GREEN KEYS

How sustainable principles regenerate the Westland spatially

Thesis

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Colophon

Thesis plan and methodology

Green Keys, how sustainable principles regenerate the Westland spatially

How can the Westland work as a sustainable testbed for new ways of integrated living, working and producing.

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Word of gratitude:

I sincerely want to thank Anne Loes, Dirk, Sander, Etwin and Henk for helping me along the way.

Preface

The Westland is an area with a high spatial pressure. Through time it was develloped to a landscape totally controlled and occupied by humans. The quality of the landscape and ecosystem has suffered under this cultivation of the Westland.

The hard surface leaves very limited space for the ecosystem, the lack of space for nature causes a poor water quality, the need for space for water-storage and a low biodiversity. A new approach is needed for the spatial planning, the current approach is sectoral and misses the chance to create an integrated direction for spatial planning.

In order to deal with this problems the following research question gives direction:

How can the Westland work as a sustainable testbed for new ways of integrated living, working and producing.

The first part of the research investigates the spatial structure and problems of the Westland. The second part investigates the glass-house and its possibillities. Together these parts form the needed research to renew the Westland in its framework and in its pattern to a sustainable area with a good experience, resilience and usability.

Figure 0 The past of the Westland (Photo from photo, Westlands museum)

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Motive

‘I believe that there is a subtle magnetism in Nature, which, if we unconsciously yield to it, will direct us aright.’ Henry David Thoreau.

Man is always struggling with the changing of its environment to his demands. In this battle of man versus nature many times the positive aspects of nature on the human are not considered. A more holistic approach to nature could give us as humans a better position in relation to nature.
The Westland is cultivated by man; there is almost no space for natural processes that could improve the environment of man. These natural processes can be natural water purification or a green and scenic living surrounding.

The motive is to bring something back of the original quality of nature into the Westland in combination with a viable vision on living working and producing. This will yield a Westland with a more diverse landscape and better ecology, facing a greener future.

Nature

Cultivation: Man versus Nature

New direction: Man with Nature

Figure 1 Man vs Nature

Location

During the last fifteen years the extend of the struggle between man and nature was visible various times by the floods. These were caused by heavy rainfall on the hard surface of the glasshouses and the limited space for storage of water.

Combined with the poor water quality and the lack of a green structure the Westland is an interesting challenge for an holistic spatial approach to solve these problems.

Figure 2 one of the floodings in 1998 (Youtube)

´Extreme regenval zorgt voor wateroverlast in Westland´
http://www.nbdc.nl/cms/show/id=509994/contentid=7525
5/10/1999

Veel wateroverlast rond Den Haag en in Westland
http://www.trouw.nl/tr/nl/5009/Archief/archief/article/detail/2778714/2001/08/06/Veel-wateroverlast-rond-Den-Haag-en-in-Westland.dhtml
06/08/01

En weer staat het gewas onder water
http://www.trouw.nl/tr/nl/5009/Archief/archief/article/detail/2491291/2001/09/21/En-weer-staat-het-gewas-onder-water.dhtml
van onze verslaggever 21/09/01

Opnieuw wateroverlast in Westland
http://www.nu.nl/algemeen/383067/opnieuw-wateroverlast-in-westland-video.html#
Laatste update: 23/08/2004

Wateroverlast in het Westland
http://nos.nl/video/180215-wateroverlast-in-het-westland.html
maandag 23/08/2010

Approach

The method that can be used in this approach is the concept of the triple bottomline (TBL) (Elkington, 1997). This concept was originally used for measuring the success of organizations but also includes the possibility to use it for the perception of the spatial coherence of an area.

This concept consists of three pillars: people, planet and profit. Each of these originally stands for different means of money, but in this case it is used for the spatial use. This concept can provide a more holistic understanding of the space in the Westland with a wide view on the three pillars.

The people stands for societal use and the different communities using the Westland. It is about the different uses and interests of people living in the Westland.

Planet is the ecological and environmental use of the Westland. How to deal with water, pollution and energy.

The economical denominator 'profit' consits of bussineses and their use of the Westland. When the approach of the analysis uses the TBL concept, it gives a better understanding what sustainable is for the Westland.

When this concept is incorporated in the concept of spatial quality the joint approach could even be strengthened. The definition of spatial quality consists of three values namely: use-value, experience-value and the future value (Timmeren, van, 2006 p.13-14).

Use-value: functionality and efficiency.

Experience value: of the experience of culture and nature and the value thatis attached to these.

Future value: the durability and flexibility.

By putting these values for spatial quality in the scheme of the TBL concept (Fig .3), there rises a concept for the spatial understanding of sustainabillity. Problems can be found by tracing conflicts in this model. The use of this model for spatial problem analysis can be helpfull to see the links and have a better understanding of where these problems arise. Eventually this model is also usefull for the making of plans to improve the sustainabillity of the Westland.

This approach is used for the whole project. Literature used are 'Autonomie en heteronomie' (Timmeren, 2006) and 'Use your potential! Sustainability through local opportunities' (Dobbelsteen, van den, 2010). These describe the debate on sustainability. More theoretical research on greenhouses can be found in the theory-paper which is added as an attachment to this report.

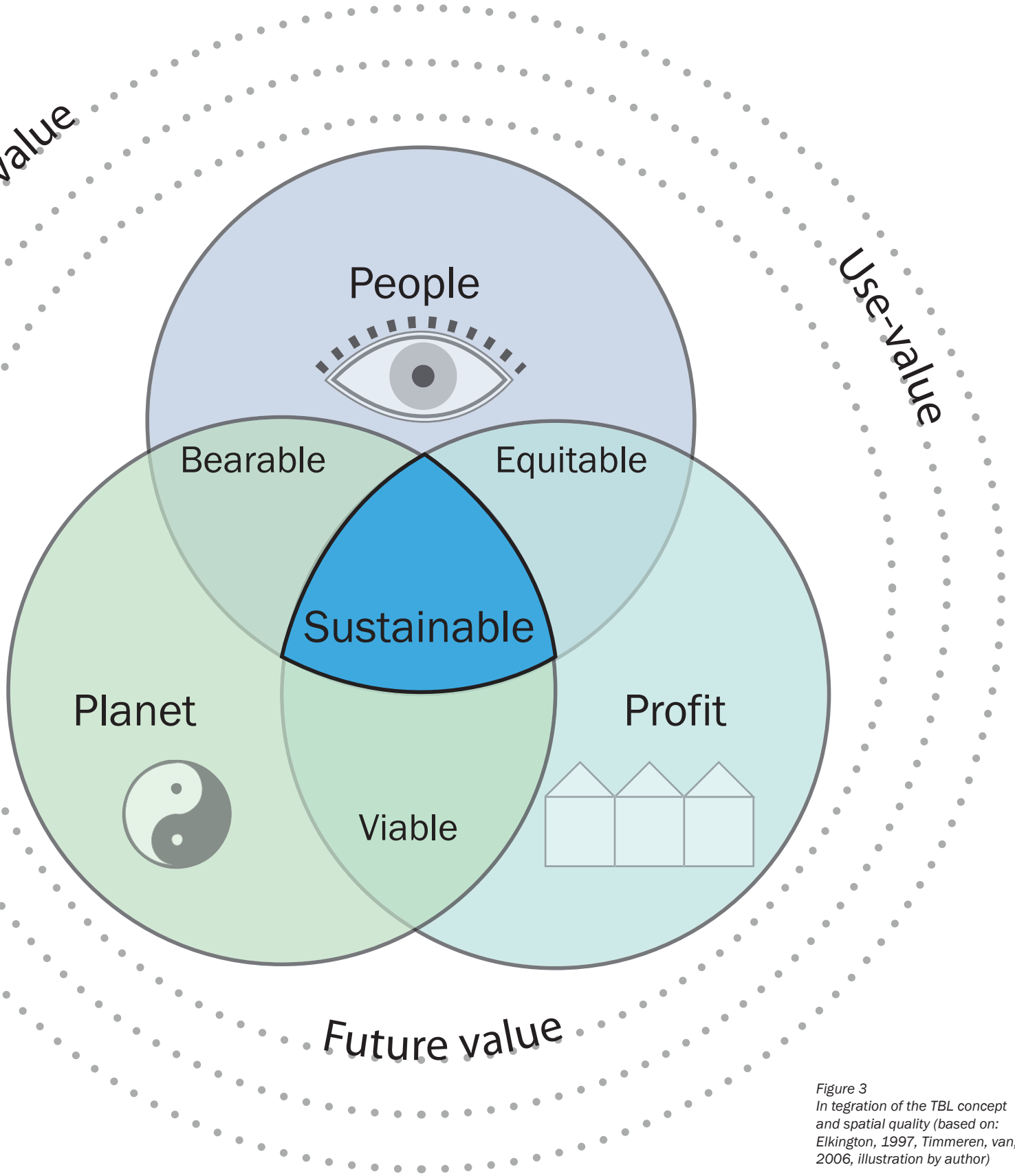


Figure 3
In tegration of the TBL concept and spatial quality (based on: Elkington, 1997, Timmeren, van, 2006, illustration by author)

Context

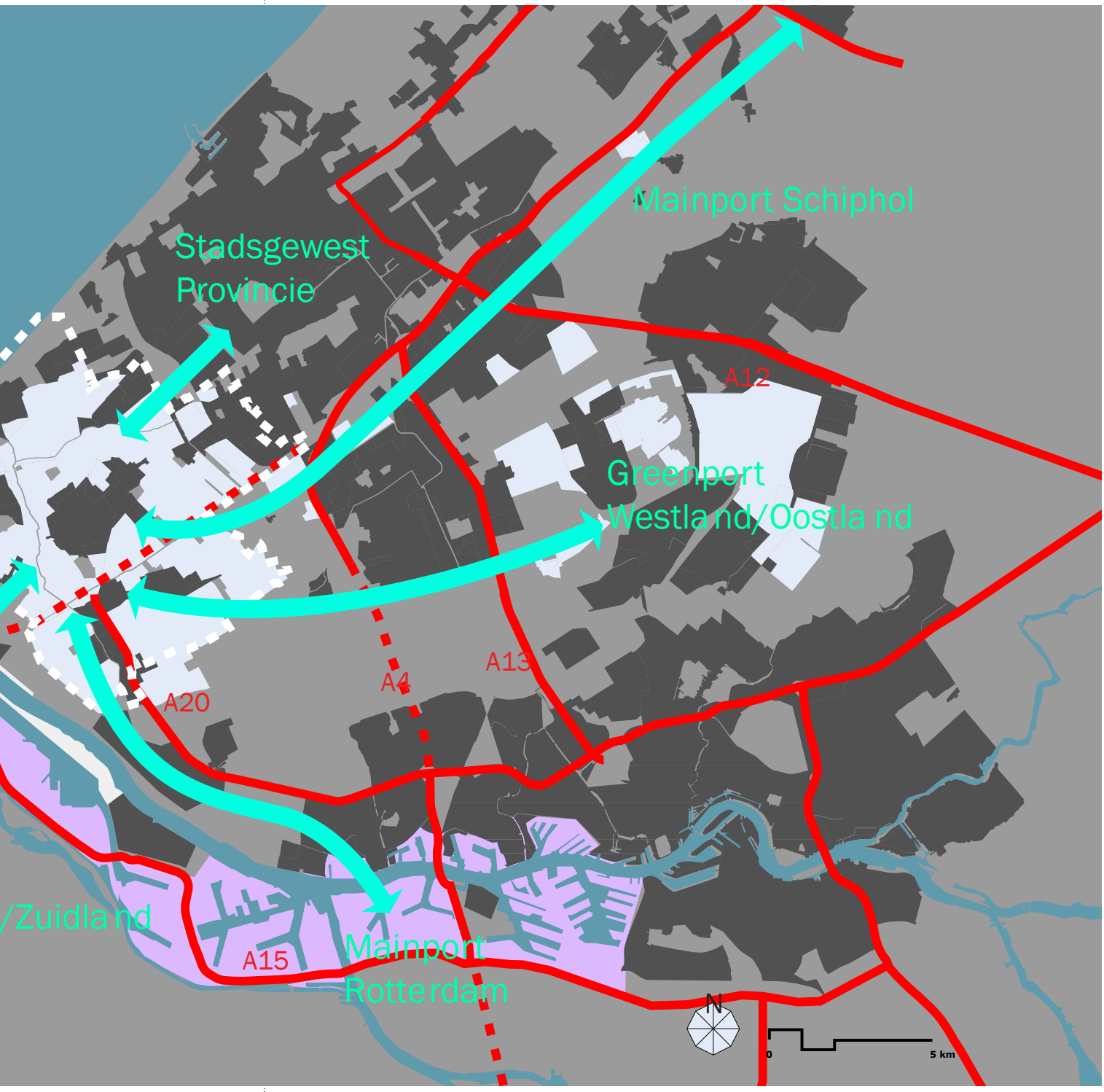
The Westland is an area characterized by greenhouse horticulture. At night the greenhouses light the clouds with a strange orange light that can be seen from afar. In the nineteenth century the Westland became an horticultural area, first for the export of grapes but after the war this horticulture of grapes changed to an horticulture of tomatoes (De Ridder, 1979).

Through time the Westland developed to the main greenport of Holland. Besides tomatoes, nurseries and floriculture became part of the Westland identity. Innovations of greenhouses shaped the Westland into the City of Glass.

Nowadays there is a shift in the spatial layout of the area. The present emphasis is more directed towards an experience of the area for secondary uses such as cycling and other leisure. A reorganization of the greenhouse landscape gives more space to the development of a network for recreation and ecology.

Through time there developed greenports around the Westland, Westland-Oostland and Westland-Zuidland. The Westland is situated close to the mainports Schiphol and the Rotterdam harbour, with these mainports closeby the greenport Westland has a strategic position in the Netherlands.

Figure 4 Westland and its surroundings (source: Visie Greenport, edited by author)

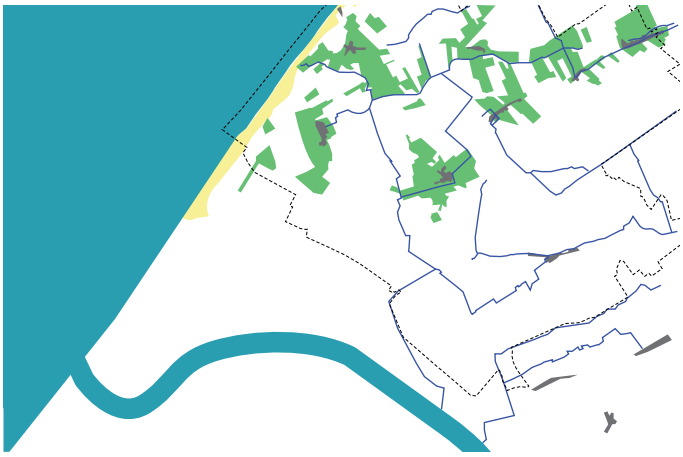

Mainport Schiphol
Stadsgewest
Provincie
A12
Greenport
Westland/Oostland
A13
A4
A20
/Zuidland
A15
Mainport
Rotterdam
N
0
5 km

Context in time

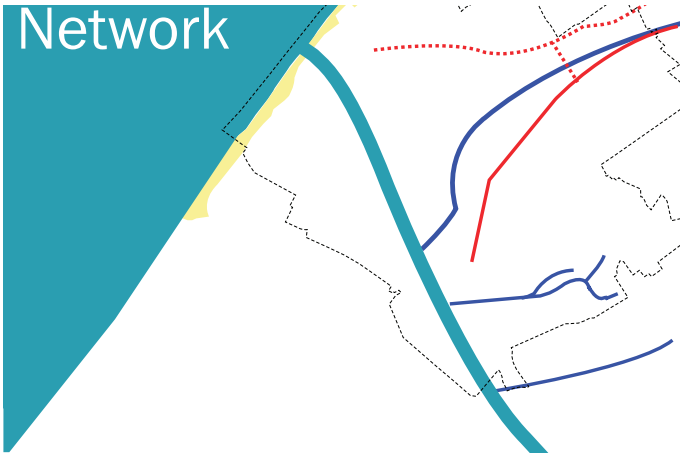
Roman period

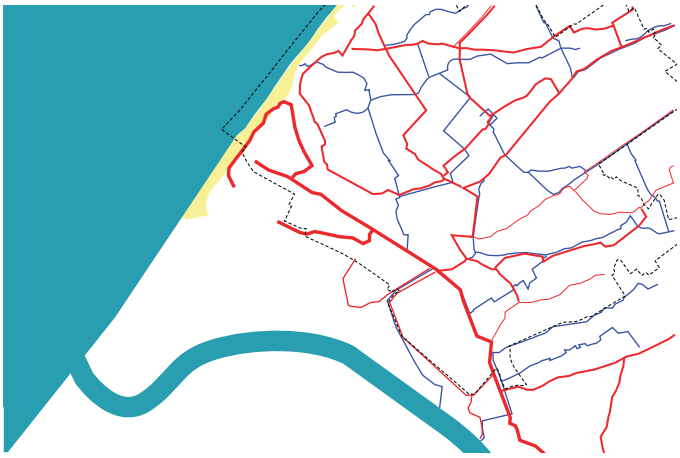
1850

Occupation



Network



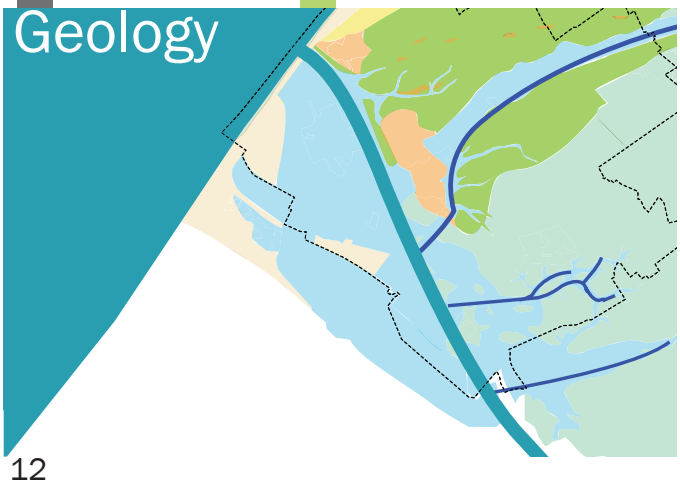


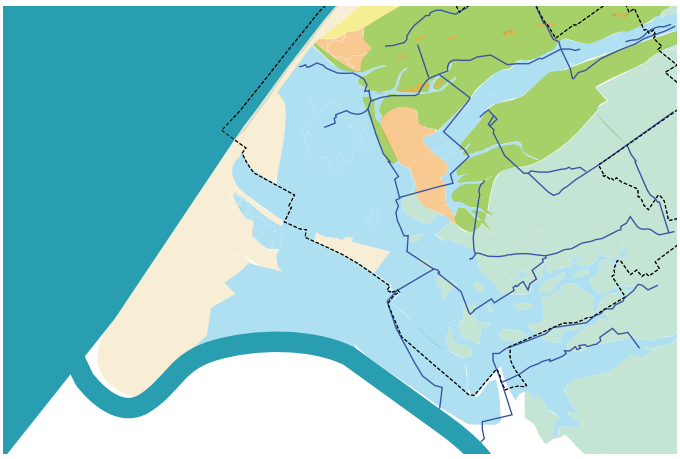
Historical development Westland

LEGEND:

- Great waters
- Dunes
- Residential areas
- Embankments
- Younger dunes
- Young sea clay
- Auctions
- Bussines areas
- Horticulture
- Glasshouse horticulture
- Creeks
- Peat
- Roads
- Railway
- Watercourses
- Main

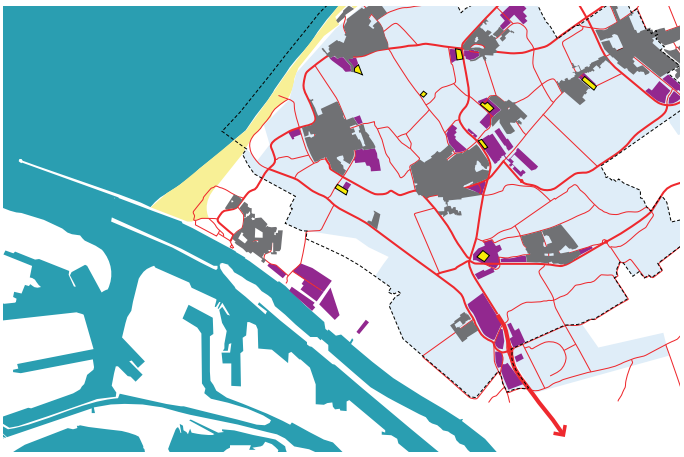
Geology

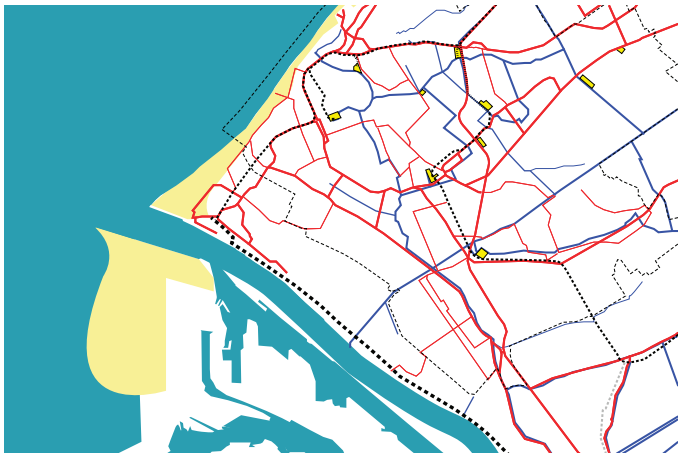


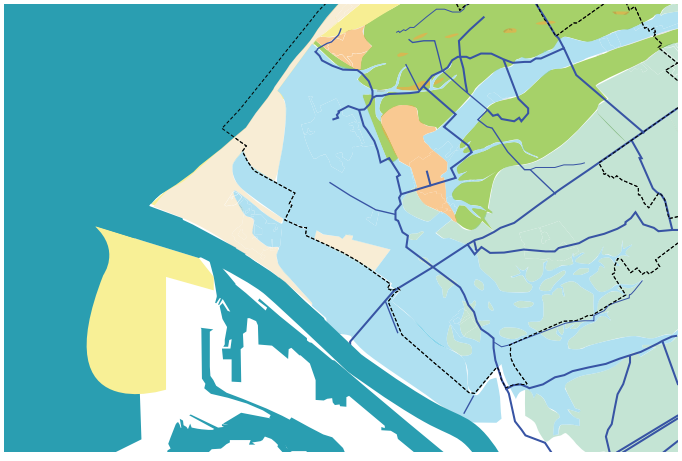


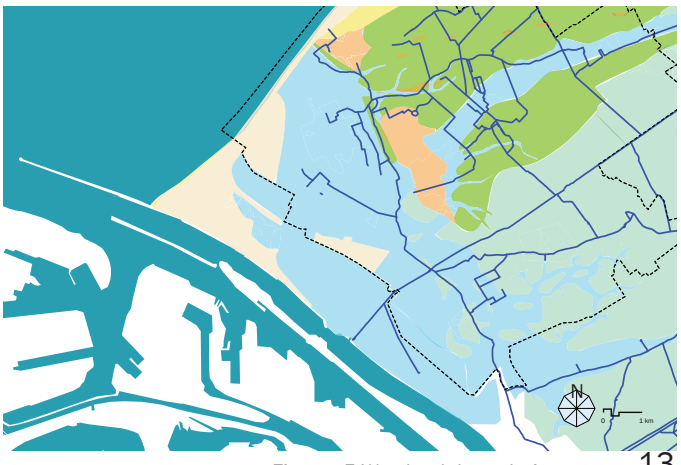
1963

2010









Figures 5 Westland through time

Continuous lines

The Westland is an intricate and complex area, the morphology of the Westland is mainly determined by the waterways.

Till the sixties these waterways functioned as the main transport routes from the glass-houses to the auctions. Than in the sixties the truck transport changed the infrastructure in the Westland.

Because of this transition from water to road, the connections over water became the backside of the landscape and the land connections were dominated by traffic.

These connections are given a closer look to have a better understanding of the framework of the Westland.

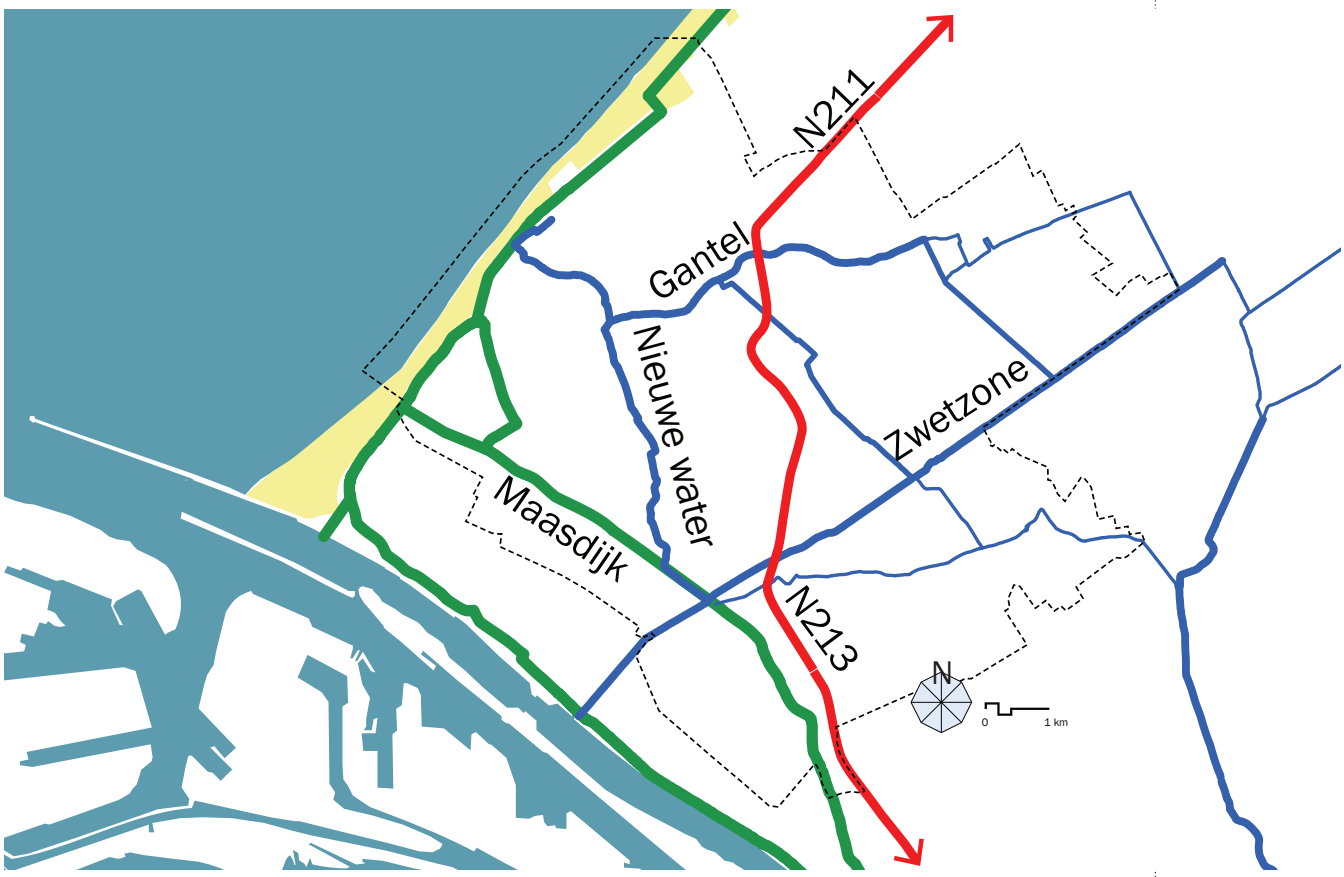
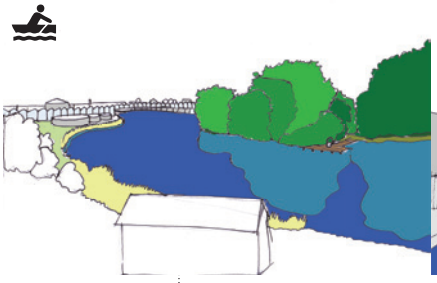


Figure 6 Spatial framework

Water lines

The experience along continuous waterways.

Creeks



Figures 7-8 Creek

Canals

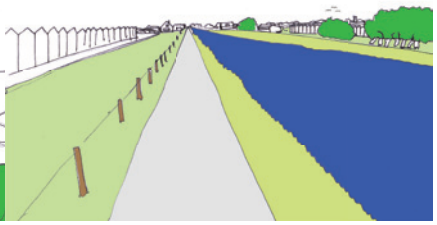


Figure 9 Canal

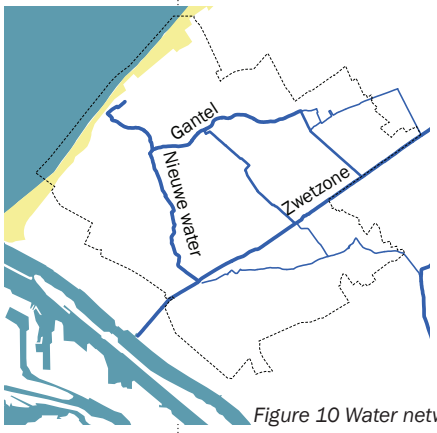


Figure 10 Water network

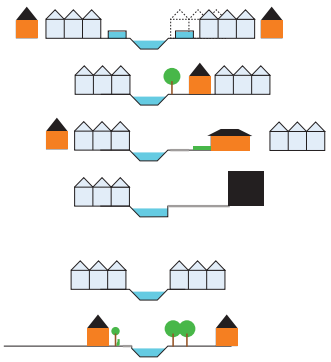


Figure 11 Sections Nieuwe Water

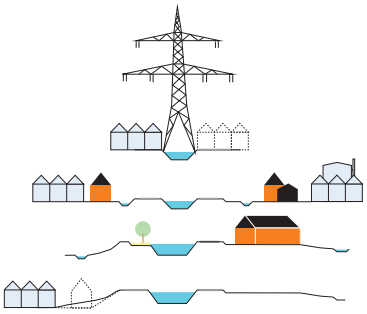


Figure 12 Sections Zweth

The waterways can be divided in roughly two groups, the creeks and the canals.

The creeks are remnants of the former tidal creeks that penetrated into the peat cushions of the present Midden-Delfland. These creeks have been altered and canalized for a large part to transport horticultural products to the auctions, they still have largely their original path. Nowadays the creeks are mainly the backsides of the landscape and have become the place for the facilities of glasshouses such as irrigation water basins, heat storage tanks and some houses.

The canals were originally made to drain and cultivate the peat area. This is how the polders of the east part of the Westland came into being, nowadays these rectilinear canals cut through the landscape and offer more connections for recreation.

Road lines

The experience along continuous roads and dikes.

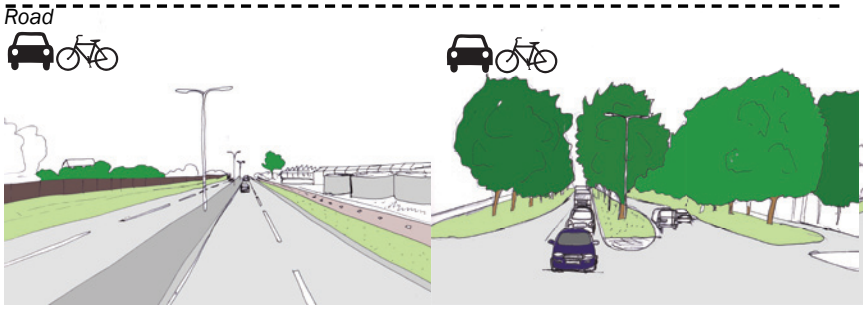


Figure 13-14 Roads

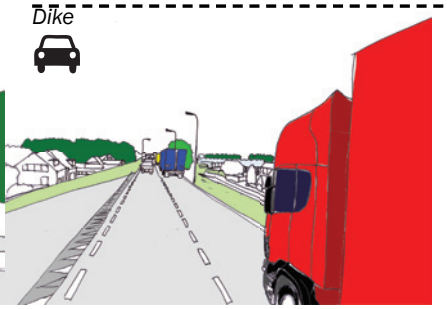


Figure 15 Maasdijk

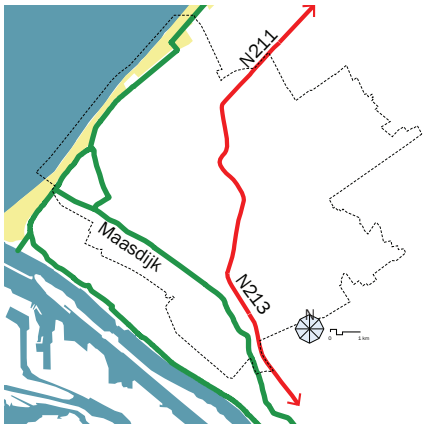


Figure 16 Roads and dikes

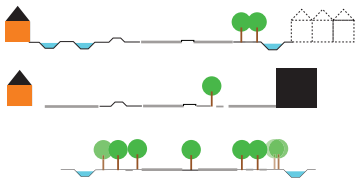


Figure 17 section N213

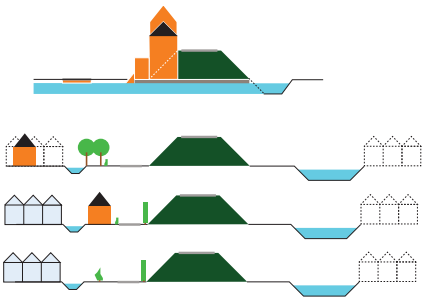


Figure 18 section Maasdijk

Besides the waterways the roads are other continuous lines through the Westland. These roads are dominated by trucks. The main routes through the Westland are the N213 and N211, but this route does not give an attractive image of the Westland; it mainly shows the backs of buildings and noise barriers. Many of the continuous cycle routes are along or parallel on these roads.

