



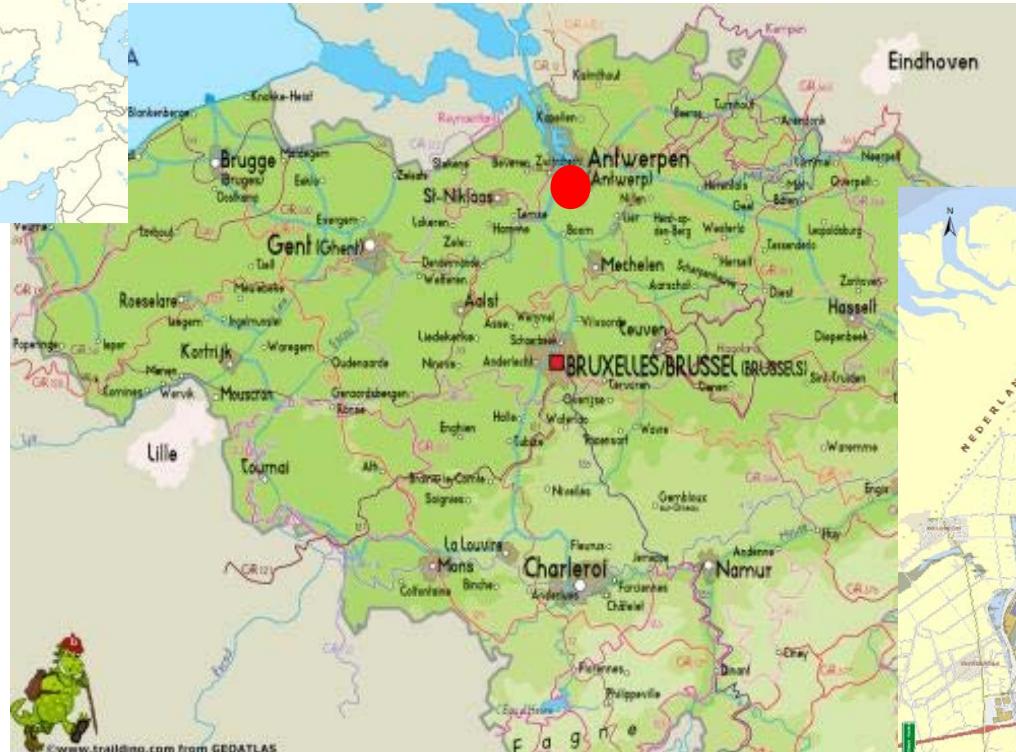
# Scheldt Quays Antwerp

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The connection between city and river

IMMERSE, Göteborg, 12/06/2019  
Ing. Koen Segher

# Geography



# History and current situation Antwerp

- City and harbour development during medieval times
- Napoleon Bonaparte
- King Leopold II



Timeline from 1200 to 1800:

