
vrij-2 (huur)			7%	7%	7%	7%	8%	8%	8%	8%	8%	8%	8%	8%	8%	100%
vrij 3 (huur)						10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	100%
parkeergarage('s)					9%	9%	9%	9%	9%	9%	9%	9%	9%	9%	10%	100%
eengezinswoning (koop)					9%	9%	9%	9%	9%	9%	9%	9%	9%	9%	10%	100%
twee onder één kap					9%	9%	9%	9%	9%	9%	9%	9%	9%	9%	10%	100%
vrijstaand duur					9%	9%	9%	9%	9%	9%	9%	9%	9%	9%	10%	100%
appartementsgebouw duur					9%	9%	9%	9%	9%	9%	9%	9%	9%	9%	10%	100%
appartementsgebeouw middelduur					9%	9%	9%	9%	9%	9%	9%	9%	9%	9%	10%	100%
vrij 2 (koop)			7%	7%	7%	7%	8%	8%	8%	8%	8%	8%	8%	8%	8%	100%
vrij 3 (koop)						10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	100%

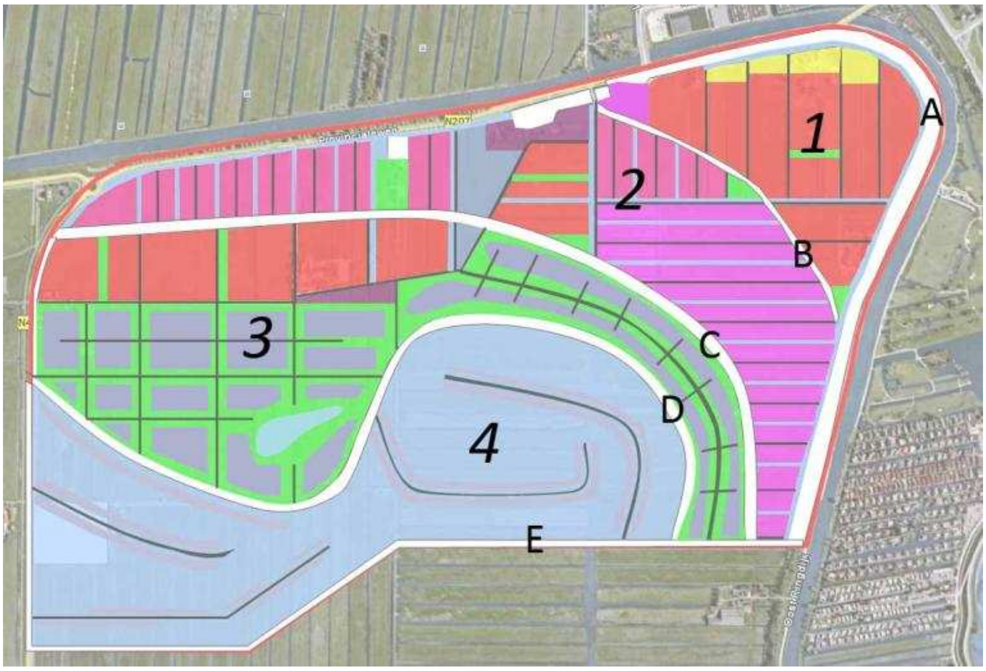
Overview data – Cascade Variant

Opbrengsten

object	hvld	eh	prijs/eh	opbrengsten	contante waarde	eindwaarde
Huur				**€ 237,982,173**	**€ 158,092,699**	**€ 328,663,366**
maatschappelijke voorzieningen	1210	m2 vvo	150	€ 2,259,527	€ 1,435,407	€ 2,984,109
winkels	9597	m2 vvo	225	€ 24,072,241	€ 15,292,349	€ 31,791,696
bedrijven	5088	m2 vvo	225	€ 17,693,972	€ 11,240,433	€ 23,368,052
woningen sociale sector						
woningen vrije sector						
eengezinswoning	305	stuks	13,200	€ 72,671,480	€ 46,165,942	€ 95,975,677
speciale functies						
vrij-2	23767	m2 vvo	83	€ 35,607,899	€ 23,675,959	€ 49,220,619
vrij 3	53938	m2 vvo	88	€ 85,677,054	€ 52,919,182	€ 110,015,179
parkeergarage('s)	9999	m2 vvo	75	€ 11,591,036	€ 7,363,426	€ 15,308,034
Koop				**€ 541,867,968**	**€ 915,717,481**	**€ 1,331,476,677**
woningen sociale sector						
woningen vrije sector						
eengezinswoning	661	stuks	255,500	€ 168,885,500	€ 107,287,730	€ 223,043,485
twee onder één kap	178	stuks	432,000	€ 76,896,000	€ 48,849,648	€ 101,554,911
vrijstaand duur	86	stuks	648,000	€ 55,728,000	€ 35,402,273	€ 73,598,783
appartementsgebouw duur	480	stuks	246,000	€ 118,080,000	€ 75,012,569	€ 155,945,743
appartementsgbeouw middelduur	200	stuks	161,354	€ 32,270,800	€ 20,500,640	€ 42,619,359
speciale functies						
vrij 2	159297	m2 bvo	1,944	€ 309,673,368	€ 205,904,145	€ 428,059,930
vrij 3	128997	m2 bvo	1,800	€ 232,194,600	€ 147,506,041	€ 306,654,466
			totaal (D)	**€ 779,850,141**	**€ 1,073,810,180**	**€ 1,660,140,043**
			resultaat (C+D)		**€ 720,021,200**	**€ 924,638,164**
			resultaat (B)		**-€ 229,095,312**	**-€ 476,272,699**
			resultaat (C+D+B)		**€ 490,925,888**	**€ 448,365,464**