The Maasdijk is in use as a busy road dominated by trucks, this limits the experience from this landscape element to car users. The higher view from this dike does provide an recreational opportunity for experiencing the landscape.

If you enter the Westland from the side of The Hague you are driving through a dense lane, once you enter the Westland there is a contrast because there is no consistent road design. It is just an open road and everything is purely functional; it does not give an attractive image of the Westland and from the road you see backs of buildings and noise barriers.

Spatial image

Through time the Westland is shaped by water, the Meuse river and tidal creeks which meandered to the peat marshes in the hinterland. The first settlements were on the levees of those creeks. Later on canals were dug and the peat marshes were drained to become agricultural land. These ways of development are still visible in the morphology, although altered through the years. The winding creeks left some areas with a more amorphical parcelation whilst the former marshes, the polders, have a more rectilinear lay-out.

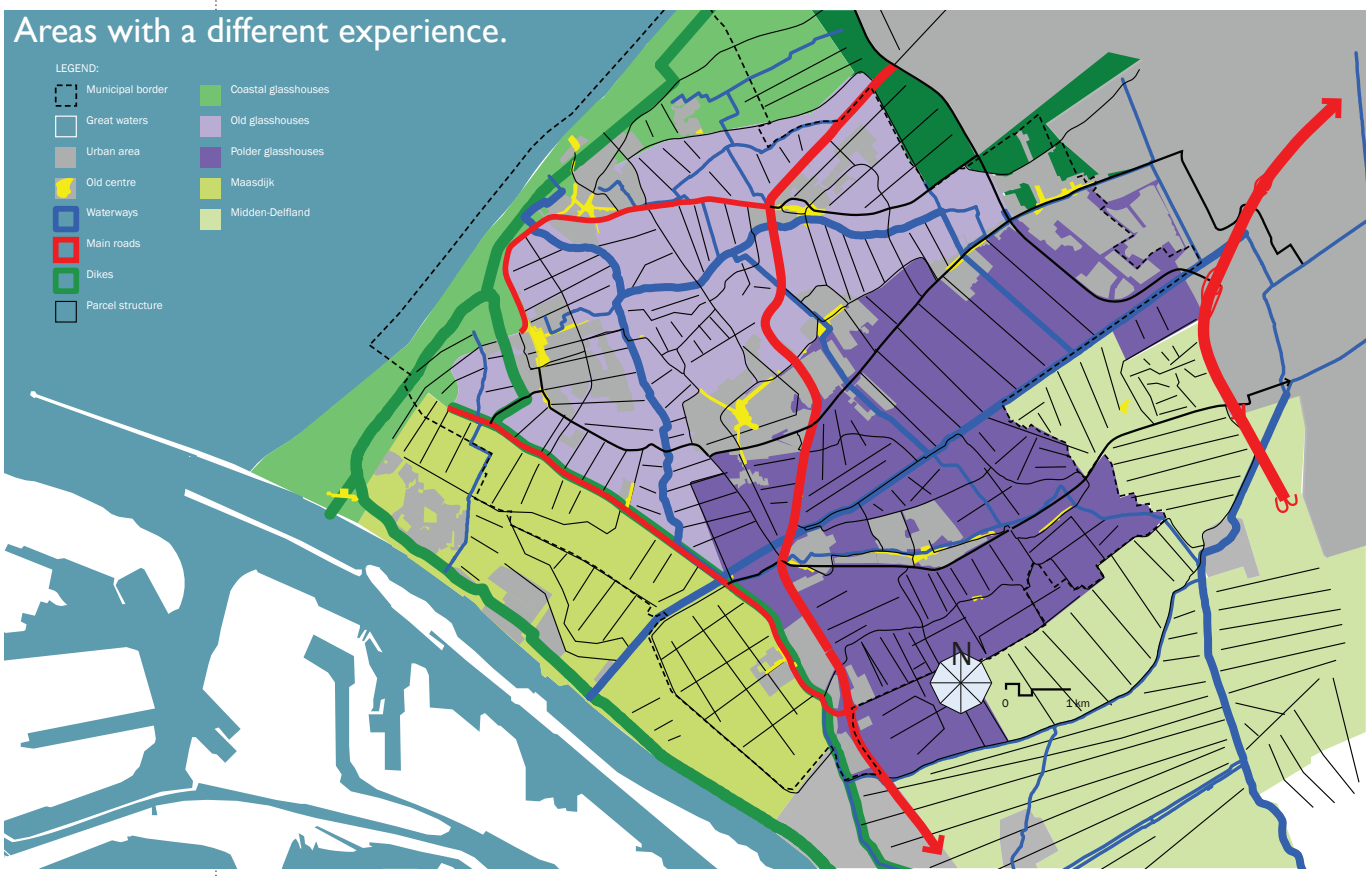
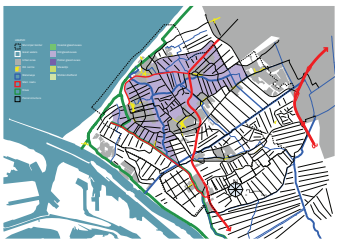


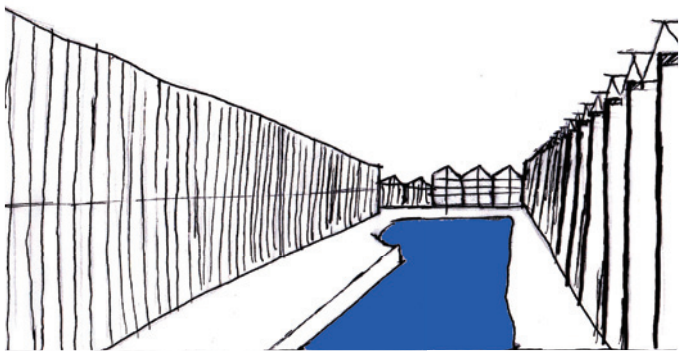
Figure 19 Areas and their experience

Old horticultural complex

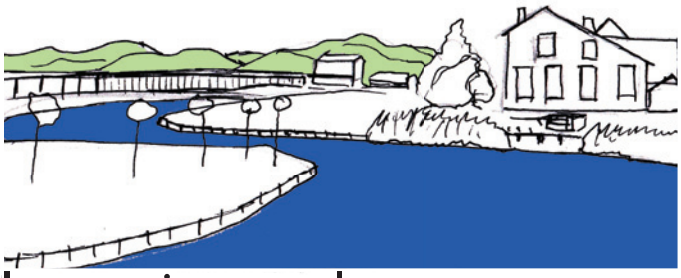


In the old horticultural complex there are still remains of creeks and of the glass-house history of the Westland is still visible in small docks and old chimneys.
There are different approaches to living in this landscape, the defensive: where the residence is enclosed by glass and isolated of the landscape features that are left, the innovative typology makes use of the glass-landscape by elevating the house over this sea of glass, and there are view houses situated on the back of the glass-houses.

Glasshouse shipping



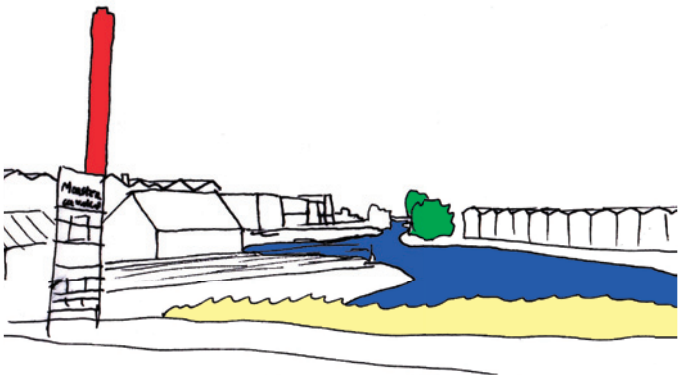
Creek and dunes



Creek and plantation

Innovative typology

Creek and glasshouses



Defensive typology

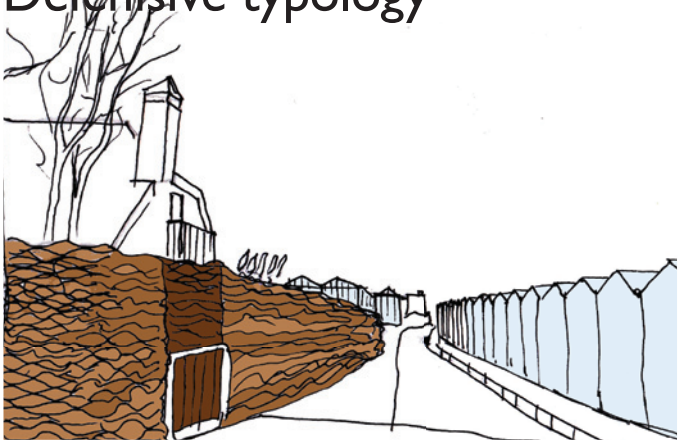
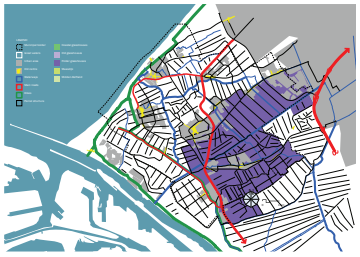


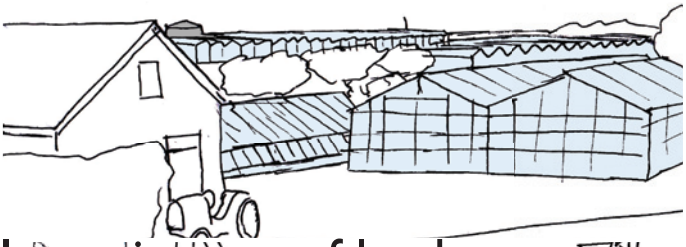
Figure 20 Old horticulture complex

Glasshouse polders

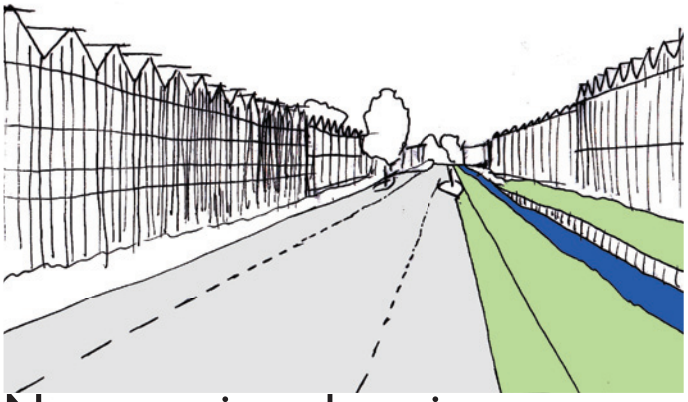


The polders have a much larger scale than the old horticultural complex, because of the cultivation of the peat areas by man there camen a landscape inot being that was rectangular. Because of its later development and the larger parcel-scale the horticulture is more productive and the cultivation is more intense. The houses are spacious and placed on big plots, they are bigger than the ones in the older glass areas.

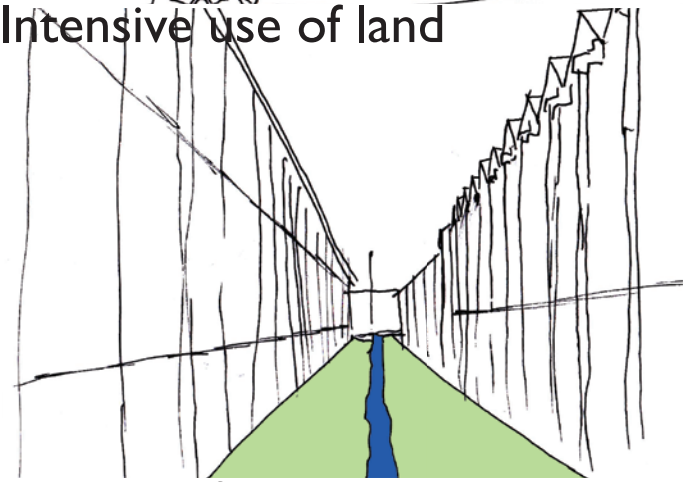
Contiguous glasshouses



Lineair infrastructure

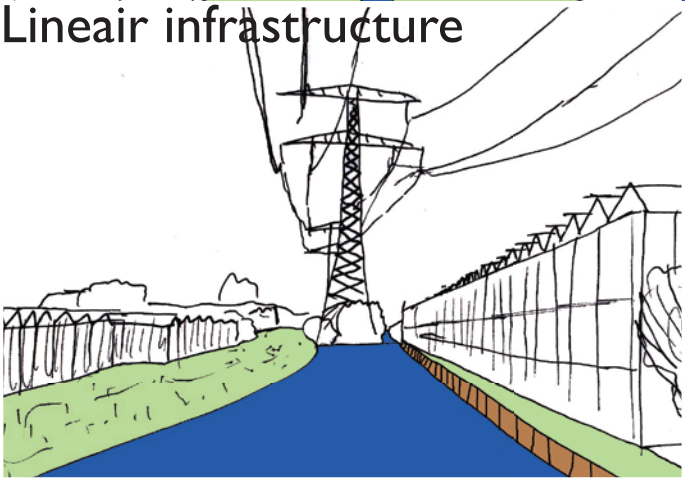


Intensive use of land



New spacious housing

Lineair infrastructure



Facilities

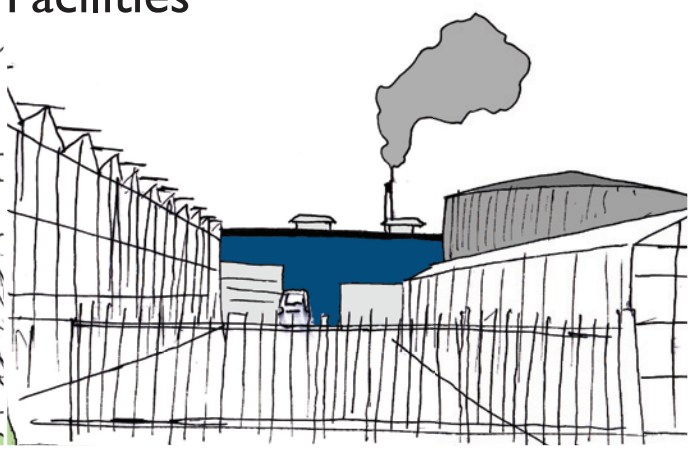
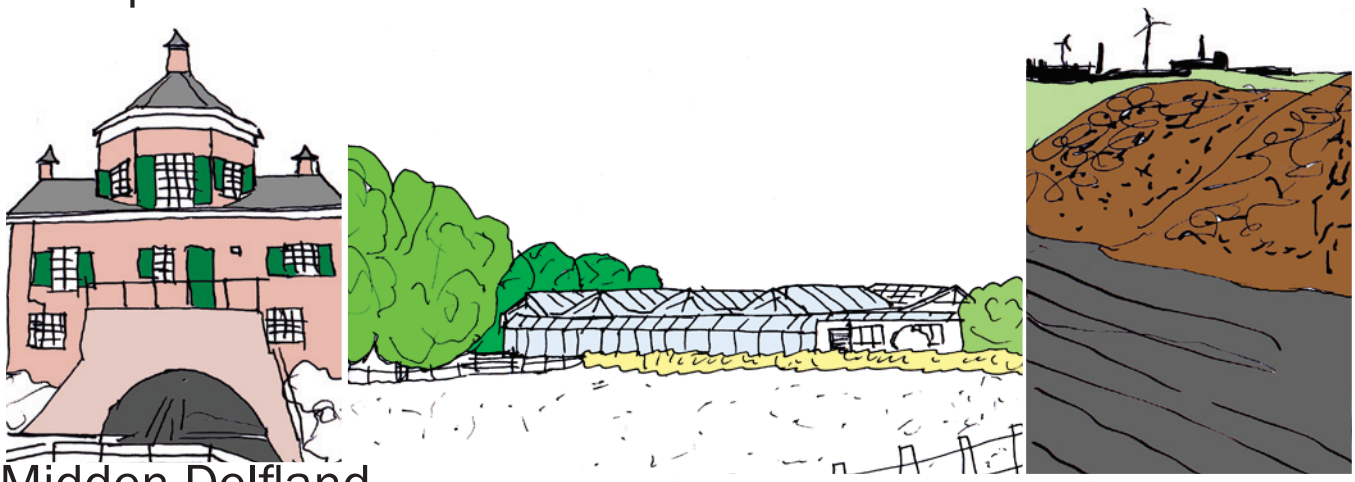


Figure 21 Glasshouse polders

Surrounding areas

The surrounding areas on the south and east side of the Westland contrast with an openness and emptiness to the dense and closed glass-areas. Through the Midden-Delfland there are view connections, only a limited recreational connection. In this way the Midden-Delfland is a barrier to the hinterland that would be interested to go to the Westland.

Maaspolders



Midden-Delfland

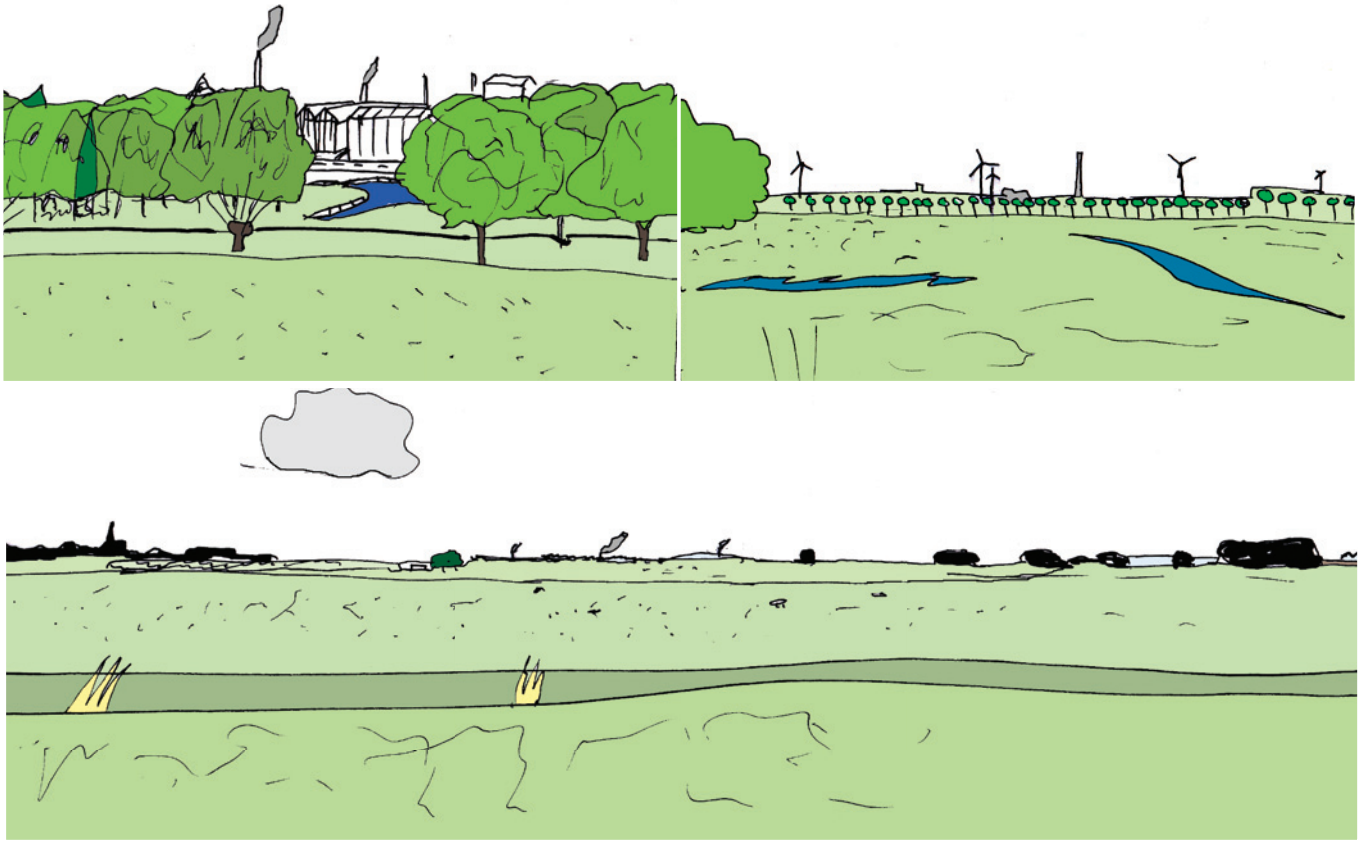
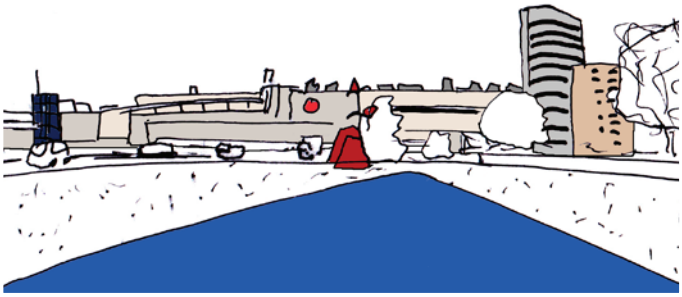


Figure 22 Surrounding areas

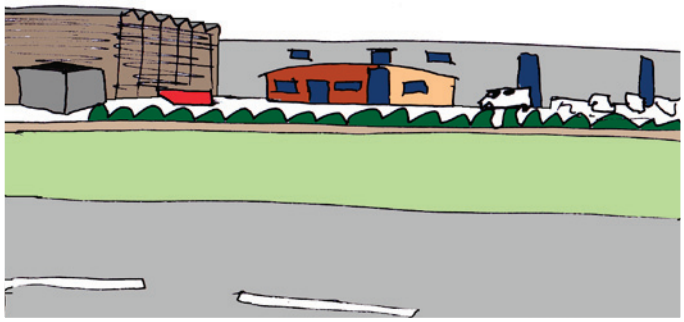
Business areas

The business parks in the Westland are the same as in the rest of the Netherlands. The identity of the Westland as a glass-horticulture area is not visible at all in architecture or urban plan. Some attempts have been done to propagate the identity in the Westland which is visible the glass-house-inspired roof on an overpass.

Auction



Bussines parks



Overpass

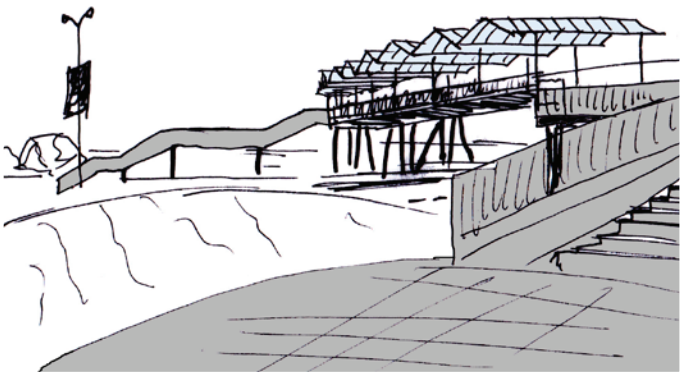


Figure 23 Business areaa

Glasshouses in time

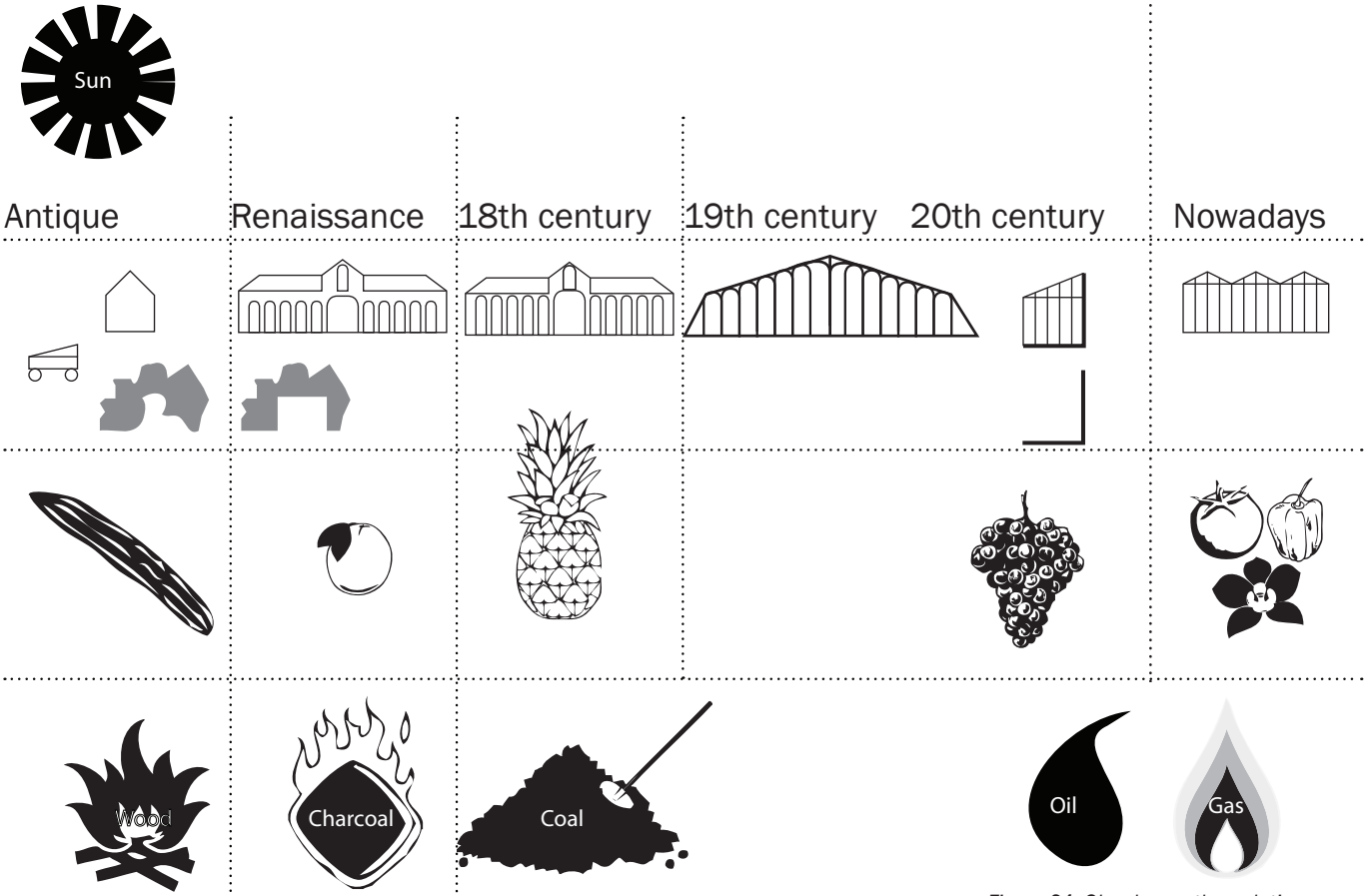


Figure 24 Glasshouse through time

The greenhouse came forth out of the orangery, through innovations in glass, heating and growing conditions the commercial glasshouse was developed in the twentieth century.

Whilst earlier greenhouses came with prestige and ornaments, the commercial glasshouses were stripped of all ornaments and purely functional.

In the seventies the image of these commercial greenhouses was damaged. The energy crisis made people aware of the state of the earth. Greenhouses in these times were heavy energy consumers, because of the use of electrical lighting during night and the heating in colder times. The commercial glasshouse was polluting; this was no example of a sustainable development (Muijzenberg, 1980).

Nowadays the cultivation in glasshouses is shifting to a closed system in which the environment does not have to deal with the waste of the glasshouse cultivation. To achieve this shift there is the need for integral thinking where solutions provide a clean and liveable environment.

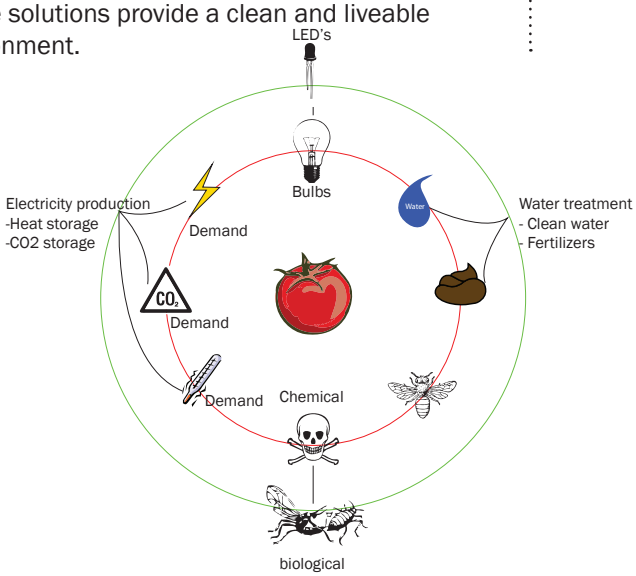


Figure 25 Closed Glasshouse

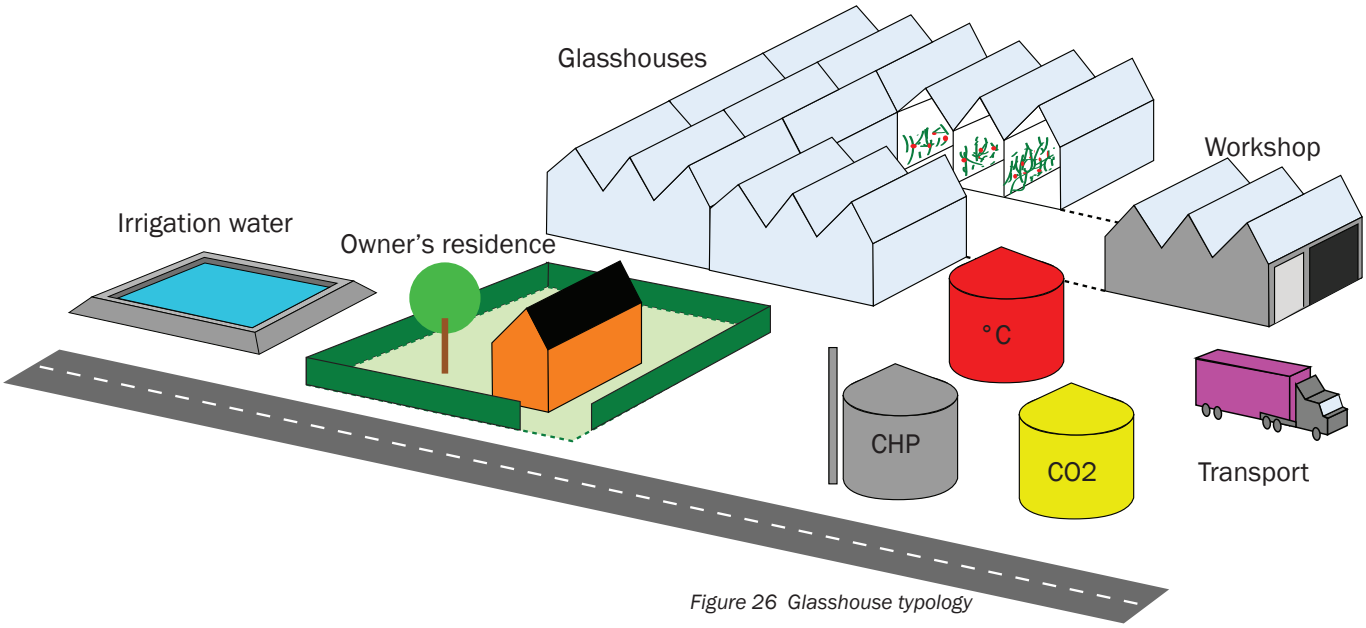


Figure 26 Glasshouse typology

The glasshouses entail different facilities. The sprinkling of the plants requires a good quality of water that is why rainwater is storaged in basins. For power, heat and carbondioxide there are combined heat power generators (CHP) (Dutch: WKK). All of these can be used in the cultivation process.

Owner's Residence

Before there were glasshouses in the Westland it was still a horticultural area with estates and farms. Transport was mainly done by boats using the waterways. This way of transportation was used till the sixties when road transport became thriving. While the glasshouses developed on the backside of the house and had their docks on the water, the transport area came to the roadside and isolated the houses of the owners between glass and other facilities.