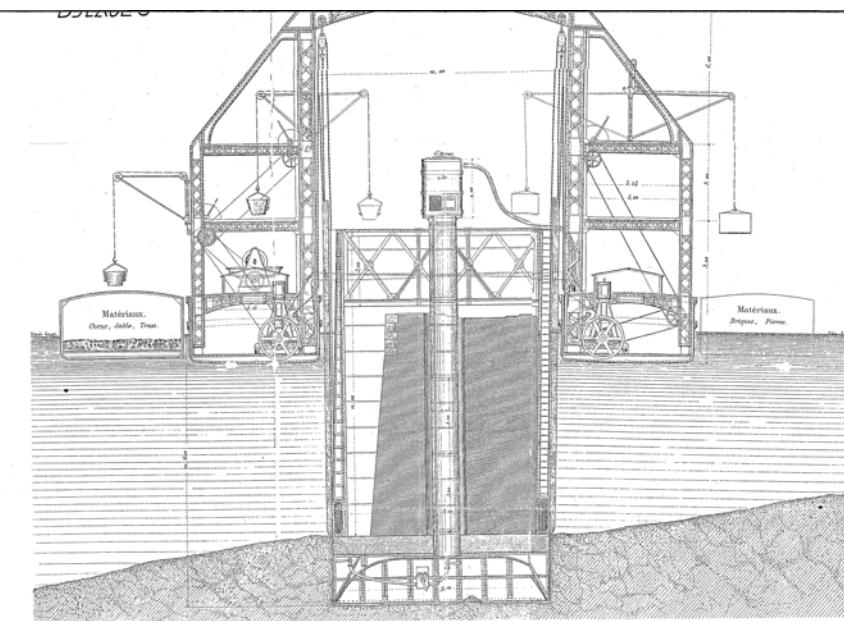
- Middeleeuwen**: Er was al een haven in Antwerpen rond 1200. Die getijdenhavens bestond uit vier inhammen of binnenhavens die diep in de stad oordringden en had aanlegsteigers aan de oevers van de Schelde.
- 15de eeuw**: Zware stormvloeden maakten de Westerschelde dieper, waardoor de haven toegankelijker werd.
- 16de eeuw**: Geleidelijk ontwikkelde de rivierhaven zich tot de ware havens van de gronden. 16de eeuw. Door de scheiding van de Nederlanden en de Spaanse blokkade verviel de haven twee decennia later weer tot binnenhaven.
- 1803-1813**: Napoleon wilde van de Schelde een "pistool" gericht op het hart van Engeland maken. Op zijn bevel werden de eerste rechte kai-muren gebouwd. Zo werd in 1803 de aanzet gegeven voor de kai-muren zoals we die vandaag kennen.



# Stabilisation problems historical quay walls

## Identity

- Gravity wall (1875 – 1911)
- Height: 15 to 18 m
- Length: 5,5 km
- Scheldt : tidal river
  - MLW: 0,00mTAW
  - MHW: +5,29mTAW
- Abandoned Port activities



## Instability problems

(already during construction):

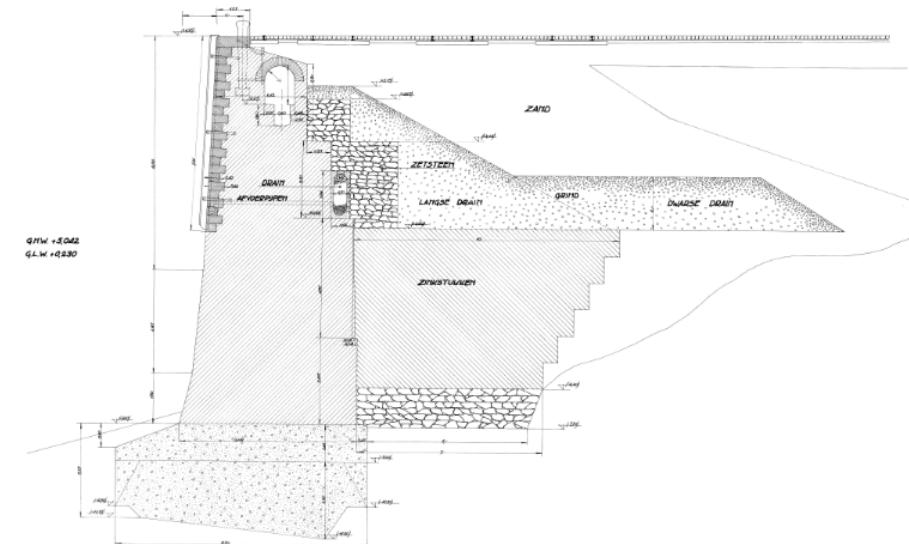
- Resistance against sliding insufficient
- "walking quays wall of Antwerp"

## Renovation of Quay Wall

Cause Instability problems :

- Clay foundation (Boom), underestimation of geotechnical soil characteristics
- Uncomplete technical calculations, influence of ground water disregarded in the design