object	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	
maatschappelijke voorzieningen						10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	100%
winkels						10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	100%
bedrijven						10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	100%
eengezinswoning (huur)						10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	100%
vrij-2 (huur)				8%	8%	8%	8%	8%	8%	8%	8%	9%	9%	9%	9%	100%
vrij 3 (huur)							11%	11%	11%	11%	11%	11%	11%	11%	12%	100%
parkeergarage('s)						10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	100%
eengezinswoning (koop)						10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	100%
twee onder één kap						10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	100%
vrijstaand duur						10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	100%
appartementsgebouw duur						10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	100%
appartementsgbeouw middelduur						10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	100%
vrij 2 (koop)				8%	8%	8%	8%	8%	8%	8%	8%	9%	9%	9%	9%	100%
vrij 3 (koop)						10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	100%

Cascade variant



Four living areas:
1) high-dry ground: single family homes
2) rural living area, free standing homes, semi detached homes
3) amphibious homes and dry-proof homes
4) water/floating homes

Five different dykes:
A) ring dyke
B) green area, dune
C) dyke ring
D) dyke ring
E) dyke ring

Referential image of floating parking garages

Source: Prospectus, de Drijvende Stad, oktober 2008

Cascade Variant

Overview of living areas and housing typologies:

Facilities

Social/public facilities	1,512	m^2
shops	11,996	m^2
business	6,360	m^2
Total	**19,868**	**m^2**

Living area (1)

Single family homes	608	Homes
Urban villa, apartm. Expensive, owner occupied	480	Homes
Total	**1,088**	**Homes**

Living area (2)

Single family homes	53	Homes
Bebo, social, apartm. Owner occupied	200	Homes
Semi detached homes, owner occupied	178	Homes
Free standing homes, owner occupied	86	Homes
Total	**517**	**Homes**

Living area (3)

Single family homes, rent			305	Homes
Free-2, owner occupied	159,297	m^2 gfa	885	Homes
Free-2, rent	29,709	m^2 gfa	187	Homes
Total			**1,377**	**Homes**

Living area (4)

Free-3, owner occupied	128,997	m^2 gfa	537	Homes
Free-3, rent	67,422	m^2 gfa	281	Homes
Total			**818**	**Homes**

Total amount of homes

Rent	773	Homes	20.3%
Owner occupied	3,027	Homes	79.7%
Total	**3,800**	**Homes**	

Parking garages

Parking for floating homes

Standard	11	m^2/pp		
Number of homes: Free-3, owner occupied	537	Homes	1.8	Per household
Number of homes: Free-3, rent	281	Homes	1.2	Per household
Total available	12,499	m^2		

Cascade Variant

Overview of landscaping activities:

Area	Referential	(%)
Water	579,884 m^2	33.9 %
Land/green	547,685 m^2	32.0 %
Paving	368,924 m^2	21.6 %
Constructed building area	322,917 m^2	18.9 %
Total	**1,709,901 m^2**	**106.4 %**

Area	Referential	(%)
Water	970,667 m^2	56.8 %
Land/green	547,685 m^2	32.0 %
Paving	368,924 m^2	21.6 %
Constructed building area	322,917 m^2	18.9 %
Total	**1,709,901 m^2**	**129.3 %**

Extra water capacity of 22.9%.

Revetment embankments	
Type A: ring dyke	3,450 m
Type B: living areas	2,150 m

Construction of quays	
Total	**4,150 m**

Water facility system	
Total	**2**

Heightening living area (1)		
Area	175,483 m^2	
Height	4.75 m	
Total	**833,544 m^3**	Street level at 0m NAP
Heightening living area (2)		
Area	356,637 m^2	
Height	5.0 m	
Total	**1,783,185 m^3**	Street level at 0m NAP
Heightening living area (3)		
Area	676,348 m^2	
Height	0.45 m	
Total	**304,357 m^3**	Street level at -5.3m NAP
Heightening living area (4)		
Area	501,433 m^2	
Height	0.3 m	
Total	**150,430 m^3**	Street level at -6.3m NAP
Total area location	**1,709,901 m^2**	
Total elevated height	**3,811,365 m^3**	

Cascade Variant

Excavation of waterways/canals

Total water area 4	**78,451 m2**

Heightening ground

Dyke ring (A)	Area	39,890 m^2	Length	1,500 m
	Height	5 m	Total	189,478 m^3
Dyke ring (B)	Area	7,951 m^2	Length	700 m
	Height	5 m	Total	39,755 m^3
Dyke ring (C)	Area	49,206 m^2	Length	2,000 m
	Height	6 m	Total	270,633 m^3
Dyke ring (D)	Area	39,907 m^2	Length	2,150 m
	Area	6 m	Total	229,456 m^3
Dyke ring (E)	Height	27,991	Length	1,950 m
	Height	6 m	Total	160,948 m^3
Total				**890,279 m^3**

Appendix X Overview data Water variant

Grondexploitatie

rente	5.0%	plangebied	1,709,901	m2	startdatum project	2009	
kostenstijging	2.5%	exploitatiegebied	1,709,901	m2	looptijd project	15	jaar
opbrengstenstijging		prijspeil	2009				