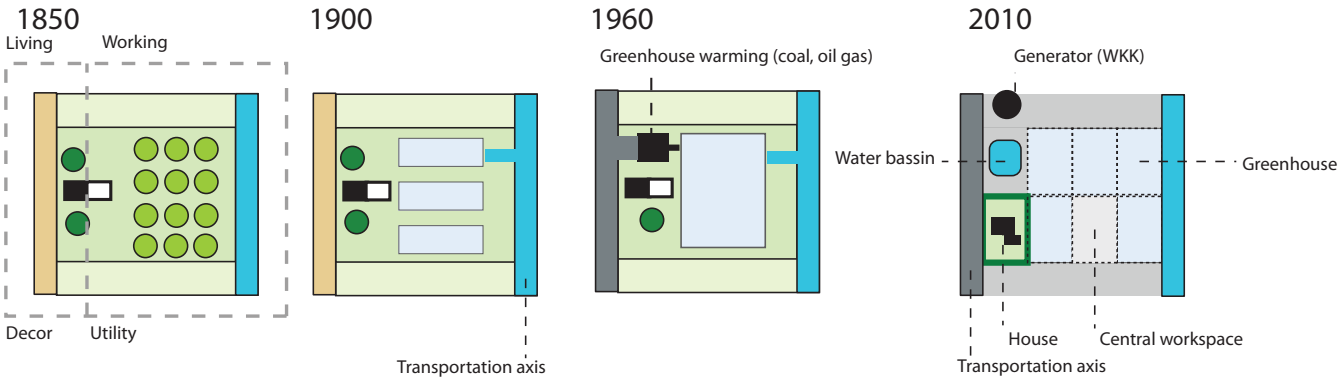


Figure 27 Development the glasshouse plot

Glasshouses now

The Glasshouse

To sustain production in the Westland an upscaling is inevitable, the common size for glasshouses is about 3-5 hectares in the Westland and towards 2020 this will change to a size of 10 Ha. According to the dossier 'Herstructurering glastuinbouw' (Agriholland, 2011) the glass-horticulture in the Westland is less modern and has a lower scale than outside of the Westland, for instance look at the developments of Tomaholic (www.tomaholic.eu). This is due to the lack of space and the high land price. Modern glasshouses have a proven higher efficiency, they use seven percent less energy per unit product(Agriholland, 2011).

Types

The most used type of glasshouse nowadays is the Venlokas, the Venlokas is built up of glasshouses with a width of three meter and a hight of maximal seven meter. The 'Breedkapper' is a wider glasshouse with a width of 6 meter and also a height of seven meters (Agriholland, 2011).

Orientation

The common orientations of glasshouses are either north-south or east-west, in which the north south orientation has a small advantage in the light penetration (Hemming 2004, p.83).

Figure 28 raised house

Figure 29 monotonous area

Figure 30 Truck pit

Waterbasin

The Dutch government has limited the use of irrigation water for glass horticulture, on a yearly basis this cannot exceed 1140 l/m2 (Kierkels, 2009). A hectare can use 11 400 m3 on a yearly basis.
With an average annual precipitation of about 800 mm (Weerstation Westland – De Poel, 2011), 8000 m3 of rainwater can be collected. To use this clean rainwater for glass-horticulture there is the need for a buffer. This can be reached by making water basins.
The ideal size of the water basin has to fit the demand for storing as much rainwater in times of rain so there is a buffer for the case there will be a drought. According to the weatherstation the longest continuous drought in the last couple of years was 20 days and the longest sequence of days with rain 13 days. The highest daily precipitation was 65,8 mm, the highest monthly precipitation was 199, 4 mm (Weerstation Westland – De Poel, 2011). This last number is a directive for the size of the water basin, in a longer sequence the rain can be collected for irrigational purposes and there will be a buffer for times of drought. For the ease we take 200mm instead of the 199,4 to calculate the size of the water basin. For one hectare the storage has to be 2000 m3. The demand of the government is a waterbasin with at least the size of 500 m3/ha (Besluit glastuinbouw, 2002). The use of rainwater is benevolent to groundwater; rainwater can be used to prevent that the minerals from the groundwater will accumulate in the substrate of the glasshouse (Dierickx, 2007 p. 26-27).
These water basins have to meet the demands of the zoning plan, urban planners can therefore demand for an implementation of these water basins in the ground.

Heat storage

In the Westland there are many tanks for heat storage. The size of these tanks are variable in relation to the produced crops, size of the glasshouse and the way of working. According to Wetzels (2007), the average size was 126 m3 per Ha in 2004. For 10 hectares this gives a tank of 10 m high and a diameter of 12,6 meters.

Logistic connection

The ideal depth of the yard for articulated trucks is 35 meters, this is when the distance between the adjacent trucks is 3,8 m, when this distance is made 6,5 meters this distance can be limited to 30 meters (Neufert, 2002).

Figure 31 Water basin

Figure 32 Heat tank

Glasshouse trends

Annual renewal

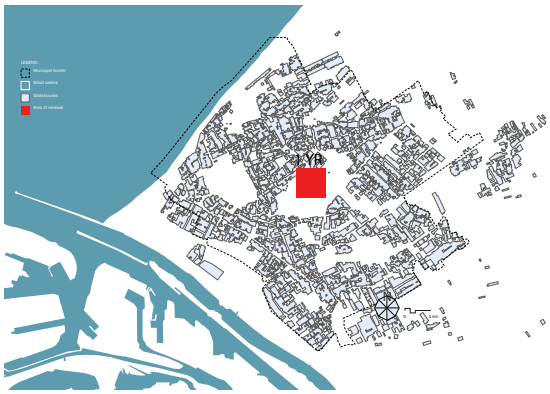


Figure 33 Renewal glass-houses (CBS/Agriholland, 2010, map by author)

Disappearing glass-houses

Figure 34 Disappearing glass-houses (Visie greenport, editted by author)

Glasshouses

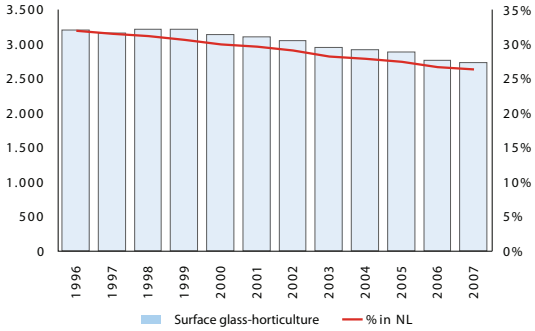


Figure 35 Development area glass in Westland (Kracht van het Westland 2008, edited by author)

According to the CBS the total area of glass-houses was 2441 hectares in 2009. This was Divided over 984 businesses. The total area and the amount of businesses is diminishing every year.
The lifetime of glasshouses is around 20 years, this implies that every year 5% of the glass-area is renewed. For the Westland that results in an area of around one square kilometer. (Agriholland, 2010).

While the size for glasshouses of 3 ha is still sustaining, the near future will need bigger scale glasshouses. Due to the globalization there are different perspectives for glass-horticulture in the Westland. Westland as a cradle of the glass-horticulture will always be connected to glass, there are different possibilities.
Some companies in the Westland are expanding their businesses outside of the Westland sometimes in the Netherlands but also to places like Tanzania or Colombia. The headquarter of these businesses are still situated in the Westland. The businesses that do stay in the Westland can survive by following other strategies; one is the upscaling in the Westland, others are product branding or broadening the businesses.
So the strategies for glass-horticulture businesses leaving the Westland, upscaling the glasshouses, broadening businesses and innovative product marketing.

All in all, this leaves the Westland with upscaling glasshouses and the need for business areas for trade and technological development, the problem is the complexity of this upscaling and the lack of space for expanding business areas.

The scale of glass-houses is growing, this upscaling is taking place in a short time. With this speed of upscaling the glasshouses will be 6-10 Ha within a view decades (Knijf, van der A, 2009).

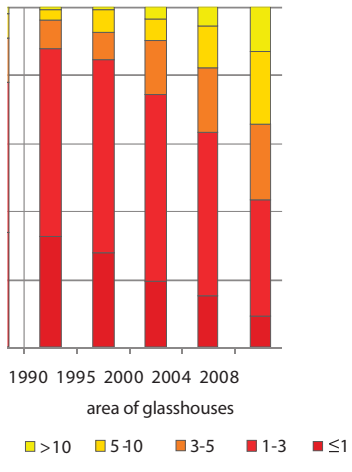


Figure 36 Upscaling glass (Knijf, van der A. 2009)

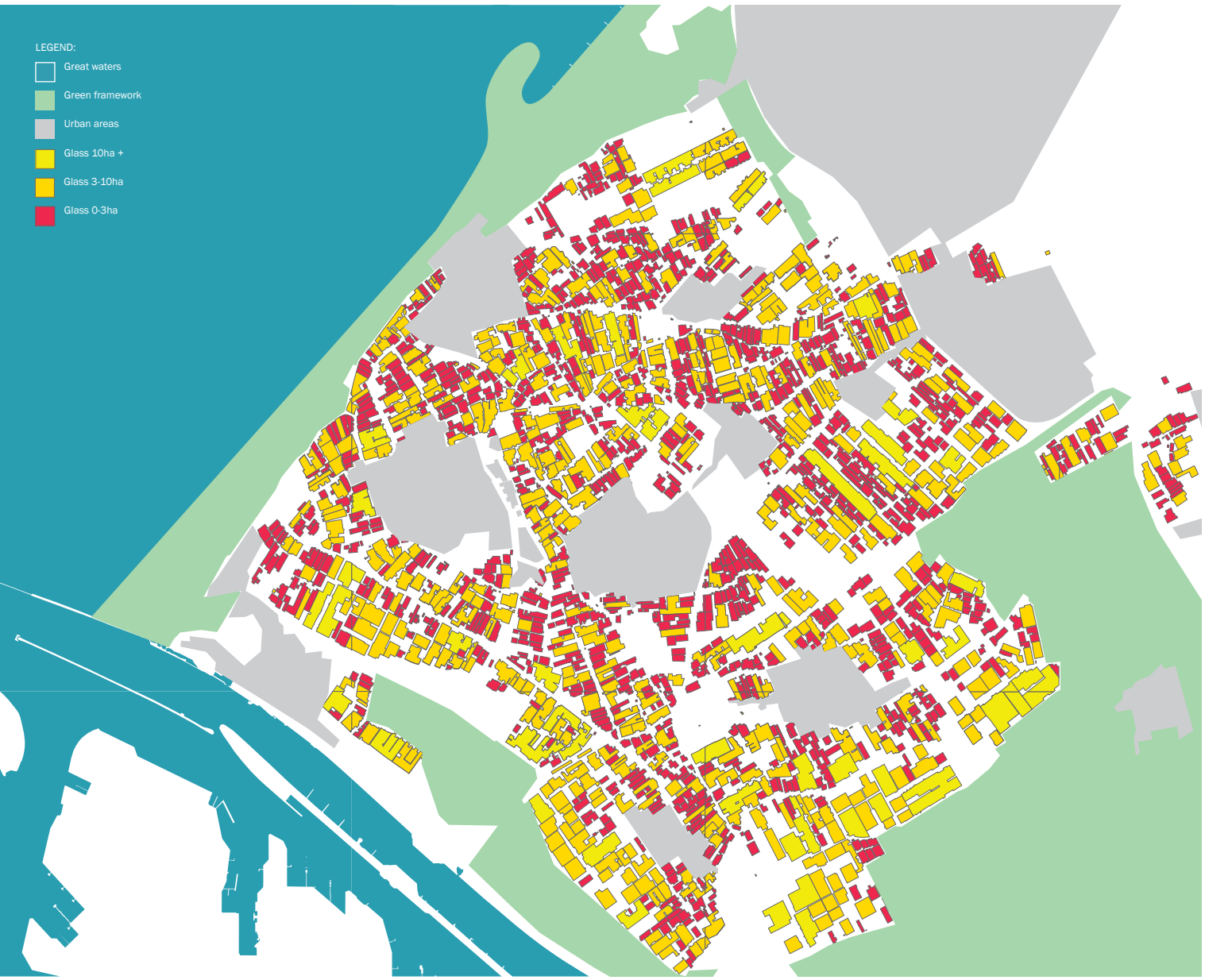


Figure 37 Upscaling glass Westland

Logistic

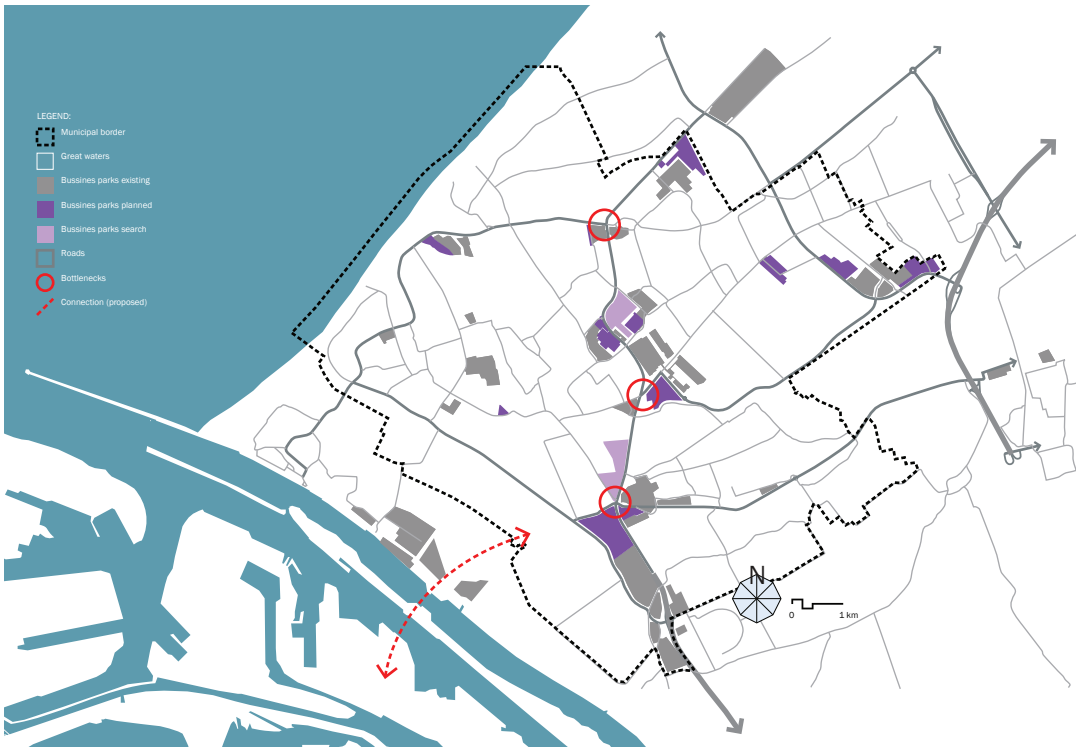


Figure 38 Logistic network and nodes

Plant breeding (plantveredeling)

Cultivation

Starting material

Propagation/harvest

Packaging/Storage

The sale of horticultural products from the Westland is done by auctions or brokers or directly by digital auction. From the glass-houses it moves to cooled storehouses near the transport axis, or it is stored on the site of the glass-house.

From the auctions and storehouses the products are moved to the mainports of Schiphol and Rotterdam where they are transported to the desired destination.

On the business parks around the auctions there are also glasshouse related businesses such as suppliers, technology businesses and services.

Quick transport is one of the key factors for a good greenport. The Westland has an advantage that it has good connections to the mainports, but there is still room for improvement of the infrastructure in the Westland and the connections to the Rotterdam harbour and the railways system.

There are diverse nodes in the Westland that have to handle a high intensity of traffic. For 2020 there is the plan to have a connection over De Nieuwe Waterweg to the harbours (Gemeente Westland, 2006). With this connection a highway couls pass through the Westland and connects to the southern harbour and Schiphol. This connection also makes the connection between The Hague and Zeeland much shorter.

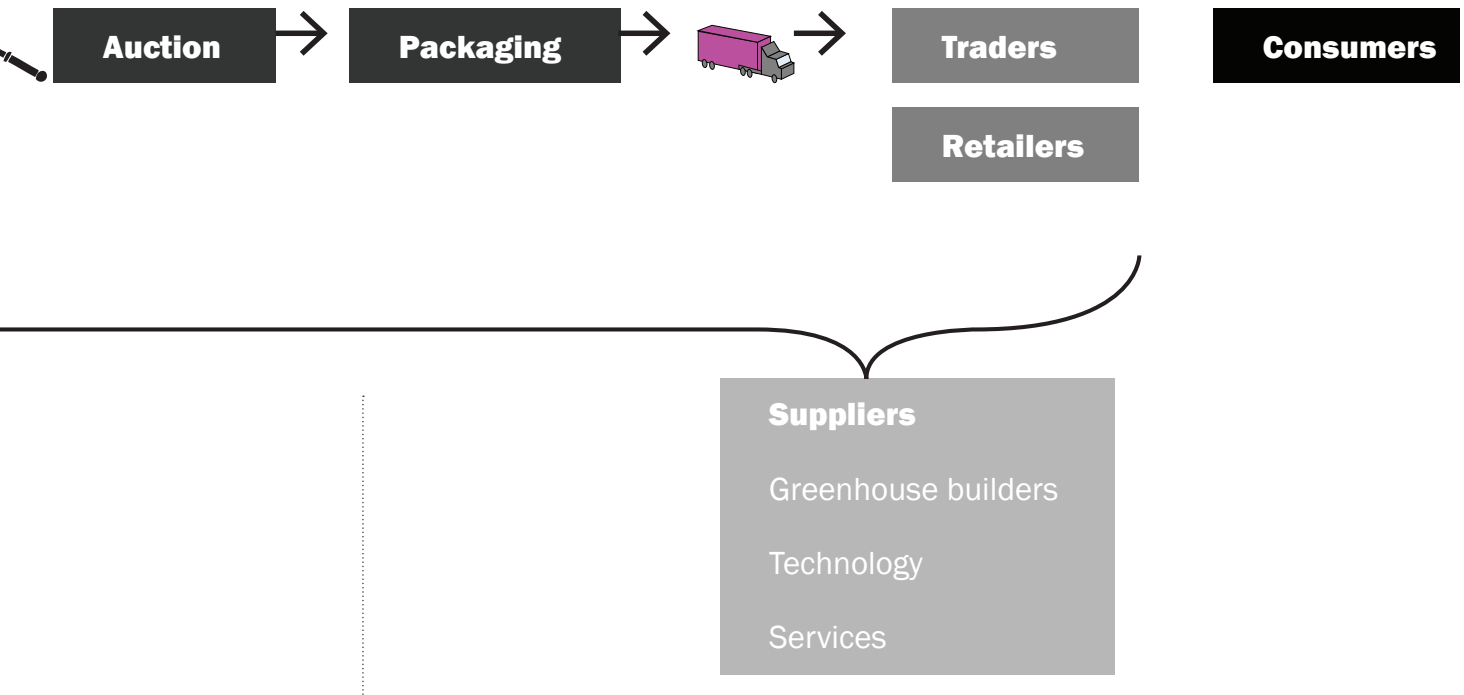


Figure 39 Chain of the greenport

Posibillities glass

GLASSHOUSES IN THE WESTLAND

Glasshouses AREA

Lifetime 20 years

5 % renewal every year (123 Ha 2009, CBS)

Released areas (9 Ha 2009, CBS)

Glasshouses CULTIVATION

Food (994 Ha 2009, CBS)

Flower (1424 Ha 2009, CBS)

Future

Fuel

Pharmacy

Glasshouses FORM

Conventional

Stapled

Mixed function

Floating

Glasshouses FACILITIES

CHP -Combined Heat and Power plant

Heat storage

CO2 storage

Water storage (sprinking water)

Water cleansing

Product storage

Transport

Owners residence

The glass-house story is summarized in this ‘iconography’.

Glasshouses SPATIAL LINKS

Glasshouse + Enterprise

Glasshouse + Residence

Glasshouse + Water storage

Glasshouse + Integration recreation

Glasshouse + sewage treament plant

Glasshouses SUSTAINABLE LINKS

Solar energy generating glasshouse

Wind energy generating glasshouse

Biomass energy generating glasshouse

Heat generating glasshouse

CO2 reducing glasshouse

Water cleansing glasshouse

Nutrient extracting glasshouse (nutrients)

Glasshouses STRATEGIES

Stop

Move

Upscaling

Broadening the bussines

Innovative products/marketing

Expanding outside Westland

Glasshouses UPSCALING

Upscaling with respect to present structure

Upscaling combined with restructuring

Upscaling for specialized production (3-6 ha)

Upscaling for bulk production (6-60 ha)

Glasshouses SUSTAINABLE RENEWAL

Coexistence - space for both glasshouses and linked functions

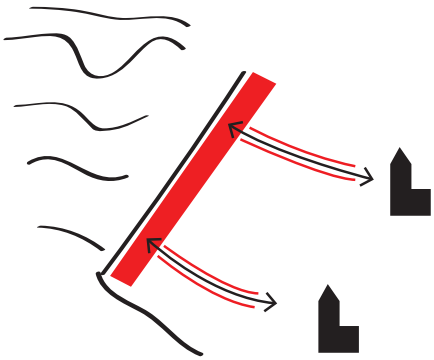
Integration - captures the structure

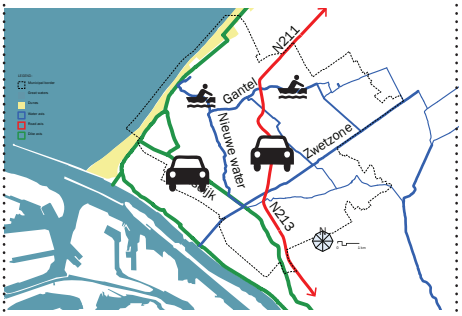
Segmentation - residential and glasshouse complexes are segmented

Figure 40 Possibilities Glass

Problems Experience

Recreative problems





Average public space/residence

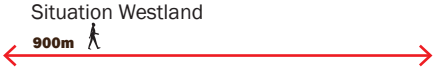
Directive VROM

Situation Westland

Average distance public space/residence

Directive VROM

Situation Westland



USE POTENTIAL

Delft - Monster 16km = 1hr
Rotterdam - Hoek van Holland 30 km = 2 hr

ROUTING THROUGH WESTLAND

Routing dominated by cars, waterways are backsides.

LIMITED PUBLIC SPACE

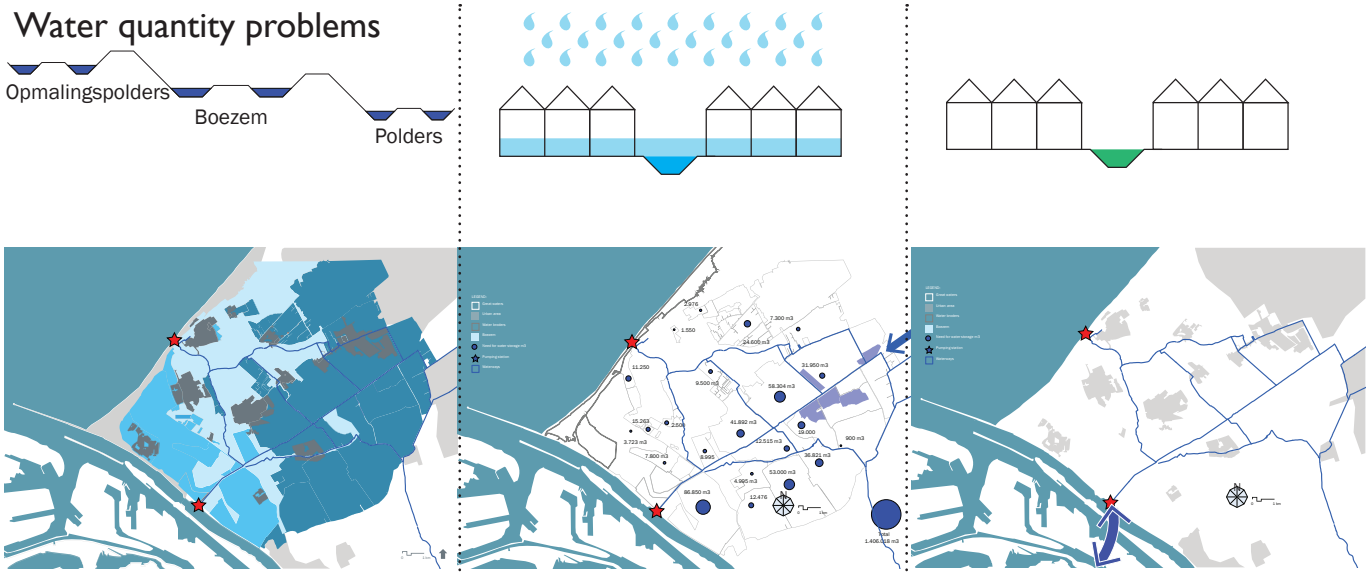
The overall demand for space suppresses the public space in the Westland. (CBS, 2006, Compendium 2010).

Figure 41 Recreative problems

The dense Westland has an intricate structure with a poor orientation. Besides the main routes through the Westland there are not many alternatives that deviate from the main roads (Gemeente Westland, 2006).

The continuous routing for cyclists through the Westland uses mainly the big roads, this gives a poor experience of the Westland. The cycling routes that go into the Westland use small roads that don't provide a clear continuous route. The Westland is surrounded by a frame of green areas, though this provides an interesting area for recreation and nature it is also an obstacle in the cycling network to the hinterland due to the limited connections through them. The lack of good connections also limit the potential for recreation of the coast and the Westland.
Because of the intensive use of space the Westland has less public space than directed by the Government also the distance to public space is bigger than directed by the government (CBS, Compendium, 2010).

Problems Resilience



POLDER COMPARTMENTS

Polders
Opmalingspolders
Boezem

NEED WATER STORAGE

-Heavy rainfall VS Hard surface
-Heavy rainfall surroudning areas
-Limited capacity flow off

NEED WATER BUFFER

Brielsemeerleiding: 4000 l/s

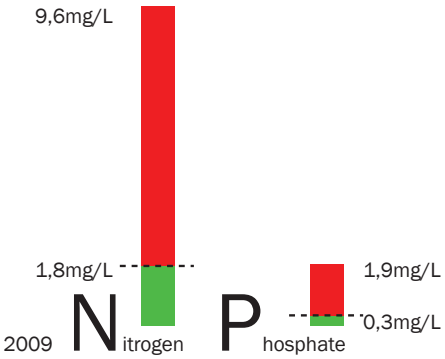
- During drought extra water from the Brielsemeer and Hoekse Waard is used for flushing the watersystem to keep its quality acceptable.

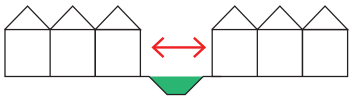
Figure 42 Problems water quantity

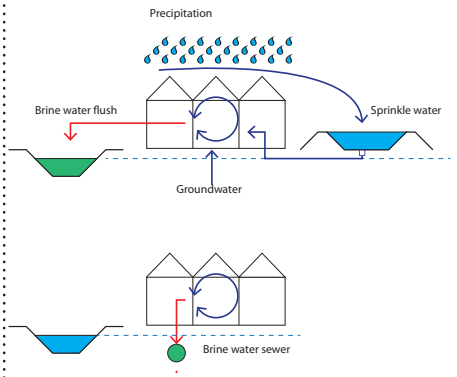
Due to the hard surface of glasshouses that cover the Westland there is a large flow off of rainwater. This has to be stored and discharged to the sea and Nieuwe Waterweg. The ABCDelfland is a plan of the Waterboard Delfland that has the directives to improve the capacity for water discharge and the water storage (Hoogheemraadschap Delfland, 2001). To improve the discharge capacity of the waterways 'Het Nieuwe Water' and 'De Zweth' they have to be widened. At the same time water storage has to be realized on the lower parts of the Westland (the polders). In summertime there is used water from the Brielsemeer to flush the system and keep the water quality acceptable, this Brielsemeerleiding has a capacity of 4000l/s (Hoogheemraadschap Delfland, 2011) besides this supply there has to be looked at the buffering with local water and the improvement of the quality.

Problems
Resilience

Water quality problems







POOR QUALITY

The average exceeding levels of N and P in the Westland indicate a very poor water quality.

7,8 Mg/N/L
1,6 Mg/P/L

Hoogheemraadschap Delfland (2010) Waterkwaliteit

LIMITED NATURAL PROCESSES

Limited natural filtering,
No living processes under glasshouses

POLLUTING GLASS-HORTICULTURE

Flush of brine water

Figure 43 Problems water quality

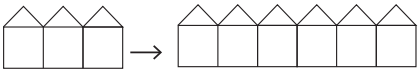
In ‘Westlands water nu en later’ a joint plan of Waterboard Delfland and the municipality Westland (2008), there are three core themes: dry feet, liveable water and visable water.

The Glasshouses in the Westland are a dead system, covering such a large part of the landscape causes that natural processes of the ecosytem cannot take place which results in a poor Water quality.

A recent report (Hoogheemraadschap Delfland, 2010) proves this poor quality, the maximum allowable values for Nitrate and Phosphate are exceeded.
Another cause for this polluted water are (illegal) discharges of concentrated waste water from glasshouses, on this moment this discharging is tolerated while simultaneously there is worked on an expensive sewer network for these glass-houses.

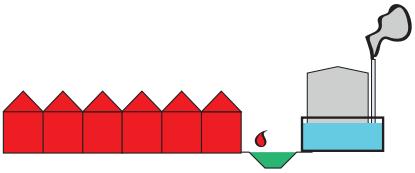
Problems Usability

Economic developments



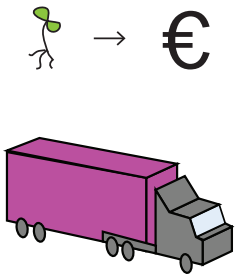
UPSCALING

- 10 ha in 2020



UNSUSTAINABLE IMAGE

- Bad image



UPCOMING TRADE/ CONNECTIVITY

- Connecting to mainports
- Focussing on plant trade.

Figure 44 Problems usability

The scale of the glasshouse is still increasing. In 20 years the size of a glasshouse will be around 10 ha. Present size of glasshouses is much lower, so this will have a big impact on the Westland.

The glasshouse horticulture has an unsustainable image as a wasting, energy consuming business. This image has to be remade by a more sustainable image to minimalize energy consumption and to use renewable energy sources.

Besides the Westland as a production area it has become an important centre of horticultural knowledge and trade. To keep glasshouses in the Westland the connections to the mainports must be efficient, for the trade the business-parks have to be representative.

Problem statement

The Westland faces many spatial problems, these can be summarized by looking at the experience, resilience and usability of the space in the Westland.

There is the lack of a green structure in the Westland that creates space for recreation and continuous connections in the Westland and to the hinterland.

Because of the intense use of space for glass-horticulture; the Westland is largely a dead system. There is no space for a resilient system, this causes a shortage of water storage and a poor water quality.

The present grain size of glasshouses in the Westland is behind of that of the glasshouses outside of the Westland. This causes them to be less energy-efficient and profitable.

Therefore there is the need of an integral approach to create a strong and sustainable Westland. The people, planet and profit should all be taken into account.

In the end the Westland should become a coherent example of a sustainable landscape where living, working and producing are done in respect to one another.

Research question

Research question:

How can the Westland work as a sustainable test bed for new ways of integrated living, working and producing?

Subquestions:

A

What is the current glass-house technology and what are current needs for ecological friendly production, how can these shape the Westland in the future.

B

What is the spatial image of the Westland and which structures achieve spatial coherence. How can spatial developments for living, working and recreation in the Westland cooperate in a sustainable way with glass-horticulture and make the spatial structure more clear.

Goals

Experience

In the crowded Westland there is too little space for nature and recreation. The continuous lines in the landscape that do have a recreational value do not make up to their potential. The goal is to upgrade the recreational connections throughout the Westland and make better connections between the coast and the hinterland. These connections should emphasize the characteristics of the Westland. Glass-houses should be integrated into the landscape instead of having only an economical purpose. These connections could provide the Westland with a green framework that is integrally developed with other functions.
The Gemeente Westland and Hoogheemraaschap Delfland (2008) plead for visible water in the Westland. The goal is to improve the liveability and the spatial quality for waterways significantly before 2015. These waters, banks and quays have to provide more possibilities for recreational purposes and improving the experience-value.