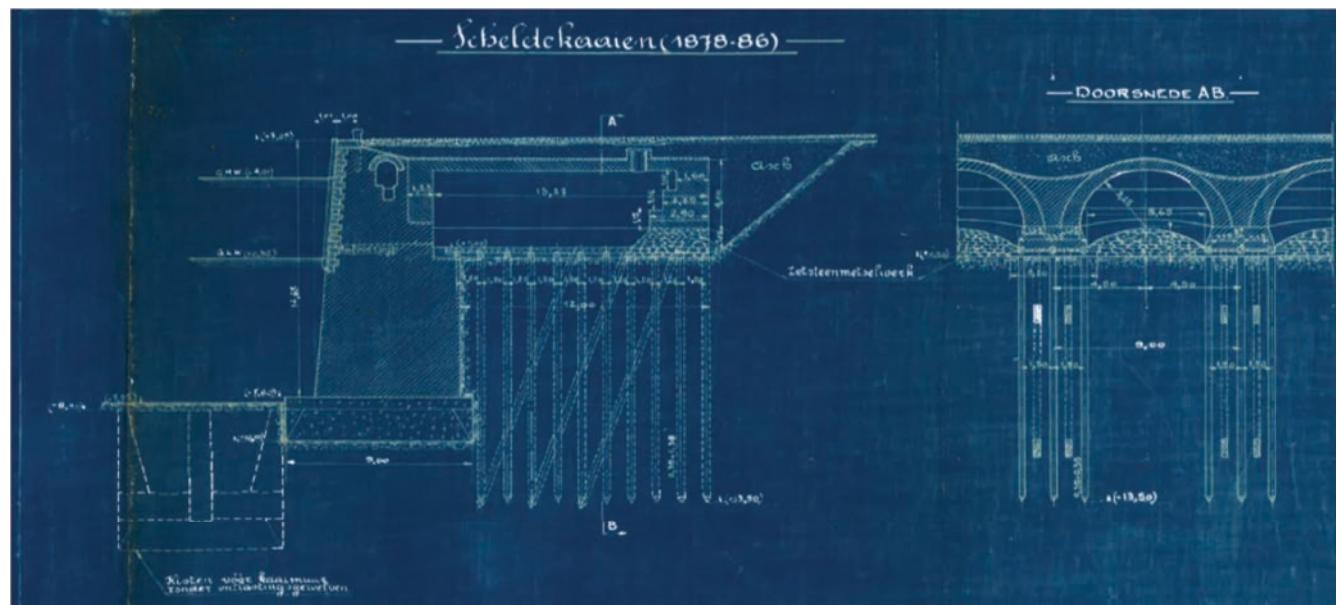
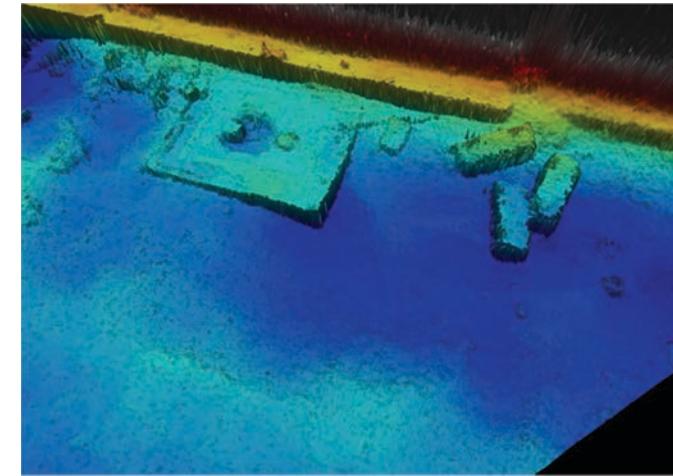
DETAIL BESTAANDE KAAIMUUR