Kosten

activiteit	hvld	eh	prijs/eh		kosten	contante waarde	eindwaarde
Verwerving				€	**61,898,416**	**-€ 52,375,634**	**-€ 108,885,182**
exploitatiegebied	1,709,901	m2	36.20	€	61,898,416	-€ 52,375,634	-€ 108,885,182
Tijdelijk beheer				€	**170,990**	**-€ 149,039**	**-€ 309,842**
exploitatiegebied	1,709,901	m2	0.10	€	170,990	-€ 149,039	-€ 309,842
Opruiming en sloop				€	**265,000**	**-€ 224,231**	**-€ 466,160**
exploitatiegebied		po	265,000	€	265,000	-€ 224,231	-€ 466,160
Milieukosten				€	**478,772**	**-€ 405,115**	**-€ 842,206**
exploitatiegebied	1,709,901	m2	0.28	€	478,772	-€ 405,115	-€ 842,206
Bouwrijpmaken				€	**83,840,127**	**-€ 67,645,927**	**-€ 140,631,024**
Bouwrijp maken (Type A)	277,250	m2	55.00	€	15,248,764	-€ 12,303,378	-€ 25,577,839
Bouwrijp maken (Type B)	92,417	m2	35.00	€	3,234,586	-€ 2,609,807	-€ 5,425,602
Bouwrijp maken (Type C)	1,178,791	m2	15.00	€	17,681,865	-€ 14,266,512	-€ 29,659,053
Water	1,178,791	m2	2.00	€	2,357,582	-€ 1,902,202	-€ 3,954,540
Civiel technische kunstwerken	1	po	6,000,000	€	6,000,000	-€ 4,841,066	-€ 10,064,228
Hoofd infrastructuur	531,110	m2	11.87	€	6,304,276	-€ 5,086,569	-€ 10,574,611
Kabels & leidingen		po	499,000	€	499,000	-€ 402,615	-€ 837,008
Extra kosten nuts/riool (amf. Won)	1,098	po	5,000	€	5,487,929	-€ 4,427,904	-€ 9,205,295
Extra kosten nuts/riool (drijv. Won)	2,703	po	10,000	€	27,026,125	-€ 21,805,874	-€ 45,332,847
Woonrijpmaken				€	**27,276,084**	**-€ 22,007,552**	**-€ 45,752,120**
Verharding	36,086	m2	90.00	€	3,247,729	-€ 2,620,411	-€ 5,447,647
Groen (parkachtig/buffer)	369,667	m2	65.00	€	24,028,355	-€ 19,387,141	-€ 40,304,473
Planstructurele kosten				€	**46,556,000**	**-€ 40,177,400**	**-€ 83,525,928**
VAT-kosten		po	24,349,000	€	24,349,000	-€ 21,012,963	-€ 43,684,441
Fonds voor bovenwijkse voorziengen		po	2,464,000	€	2,464,000	-€ 2,126,409	-€ 4,420,652
Plankosten		po	6,702,000	€	6,702,000	-€ 5,783,764	-€ 12,024,031
Onvoorzien		po	13,041,000	€	13,041,000	-€ 11,254,263	-€ 23,396,804
Meerkosten				€	**58,711,098**	**-€ 55,656,986**	**-€ 107,896,818**
Aanleg dijken/dijkring	5,442	m1	150	€	816,225	-€ 744,711	-€ 1,548,200
Grondverbetering/ophoging	2,218,002	m3	7.00	€	15,526,014	-€ 14,165,687	-€ 29,449,446
Afgraving grond	725,567	m3	7.40	€	5,369,196	-€ 4,804,802	-€ 9,988,838
Oeverbekleding type A (buitenrand)	5,442	m1	800	€	4,353,200	-€ 3,756,772	-€ 7,810,058
Oeverbekleding type B (woonmilieu)	11,526	m1	15	€	172,890	-€ 149,202	-€ 310,181
Aanleg kaden	11,526	m1	700	€	8,068,200	-€ 6,962,782	-€ 14,475,124
Watervoorzieningen	117	po	157,000	€	18,369,000	-€ 15,852,278	-€ 32,955,747
Extra onderhoud tbv waterkwaliteit	1,178,791	m2	3.00	€	3,536,373	-€ 3,051,857	-€ 6,344,592
Onteigening		po	2,500,000	€	2,500,000	-€ 2,412,123	-€ 5,014,631
Indirect				€	**64,215,192**	**-€ 54,335,985**	**-€ 112,960,610**
Voorbereiding en begeleiding	10.0%			€	27,919,649	-€ 23,624,341	-€ 49,113,309
Bijdragen en fondsen	6.0%			€	16,751,789	-€ 14,174,605	-€ 29,467,985
Onvoorzien	7.0%			€	19,543,754	-€ 16,537,039	-€ 34,379,316
			totaal (A)	€	**343,411,680**	**-€ 292,977,869**	**-€ 601,269,890**