Resilience

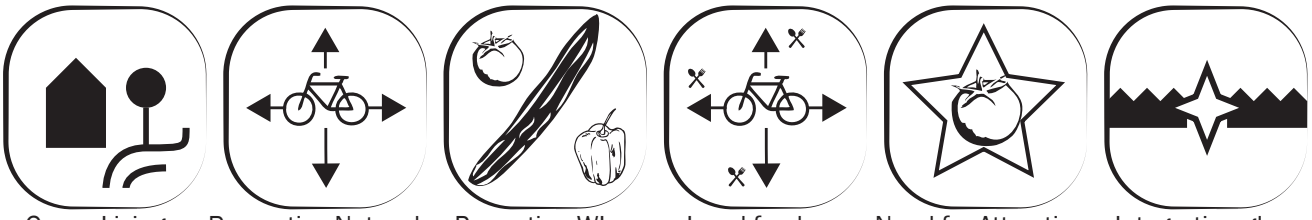
With climate change and more people on this earth we got to have an landscape that can adapt to these changes. In the Westland there has to be enough space to storage the water quantity; the high percentage hardened surface make that there is little space for such storage and that the flow-off is higher than in case of a 'soft' landscape where infiltration is possible. In the water plan 'Westlands water nu en later' (Gemeente Westland, 2008) there are chosen different goals. One is providing dry feet in the Westland, therefore different safety margins are built in for the different spatial users.
The high percentage of hardened surface also prevents natural water cleansing, and in combination with the flushes of wastewater of glass-horticulture the quality of the surfacewater in the Westland is poor. Another goal in the water plan is living water(Gemeente Westland, 2008), that stands for an approach where the quality of the water is improved till it reaches under the normative standard. In 2015 this water quality level should be reached. There is the need for water filtering and no wastewater from the glass-horticulture to improve the water quality, 2015 is very close in these terms so there is the need for a strong approach.
In the last 20 years an effort on saving primairy fuel has saved 53 % per unit of product (Velden, van der 2010, p. 8.). But at this moment only 1,3 percent of the energy use of the glass-horticulture is renewably generated (Velden, van der 2010, p. 9.). This is far less than the 4 percent that was the target for 2010, for 2020 there is a target for 20 percent of renewable energy (Velden, van der 2010, p. 9.). The present energy production that uses gas to produce energy in the form of electricity and heat and the CO2 is used to stimulate plant growth. Alternatives to this energy producing have to be found to reach the 20 percent for 2020.

Usability

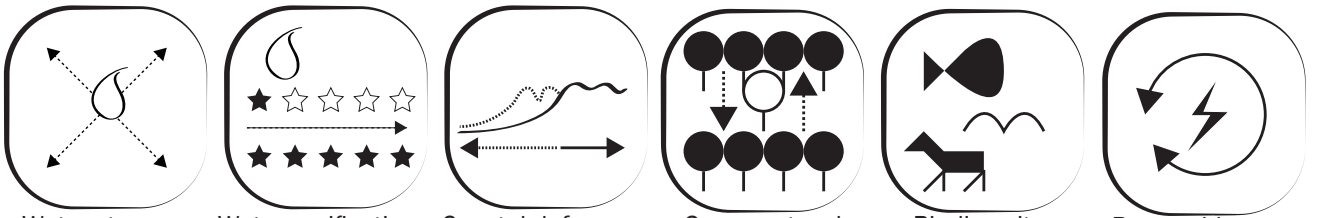
Of utmost importance is the usability; in the end if it is not usable, it will probably disappear. So that's why it is important to look at the factors of glass-horticulture, if the Westland is less suitable for this sector than it will slowly disappear and make space for other uses.
In the glass-horticulture there is an upscaling, this is necessary to keep competing with the global market. Glass-house are bigger than 10 years ago and will still become bigger the coming years. The grain size of plots in the Westland asks for the merging of plots to promote this upscaling of glass-horticulture. At the same time other functions and targets can be integrated into the new glass-houses.
For the usability of glass, the connection to

the mainports is important, the connections to hubs for transport over rail, water and through the air should be easy and effective.
Housing nearby green and blue has a higher market value, the connection of housing with projects for water storage, cleansing and nature development could then contribute to the value of these houses.

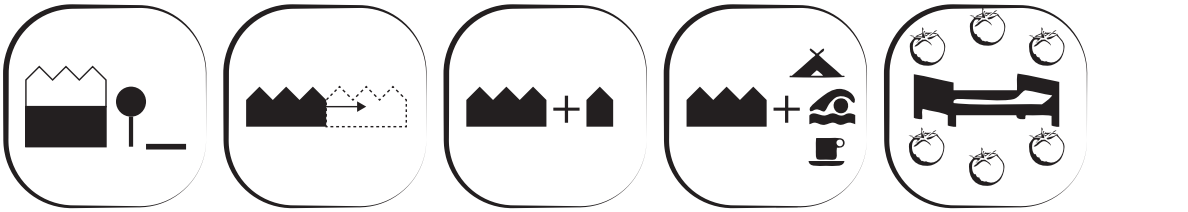
‘How can the Westland work as a testbed for sustainable ways of integrated living, working, and producing.’



Experienceability



Resilience



Usability

Figure 45 Goals

Concept Routes

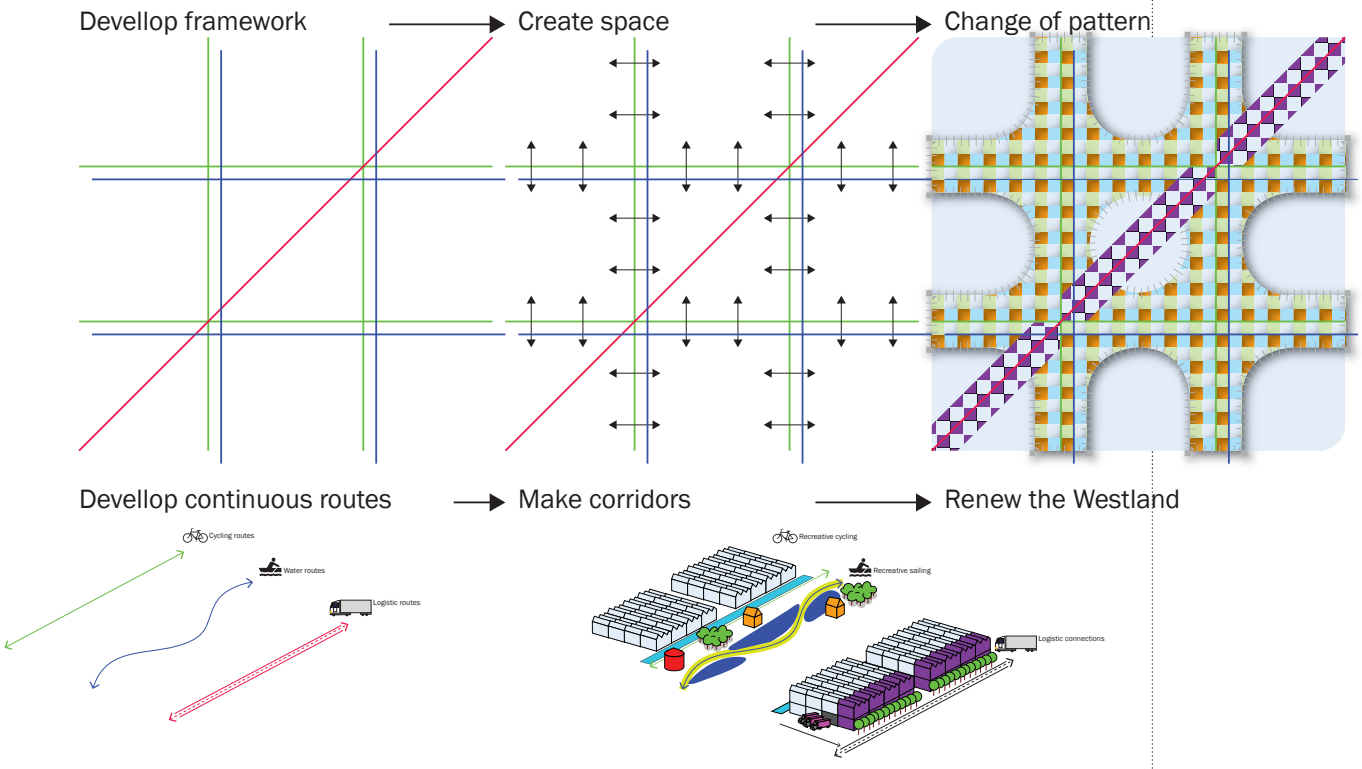


Figure 46 Concept Routes and Corridors

By focussing on three different routes the Westland should be able to attack its problems.

The cycling routes can connect to the hinterland and form an interesting recreational network in the Westland.

The water routes give the experience of the landscape a new dimension.

To create space around these routes there can be looked at a view mechanisms that could create space for developments in the Westland.

One of these is the glasshouse upscaling. There is little space for expansion and the price of it is quite expensive. Therefore the glass in the Westland is behind on scale and energy efficiency. Due to the global market and higher production demands the (standard) small glasshouses in the Westland will not survive on the long term. There can be anticipated on this exodus of small glasshouses and this can generate space for bigger glass and other programme.

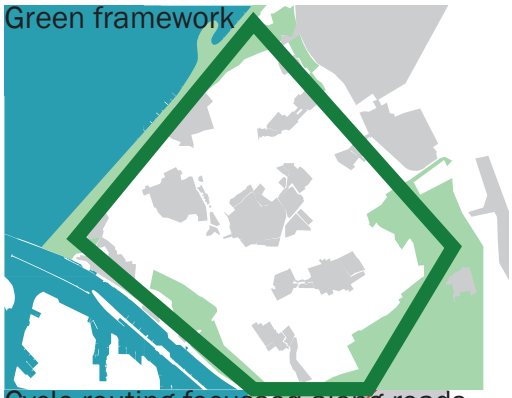
The limited space for water storage is a real problem, space needs to be created to solve this problem.

Concept Corridors

The created space by the glasshouse renovation can be used to implement a programme that can renew the Westland. The bundling of this space for other functions along the routes will create the corridors and will change the pattern.

Within these corridors a programme for upscaling, living, nature, water cleansing, water storage and businesses can be laid out. The corridors will influence the whole Westland and stimulate an integral sustainable approach towards space.

Cycling routes



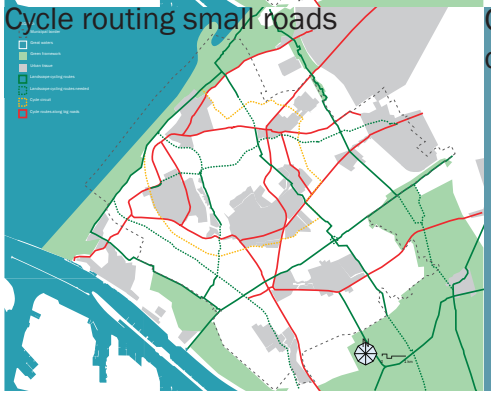


Figure 47 Green Framework
Figure 48 Cycle network road
Figure 49 Network road and small roads

Recreational routes

The interesting areas for recreation can be found as a framework around the Westland, but there is no green piercing in the Westland.

The present continuous cycling infrastructure is bundeled along the bigger roads. This gives an experience that has not much recreational value. Besides these routes along the bigger roads there are routes that follow small roads into the glass areas, the orientation for these routes is somewhat fuzzy. In the traffic plan for the Westland, the 'Westlands Verkeer en Vervoerplan', these problems are acknowledged (Gemeente Westland, 2006). To improve the recreational network the continuous landscape lines, analysed earlier in the spatial research, can be used as a recreational corridor to provide continuous routes with scenic qualities through the Westland. These routes can also provide connections to the hinterland.

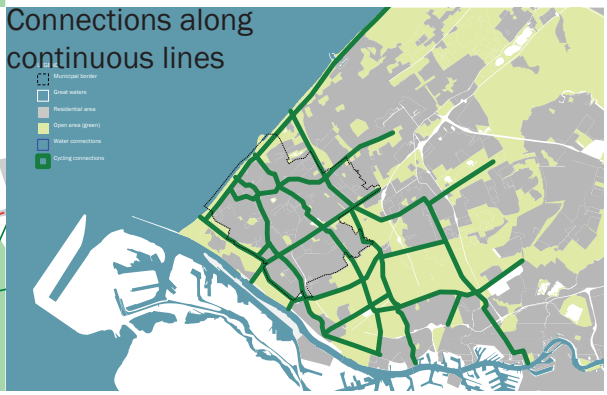


Figure 50 Regional Network

Figure 51 Network with new connections

Water routes

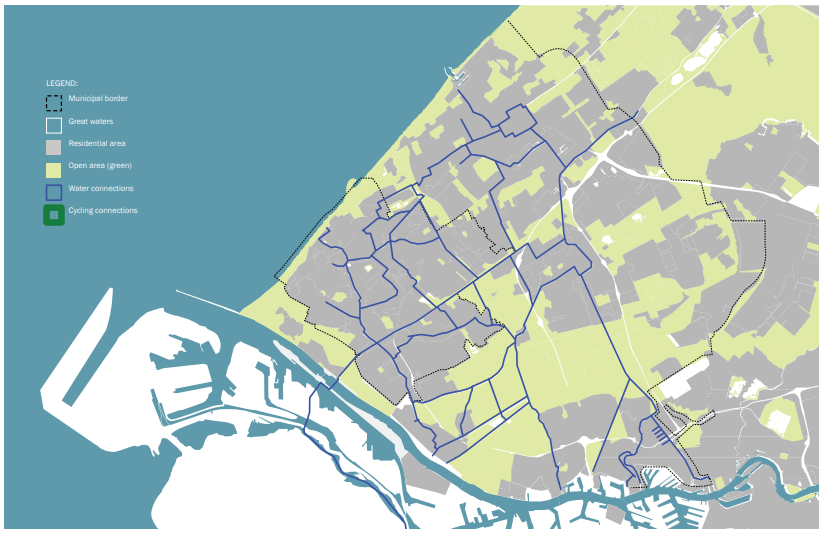


Figure 52 Regional water network

Water is the original spatial backbone of the Westland, through time the water as backbone was by a road-network over land that thrives nowadays. This backside of water in the Westland can be used to create a green-blue veining through the Westland.

This could improve the ecological and recreational quality in the Westland and could open up the framework of green that surrounds the Westland. This can create a well-proportioned green structure.

Figure 53 Local water routes

Logistic routes

Strenghtening connections and improving road capacity and look

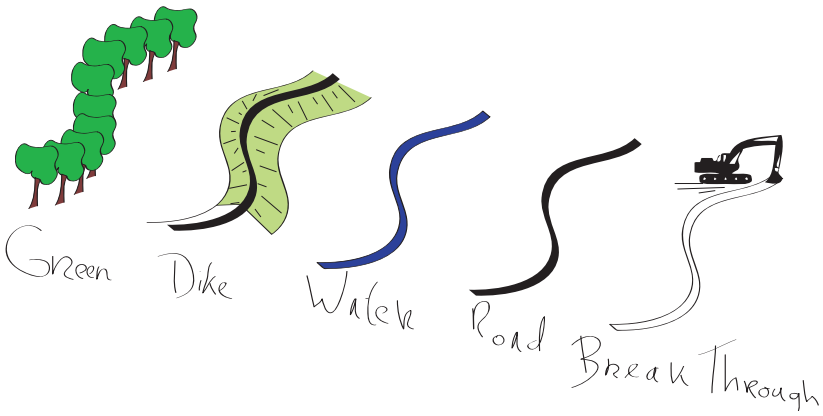
Figure 54 Business parks and logistics

The chain of the greenport shows the sequence of horticultural production, Nowadays one of the advantages of the Westland is the lower transport costs (Alleblas, 1996) caused by the proximity of mainports such as the Rotterdam harbour and the Airport Schiphol. These connections can be improved by improving the links to the harbour and the airport by making a connection between the A4 at The Hague and the Rotterdam Harbour, this is also foreseen in the traffic plan for the Westland (Gemeente Westland, 2006). In this way the Westland and both mainports get a better connection.

The Westland is inextricably connected to glass-horticulture. For the near future it is unthinkable that the total horticultural production will leave the Westland. But due to high land prices Westland horticulturists are moving their businesses to other parts of the Netherlands and even to international locations (De Boo, 2010). The base for these companies is still located in the Westland, therefore the Westland becomes more and more a trading centre. The technological lead of glass-horticulture and the Westland becoming more and more the trade centre for glass-horticulture entails a demand for more business areas. These business areas should represent the Westland as an innovative city of glass.

Figure 55 Main road network

Routes



By using landscape elements such as greenstructures, dikes waterways and roads a good recreative network can be created.

By making breakthroughs the network can become a good way to experience the whole Westland and to connect to the coast. The use of different elements can help experiencing the Westland on different ways: on water on the land and on dikes, all offering a characteristic experience.

These attractive recreative networks can also help to lower the cycling resistance between the different urban cores in the Westland.

The logistic main route is the focus for the development of trade and businesses and should become a representative road for the city of glass.

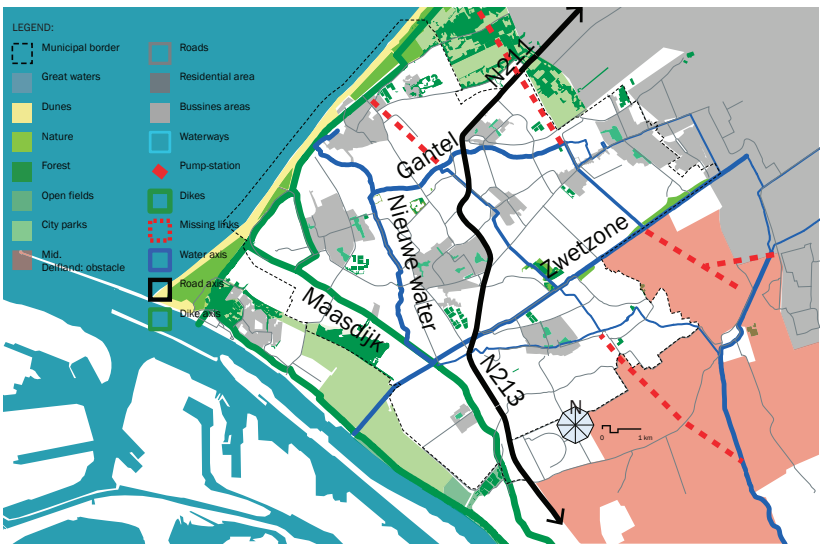


Figure 56 Missing links

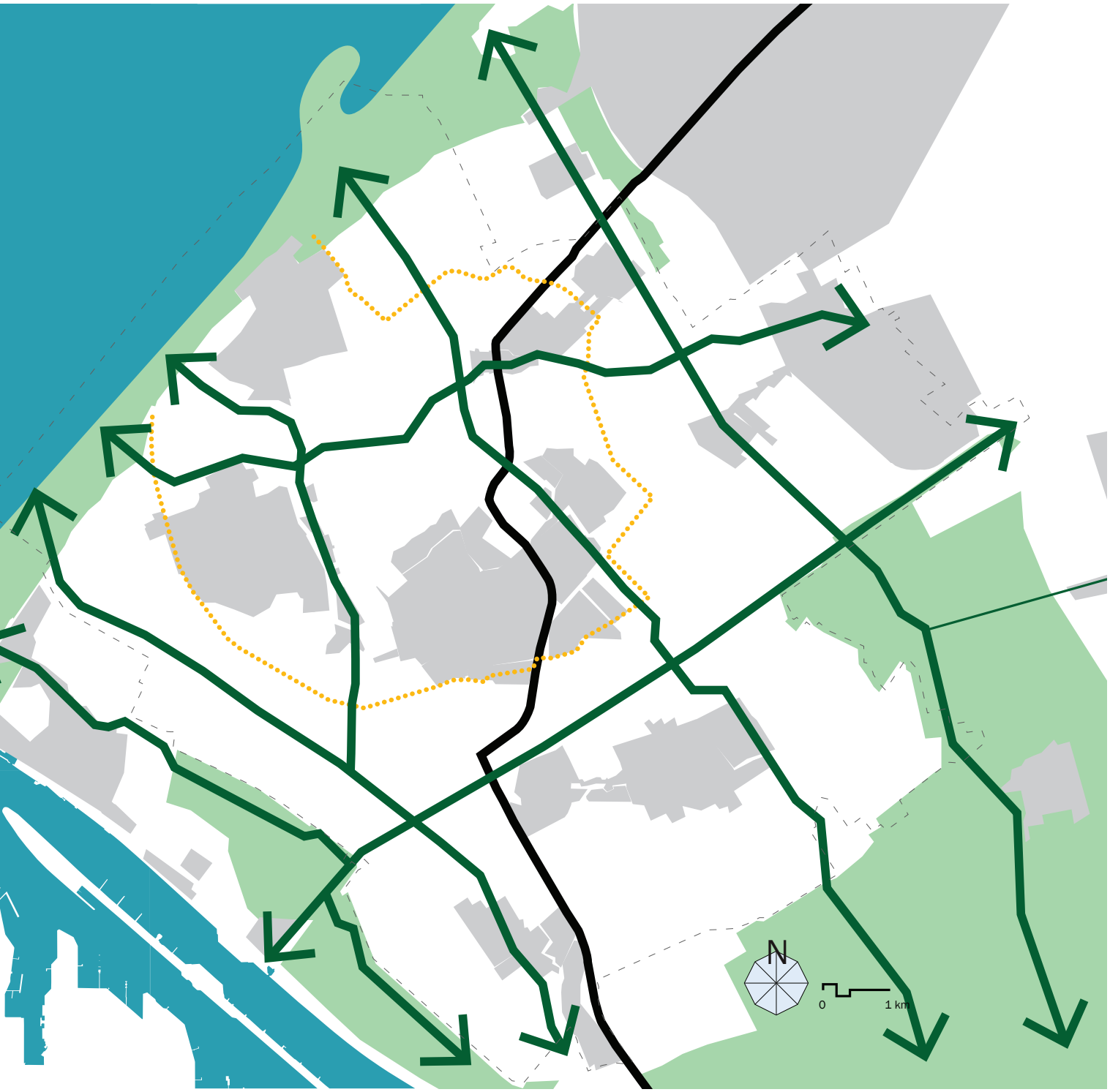
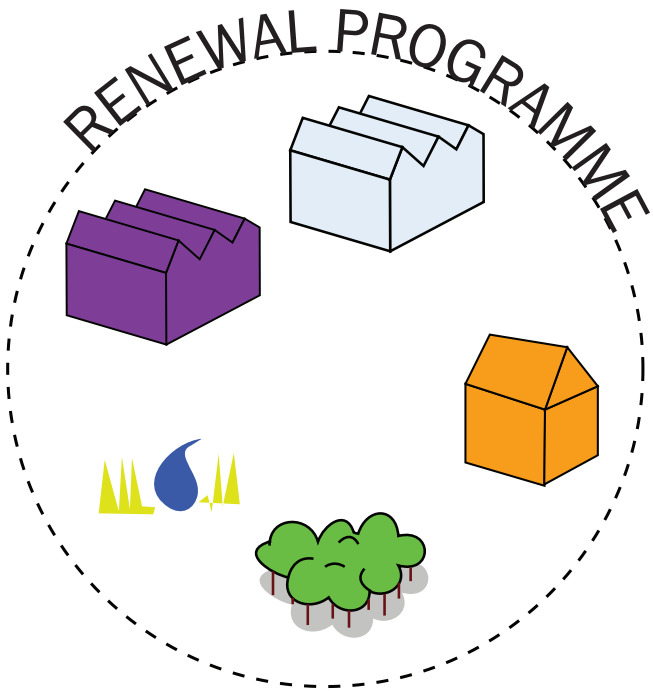


Figure 57 Corridors network

Corridors



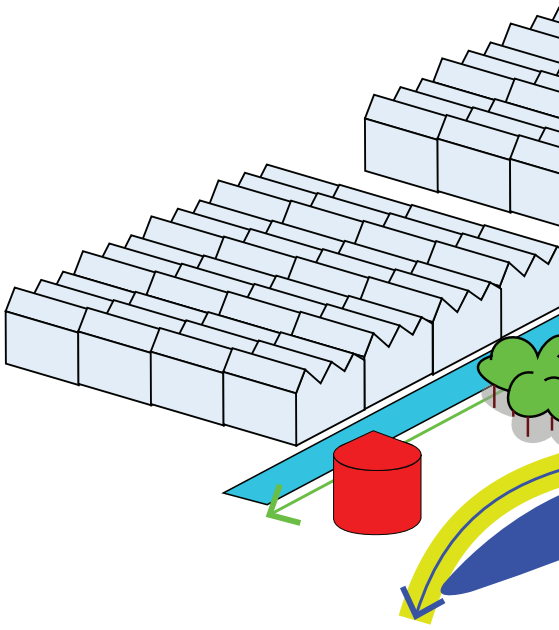


Figure 58 Renewal Programme

The recreative cycling route can be combined with living, nature and the glasshouse facilities. The goal of this route is to experience the Westland in all it aspects.

The water connection can come together with water storage, water purification, living and nature. The water route is a total different world where you can sometimes picture yourself in a natural landscape and then suddenly be confronted with the high tech glass-landscape.

And the logistic route can come together with road development, new business and trade areas and mixed functions. It will have an urban appearance and is integrally designed so the businesses and planting can really make it feel like an urban road,

So these targets have to be implemented in the different routes:

- Glass-upscaling
- Water quality
- Water quantity
- Nature development
- Green living
- Logistic strong connections

At the end this will deliver a renewed experience, resilience and usability for the Westland. It is also an example for how to modernise the areas in between these corridors.

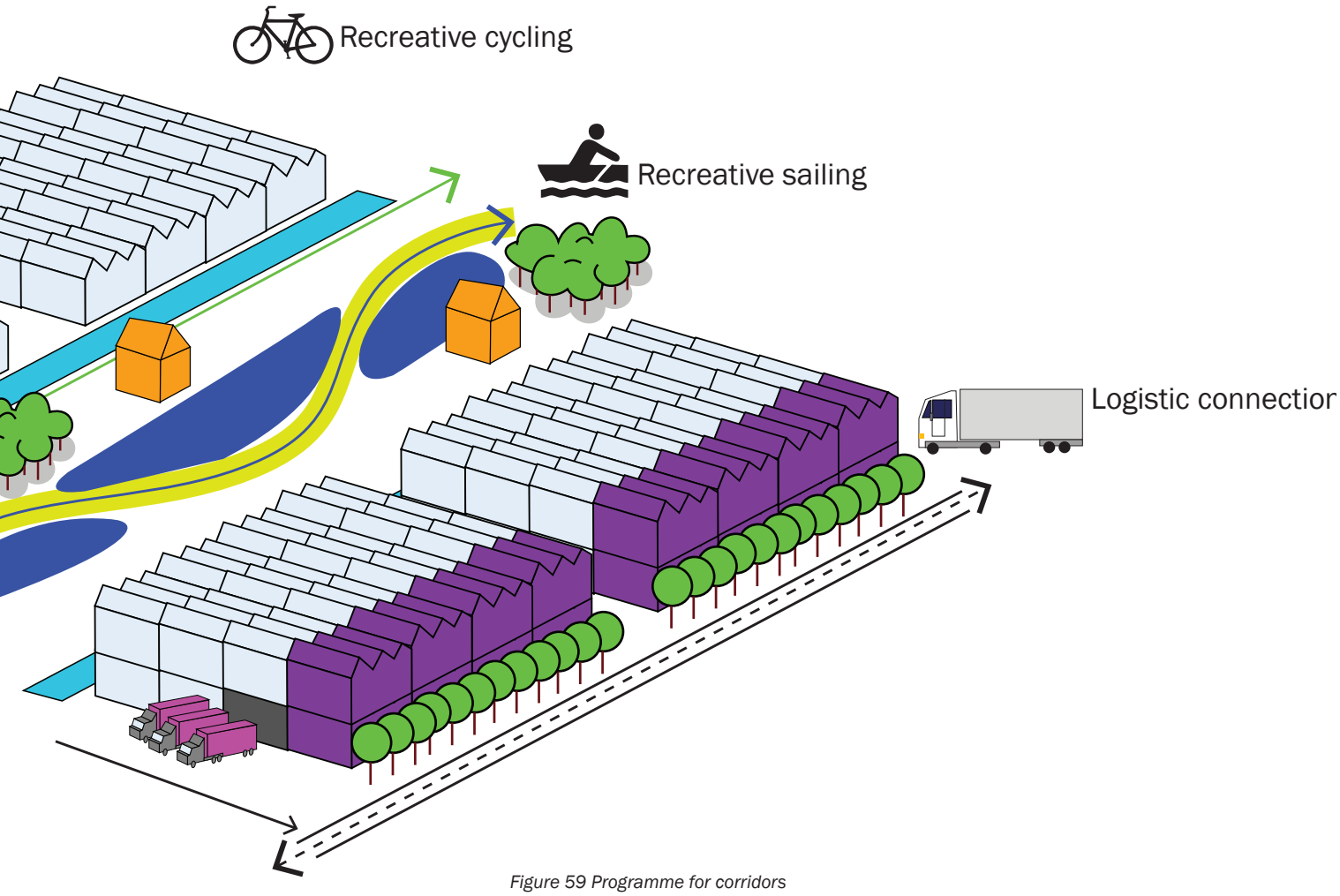


Figure 59 Programme for corridors

Corridors
Space generators

Glasshouse horticulture in Holland is upscaling. While in 1990 the size of circa 90 percent of the glasshouses in the Westland was less the 3 Ha, in 2008 that was only a bit more than 40 percent. This decennium the size of glasshouses will only increase (Bal, 2008). In the Westland this upscaling will cause a change of the pattern, the lifetime of the built glasshouses is around 20 years (Agriholland, 2011) so in this timespan this change will have its way. This upscaling will change the pattern of the Westland.

The space generated by this upscaling can then be used for the programme of the corridors that will help solve the spatial problems.

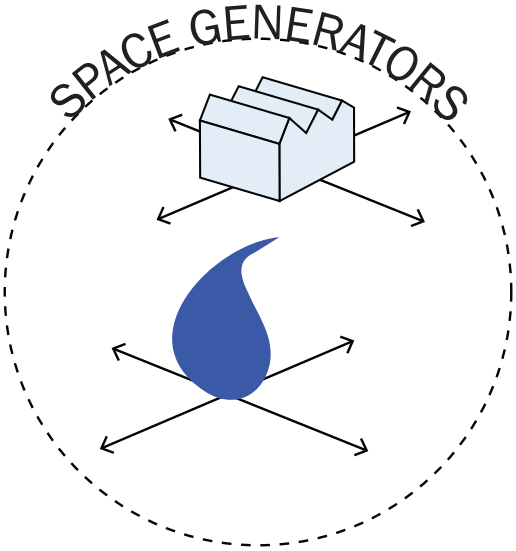


Figure 60 Space generators

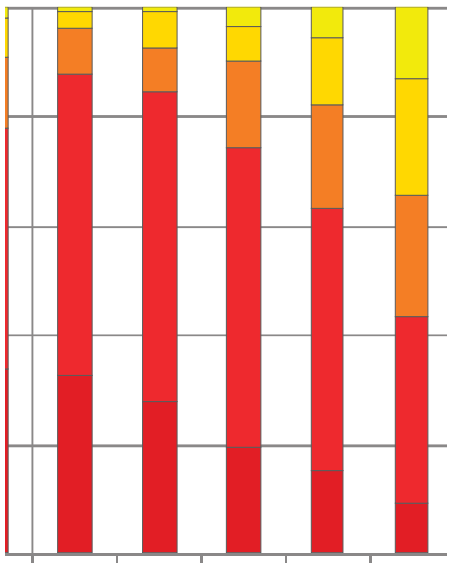


Figure 61 Upscaling glass (Knijf, van der A. 2009)

Figure 62 Space generators: Renewal glasshouses

Corridors
Space generators

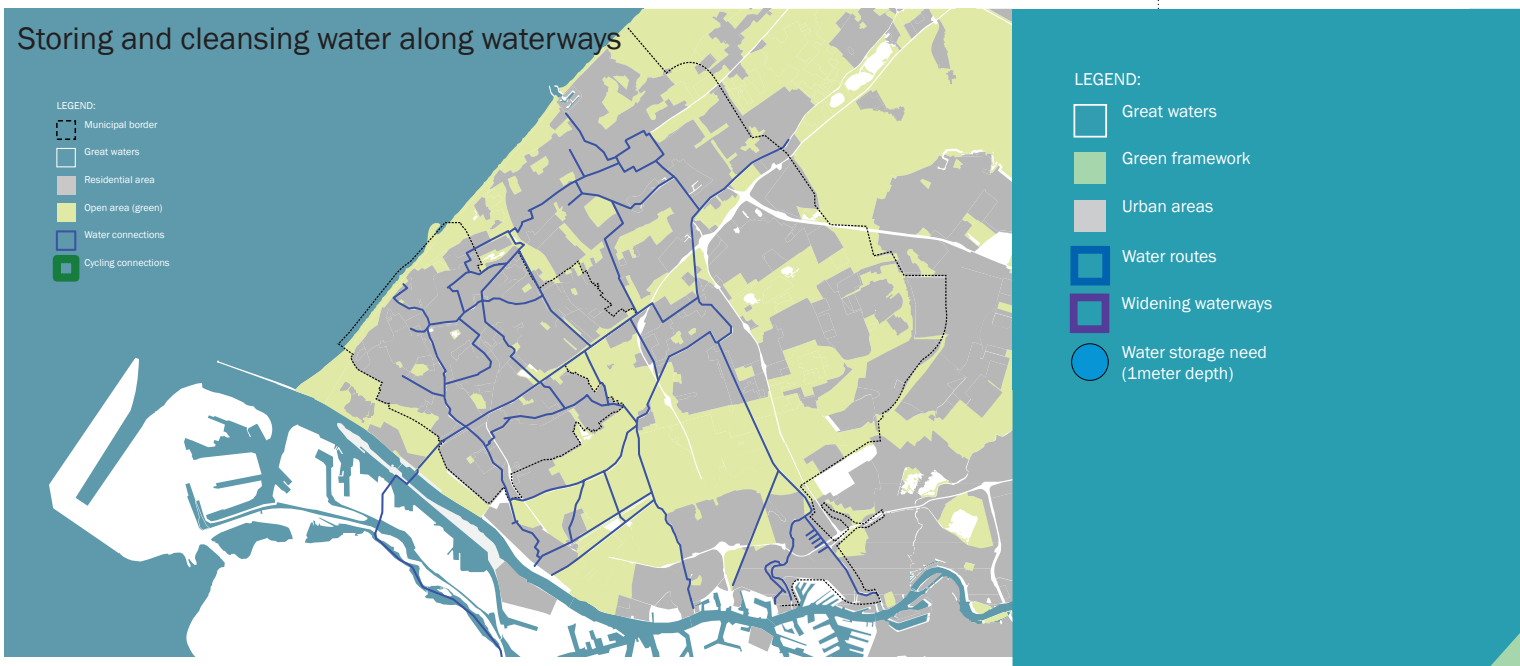


Figure 63 Regional water network

The water storage in the Westland is mainly needed in the polders. The discharges takes place in the sea south of Monster and in De Nieuwe Waterweg at Oranjesluis. Due to the large percentage of hard surface and the limited discharge in the drainage-canals the lower parts have to expand their water storage for heavy rainfall.