# Stabilisation problems historical quay walls

## Historical remedial measures

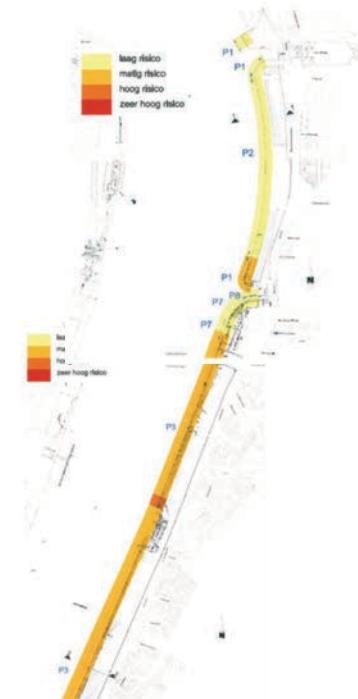
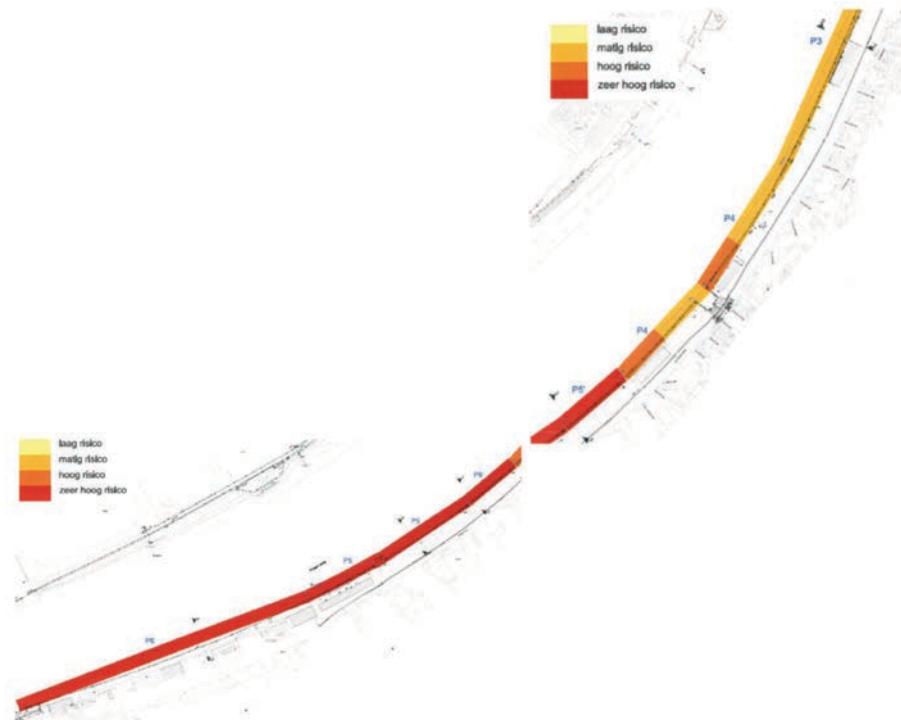
- Counterfort caissons
- Stress relieving vaults
- Excavation behind quay wall
- Clay berm at toe quay wall