Planning

activiteit	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	
Verwerving – exploitatiegebied	20%					20%		20%			20%				20%	100%
Tijdelijk beheer – exploitatiegebied	9%	9%	9%	9%	9%	8%	7%	5%	5%	5%	5%	5%	5%	5%	5%	100%
Opruiming en sloop – exploitatiegebied	20%					20%		20%			20%				20%	100%
Milieukosten – exploitatiegebied	20%					20%		20%			20%				20%	100%
Bouwrijp maken (Type A)					10%	10%	10%	15%		10%	10%		10%	10%	15%	100%
Bouwrijp maken (Type B)					10%	10%	10%	15%		10%	10%		10%	10%	15%	100%
Bouwrijp maken (Type C)					10%	10%	10%	15%		10%	10%		10%	10%	15%	100%
Water					10%	10%	10%	15%		10%	10%		10%	10%	15%	100%
Civiel technische kunstwerken					10%	10%	10%	15%		10%	10%		10%	10%	15%	100%
Hoofd infrastructuur					10%	10%	10%	15%		10%	10%		10%	10%	15%	100%
Kabels & leidingen					10%	10%	10%	15%		10%	10%		10%	10%	15%	100%
Extra kosten nuts/riool (amf. Won)					10%	10%	10%	15%		10%	10%		10%	10%	15%	100%
Extra kosten nuts/riool (drijv. Won)					10%	10%	10%	15%		10%	10%		10%	10%	15%	100%
Verharding					10%	10%	10%	15%		10%	10%		10%	10%	15%	100%
Groen (parkachtig/buffer)					10%	10%	10%	15%		10%	10%		10%	10%	15%	100%
VAT-kosten		10%	10%	10%	10%	10%	10%	5%	5%	5%	5%	5%	5%	5%	5%	100%
Fonds voor bovenwijkse voorziengen		10%	10%	10%	10%	10%	10%	5%	5%	5%	5%	5%	5%	5%	5%	100%
Plankosten		10%	10%	10%	10%	10%	10%	5%	5%	5%	5%	5%	5%	5%	5%	100%
Onvoorzien		10%	10%	10%	10%	10%	10%	5%	5%	5%	5%	5%	5%	5%	5%	100%
Aanleg dijken/dijkring		15%	15%	15%	15%	15%	15%	10%								100%
Grondverbetering/ophoging		15%	15%	15%	15%	15%	15%	10%								100%
Afgraving grond		15%	15%	10%	10%	10%	10%	10%	10%	5%	5%					100%
Oeverbekleding type A (buitenrand)		10%	10%	10%	10%	10%	10%	5%	5%	5%	5%	5%	5%	5%	5%	100%
Oeverbekleding type B (woonmilieu)		10%	10%	10%	10%	10%	10%	5%	5%	5%	5%	5%	5%	5%	5%	100%
Aanleg kaden		10%	10%	10%	10%	10%	10%	5%	5%	5%	5%	5%	5%	5%	5%	100%
Watervoorzieningen		10%	10%	10%	10%	10%	10%	5%	5%	5%	5%	5%	5%	5%	5%	100%
Extra onderhoud tbv waterkwaliteit		10%	10%	10%	10%	10%	10%	5%	5%	5%	5%	5%	5%	5%	5%	100%
Onteigening	25%	25%	25%	25%												100%
Voorbereiding en begeleiding	20%					20%		20%			20%				20%	100%
Bijdragen en fondsen	20%					20%		20%			20%				20%	100%
Onvoorzien	20%					20%		20%			20%				20%	100%

Opbrengsten gronduitgifte

object	hvld	eh	prijs/eh	opbrengsten	contante waarde	eindwaarde	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	
Huur				**€ 118,237,284**	**€ 89,991,899**	**€ 187,086,695**																
maatschappelijke voorzieningen	1000	m2 uitg	300	€ 300,000	€ 190,180	€ 395,370						20%		25%			20%				35%	100%
winkels	18758	m2 bvo	450	€ 8,441,100	€ 5,351,083	€ 11,124,518						20%		25%			20%				35%	100%
bedrijven	7950	m2 uitg	450	€ 3,577,500	€ 2,267,892	€ 4,714,784						20%		25%			20%				35%	100%
woningen sociale sector		stuks																				
woningen vrije sector		stuks																				
speciale functies																						
vrij-2	65784	m2 bvo	455	€ 29,931,720	€ 18,974,675	€ 39,446,987						20%		25%			20%				35%	100%
vrij 3	84618	m2 bvo	898	€ 75,986,964	€ 48,170,568	€ 100,143,151						20%		25%			20%				35%	100%
parkeergarage('s)	47442	m2 bvo	500	€ 23,721,000	€ 15,037,501	€ 31,261,885						20%		25%			20%				35%	100%
Koop				**€ 562,487,397**	**€ 356,578,761**	**€ 741,301,634**																
woningen sociale sector		stuks																				
woningen vrije sector		stuks																				
speciale functies																						
vrij 2	123093	m2 bvo	455	€ 56,007,315	€ 35,504,829	€ 73,811,990						20%		25%			20%				35%	100%
vrij 3	564009	m2 bvo	898	€ 506,480,082	€ 321,073,931	€ 667,489,644						20%		25%			20%				35%	100%
			totaal (B)	**€ 680,724,681**	**€ 446,570,660**	**€ 928,388,328**																
			resultaat (A+B)		**€ 153,592,790**	**€ 327,118,438**																

Vastgoedexploitatie

BAR woningen	5.54%	**bbo**		665,994	m2	**FSI**	0.514	**GSI**	0.389
BAR maatschappelijke vzn.	8.03%								
BAR winkels	8.97%	**bvo**		879,612	m2	**OSR**	1.187		
BAR bedrijven	6.47%	**vvo/bvo**		0.8		bvo/bbo	1.321		