In the ABCDelfland and later in the plan ´Westlands water nu en later´ (Hoogheemraadschap Delfland, 2008) there is made a plan for the discharge and storage capacity in the Westland. This plan foresees extra water storage in the Polders and a widening of the main waterways to increase the discharge capacity.

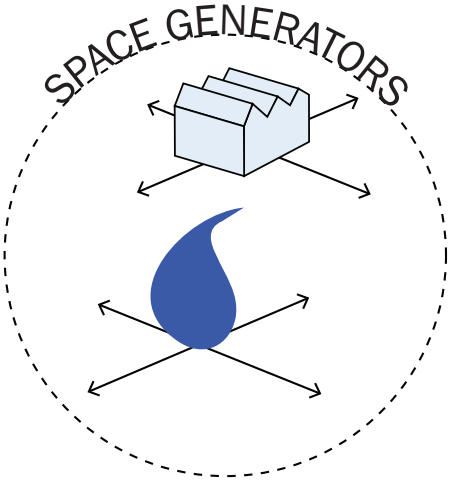


Figure 64 Space generators

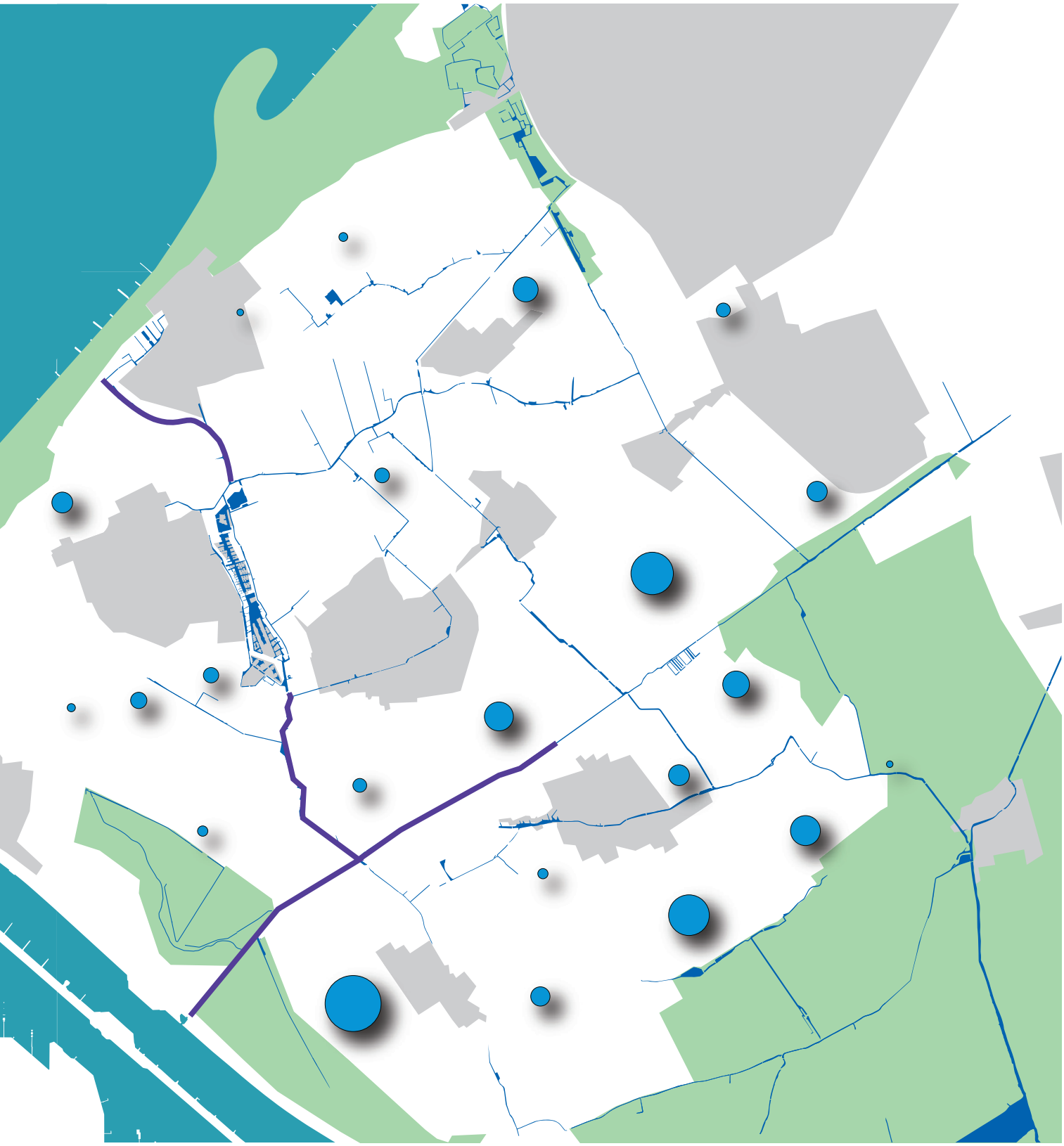


Figure 65 Space generators: Water storage

Corridors

Corridor Nieuwe Water:

'Het Nieuwe Water' is a creek from origin. Through time it was canalized and used for transport of goods to auctions. With road transport the Nieuwe Water became a backside of the profile.
The corridor begins in the Staalduinse Bos. The Staalduinse Bos is a forest on the dunes that came into existence when the Meuse Delta was still a dynamic landscape. The natural qualities can be continued into the Westland. This is elaborated by softening the barrier of the Maasdijk. By transforming it to a slow connection for cyclists and local traffic.By making forest also on the other side, a connection for nature is possible. The downgrading of the Maasdijk also creates a new perspective for the cyclists over the Westland; the experience will change to a view over the area with glasshouses, water and forest. The Maasdijk also forms a strong connection to the coast with landscape qualities. The heavy traffic will be leaded to the southern connection along the Nieuwe Waterweg, there the possibility arises to transport goods on rail.
In the middle area of the corridor an intricate mix is created of nature, water, living, recreation and glasshouses. Nature then continues by stepping stones that are connected by the upgraded water system with nature friendly banks and water cleansing reed beds. When the corridor is adjacent to the urban areas there are made urban expansions that improve the attachment of the urban tissue. When not adjacent to urban areas the focus is laid on the spatial integration of glasshouses and their facilities into nature and for recreation, with also the development of rural villas. Clusters of small glass-houses (<3Ha) are transformed to bigger glasshouses with a target size of 10 Ha. All in all this creates an interesting corridor for recreation.

At Monster the Nieuwe Water is connected to the sea by a pumping station. This place is a connection to the coast corridor. By transforming the Business park to a residential area, Monster can be attached to the Nieuwe Water. The connection of the Nieuwe Water to the sea demands space for the storage in case of peek storages, this is translated into an area of nature and water.

Corridor Gantel

A smaller waterway in the Westland is the Gantel. This waterway is also the remnant of a creek. The small-scale character of this creek can be further elaborated. Small scale developments such as: nature developments, housing projects and on some places a restructuring of glasshouses, create a recreational connection from The Hague to the coast nearby Naaldwijk.

Coastal corridor

The coast is already a strong and coherent zone, it only lacks of a good integration to the hinterland and the carrying out of the typical glass identity of the Westland. To strengthen the coast of Delfland there has been made an extra dune and by 'rainbowing' the sand to the beach a wider beach is created.
Because of littoral drift, sand has to be replenished along the Dutch coast. A coastal project that uses this littoral drift to reduce manpower is the Zandmotor, in this project a peninsula of 'rainbowed' sand used to distribute this sand by the natural force of littoral drift to replenish sand for the coast north of Ter Heijde (Rijkswaterstaat, 2011). This wider coast profile will also change the vegetation in the land direction. Leaves of plants cannot withstand the salt spray that is caused by landward winds, the construction of a new dune in front of the old one and the Zandmotor will reduce this salt spray and create opportunities for the growth of Pine woodlands (McHarg, 1967).

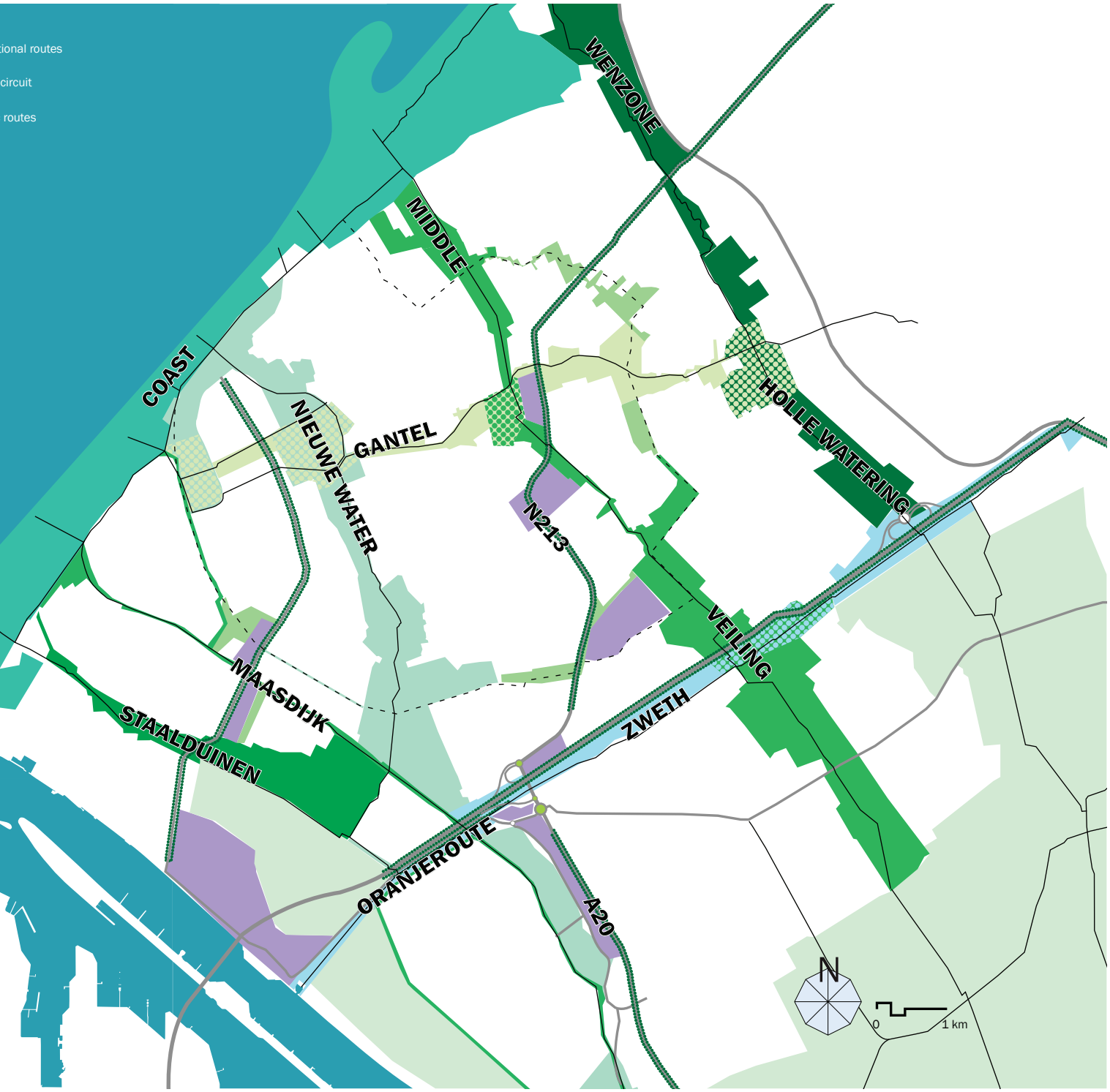


Figure 66 Corridors and routes

Transition Corridors

The scheme below represents the development of the Westland through time. In the past the transport from the glasshouses went by boat, the owners residence still had the space around it.

In the present the expansion of the glasshouses and the shift of the transport from boat to truck caused the residences to become isolated in the landscape. The waterside became the backside of the landscape and many glasshouse-facilities were built on this back-side.

In the future of the Westland the water structures in the Westland are reused for the spatial coherence. These can provide the spatial framework for making an integrated landscape of nature, living, working and producing. They regulate the water quantity and quality.

By the glass rebovatioan and the lower need for CHP's and integration of facilities such as the water basins and remaining tanks, space is generated for another landscape. This new landscape is suitable for recreation and the connection from the coast to the hinterland through the Westland. With the concentration of living along this framework the needed upscaling of glasshouses can have place within the Westland. These glasshouses can generate electricity by the EIKas concept and have links to the residential areas for the exchange of CO2 and heat.

The functions with a lower dynamic are concentrated along the waterways, and by merging glasshouses there is created space for the intensification of the glasshouses in the Westland. The logistics on the opposite side of the glasshouse can be integrated and intensified in a more efficient way.

The logistic routes can also be developed as urban avenues that reflect the image of the city of glass with the multifunctional use of space. Trees can accentuate this road to create an avenue that becomes a connecting route in the Westland.

Focus spatial form through time

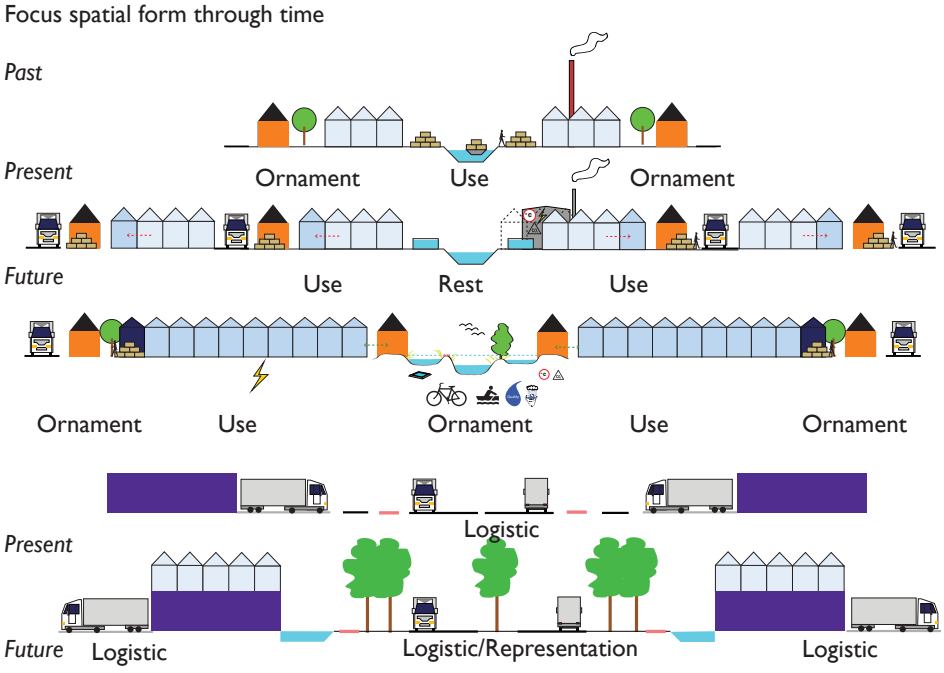


Figure 67 Development Westland and vision for the future

Principles Corridor

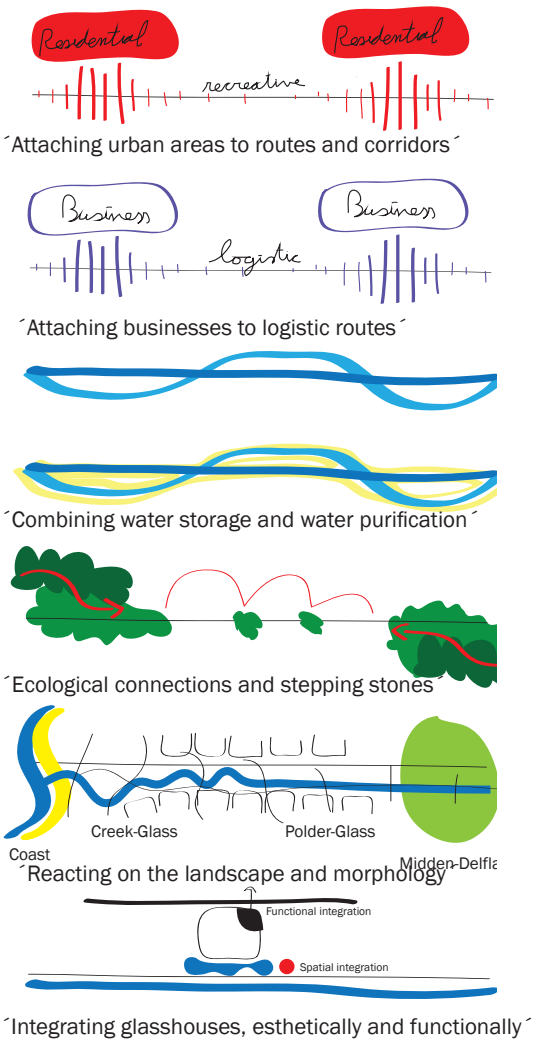


Figure 68 Principles Corridors

For designing the corridors different principles determine the look of these corridors:

-First the attaching of urban cores; when the corridor adjoins the urban areas, the urban area is continued and integrated into the corridor.

-The water storage and purification are done along the main waterways. In this way the water becomes a spacious ecological landscape feature in the Westland.

-The green is integrated in these corridors, the present natural areas have to overcome the barriers and connect to the corridors. In the corridor itself this nature can be continued in the form of stepping stones.

-The morphology of the Westland can be inspired by its cultivation history, in the areas of creeks it can become a bit amorphical whilst the canals have a more rectangular lay-out.

-Glasshouses can be integrated in such a way that their backsides become their interesting sides, with the integration of waterbasins in the landscape and the Heat Storage tanks that can become watchtowers over the city of glass.

- Also the design of the areas is inspired by their landscape: coast, boezem or polder.

Corridors
Living and working

Figure 69 Present plans Business parks and living

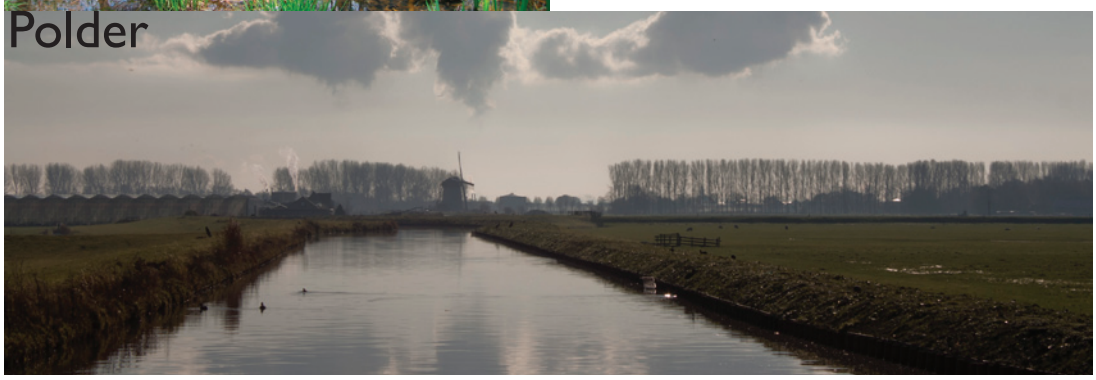
The corridors are made to improve the experience, resilience and usability. An integration of the urban areas into the corridors will help realising these corridors and brings the quality of the corridor into the living environment, at the end it will change the experience of inhabitants and make a good connection between the urban tissue and the corridors. The network of the corridors and the attaching of urban areas will help creating the city of glass.

Living

The present housing stock in the Westland is 39 900, for the year 2021 this stock should be around 46 750 houses (gemeente Westland 2010). The areas for residential plans are quite shattered at the moment, the developments do not really have a clear focus or direction for the Westland as a whole. A more integral vision on the Westland as a whole would lead to a more directed approach where living is used to obtain a sustainable green structure through the Westland that is attractive for living and recreation.

Figure 70 Alterred plans Business parks and living

Landscape characteristics



Landscape characteristics can give form to these corridors. By designing with the local charcteristics the 'genius loci' of every area can create an atracting atmosphere.

At the coast ideas can be developped that make a connection between the recreative qualities of the coast and the glass of the Westland.

The creek can be place where nature takes back what the glass has stolen. This can create new nature into the manmade landscape of glass. Also glasshouses can interact with recreation in the form of seasonal stalls for selling fresh vegetables flowers and fruits from the glasshouses.

The polders have a more open appearance and show a more rectangular parcelation and lines. In these areas the design of the corridor can also be more rectangular.

Trees are scarce in the Westland, there used to be estates with forests in the Westland but these are long gone. Trees and glass are a tricky combination, there should be no or limited shadowing by trees. Therefore one has to keep an area open that is adjacent to glass. Bringing the forest into the Westland can provide a different atmosphere and can be seen as a variation to the monotonous glass areas.

Figure 71-74 Atmosphere different areas

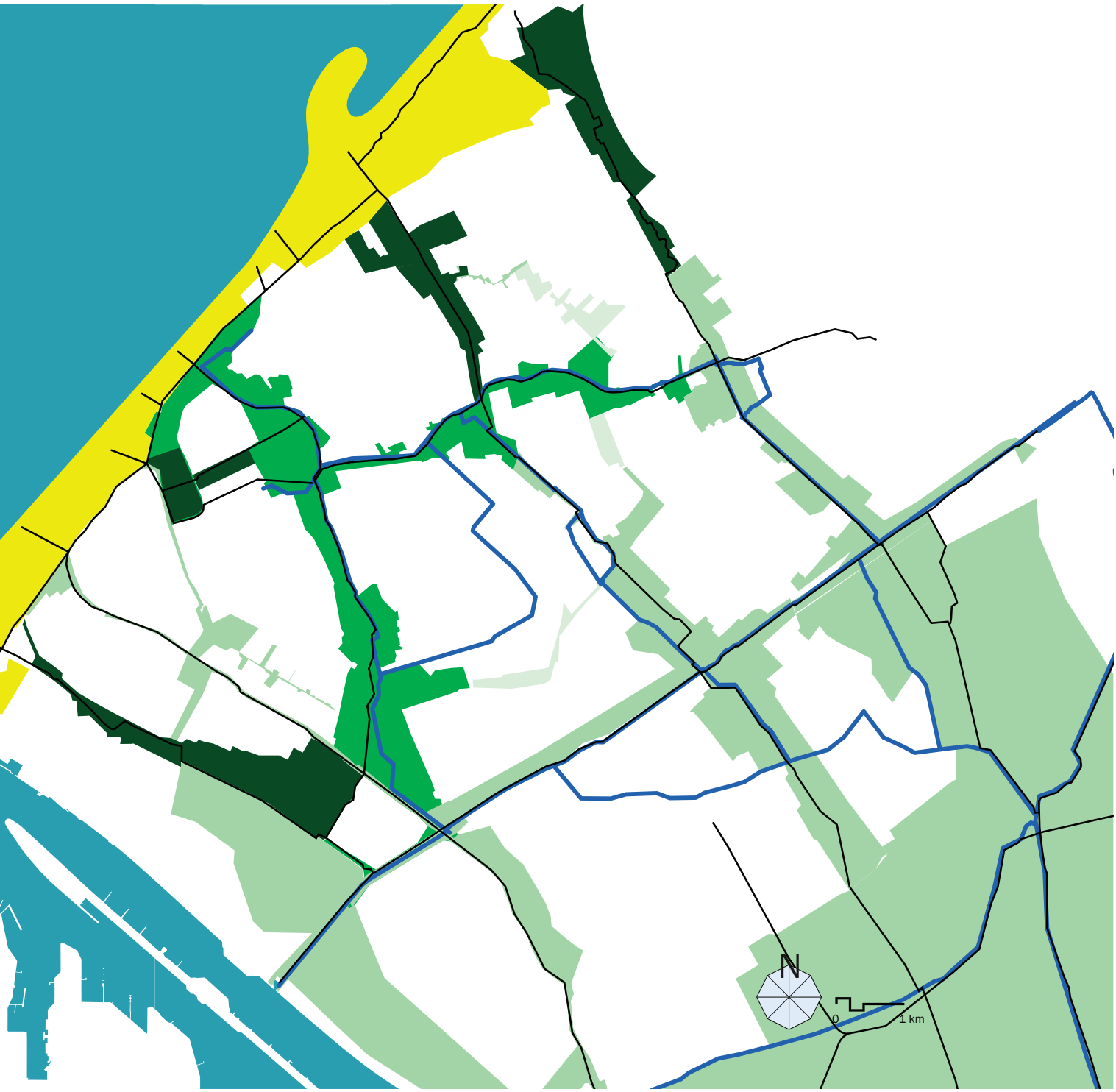
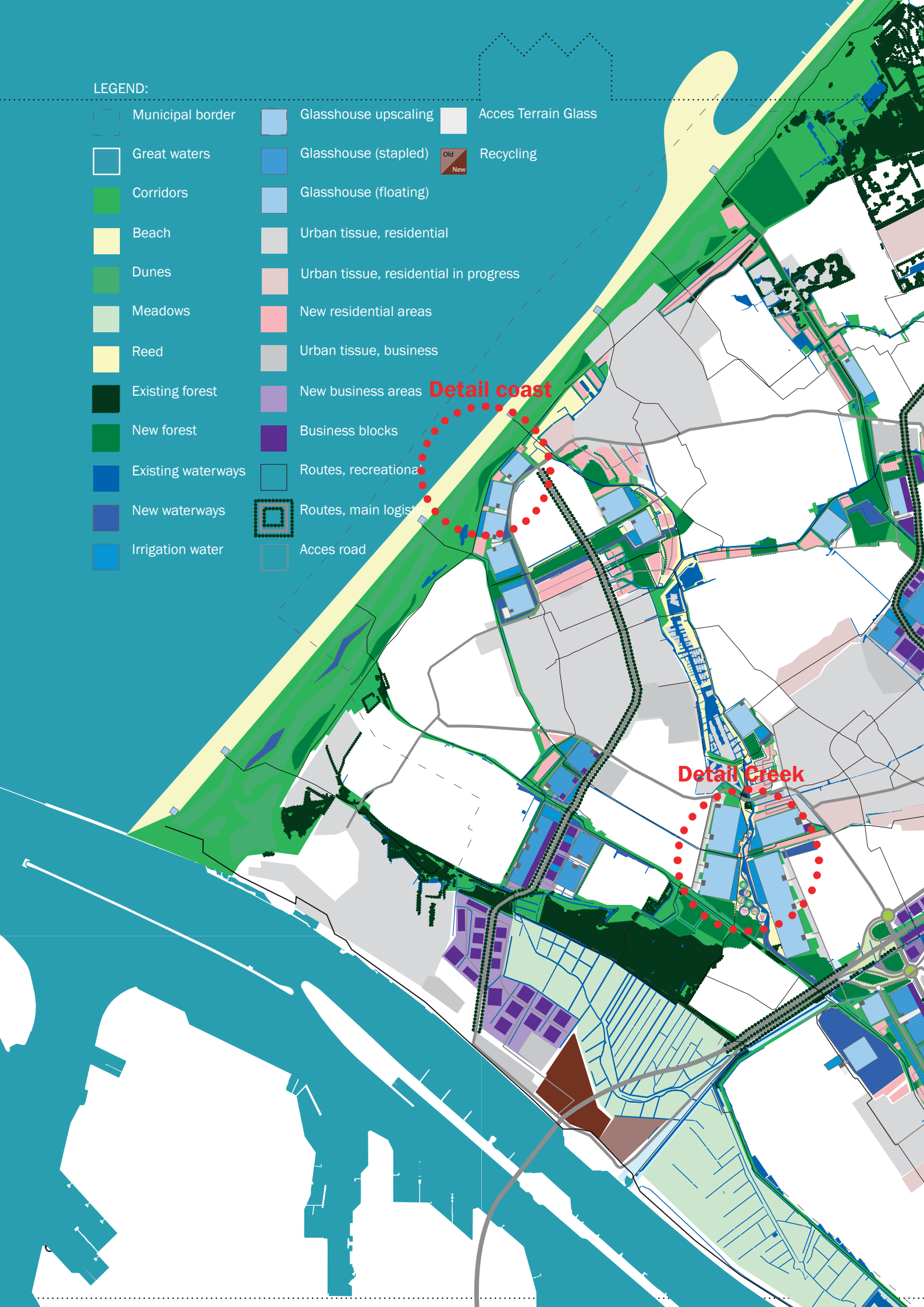


Figure 75 Corridors and charcteristics


LEGEND:
Municipal border
Great waters
Corridors
Beach
Dunes
Meadows
Reed
Existing forest
New forest
Existing waterways
New waterways
Irrigation water
Glasshouse upscaling
Glasshouse (stapled)
Glasshouse (floating)
Urban tissue, residential
Urban tissue, residential in progress
New residential areas
Urban tissue, business
New business areas
Business blocks
Routes, recreational
Routes, main logistic
Acces road
Acces Terrain Glass
Old
New
Recycling
Detail coast
Detail Creek

Westland 2040

Change is needed in the Westland: because of the pressure on space in the Westland the future has to be directed to reach a certain coherence. Otherwise the danger would be that the Westland will develop into a chaotic and fragmented area.

To improve the connectivity as well for bicycles as for heavy transport there has been chosen to develop routes. Along these routes space is created by restructuring glass and finding space for programmes such as waterstorage, water purification, residential areas and businesses.

The cycling routes connect the Westland to the hinterland, instead of focussing on car and public transport the cycling should be encouraged by good routing and a good environment. Therefore these cycling routes are positioned on places where there are still scenic qualities or where these can be created.

Along the water routes water storage and water purification in the form of reed beds have been implemented in the landscape. This creates a natural space that flows through the corridors.

The logistic routes are planted with trees in order to create the image of an avenue. When the logistic route meets the other more scenic routes there is an integration of new business parks that can be a combination of logistic businesses and stapled glasshouse.

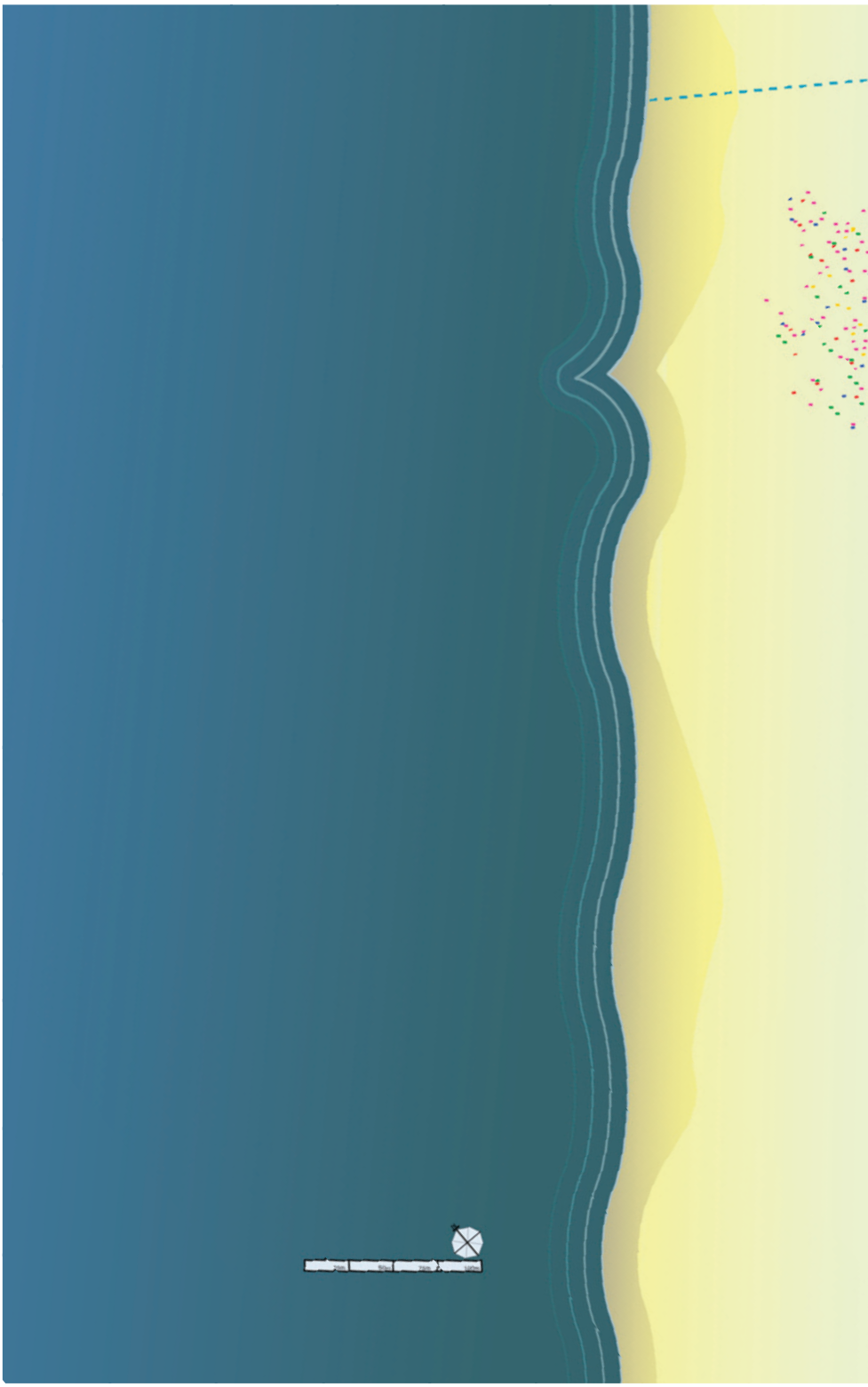
The urban program is integrated into the corridors to give the corridor more body and this also helps the urban area to attach to the corridors.