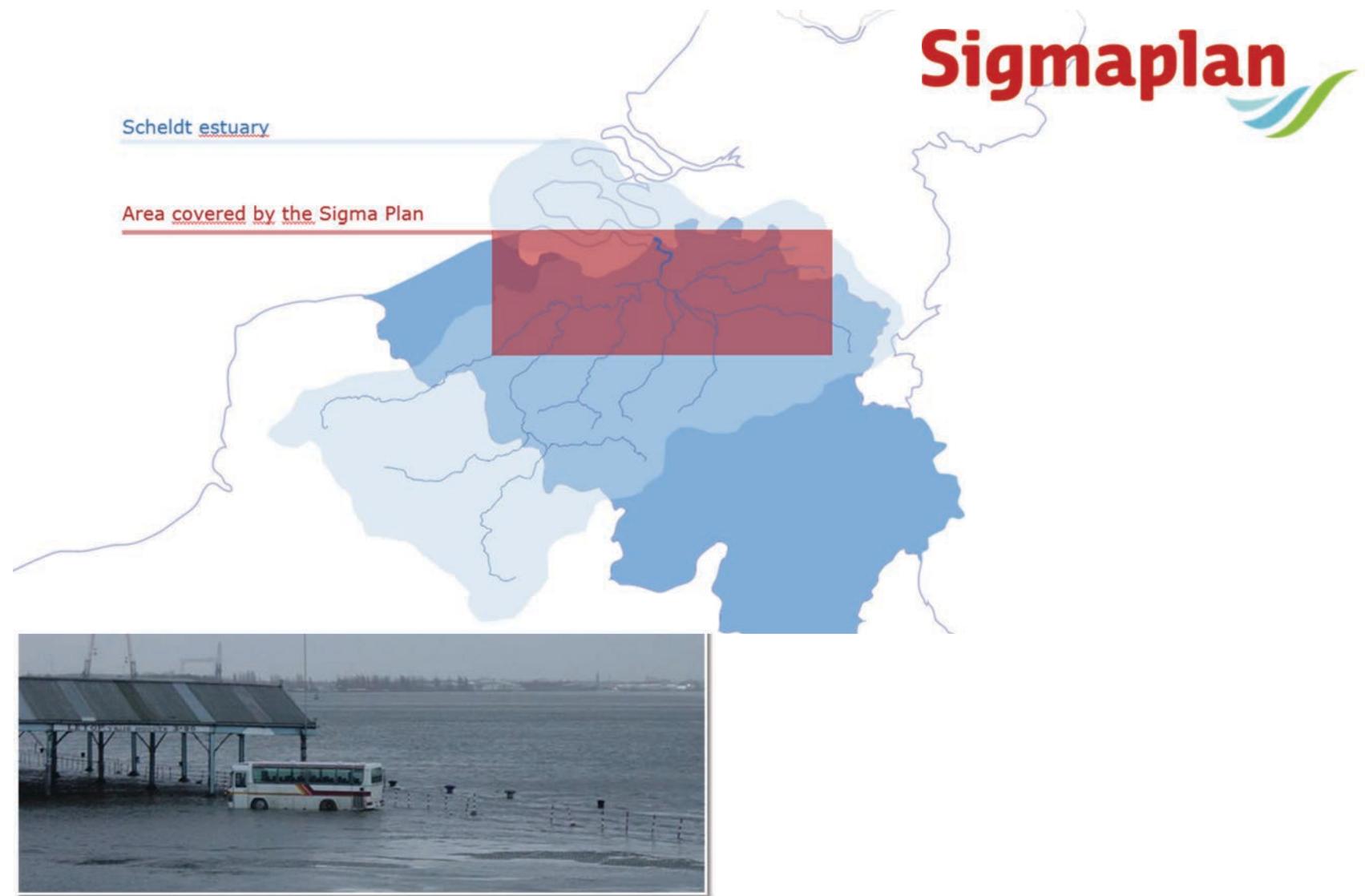
# Stabilisation problems historical quay walls

## ASSESSMENT

1. Monitoring movement
  - Inclinometers
2. Groundwater level vs.  
Scheldt water level
  - Monitoring wells – Divers
3. Bathymetric survey
  - Prop box
4. Core Drilling
  - Physical state
5. Visual inspection
6. Diver inspection



# Tidal Flood problems river Scheldt (Storm Surge)



# Area of the Scheldt Quay Project



# The original plan (1976) contained three measures

Stronger and higher embankments

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Creation of 13 flood control areas