Kosten

object	hvld	eh	prijs/eh		kosten	contante waarde	eindwaarde
Huur				€	**222,201,600**	**-€ 178,594,994**	**-€ 371,286,166**
maatschappelijke voorzieningen	1000	m2 uitg	1,800	€	1,800,000	-€ 1,435,128	-€ 2,983,528
winkels	18758	m2 bvo	1,200	€	22,509,600	-€ 17,946,755	-€ 37,310,015
bedrijven	7950	m2 uitg	1,500	€	11,925,000	-€ 9,507,724	-€ 19,765,875
woningen sociale sector							
woningen vrije sector							
speciale functies							
vrij-2	65784	m2 bvo	800	€	52,627,200	-€ 41,959,318	-€ 87,230,410
vrij 3	84618	m2 bvo	700	€	59,232,600	-€ 47,225,760	-€ 98,178,964
parkeergarage('s)	47442	m2 bvo	1,600	€	75,907,200	-€ 60,520,308	-€ 125,817,375
Koop				€	**493,280,700**	**-€ 313,365,959**	**-€ 651,465,322**
woningen sociale sector							
woningen vrije sector							
speciale functies							
vrij 2	123093	m2 bvo	800	€	98,474,400	-€ 62,557,738	-€ 130,053,044
vrij 3	564009	m2 bvo	700	€	394,806,300	-€ 250,808,221	-€ 521,412,277
			totaal (C)	€	**715,482,300**	**-€ 491,960,953**	**-€ 1,022,751,488**

Opbrengsten

object	hvld	eh	prijs/eh		opbrengsten	contante waarde	eindwaarde
Huur				€	**247,628,149**	**€ 180,124,005**	**€ 374,464,869**
maatschappelijke voorzieningen	800	m2 vvo	150	€	1,494,396	€ 923,027	€ 1,918,906
winkels	15006	m2 vvo	225	€	37,641,472	€ 23,249,584	€ 48,334,216
bedrijven	6360	m2 vvo	225	€	22,117,465	€ 13,661,046	€ 28,400,333
woningen sociale sector							
woningen vrije sector							
speciale functies							
vrij-2	52627	m2 vvo	83	€	78,845,805	€ 48,699,801	€ 101,243,389
vrij 3	67694	m2 vvo	88	€	107,529,011	€ 66,416,234	€ 138,074,581
parkeergarage('s)	37954	m2 vvo	75	€	43,995,672	€ 27,174,312	€ 56,493,443
Koop				€	**1,254,508,992**	**€ 774,858,455**	**€ 1,610,875,077**
woningen sociale sector							
woningen vrije sector							
speciale functies							
vrij 2	123093	m2 bvo	1,944	€	239,292,792	€ 147,801,287	€ 307,268,260
vrij 3	564009	m2 bvo	1,800	€	1,015,216,200	€ 627,057,168	€ 1,303,606,817
			totaal (D)	€	**1,502,137,141**	**€ 954,982,459**	**€ 1,985,339,946**

resultaat (C+D)	**€ 463,021,507**	**€ 962,588,458**
resultaat (B)	**-€ 446,570,660**	**-€ 928,388,328**
resultaat (C+D+B)	**€ 16,450,847**	**€ 34,200,130**

Planning

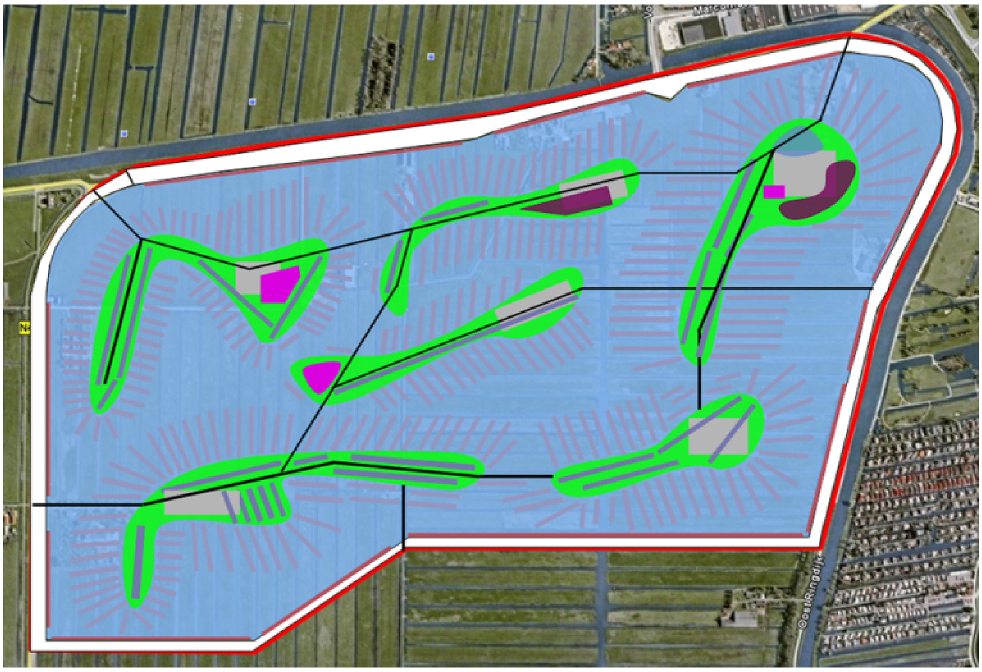
Kosten

object	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	
maatschappelijke voorzieningen						10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	100%
winkels						10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	100%
bedrijven						10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	100%
vrij-2						10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	100%
vrij 3						10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	100%
parkeergarage('s)						10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	100%
vrij 2						10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	100%
vrij 3						10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	100%