The present nature areas are also expanded into the corridors and will overcome the barriers to the corridors. The Maasdijk becomes a cycling route and makes way for a good connection of the Staalduinse bos to the corridor.

Figure 76 Westland 2040

Detail Coast

The coast of the Westland is a thin strip of dune. The strengthening of the coast will cahnge the experience. With a better connection to the hinterland and the integration of the horticulture identity of the Westland, the Westland may increase in the recreational attractivity. The glasshouses along the edge of the dunes, can integrate functions as irrigation basins in the landscape and make it part of the experience. These basins can be used for the exhibition of floating art. There can also be a limited residential development on the edge of the dunes. This has to be bright architecture and can only be as high as 20 meters.
On the backdune there will develop a pine forest due to the wider coast.
The recreational connection of the Nieuwe Water pierces through the dunes to a pavillion in the glass-house style of the Westland.



LEGEND:

- Sea/Water
- Irrigation basins
- Beach/Reed
- Dune/Green
- Glass
- Parcels
- New houses
- Old houses
- Glass-business
- Migrant accommodation
- Vegetable garden
- Recreational route
- Roads
- Walking paths
- Parking
- Glass-facilities
- Decidious tree
- Pine tree

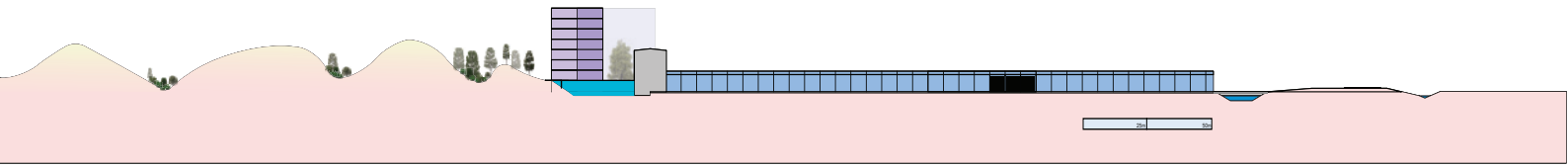


Figure 77 Section coast

Figure 78 Detail coast

Detail Coast

Figure 79 Dune edge now

Figure 80 Dune edge future

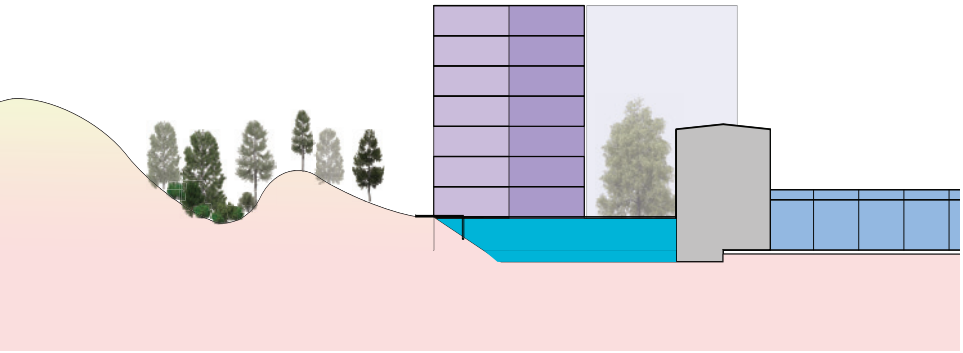


Figure 81 Section dune edge

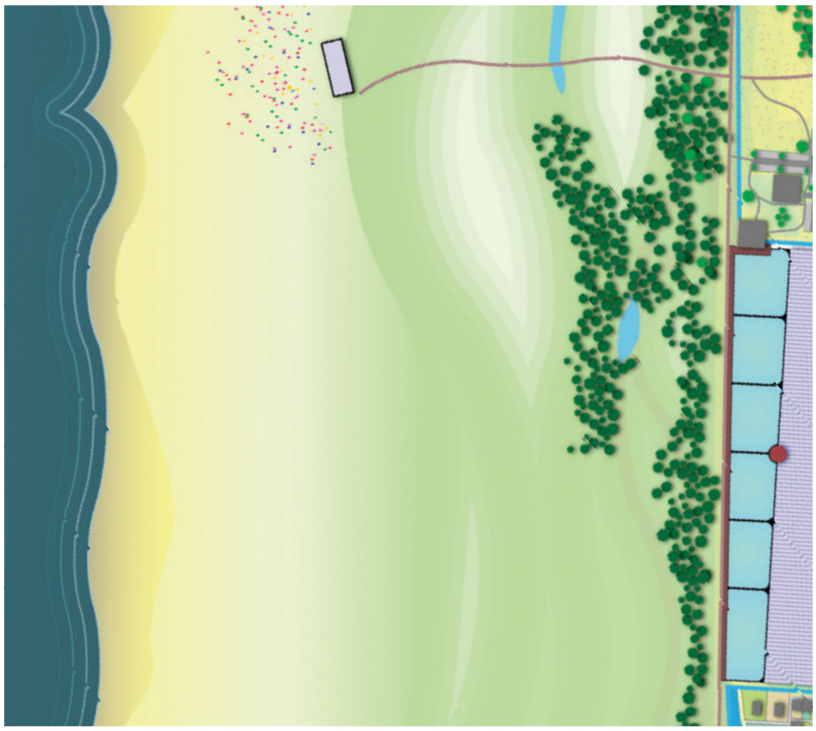


Figure 82 Detail coast

To strengthen the coast the Hoogheemraadschap Delfland has ‘rainbowed’ sand on the beaches of the Westland. Another measure is the expansion of the dune with another dune. This wider coast will diminish the salt spray and with that offer opportunities for a vegetation on the back dune, the tree that can grow in such circumstances is the Pine tree (Pinus sylvestris).

A combination of living and the integration of the glasshouse facilities will create an interesting recreation area on the back dune. Also there are created houses and touristic accomodations on a small scale.

The architecture of the restaurants in beach houses can be inspired by the glass of the Westland and serve local products. In this way the Westland Coast can distinguish itself from other coastal areas.

Figure 83 Westland coast

Branding

Just like in the Mozel area where the names of the wine-companies are on the vineyards in the hills, the Westland could promote its product on a way that fits the Westland.

The marking of glasshouse businesses can be done in several ways. One of these is to use the facilities to brand the Westland and give a business card to the people passing by.

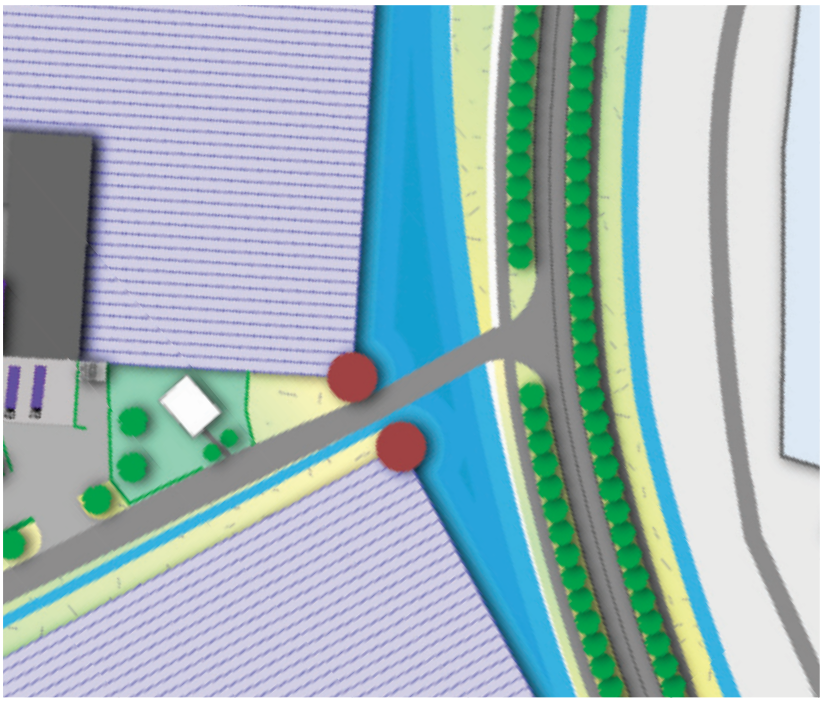


Figure 85 Detail entrance glass-house

Figure 84 Westland coast

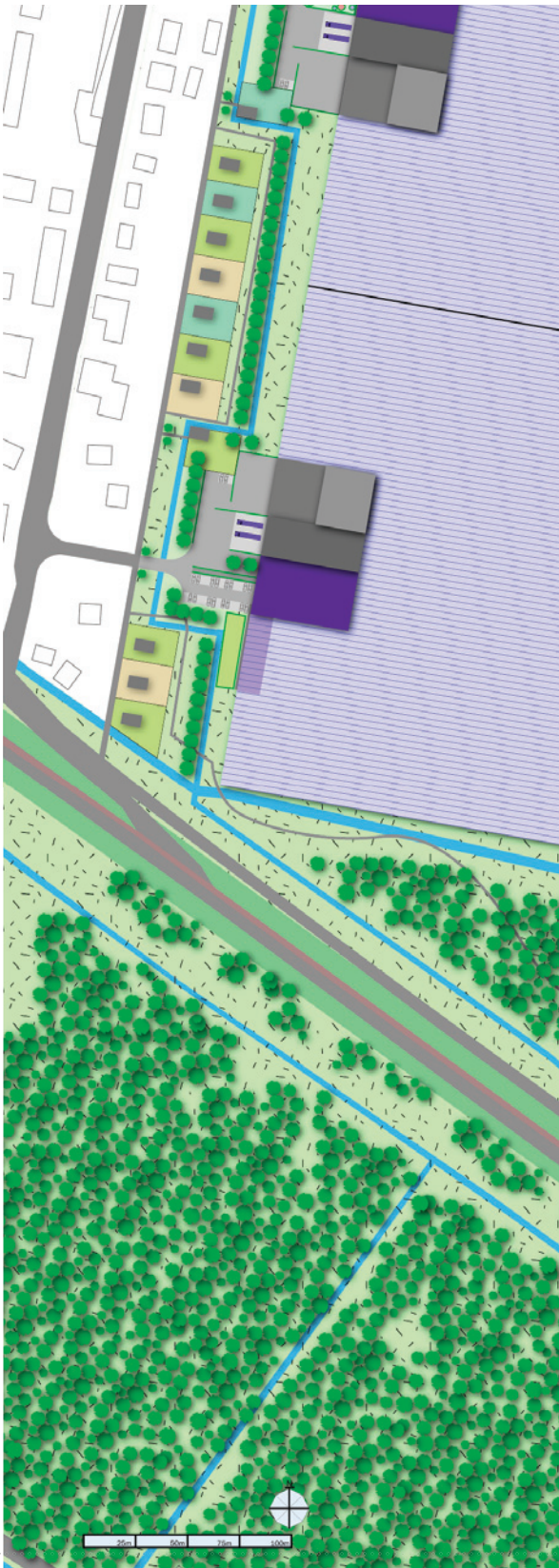
Figure 86 Branding in the Mozel area

Detail Living

In order to make routes and corridors in the Westland there is the need for an integral approach. This to prevent the Westland from becoming a fragmented area with no clear structure. An approach in which the upscaling for glass horticulture and the needed space for waterstorage are the generators of space in the uptight Westland. These provide space for bigger glasshouses (producing), water cleansing, nature, living and recreation.

The facilities of the glasshouses are located at the backside of the glasshouses where the waterways are the integration of these facilities helps creating a new arcadia in the corridor.

The water storage and cleansing is done in a circuit of water with a curvy image, this creates more gradients between the water and land and is beneficial for ecology. In this landscape residential islands are created that give a new view on living in the Westland. The forest `Het Staalduinse Bos´is extended over the Maasdijk to connect to the Nieuwe Water.



LEGEND:

- Sea/Water
- Irrigation basins
- Beach/Reed
- Dune/Green
- Glass
- Parcels
- New houses
- Old houses
- Glass-business
- Migrant accommodation
- Vegetable garden
- Recreational route
- Roads
- Walking paths
- Parking
- Glass-facilities
- Decidious tree
- Pine tree

Figure 87 Detail creek

Living Creek

Figure 88 Creek now being a backside

Figure 89 Creek future becoming green-blue front

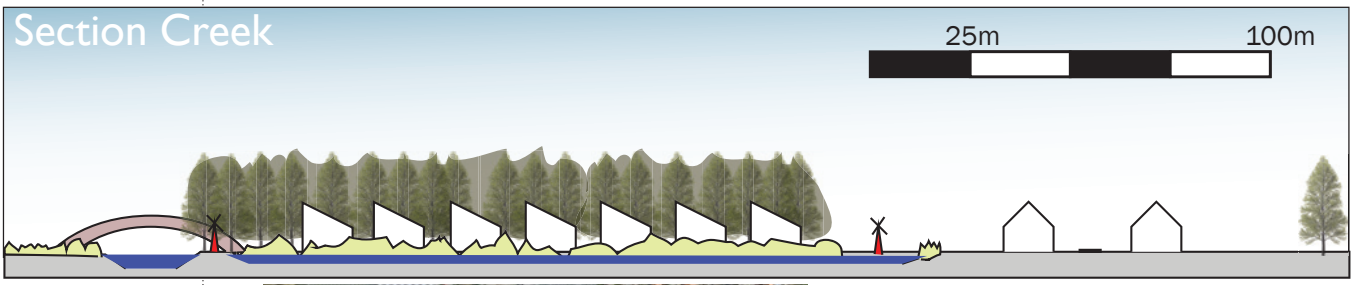


Figure 90 Section creek

Figure 91 Situation before and after renewal

The creek 'Het Nieuwe Water' will be given a wider profile with more space for natural processes such as water purification by helophytes. The expansions of the urban areas are integrated into this corridor, and help creating the corridor.

The urban area even helps with cleansing the water by a filtering system, the water is pumped in a circuit by so called Bosman-mills, that are small windmills with a low capacity (20-25ha, Wikipedia 2012). These can pump the water through the system where nutrients are removed by helophyte plants.

The materials that are used in the public space are mainly soft materials that give a green atmosphere instead of a hard urban atmosphere.

There are created stepping stones for nature throughout the Westland. Forest of ash and willow trees are typical for a wet forest of these rich grounds.

Materialisation

Figure 92 Soft materials (Hosper.nl)

Figure 93 Bosman-Mill (Wikipedia)

Water purification

The water quality in the Westland is very poor, the average levels of Nitrate and Phosphate exceed the maximal levels for Nitrate and Phosphate (Hoogheemraadschap Delfland, 2010). To reach acceptable levels, interventions are necessary. Nowadays many businesses (illegally) discharge their waste-water into the water system. This is tolerated because there is not yet an alternative, plans are made for a connection to a sewer system for this water.
Another possibility is to use natural cleansing to improve the water quality in the Westland. This can be by leading the water through a swamp with Helophytes.
The present value for nitrate is 9,6 mg/l which exceeds the maximum with 7,8 mg/l. For Phosphate this value is 1,9 which exceeds the maximum with 1,6 mg/l. By making a calculation for 1 Ha with a dept of 1 meter this gives an of 78 kilo for N and 16 kilo for P. The disposal effectivity for N is 1300 Kg/Ha (WLDelft, SME 1997) with an factor of 0,5 to promote the ecological management of the helophyte beds. For the disposal a swamp is needed of 1200m/2, 12 percent of the surface (depth 1m, exceeded N level78mg/l). For P the effectivity for disposal is 55 kg/Ha, with the factor 0,5 for ecological effectivity, a swamp is needed of 5818 m2, 58 percent of the surface (depth 1m, exceeded P level 16mg/l).
So assuming an average water depth of 1m a swamp of 58% of the surface should be sufficient to reach an acceptable water quality.

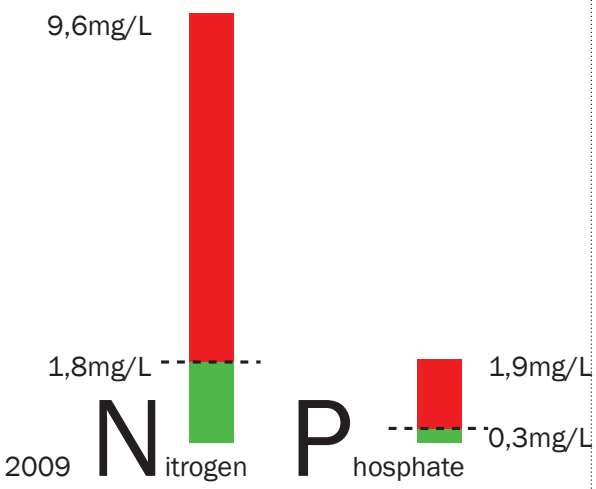


Figure 93 Exceeding levels of N and P (Hoogheemraad-schap Delfland, 2010)

Figure 94 Bosman-Mill (Wikipedia)

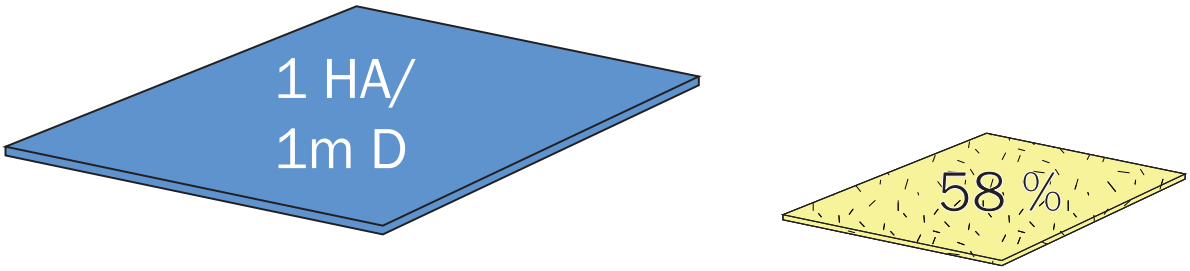


Figure 95 ratio water and reedfilter

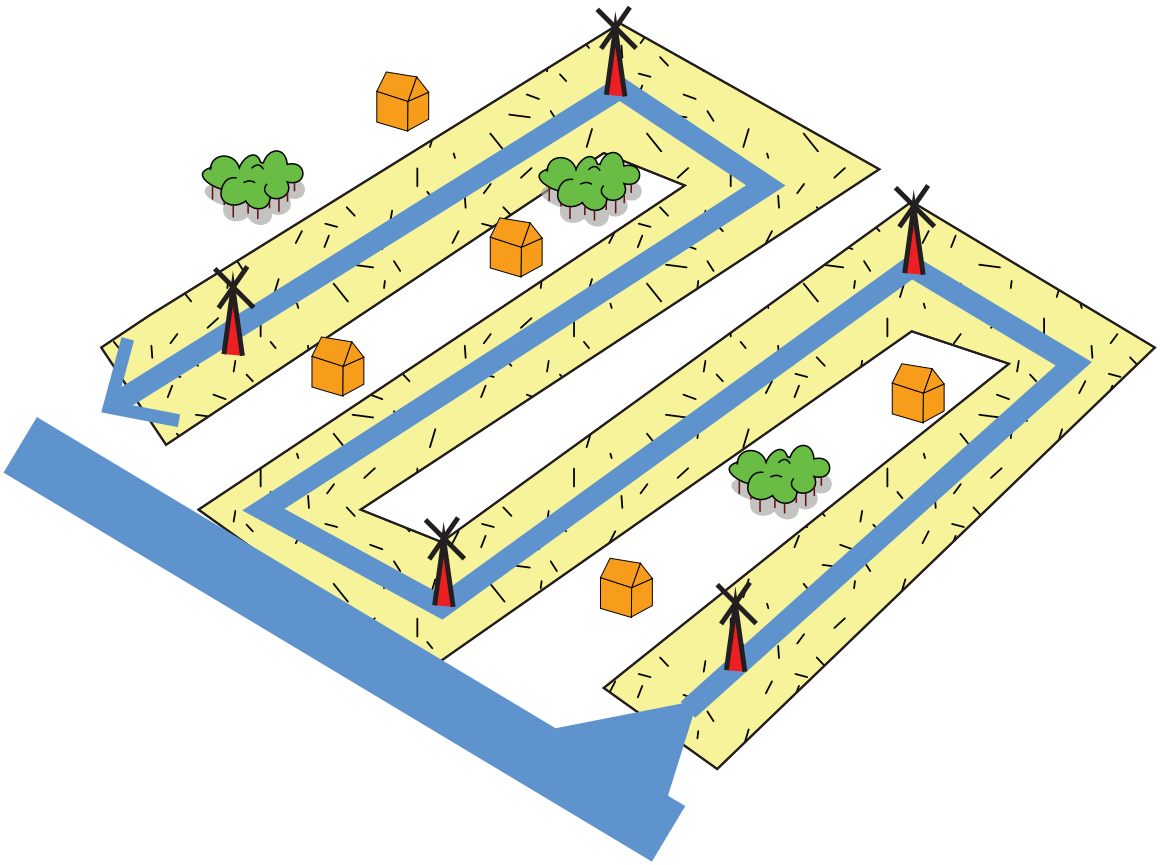


Figure 96 Principle of living and water purification

Creek

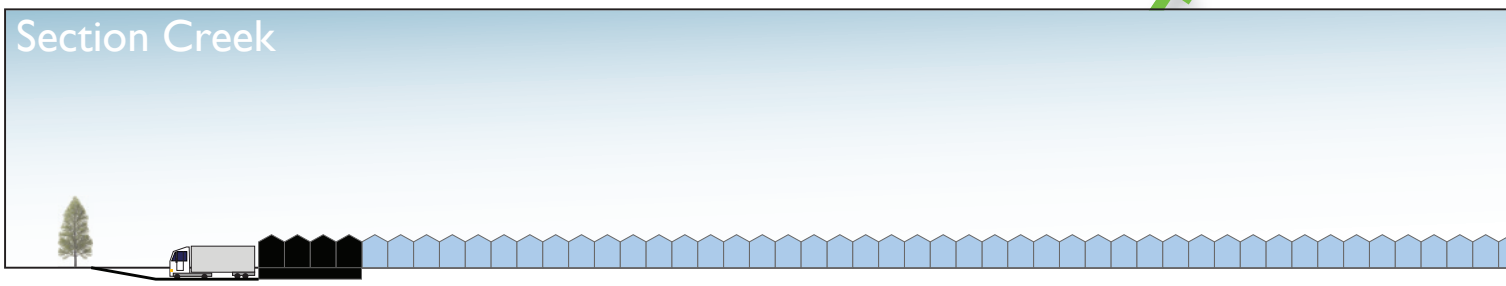


Figure 98 The creek is a backside

Figure 99 The creek is a recreative connection with the integration of facilities for glass-houses

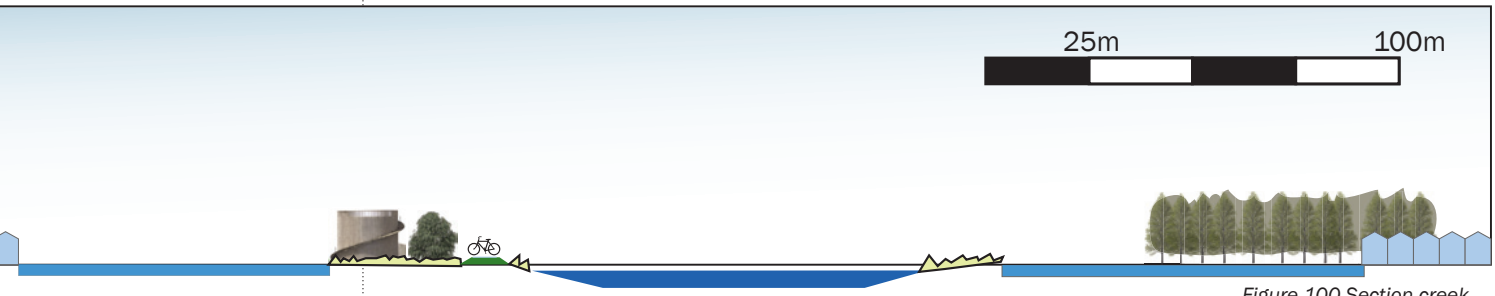


Figure 100 Section creek

Figure 101 Situation before and after renewal

On some spots the creek will have an appearance that is determinded by the glass surrounding it. In this landscape the facilities for glasshouses such as water basins and heat storage tanks can be integrated into the landscape.

The water storage can be integrated so it will be under the surface level and does not look like a big plastic dike. The heat storage tanks can become watchtowers over the landscape or can be architecturally implemented.

The glasshouses scale wil be around 10 hectares, by making electricity generating glasshouses these could help making the environment more sustainable.

The glasshouses can offer some of their local products to the recreants. On the more bussy routes even a restaurant in a glasshouse can be created.

Up: Figure 102 Product branding Westland
Down Figure 103 ElKas concept (WUR)

Glass and Sustainability

Heat storage and links
In the new developped residential area 'Het Hoogeland' near Naaldwijk is made a link between glasshouses and other buildings. In this case the link between a geothermical heat source and 34 000 m2 of glasshouse delivers sufficient heat to 800 houses. The glashouse transfers the heat to the buildings and the residential area delivers back a minimum of cold (Vestia, 2010).

Glass and electricity
The last 20 years a huge leap has been made in the energy efficiency of the glasshouse, in comparison to 1990 now glass-houses use 53% less primary fuel is used per unit of product (Velden, van der 2010, p. 8.). At the moment the glass-house has a huge demand for energy, only 1,3 percent of this energy is renewably generated (Velden, van der 2010, p. 9.). This is far below the directive of 4 percent for 2010 and 20 percent for the year 2020 (Velden, van der 2010, p. 9.).

The University of Wageningen has developped a new concept of glasshouse in which the glasshouse becomes an energy producer. This is the so called ElKas that can deliver the average of 20 kWh/year/m2 (Visser, 2008). The average household uses 3480kWh of electricity a year (NIBUD, 2011) so one hectare is able to generate electricity for 57 households.

Potential of the ElKas
In 2009 the total are of glasshouses was 10 324,06 Ha (CBS, 2010). If this surface can be translated into glasshouses like the ElKas the total energy production could be 2,064 billion kWh a year. The total use for glass horticulture of the year 2009 was 7,3 billion kWh (Velden, van der 2010, p. 35.) . So with the ideal circumstances the ElKas can deliver 28,3 percent of the energy consumption of glass-horticulture itself.
With a lot of Combined Heat and Power plants CHP, Glass horticulture is already a net producer of energy, in 2009 11 billion kWh was produced, this is about 10 percent of the national electricity use (Velden, van der 2010, p. 35.). The electricity generating in the CHP's is mainly directed from gas. The partial replacement of the CHP should deliver a reduction in the use of fossil fuels.

Figure 104 ElKas Concept (WUR)

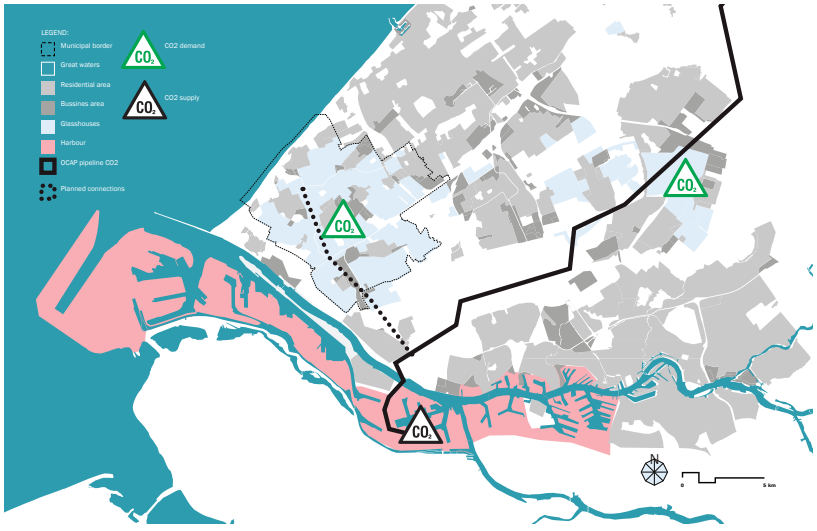


Figure 105 OCAP Network for CO2

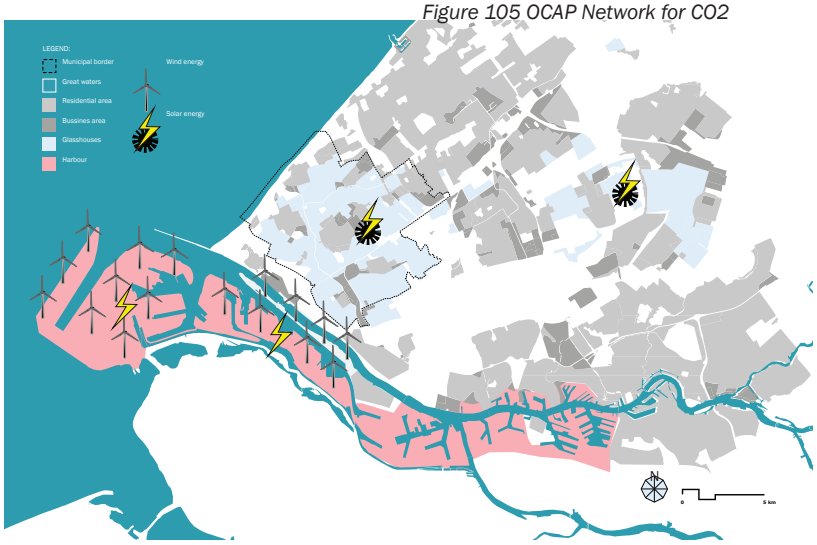


Figure 106 Energy production in the harbour and Westland

Glasshouses and recycling

The waste flows of glass-horticulture could be used for various applications, one of these is the use of waste flows of organic material to produce bio-gasses, these can than deliver electricity (Xplorelab, 2011).
The present waste flow of biomass in the Westland is around 100 000 tons, a combination with the organic substrate from Sewage Treatment Plants could increase this amount of biomass to circa 180 000 tons. The calculations of the province of Zuid-Holland (2011), show that this can deliver 23 325 915 m3 of biogas. The present biomass is treated at Van Vliet Recycling which is located at the South of the Westland along the Nieuwe Waterweg. The Amount of energy that can be yielded from one cubic meter of biogas is 6 kWh, this is converted to 4 kWh of heat and 2 kWh of electricity (Electricgaz, 2010). This heat can be distributed throughout the Westland for the use in glasshouses in the planned heat transportation network. The electricity can be delivered to the network. With taken in account an electricty use of 3480 kWh(NIBUD, 2011), this indicates that 13 405 households can be sustained with this energy.