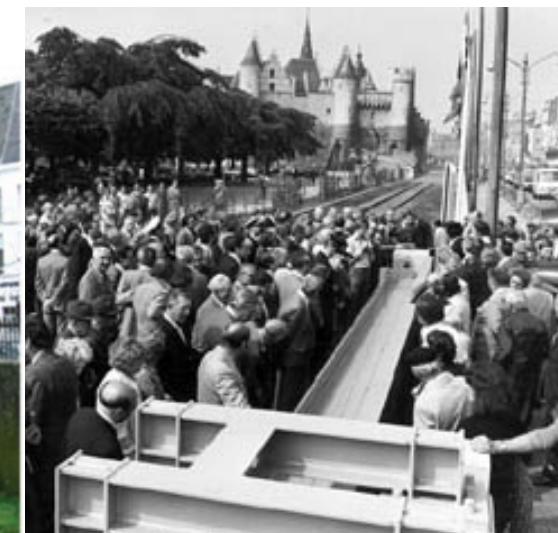
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Storm surge barrier



# Antwerp : concrete water barrier

1. Concrete wall built in 1977
2. Length: 5,5 km
3. Height: 1,35 m (8,35m TAW)



# Why the plan needed updating

Climate change (sea level rise of 60cm over 100yrs) / stronger tidal conditions

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New view on water management : sustainable development,  
cost benefit analysis

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Birds Directive and Habitats Directive (Natura 2000) / Water Framework  
Directive / Long-term vision for the Scheldt Estuary / Flemish nature  
preservation laws => conservation objectives