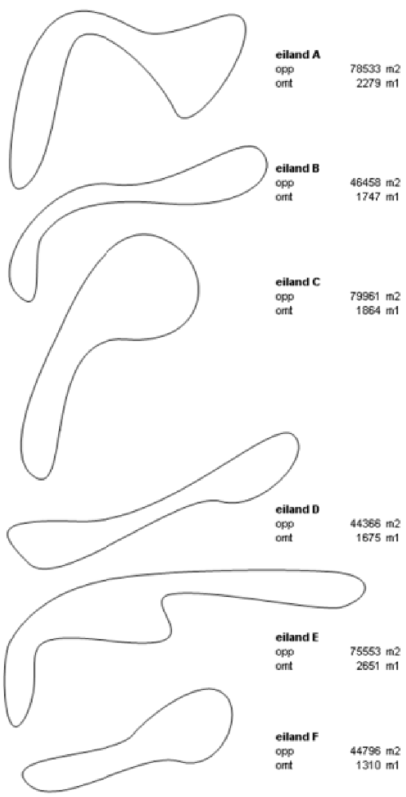
Opbrengsten

object	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	
maatschappelijke voorzieningen							11%	11%	11%	11%	11%	11%	11%	11%	12%	100%
winkels							11%	11%	11%	11%	11%	11%	11%	11%	12%	100%
bedrijven							11%	11%	11%	11%	11%	11%	11%	11%	12%	100%
vrij-2							11%	11%	11%	11%	11%	11%	11%	11%	12%	100%
vrij 3							11%	11%	11%	11%	11%	11%	11%	11%	12%	100%
parkeergarage('s)							11%	11%	11%	11%	11%	11%	11%	11%	12%	100%
vrij 2							11%	11%	11%	11%	11%	11%	11%	11%	12%	100%
vrij 3							11%	11%	11%	11%	11%	11%	11%	11%	12%	100%

Water variant



6 islands:



Island A
area: 78,533 m^2
circumference: 2,279 m

Island B
area: 46,458 m^2
circumference: 1,747 m

Island C
area: 79,961 m^2
circumference: 1,864 m

Island D
area: 44,366 m^2
circumference: 1,675 m

Island E
area: 75,533 m^2
circumference: 2,651 m

Island F
area: 44,796 m^2
circumference: 1,310 m

Total area: 369,667 m^2
Total circumference: 11,526 m

Overview of living areas and housing typologies:

Facilities

Social/public facilities	1,000	m^2
shops	18,758	m^2
business	6,360	m^2
Total	**26,118**	**m^2**

Owner occupied homes

Free-2, owner occupied	123,093	m^2/gfa	684	Homes
Free-3, owner occupied	564,009	m^2/gfa	2,350	Homes
Total	**687,102**	**m^2/gfa**	**3,034**	**Homes**
Rental homes				
Free-2, rent	65,784	m^2/gfa	414	Homes
Free-3, rent	84,618	m^2/gfa	353	Homes
Total	**150,402**	**m^2/gfa**	**766**	**Homes**
Total			**3,800**	**Homes**

Parking garages

Parking for floating homes

Standard	11	m^2/pp		
Number of homes: Free-3, owner occupied	3,034	Homes	1.8	Per household
Number of homes: Free-3, rent	766	Homes	1.2	Per household
Total available	47,442	m^2		

Overview of landscaping activities:

Area	**Referential**	**(%)**
Water	1,178,791 m^2	68.9 %
Land/green	369,667 m^2	21.6 %
Paving	36,086 m^2	2.1 %
Constructed building area	665,994 m^2	38.9 %
Total	**1,709,901 m^2**	**131.6 %**

Revetment embankments

Type A: ring dyke	5,442 m
Type B: living areas	11,526 m

Construction of quays

Total	**11,526 m**

Water Variant

Water facility system

Total	**1**

Excavation

Area	1,451,134 m^2
Depth	0.5 m
Total	**725,567 m^3**

Water depth (ground level) -6.3m

Heightening dyke

Area	141,683 m^2
Circumference	5,442 m
Height h	8 m
Total	**1,133,464 m^3**

Dyke level +3m NAP

Heightening islands

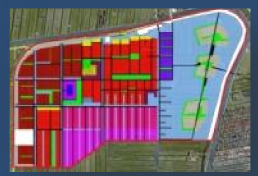
Island (A)	Area	78,533 m^2	Height	6 m
Island (B)	Area	46,458 m^2	Height	6 m
Island (C)	Area	79,961 m^2	Height	6 m
Island (D)	Area	44,366 m^2	Height	6 m
Island (E)	Area	75,553 m^2	Height	6 m
Island (F)	Area	44,796 m^2	Height	6 m
Total	**Area**	**369,667 m^2**		
Total		**2,218,002 m^3**		

Street level 0m NAP

Data analysis – Area distribution

Appendix XI Data analysis - variant comparison

Referential variant



Referential variant	(m^2)	(%)
Water	501,093	29.7
Land/green	159,309	9.4
Paving	528,842	31.3
Constructed building area	577,655	34.2
Total	**1,688,901**	**104.6**

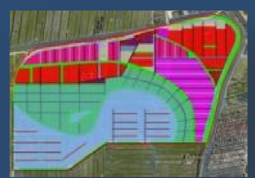
Land raising variant

Land raising variant	(m^2)	(%)
Water	492,794	29.2
Land/green	159,309	9.4
Paving	528,842	31.3
Constructed building area	646,123	38.3
Total	**1,688,901**	**108.2**