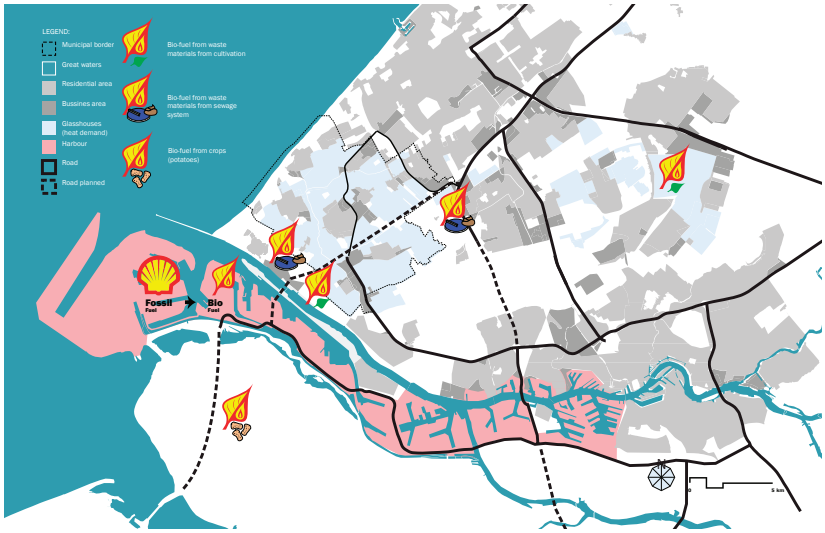


Figure 107 Biogas production opportunities in the Westland

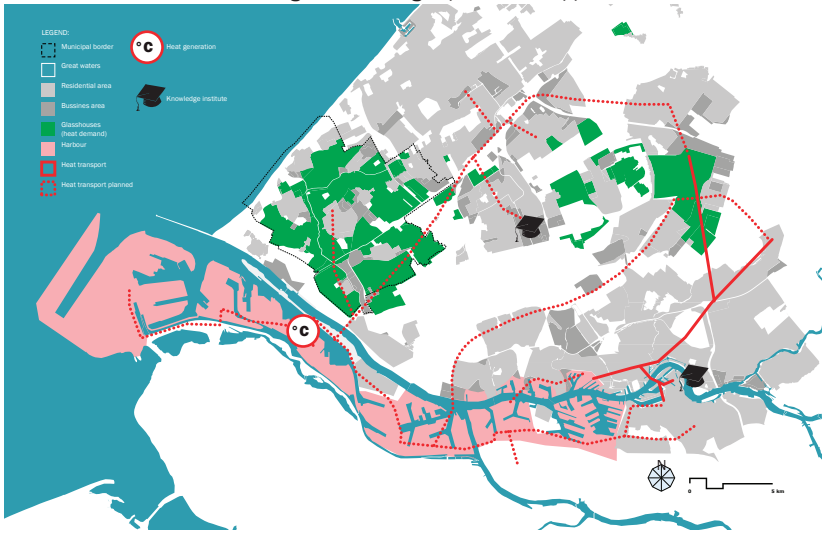


Figure 108 Heat network and projected network

CO2

In 2008 there has been agreed within the Agroconvenant that the glass-horticulture will reduce 3,3 Mton CO2 with respect to the year 1990. The use of CHP's delivers a gain of 2,3 Mton and the reduction of 1Mton is related to the cultivation(Velden, van der 2010, p. 14). However, these CHP's still prevent the goal of reaching 20 percent of renewable energy in the glass-horticulture (Velden, van der 2010, p. 10). An old oil pipe from the harbour of Rotterdam is used for transporting CO2 for the growth of plants, this so called OCAP project saves 95 milion m3 of gas and 170 kton of CO2 (Wetzels, 2007 p.23).

CHP

Within glass-horticulture CHP's are used to sustain in the need for electricity, heat and CO2. In this process fossil gas is used to generate energy, despite its efficiency in the re-use of CO2 and heat the CHP's do not deliver renewable energy. The use of the ElKas can be used to replace a part of the energy production of the CHP's the heat from the CO2 can be replaced by the heat from biogas production and the CO2 of the CHP's can be replaced by transporting the CO2 of the harbour area to the Westland. In this way the CHP can be replaced first partially and on the longer term maybe totally.

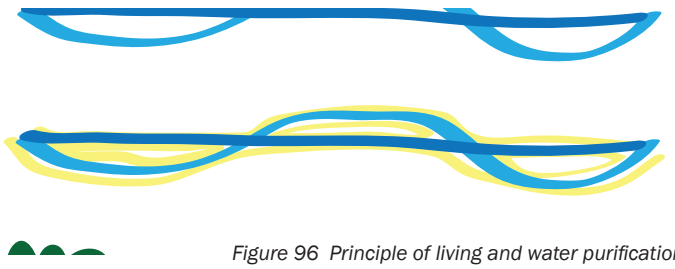


Figure 96 Principle of living and water purification

Figure 109 Dike and creek now

Figure 110 Dike creek and forest in the future

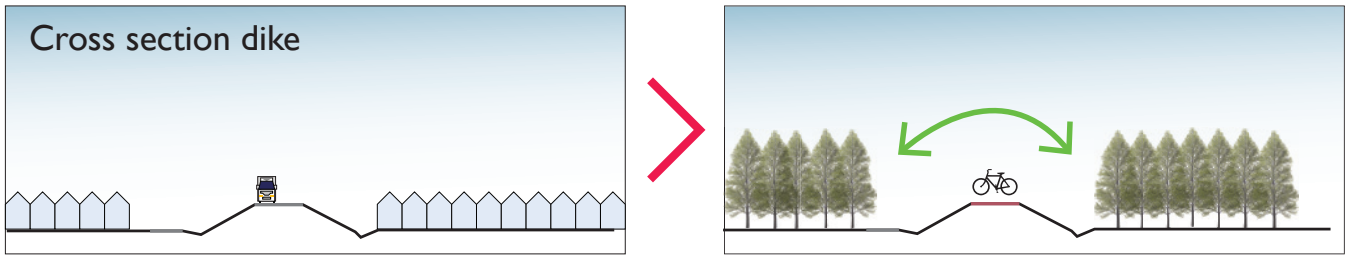


Figure 111 Barrier dike becomes point of experience and good bridgeable for nature

The Maasdijk nowadays is a busy road on a dike, from the dike there are beautiful perspectives on the landscape.

Due to the heavy traffic it has become a barrier in the Westland, a barrier for nature as well as for people.

By moving the heavy traffic to both the banks of the Nieuwe Waterweg and the N467 the Maasdijik can become a bicycle path with additional slow traffic.

From this dike there are good views over ‘Het Nieuwe Water’ and the glasshouses of the Westland, At the same time can nature cross the dike more easily.

Figure 112 Situation before and after renewal

Figure 113 infrastructure and dike

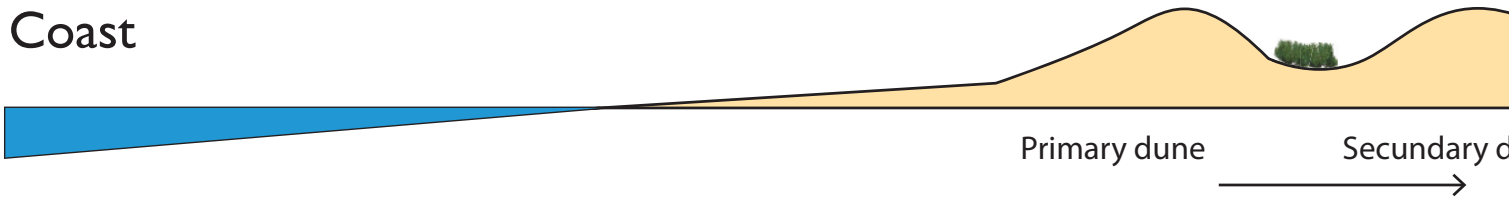


Figure 114 Ecological section coast and dunes

Figure 115 Different trees and their place in the Westland

Creek: Marsh Forest

Figure 116 Ecological profiles (Willem Brouwers)

lune Backdune

Pine woodland

a

Nowadays nature can only be found outside the Westland, be it the dunes, forest or the meadows. The fact that there is limited public space and that there are almost no trees in the city of glass mark this industrial landscape.

There is a need for a green structure in the Westland; First, the water quality is poor and because of the Westland being merely a dead system; a green structure could help brining it alive for instance by purifying the water. Second, there is the need for water storage in the lower areas, this could be done in a green structure. Third, there is an underdeveloped framework for recreation, a green structure could be used for this function and is a healthy surrounding for people. Fourth, there is no diversity of life in the Westland, a developed green structure could help bringing more diverse ecological life into the Westland.

A different approach to each area could deliver a spatially more diverse Westland.

Coast

Dunes are a dynamic ecosystem with a typical transition of species from the coast till the back dunes. On the front pioneers such as dune grasses lay the first foundation for dunes, and in the lee of the dune valley there can grow a low thicket, the back dunes are suitable for pine forests.

Creek

The creeks in the Westland are former tidal creeks, now they largely have the same path but they lack the dynamics. The creeks can be redeveloped by giving them space and using them for the storage of water. The banks can be developed in a nature friendly way.

Forest

The conditions in the Westland are suitable for a Birch-Ash forest, a slow natural growth will help creating a diverse forest.

Polder

The polders areas have a rectangular parcelling, this polder landscape fits the Poplar tree, it has architectonical qualities and functions as a wind break in the open landscape of the polder.

Detail integration glass

On the logistic side of the glasshouses a minimal design gives access to the glasshouse. There is the possibility for the Horticulturist to have a house on the terrain of the glasshouse. Also accomodations for migrant workers can be integrated in the glasshouse. For these people whom mainly orginate from eastern Europe there is the possibility to grow their vegetables in the communal garden for the season they are employed in the glasshouse.

Figure 117 Integrated labourer accomodations

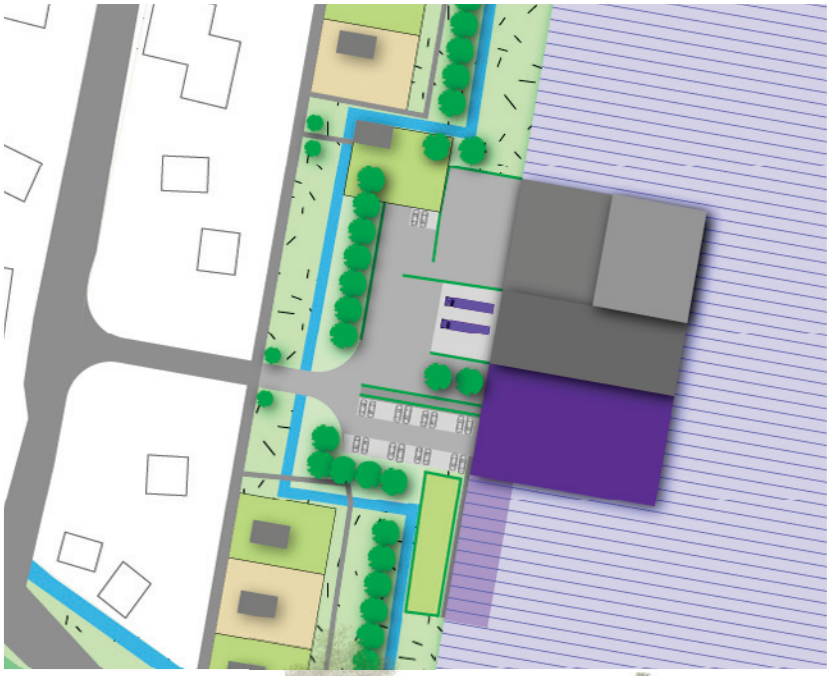


Figure 118 Principles of the Glass-house court

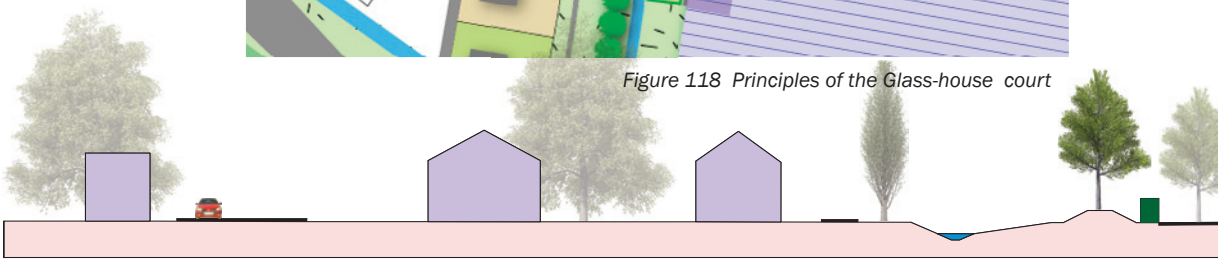


Figure 119 Geothermal spa combined with glass-horticulture

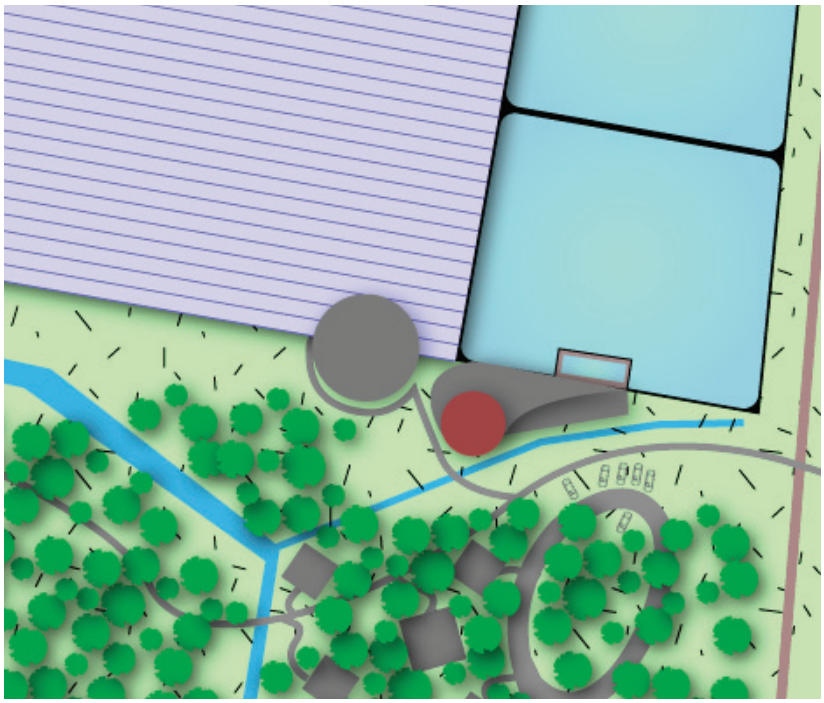


Figure 120 geothermal spa and Bumgalowpark

The broadening horticulture businesses could also broaden their businesses to other branches that supplement their horticultural income. The geothermal heat can heaten up the glass-houses and at the same time the Spa where local products are served and the special atmosphere of the Westland can be enjoyed.

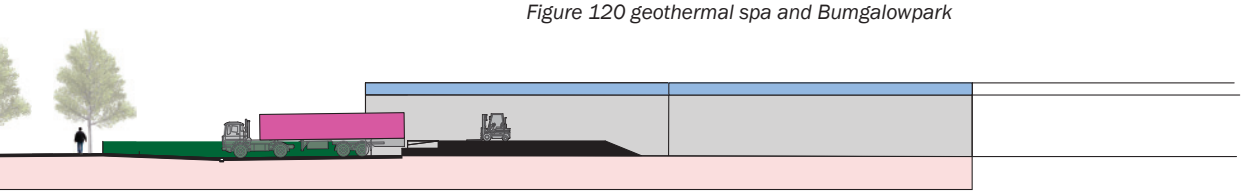
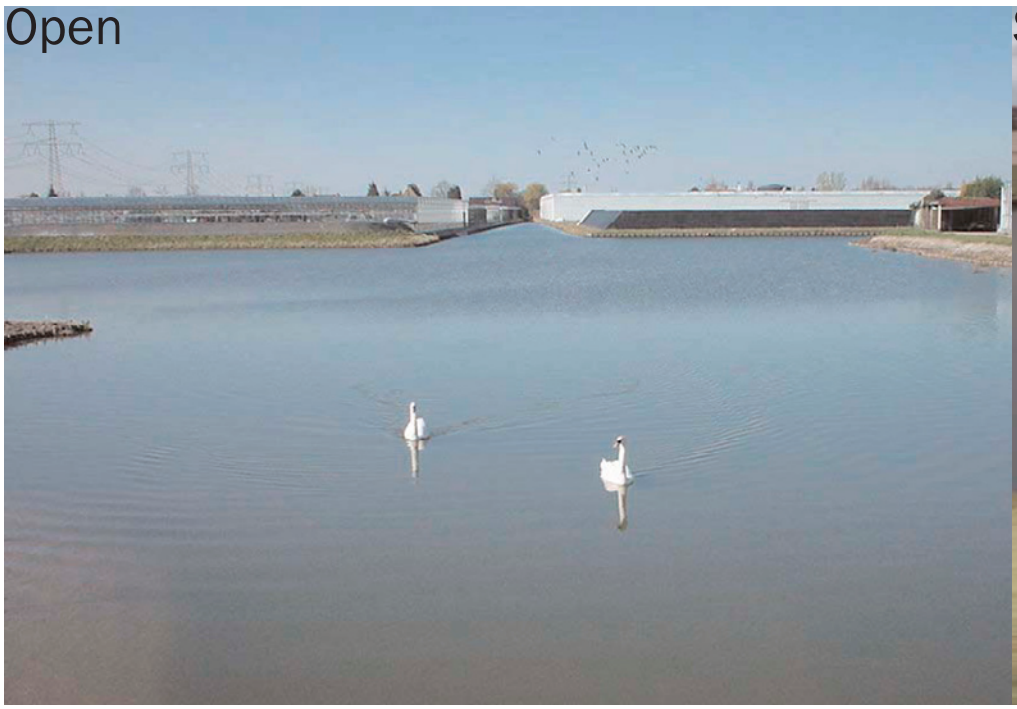
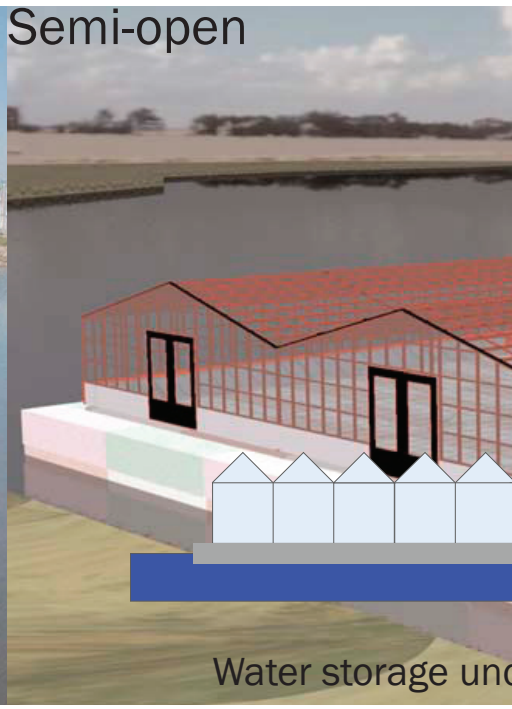


Figure 121 section Glass-house court

Figure 122 Larger water storage unities in the Westland





In the lower areas of the Westland there is the need for bigger peek storages for water. One option is the open storage, this can be done in the form of small lakes or temporary flooded areas.

The semi-open storage can be done under glasshouses or can be lakes with floating glasshouses. To find if other functions are also possible a pilot project called 'Floating Roses' is going to research the effects of a floating glasshouse of 5ha on the water quality. If this turns to be positive a floating glasshouse could be an option for making the water storage functional.

Then there is closed storage, where water can be stored in a second aquifer or in closed compartments under glasshouses. The storage in closed compartments is also bad for the quality and with the present quality of the water it is not possible to store in deeper aquifers because of the pollution (DuraVermeer, 2002).

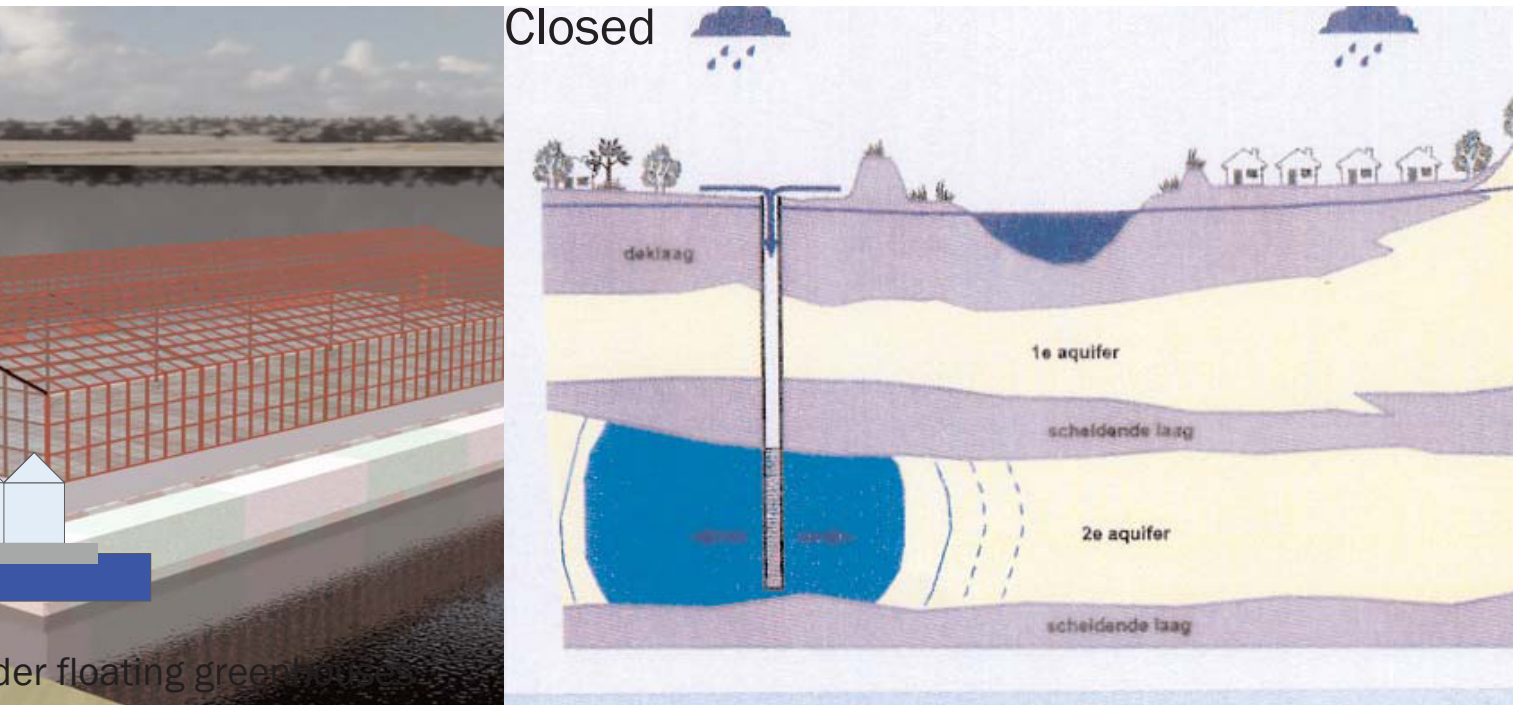
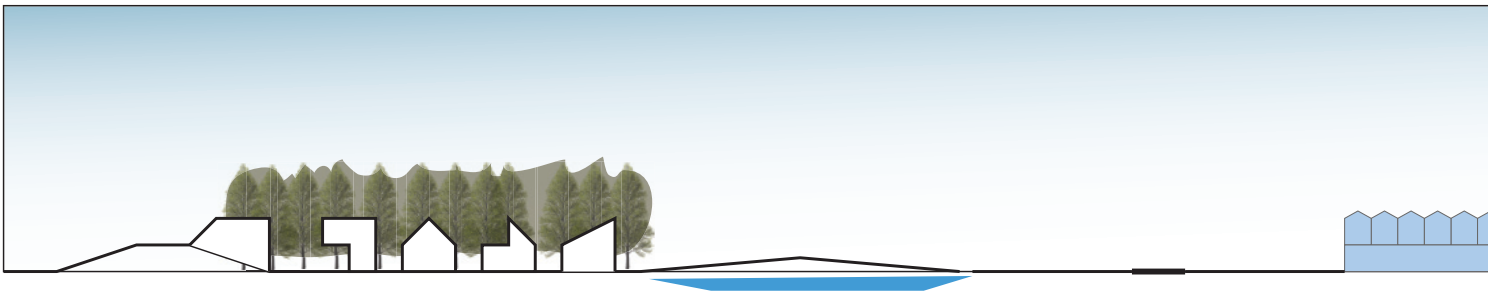


Figure 123 Different water storage strategies. (DuraVermeer, 2002)

Businesses



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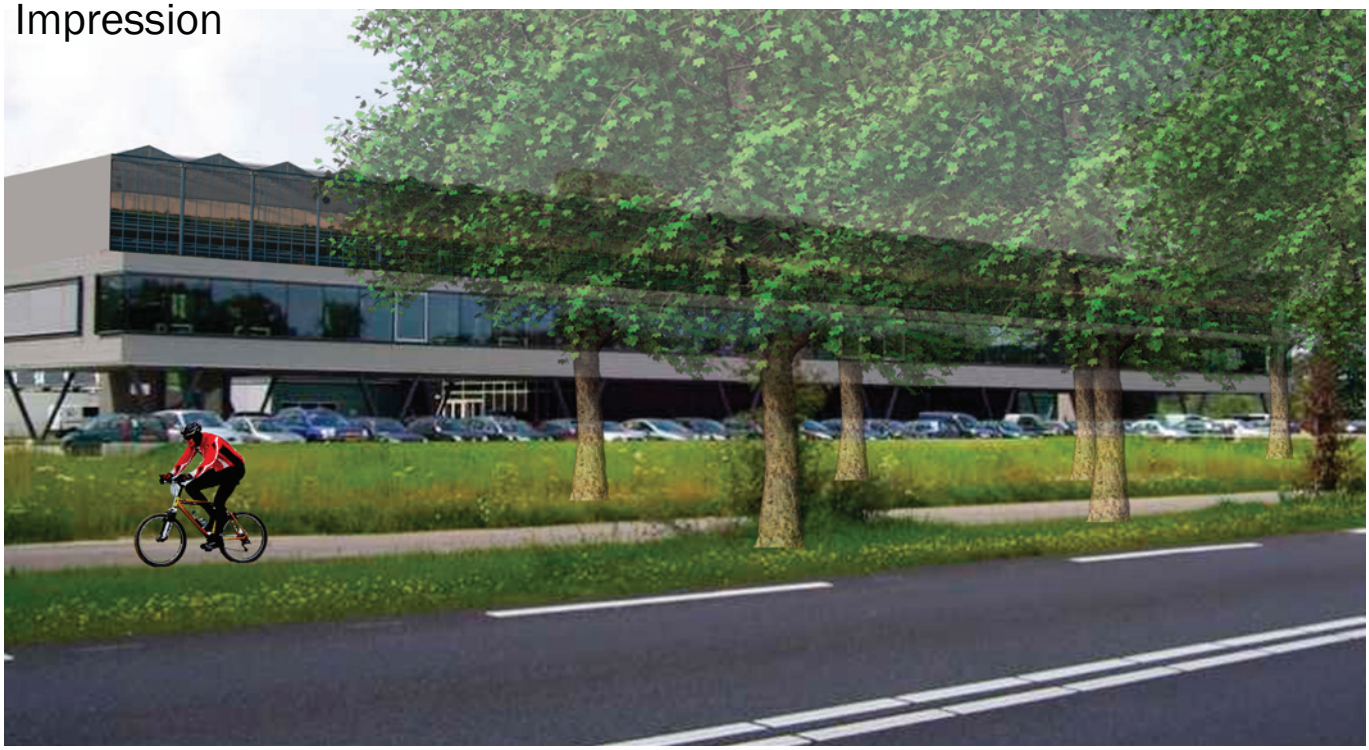


Figure 124 integral development logistic routes and businesses

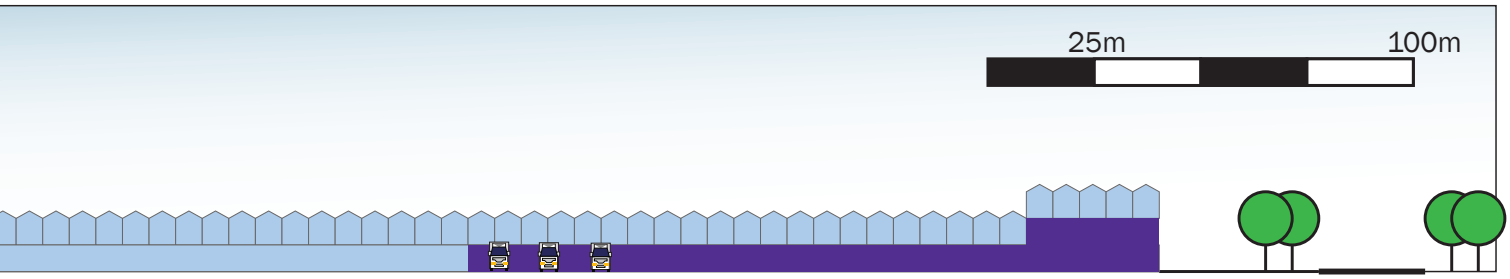


Figure 125 Section business park

Figure 126 Situation before and after renewal

The roads through the Westland have a bad appearance, they are practically one stroke of asphalt with some lampposts and sound barriers. To give the Westland a better appearance on the road, these roads should be upgraded to avenues.

The present situation with the glasshouse and businesses with their backsides on the road should be replaced by an intelligent design of glasshouses and businesses.

The connections through the Westland will support the new spatial image of the city of glass.

Figure 127 Good example of business and production (OVATA)

Realisation and support

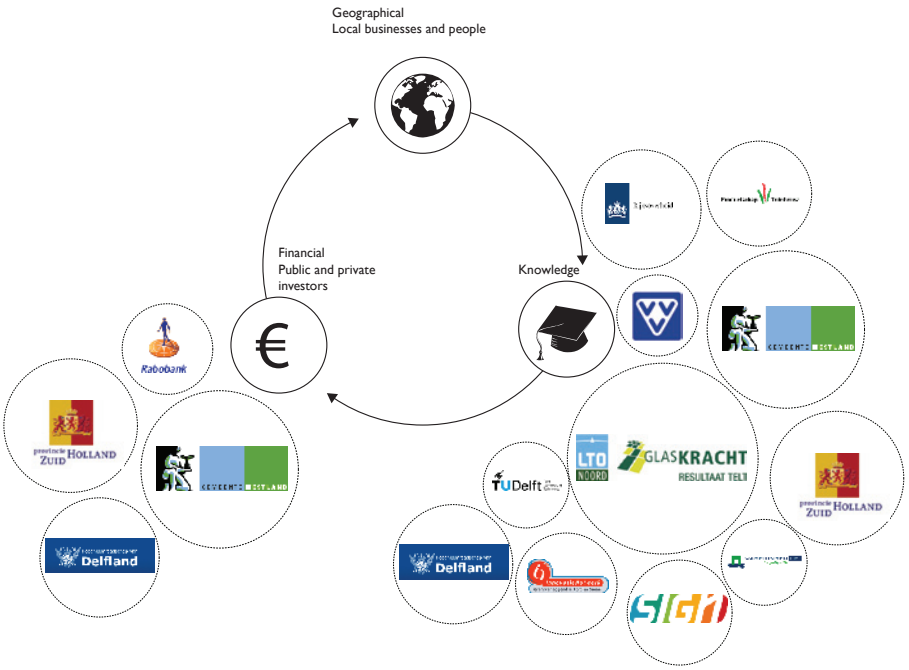


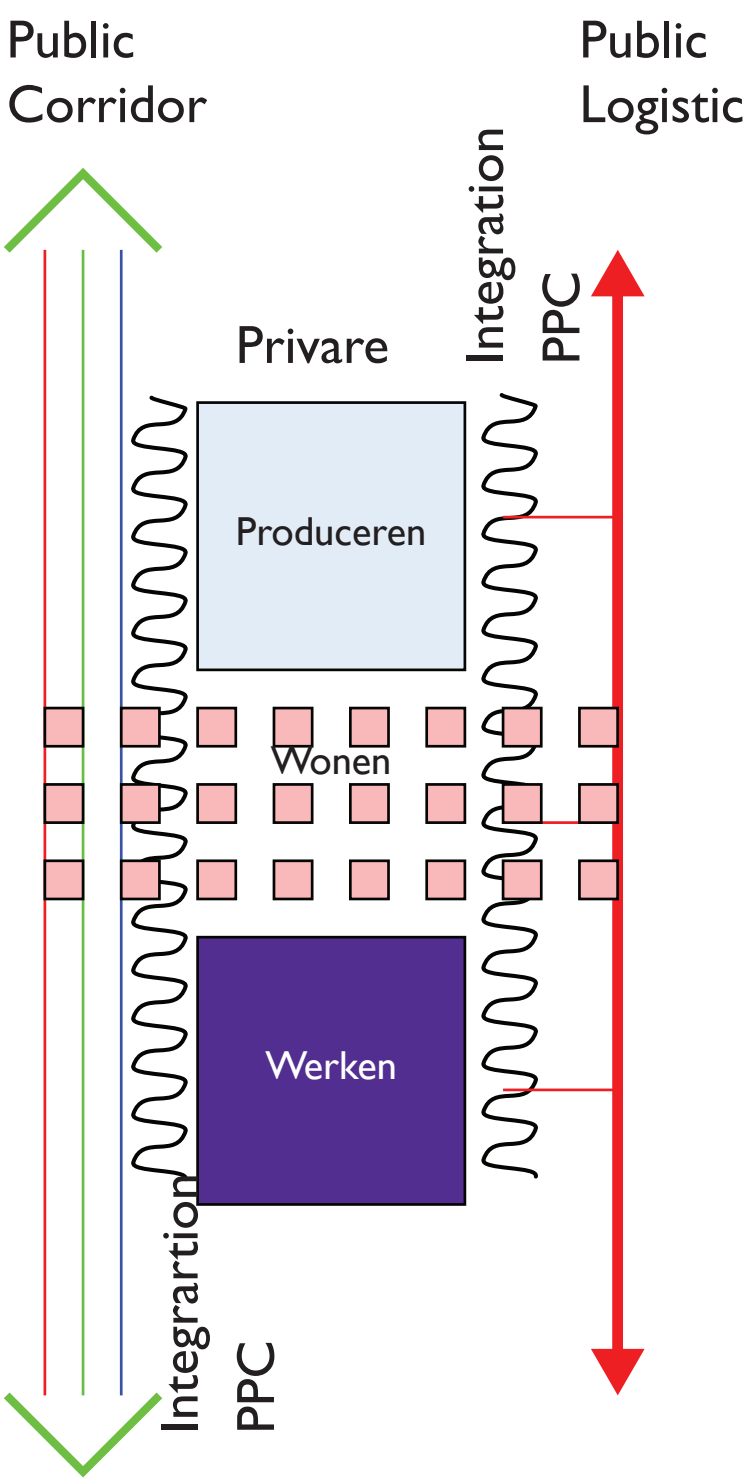
Figure 128 Clouds of actors

To renew the Westland there is the need for a coöperation between different actors throughout the layers and areas of the Westland.