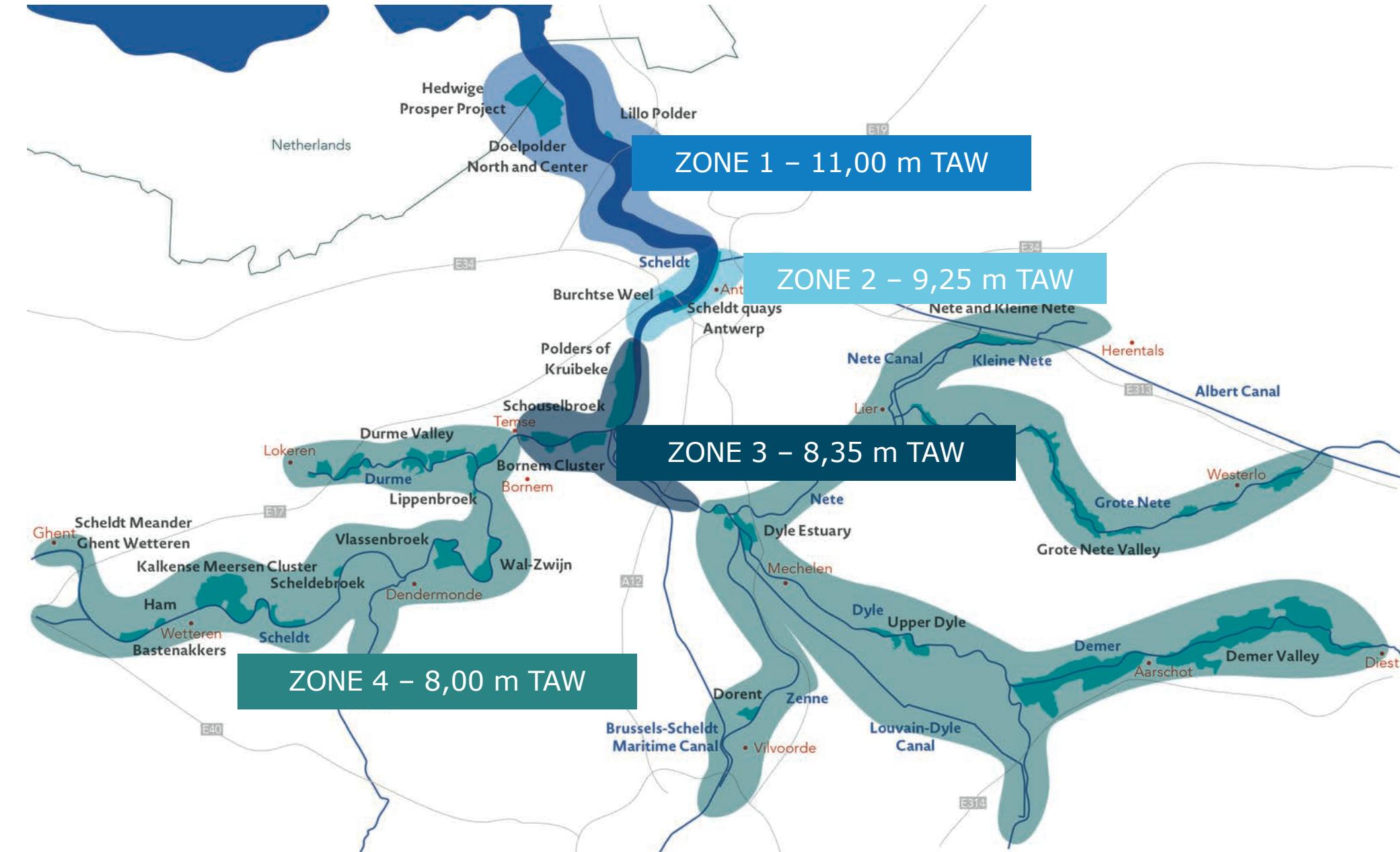


**Measures in the original Sigma Plan are no longer sufficient: an update is required**  
**Decision Flemish Gouvernement 2005 - 2006**



**Phased implementation between 2005 and 2030**

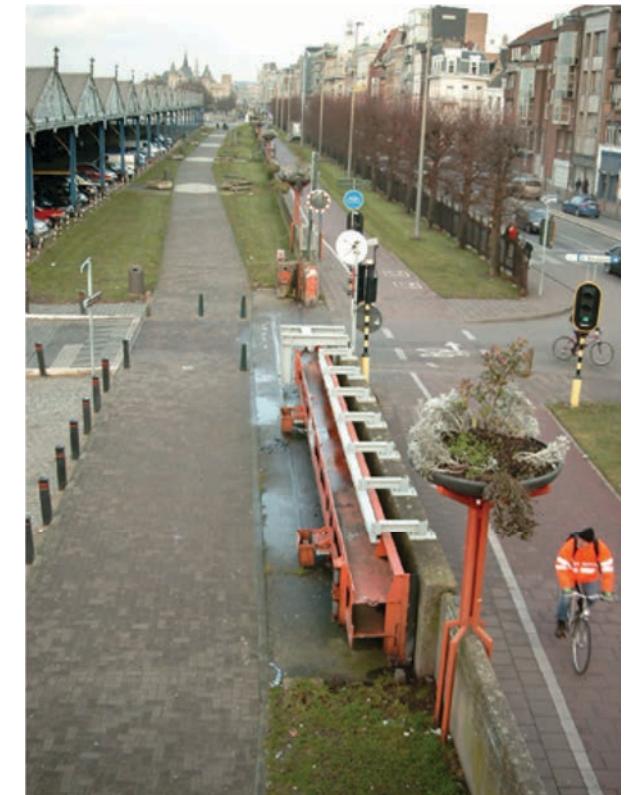
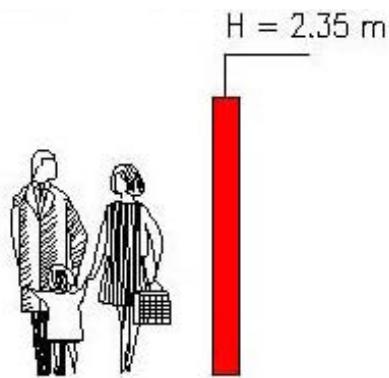
# Heights embankments updated Sigma Plan



# Antwerp : water barrier + 90cm

- **New water barrier**

1. Height: 2,25 m (9,25m TAW)



# Antwerp : current use Scheldt Quays

- Free car parking
- Sense of Freedom
- Escaping city
- Local and big events (tall ship, tour de Flandre, food truck festival, ...)
- Maritime feeling (ships, bollards, ...)
- Heritage & monuments (Steen, Hangars, ...)