Cascade variant

Cascade variant	(m2)	(%)
Water	579,884	33.9
Land/green	547,685	32.0
Paving	368,924	21.6
Constructed building area	322,917	18.9
Total	**1,709,901**	**106.4**

In peak water conditions

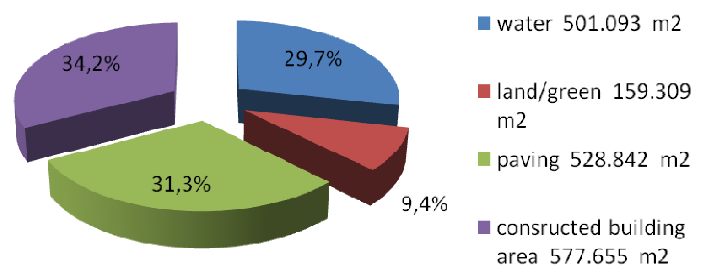


In peak water conditions		
Water (Peak)	970,667	56.8
Land/green	547,685	32.0
Paving	368,924	21.6
Constructed building area	322,917	18.9
Total	**1,709,901**	**129,3**

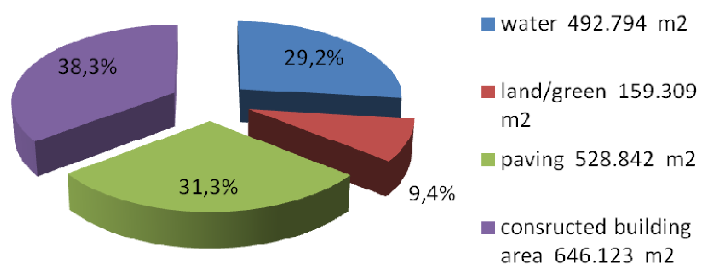
Water variant

Water variant	(m^2)	(%)
Water	1,178,791	68.9
Land/green	369,667	21.6
Paving	36,086	2.1
Constructed building area	665,994	38.9
Total	**1,709,901**	**131.6**

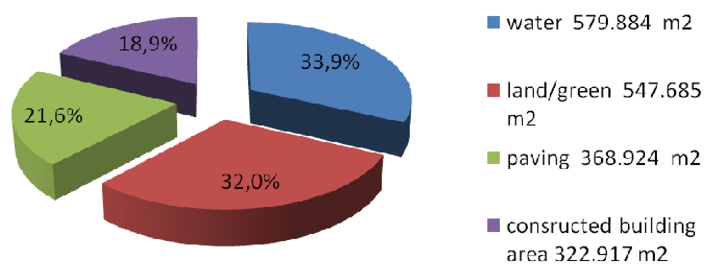
Referential variant



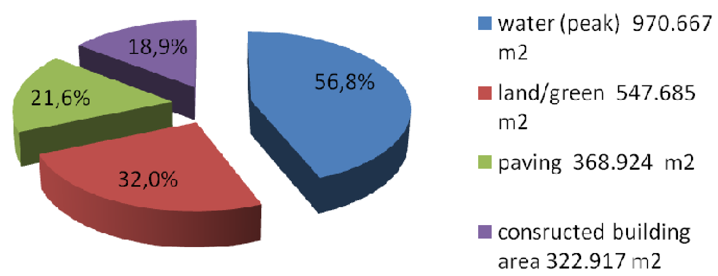
Land raising variant



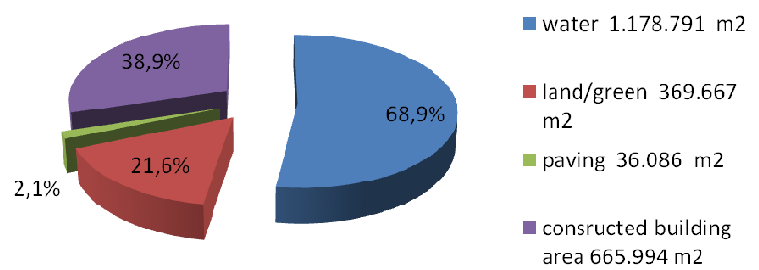
Cascade variant



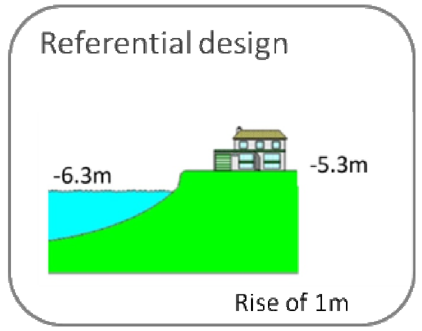
Cascade variant (peak circumstances)