There is the need for local entrepreneurship that can be sustained by the knowledge of different labs, institutes and organisations.

With the public and private investors the vision for a new Westland can be shaped in the direction of an ideal sustainable Westland.

Together these groups have to interact and form a public private collaboration(PPC). This group has to bring together the local entrepreneurs, the knowledge and the investors.



The framework of corridors have to be made by different actors. The central public corridor with the recreational water and cycling routes , the nature connections and the water storage and purification areas have to be created by the governemental and public organizations, supplemented with private, residential developments.

Linked to this corridors there can be developped plans for houses, glass-houses and businesses. These can be made in a way they interact with the public corridor.

Together this will renew the structure and the pattern of the Westland, it will make a new experience of the Westland.

Figure 129 Principles of realisation

Conclusion

To give the Westland a sustainable future, the focus should lay on solving the problems integrally. In this way spatial relations can be obtained that deliver a mutual quality. For example the combination of living with nature, water storage, water cleansing and recreation. If these would be goals in themselves without looking to the bigger picture an opportunity will be lost.

The use of routes in the Westland with the application of programmes around these routes in the so called corridors will eventually provide a strong and sustainable framework. This framework will pierce through the now monotonous Westland and will create a green structure and generate renewal for the water system and glass horticulture.

The routes for cycling and water will strengthen the recreational network of the Westland, the logistic route will improve the appearance of the Westland from the road and gain better connections to the mainports.

In order to reach these goals there has te be a consistent vision and coöperation. Therefore there is the need of a public privitate coöperation (PPC) in which the local, knowledge and financial are represented. This PPC has to do a pilot project, and based on the experience of this pilot the net of routes and corridors can be develloped.

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The Greenhouse effect

How unsustainable becomes sustainable

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Abstract – The greenhouse came forth out of the orangery, through innovations in glass, heating and growing conditions the commercial glasshouse was developed in the twentieth century. Whilst earlier greenhouses came with prestige and ornaments, the commercial glasshouses were stripped of all ornaments and purely functional. In the seventies the image of these commercial greenhouses was damaged. The energy crisis made people aware of the state of the earth. Greenhouses in these times were heavy energy consumers, because of the use of electrical lighting during night and the heating in colder times. The commercial glasshouse was polluting; this was no example of a sustainable development. But what is this sustainable development?
This paper reviews different approaches on sustainability and tries to see links between those approaches. In the triple bottom-line (TBL) concept of John Elkington (1997), sustainability is unravelled in three pillars: People, Planet and Profit. These three pillars are combined with the definition of spatial quality, which subdivides spatial quality in use-value, experience value and future value. The TBL concept can be used as a holistic model for understanding sustainable development. Other approaches stimulated the sustainable dealing with energy and the closing of different cycles. By combining these approaches a holistic and sustainable approach is obtained.
In order to see what possibilities there are for glasshouses some experiments and state of the art projects for sustainable glass are described. From these projects different sustainable principles are extracted.
These principles are placed in the sustainable approach to see how glasshouses can become mediators for sustainability. The conclusion could be that links with other functions create possibilities to improve the sustainability, when greenhouses are placed in a holistic approach for improving sustainability.

Key words – greenhouse, glasshouse, history, definition sustainability, sustainable energy, closed cycles, spatial design.

1 Introduction

The genesis of the glasshouse is one which illustrates the ingenuity of men and also the tendency to cultivate the exotic; to cultivate nature. In different cultures and beliefs the garden is the beginning of the world, in the Christian faith Adam and Eve cultivated the Garden of Eden. The tendency to cultivate nature delivered numerous innovations, but also alienated men from nature itself. Men were expelled from paradise, but left with the urge to innovate in search of a better world, a paradise.

This paper describes how the glasshouses came into being and developed in time, from the early history till now. This shows the different connotations of greenhouses. The emphasis is laid on the recent history and the 'emergence' of sustainability; what does sustainable mean and how can glasshouses become more sustainable. This in order to see which future possibilities arise for the sustainable implementation of greenhouses in the Netherlands. The target group of this paper are spatial designers whom are interesting in enhancing sustainability, creating a world that looks a bit more like paradise.

In order to understand the greenhouse, its different uses and connotations, this paper starts with a historical overview of the development of the greenhouse. The main books used in this second paragraph are: 'A history of greenhouses' (Muijzenberg, 1980) and 'Glasshouses' (Woods and Swartz-Warren, 1988). 'A history of greenhouses' is used because of its academic approach and the decent underpinning with references. The book 'Glasshouses' is used because it describes the history more coherently and approaches the history from a British perspective. Complementary some sources that support the storyline.
The third paragraph gives more attention to the recent developments and the rising awareness of the need for a sustainable approach. Different

approaches for sustainability are reviewed to create a better understanding of sustainability. To understand sustainability, the works 'Autonomie en heteronomie' (Timmeren, van, 2006) and 'Sustainability through local opportunities' (Dobbelsteen, van de, 2010) are used. These books reflect on the time after the energy crisis and display the development and understandings of sustainability.

To see what position the greenhouse has in relation to sustainability, the fourth paragraph uses the projects 'City Fruitful' (Kuiper Compagnons, 1992) and 'De Zonneterp' (Wortmann, 2005). Besides these works, some other experiments and projects are mentioned that are relevant for sustainable greenhouses.

The conclusion in the fifth paragraph gives insights derived from the research. Sustainable principles for greenhouse design are extracted by understanding different approaches and the experiments and projects of greenhouses with a sustainable focus. The sixth paragraph gives recommendations for further research on sustainable greenhouses.

2 The History of the greenhouse

The evolution of the greenhouse starts in the Antique with early uses of growing cucumbers for Emperor Tiberius Caesar. Cucumbers were planted in moveable hot-beds which could be transported inside caves or walls with mica in the case of bad weather or frost (Muijzenberg, 1980)(Woods and Swartz-Warren, 1988).

In the late Middle-Ages and Renaissance, the cultivation of exotic species, such as oranges, in the gardens of the Italian Villas, led to the development of the orangery. These orangeries were buildings that were used for the wintering of oranges and came with an amount of prestige, which is visible by the decoration of these buildings with ornaments (Woods and Swartz-Warren, 1988, p. 3).

Because the collecting of exotic plants became fashion under the European Courts, the concept of the orangery found its way over the whole continent. Marriages among de'Medici's with the court of France, the Stuarts of England and the Princes of Oranges in the Netherlands made that the horticultural hobby spread too(Woods and Swartz-Warren, 1988).

The use of orangeries stimulated the emergence of the greenhouse, a building that was comparable to the orangery but differed with slightly bigger windows and the cultivation of other plants. Another aspect that was integrated in these orangeries and greenhouses was heating in order to guarantee a temperature that was frost-free.
In the year 1664 the Englishman John Evelyn developed the concept of heating stoves outside of the greenhouse to prevent damage to the plants by noxious fumes from heating stoves. Evelyn was the first known to use the word conservatory for greenhouses (Woods and Swartz-Warren, 1988, p. 29,31). One of the first to write about the agricultural application of lighter structures was Olivier des Serres in 'Le Théâtre d'Agriculture' (1600). In the French language –but it also made it into other languages- the name for greenhouses was Serre, derived from the name of Des Serres (Muijzenberg, 1980, p. 46, Woods and Swartz-Warren, 1988, p. 16).

In the eighteenth century innovations in glass created opportunities to make bigger glass surfaces, which took the English Dr Bradley to think about the improvement of the greenhouse. During his collaboration with the Italian architect Allesandro Galilei, in 1718 Galilei designed the first greenhouse with a partially glazed roof (Woods and Swartz-Warren, 1988, p. 56).

In the middle of the eighteenth century the English garden which was picturesque and romantic, broke through the former hegemony of symmetry. In these gardens the greenhouse was built as an architectural ornament. All kinds of greenhouses were designed: from Classical Greek design to Baroque and Gothic. With the emphasis more on ornament than function, these greenhouses became follies in the landscape style (Woods and Swartz-Warren, 1988, p. 50-51). The combination of the improved light penetration and the heating created possibilities to grow other species like pineapples (Muijzenberg, 1980, p.97).

Later innovations of the nineteenth century made whole glazed roofs possible; furthermore ventilation and heat systems were developed. By this progress big glasshouses in the form of domes and halls were possible, as shows the design for Crystal palace for the Great Exhibition of 1851 by John Paxton (Woods and Swartz-Warren, 1988, p. 142).

Continuing developments of the twentieth century gave form to the commercial glasshouse, in these glasshouses fruits and crops could be cultivated on a larger scale, technologies for heating were further developed and the use of electricity was explored. These glasshouses such as the 'Westland Warenhuis' of 1920 and the 'Venlo Warenhuis' of 1937(Muijzenberg, 1980, p. 219,224), were pure functional glasshouses and supported with the needed technologies.

After the World War II the glasshouse industry had many developments. Vegetables like tomatoes and paprika became the most cultivated in Dutch glasshouses (illustration1). In these times experiments were done with electric light; with different light colours and different light intensities plants proved to be the most sensitive for orange and red light (Kasklimaat.nl). Also different experiments were laid out with the influence of light on the CO2 assimilation (Muijzenberg, 1980, p. 246).

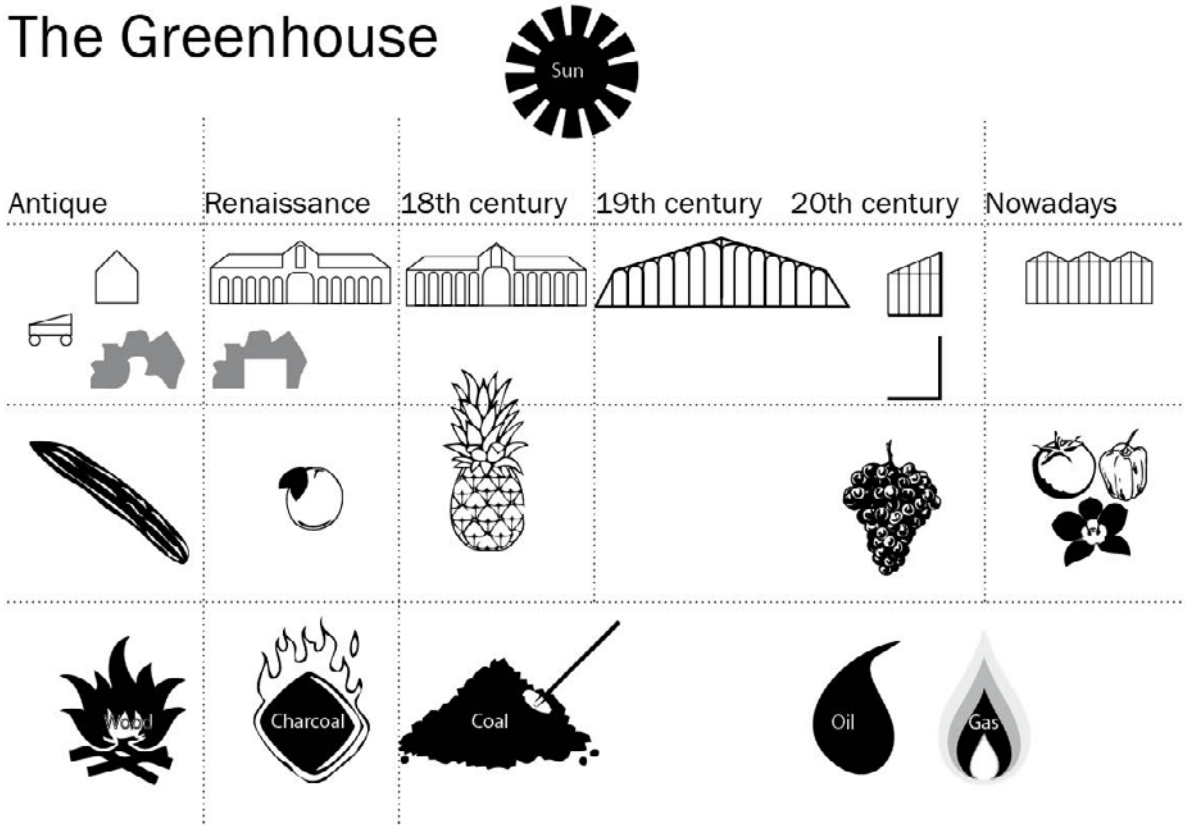

Illustration 1 The history of greenhouses in form, cultivation and energy use (Machiel Crielaard).

Soon fuels like oil and gas replaced the coal as main fuel (Muijzenberg, 1980, p.185). In the seventies of the twentieth century the wealth of Holland was rapidly increasing and so too the energy consumption. In 1972 the report 'The Limits to growth' of the Club of Rome predicts the depletion of energy resources (Meadows, 1972). A year after the report of the Club of Rome, in 1973, the first oil crisis took place and soon the second followed in 1979; these crises show the dependency of society on oil. According to the Club of Rome, the earth was waiting an ecological disaster (Van Hal, 2000,p. 8). This moment marks the turn to an approach which limited pollution and tied to save energy (Ibid.).

This turn is also seen in the glasshouse horticulture sector. The glasshouse horticulture sector was very energy consuming and the light pollution made the glasshouses a symbol of unsustainability. In the end of the seventies were experiments done with the transfer of heat from energy generators to glasshouses (Muijzenberg, 1980, p.322). Horticulturists could have their own decentred energy supply on gas and use the released heat of energy production and the energy needed for lighting in their glasshouses; the surplus of energy could be supplied to the public electricity grid (Ibid.).

3 Sustainability

After the energy crises awareness rose for the need of a sustainable approach, in order to deal with pollution of the environment and the future depletion of resources (International Energy Agency, 2008).. The first known reference of sustainability is known from the Roman architect Vitruvius who mentioned the aspects utilitas (usability), venustas (beauty) and firmitas (soundness) (Ministerie van VROM, n.d.).

In the seventies the Dutch government already stimulated energy saving and in these years the first pilot projects were done with solar energy and the isolation of houses (Van Hal, 2000,p. 8). The period of the seventies was a period of a waking awareness

of the state of the world. From that moment on different experiments were done with green building.

3.1 A definition of sustainability

In 1987 the UN Commission on the Environment and Development led by Brundtland gave the following definition of sustainability: 'Sustainable development is a process of change in which the exploitation of investments, the orientation of technological development and institutional change are all in harmony and enhance both current and future potential to meet human needs and aspirations' (WCED, 1987, p.4). This explanation focuses on the change in economics, developments and politics in order to sustain humanity; it is quite anthropocentric and emphasises a harmony between human actions instead of a harmony of humanity with its environment.

3.2 A holistic approach for Sustainable thinking

The triple bottom line concept (TBL) was introduced by John Elkington (1997). This concept consists of three pillars: 'People, Planet and Profit'. Each of these pillars originally stands for different means of money, but in the case of spatial planning it can be used for the starting point of different groups in the spatial use. The pillar 'People' stands for the society with its different communities, while 'Planet' focuses more on ecological and environmental aspects. Finally, the economic aspects find their place under the pillar 'Profit'. This concept provides a more holistic approach to sustainability; by showing different aspects and relations between these pillars, this concept gives a better understanding of sustainability (Ibid.). An integral approach with a balance of these pillars could bring mutual benefits.

In 1996 the Dutch government introduced the framework for spatial quality. Spatial quality consists of use-value, experience-value and future value (Timmeren, van, 2006 p.13-14) (Hooijmeijer, et al. 2001). This spatial quality definition also close related to sustainability and shows overlap with the TBL concept. The use-value is about spatial efficiency and functionality; this can be linked to the 'Profit' pillar: in order to provide a future that is economically profitable there is the need for functionality and efficiency. The experience-value consists of the spatial experience of culture and nature; the need for different communities is often based on this experience. This value can be a core-value for the pillar 'People'. The future value consists of the spatial durability and flexibility; This can be ranged under the pillar 'Planet', which is the carrier and provider for the pillars 'People' and 'Profit'. In the spatial planning the thinking in processes has become more holistic and the thinking of functions that are complementing each-other has become more common (Timmeren, van, 2006) (Ministerie van VROM, n.d.). The combination of these models could provide this holistic approach to sustainability and, could give a better view on the different spatial actors as well as give grip on the understanding of spatial sustainability (illustration 2).

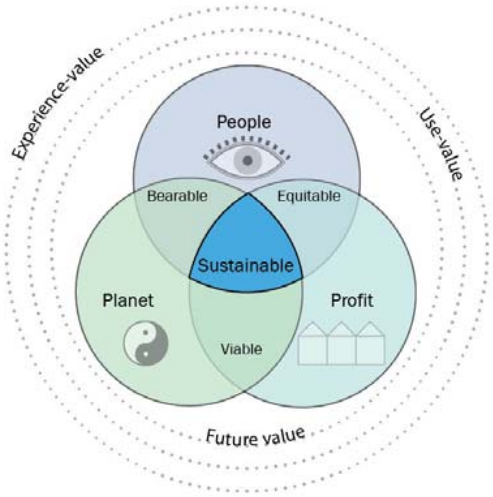

Illustration 2 What greenhouses can do to improve sustainability (Based on John Elkington, illustration by Machiel Crielaard)

3.3 Principles for sustainable energy

A model for sustainable development of energy is the 'Trias Energeticas' that was introduced by the Dutch government. It provides three steps: firstly, reduce the demand, secondly, use renewable sources and, thirdly, use finite sources clean and efficiently (Dobbelsteen, van den, 2010). According to Dobbelsteen there is a need of a transition to sustainable energy forms now: 'If we use this fossil energy for our current demands, there will not be enough for the transition.' (Dobbelsteen, A. van den, 2010, p.22). In his inaugural speech Van den Dobbelsteen sees a huge waste of energy, therefore, he pleads for an integral approach of the supply and demand of energy. He pleads for links between living, working and transport and new building forms that can adapt to the climate and produce of energy.

Another strategy introduced by the Dutch government is the three-step method which firstly, makes the energy use more extensive; secondly, closes the different cycles and thirdly, promotes the quality of products (Timmermans, 2006, p. 68). This is practised in what Van den Dobbelsteen calls the 'Rotterdam Energy Approach' which reduces the energy demand and searches for links for the smart exchange of heat and the complementing of cycles on different scales and between different urban functions. By mapping the need for heat, cold and electricity, different supplies and demands are made clear through time (Dobbelsteen, van den, 2010, p.32-33).

Besides the closing of cycles and generation of sustainable energy, sustainable also is about the lifetime of products. 'When objects or buildings are

considered 'ugly', unpractical and uncomfortable, these objects and buildings can, despite their durability, have an unsustainable lifetime, which is shorter than its technological lifetime'(Timmeren, van, 2006, p. 16).

3.4 Recent developments on sustainability

To come with an alternative for the cradle to grave approach of the modern society, which considered products waste when their lifetime ended; William McDonough and Michael Braungart (2002) proposed the ´Cradle to Cradle´ concept. In this approach waste equals food, which means that when the lifetime of a products ends, it can be recycled in the same product cycle or it can be used for other cycles. This approach already begins in the design process, where a smart design can make the product easy to disassemble. In this way there was no need to feel guilty about consuming.
In 2006 the documentary 'An inconvenient truth' by Al Gore and the report of the IPCC alarmed the world again with the prospect of a warmer earth with a rising sea level and other influences on climate raised the perception of the situation of planet earth (KNMI, 2007). This climate change was already foreseen by others, but never reached the worldwide public.

4 The greenhouse: a mediator for sustainability

Now we have a better understanding of what consists sustainability, and need a practical application on greenhouses. One person that started experimenting with using the concept of the greenhouse to improve sustainability was R. Buckminster Fuller, his words were 'To make the world work, in the shortest possible time, through spontaneous cooperation, without ecological offense or the disadvantage of anyone' (Baldwin, 1996, p.V). In 1950 he made his first geodesic dome which he called 'Garden-of-Eden' (Baldwin, 1996, p.150). It was meant to provide a house which could control weather conditions and which provided more than it consumed. Vegetables could be grown in the kitchen and it was possibly to sleep under the trees (Ibid.). After experimenting with the materials needed for such a dome and with the climate inside of it; Buckminster Fuller delivered a large scaled geodesic dome for the expo of 1967 in Montreal (Ibid., 1996, p.150). Later he even researched the possibilities of whole cities under domes. And if that were not enough he made 'Cloud Nine'; a concept of a floating dome made possible by the higher temperature inside generated by human activity and the sun (Ibid. p184-185). These first explorations of Buckminster Fuller were quiet utopian for these times, but when the technology innovates, greenhouses might provide more than they consume.

4.1 City fruitful

During time, design explorations and experiments were done with the using of glasshouses to improve sustainability. One of these is the 'City Fruitful'; an experiment in design made by Kuiper Compagnons (Kuiper Compagnons, 1992). The ambition of this design was to have an integrated approach on energy, ecology, economy and emotions (Ibid., p.4). Therefore an intermingling between living and glass-horticulture was proposed. This connection made it easy to link different processes; the proximity made it possible to exchange heat from the glasshouses to the houses. Greenhouses for private use created winter gardens which heated the house and could be used throughout the year. Waste water of the houses was cleansed in helophyte filters. Different typologies of houses combined with glasshouses created interesting living environments. According to Kuiper Compagnons the traditional approach of agriculture and urbanism would have led to a space consuming of 1,5 times more (Kuiper Compagnons, 1995). The City Fruitful concept was not built.

4.2 EVA Lanxmeer

Another design with a sustainable approach that was executed is the EVA Lanxmeer development in Culemborg in the begin of the year 2000. The approach for this residential area were people who developed an area by participation; the area had to meet the needs of these inhabitants which could influence landscape, water and energy. People themselves had the responsibility to maintain their area instead of the municipality. Small conservatories were linked to houses to transfer the heat of the sun to the house and isolate the house from heat loss. The direct surroundings of the houses were used to cleanse water by plant filters (Oei et al., 2007, p. 33).

4.3 De Zonneterp

Another example of the integration of living and glass-horticulture is the project 'De Zonneterp'. This project is the state of the art in sustainable development of the glasshouse as a climate buffer. Because of a link between the processes of different functions, like living and glass-horticulture, cycles can be closed. Links between greenhouses and waste flows from external functions can also be used to improve sustainability. The degrading of excrements can form gasses which can be used to generate energy; the residue can be used as fertilizer for the plants. Rain water can be collected in basins and after filtering this can be used for irrigation water in the greenhouse, or drinking water in neighbouring buildings.
The CO2 generated by electricity production can be used for stimulating plant growth. Also heat exchange and electricity generation are used to make this project more or less self-supplying in

energy supply and resources (Wortmann, 2005). Despite making this a closed system, the outside of the Zonneterp is still from dead glass, not providing the external ecosystems to have benefits. But instead isolated from the earth, and providing a 'plug-in' to earth. If solutions for a changed climate use technology on the basis of ecological systems, than the design and location of ecosystems could become more important (Timmeren, van, 2006, p. 12).

4.4 Energy supplying greenhouses

Recently explorations have been done on an energy generating glasshouse. The present technology of energy generators are the called CHP, which stands for combined heat and power generation. The heat of this plant heats the greenhouse, the energy is used for lighting the glasshouse and the Carbon dioxide emission is used to stimulate plant growth. The University of Wageningen delivered an greenhouse called 'ElKas' which genereates renewable energy. In the ElKas the unnecessary light spectrum for plant growth is reflected to a solar collector. This type of greenhouse is currently tested and is expected to deliver 20 kWh of renewable energy per m^2 per year (Visser, 2008). Other ways of generating of sustainable energy are wind turbines integrated in greenhouses, these wind turbines can form pillars on which an plastic canvas is anchored (Bueren, van, 2010).

4.5 Integration of the greenhouse in its surroundings

A landscape of glasshouses with all their climate technology, may not have a positive impact. In the recent study 'Parels voor het landschap' (Pearls for the landscape) (Stroeken, 2009) a design study is done to explore the possibilities of glasshouses as ornamental landmarks and how the integration between glasshouse and recreation can create an environment where the greenhouses become an experience (Bosschaert, 2010). The integration of offices with greenhouses on the roof or making greenhouses float could save space which could be used for improving the spatial quality. In Naaldwijk there is already an experiment with a floating greenhouse. Light structures of greenhouses could make it more easy to make floating greenhouses, and the use of plastic would be favourable for floating greenhouses (Bueren, van, 2010).

5 Conclusion

5.1 Sustainability

In many starting stories of civilisations the garden takes an important role, the greenhouse is a result of this human aspiration to cultivate nature. From the concept of the first greenhouse developed the commercial glasshouse. This commercial glasshouse proved to be profitable. In order to stimulate growth heating and electric light found their way into the glasshouse. With these developments, the glass-horticulture became an energy-consuming sector with a bad image. The raising awareness of the state of the earth and the human part in this matter, caused developments that promoted more sustainable innovations for greenhouses. The greenhouses were to provide more than they consumed.

5.1.1 Energy

The first possibility for greenhouses is the generating of energy. Certain types of glasshouses can collect the sunlight by reflecting the superfluous light spectrum on solar panels. Also other types of energy generating greenhouses are possible in which a wind turbine forms the pillar that holds up the plastic canvas. The links between glasshouses and other functions also open the possibility to meet supply and demand. The glasshouse can generate energy and heat of which the surplus can be used in these linked functions. This energy saving, sustainable energy production and the efficient use of finite resources fits in the 'Trias Energeticas' (Dobbelsteen, van den, 2010). model and could be economically (Profit) and environmentally (Planet) beneficial.

5.1.2 Closed cycles

A strategy introduced by the Dutch government is the three-step method which firstly, makes the energy use more extensive; secondly, closes the different cycles and thirdly, promotes the quality of products (Timmermans, 2006, p. 68). With the glass-horticulture's strive for closing cycles and energy saving, it responds to the first two steps of the three-step method. This closing of cycles can be reached by seeing these greenhouses in a more holistic perspective. Waste flows of heat, excrements, carbon dioxide and water can be linked between greenhouses and neighbouring functions. This closing of cycles is also beneficial to Profit and Planet.

5.2 Greenhouse experience: ornament and use

The first greenhouses were orangeries with slightly larger windows, these were decorated with ornaments. Sometimes the interiors were also inspired by the grottos. Later in the glasshouses there was still a reasonable amount of ornaments present. The development of the commercial glasshouse made it an economical operation. These glasshouses were purely functional and no attention was paid to its appearance and its integration in the surroundings.

Sustainability for greenhouses is not only founded by balanced cycles, but also by thinking about improving the quality of life in a broader perspective. A glasshouse area which can be a total built landscape, is not very positive for ecology and recreation. The integration of greenhouses in its

surroundings is quite possible and improves the experience of these greenhouses and their facilitating technology. Glasshouses do not have to be ornamented, but a decent adaptation to the environment could make a total landscape more attractive and could deliver a better experience for People and income for Profit.

5.2.1 Water basins

One principle to implement the greenhouses in their surroundings could be the water basins. By integrating these functional objects in the ground they could become pools. When the right materials are used these could even become valuable for ecology. In the TBL concept (Elkington, 1997) this basins used for profit could generate an experience for People and eventually when opened up for ecology also for Planet.

5.2.2 Connection to living

Living in the proximity of greenhouses create closed cycles, and in addition generate interesting surroundings. Houses could have their greenhouse garden which could be used throughout the whole year. This link between the greenhouse (Profit) and houses (People) could improve the sustainable use of energy (Planet), the experience (People) and simultaneously be economically beneficial for both pillars.

5.2.3 Creating space for other functions

By putting glasshouses on top of office buildings (Profit), space could be generated for other functions such as water storage or living (People, Planet). These stacked greenhouses could also change the experience glasshouse areas (People). Also floating greenhouses could save space.

5.3 Findings

Concluded can be that the glasshouse is able to improve sustainability by providing heat and energy and can help closing cycles. A more holistic spatial approach such as the TBL concept can help to see links between greenhouses and other functions and see their complementary advantage (illustration 3). A spatial integration can deliver a better experience for People. In order to reach a more sustainable greenhouse, the links of greenhouses with other functions such as living and working are essential.

8 Recommendations

The application of these concepts has still to be made. In order to see if these concepts are valuable they have to be tested in practice. An exploration of the effects on a glasshouse area on a bigger scale could show the spatial consequences and possibilities.

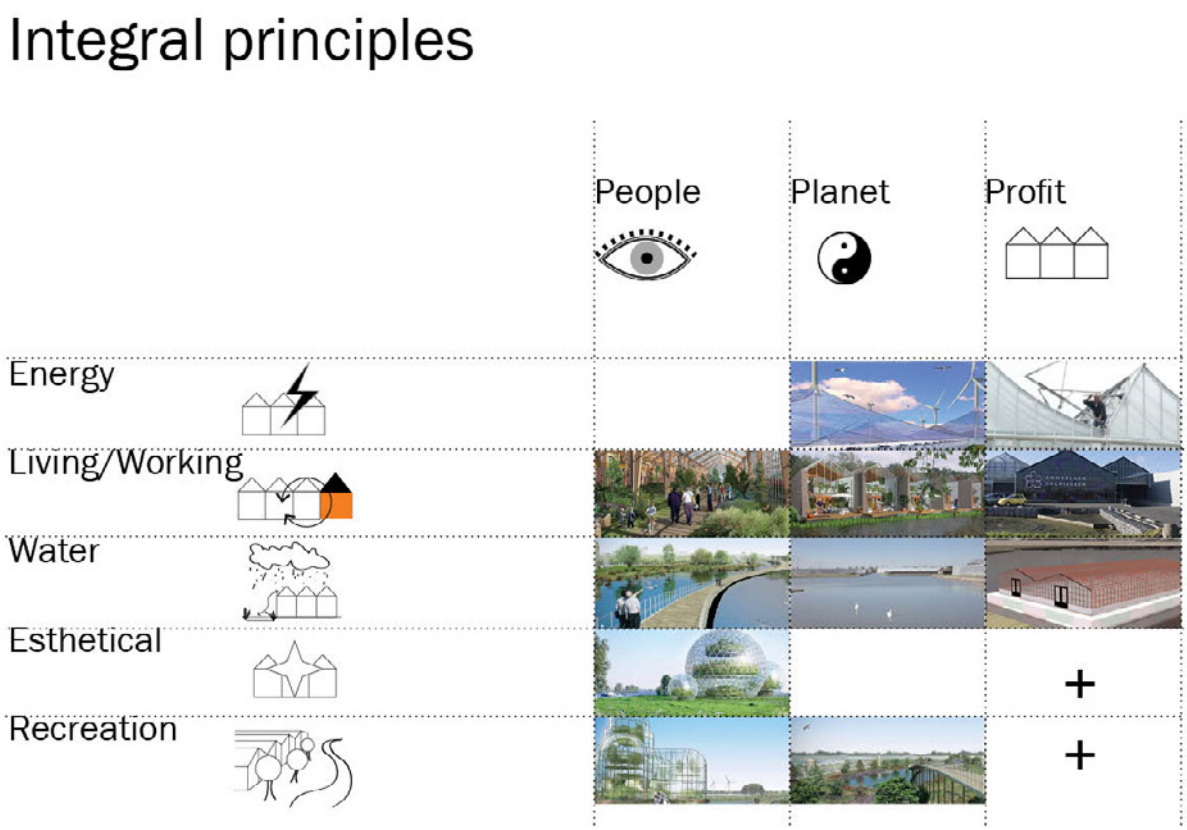

Illustration 3 What greenhouses can do to improve sustainability (Machiel Crielaard)

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