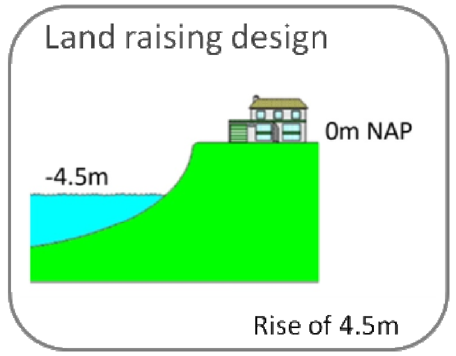


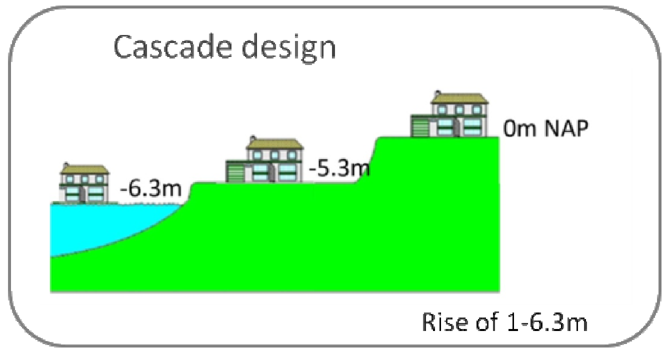
Water variant

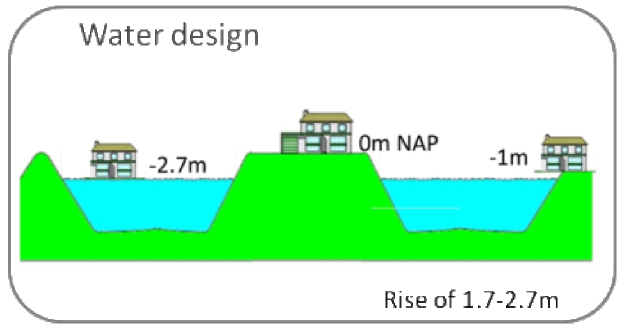


Water level heights









Appendix XII Sensitivity analysis

Land quote method used to set the balance for land use planning to 0. The newly calculated land quote rose from 26% to 40%.

Land quote	**26%**

object	hvld	eh	prijs/eh	opbrengsten	eindw aarde
Opbrengsten gronduitgifte					
Huur				**€ 92.023.036**	**€ 133.270.487**
maatschappelijke voorzieningen	1512	m2 uitg	300	€ 453.600	€ 631.279
w inkels	11996	m2 bvo	450	€ 5.398.200	€ 7.512.719
bedrijven	6360	m2 uitg	450	€ 2.862.000	€ 3.983.069
woningen vrije sector	**305**	stuks			€ 0
eengezinsw oning	305	stuks	30.317	€ 9.246.685	€ 12.868.687
speciale functies					€ 0
vrij-1	0	m2 bvo		€ -	€ 0
vrij-2	29709	m2 bvo	455	€ 13.517.595	€ 19.785.111
vrij 3	67422	m2 bvo	898	€ 60.544.956	€ 79.792.143
parkeergarage('s)	12499	m2 bvo	500	€ 6.249.500	€ 8.697.480
Koop				**€ 188.319.441**	**€ 343.002.212**
woningen sociale sector	**0**	stuks			
woningen vrije sector	**1.605**	stuks			
eengezinsw oning	661	stuks	30.317	€ 20.039.537	€ 27.889.187
tw ee onder één kap	178	stuks	66.682	€ 11.869.396	€ 16.518.735
vrijstaand duur	86	stuks	111.541	€ 9.592.526	€ 13.349.997
appartementsgebouw duur	480	stuks	31.486	€ 15.113.280	€ 21.033.275
appartementsgbeouw middelduur	200	stuks	19.618	€ 3.923.600	€ 5.460.506
speciale functies					€ 0
vrij 2	159297	m2 bvo	455	€ 72.480.135	€ 106.085.996
vrij 3	128997	m2 bvo	898	€ 115.839.306	€ 152.664.517
			totaal (B)	**€ 280.342.477**	**€ 476.272.699**
			resultaat (A+B)		**-€ 239.154.867**
			resultaat (C+D+B)		**€ 448.365.464**

Land quote	**40%**

object	hvld	eh	prijs/eh	opbrengsten	eindw aarde
Opbrengsten gronduitgifte					
Huur				**€ 111.262.312**	**€ 161.626.302**
maatschappelijke voorzieningen	1512	m2 uitg	300	€ 453.600	€ 631.279
w inkels	11996	m2 bvo	450	€ 5.398.200	€ 7.512.719
bedrijven	6360	m2 uitg	450	€ 2.862.000	€ 3.983.069
woningen vrije sector	**305**	stuks			€ 0
eengezinsw oning	305	stuks	101.934	€ 31.089.736	€ 43.267.839
speciale functies					€ 0
vrij-1	0	m2 bvo		€ -	€ 0
vrij-2	29709	m2 bvo	776	€ 23.041.491	€ 33.724.821
vrij 3	67422	m2 bvo	718	€ 48.417.284	€ 63.809.096
parkeergarage('s)	12499	m2 bvo	500	€ 6.249.500	€ 8.697.480
Koop				**€ 216.182.120**	**€ 553.801.265**
woningen sociale sector	**0**	stuks			
woningen vrije sector	**1.605**	stuks			
eengezinsw oning	661	stuks	101.934	€ 67.378.084	€ 93.770.628
tw ee onder één kap	178	stuks	172.350	€ 30.678.212	€ 42.695.117
vrijstaand duur	86	stuks	258.524	€ 22.233.086	€ 30.941.967
appartementsgebouw duur	480	stuks	98.143	€ 47.108.865	€ 65.561.790
appartementsgbeouw middelduur	200	stuks	64.373	€ 12.874.668	€ 17.917.780
speciale functies					€ 0
vrij 2	159297	m2 bvo	776	€ 123.546.415	€ 180.829.471
vrij 3	128997	m2 bvo	718	€ 92.635.704	€ 122.084.511
			totaal (B)	**€ 327.444.432**	**€ 715.427.566**
			resultaat (A+B)		**€ 0**
			resultaat (C+D+B)		**€ 209.210.597**