# Area of the Scheldt Quay Project

- 7 km long
- 80-100m wide



# Three pillars/challenges of the Scheldt Quay Project

Stabilisation of the quay walls



Elevated water barrier



Renovation / transformation of the public domain



## MASTERPLAN SCHELDT QUAYS

# Masterplan Scheldt Quays Antwerp

## How do you start?

Public – Public collaboration

Financial plan

Technical study

Cultural and archeological study

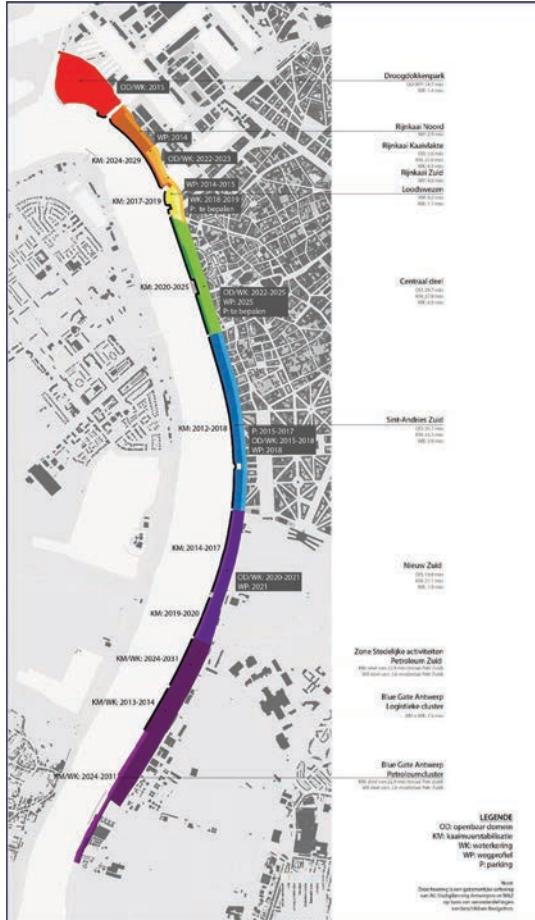
Mobility

Spatial planning

Participation / Communication plan

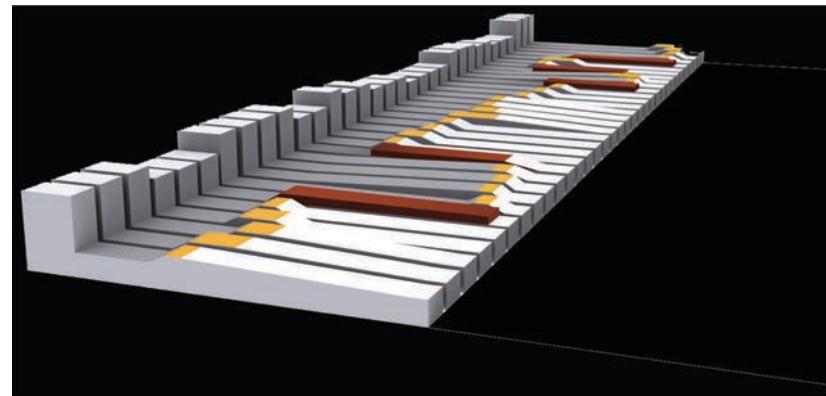


# Radical facelift Scheldt Quays Antwerp – biggest public space in the city



Masterplan is a directive that is used as a guideline for preserving values during detailed design the following years.

- Technical
- Couleur Locale
- Heritage
- Spatial planning
- Mobility



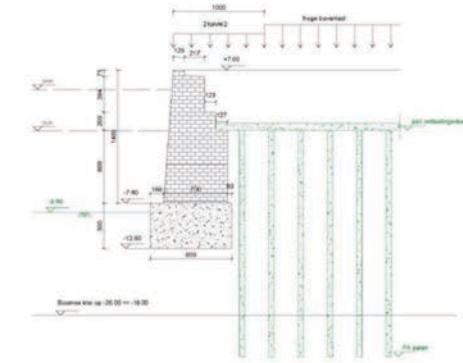
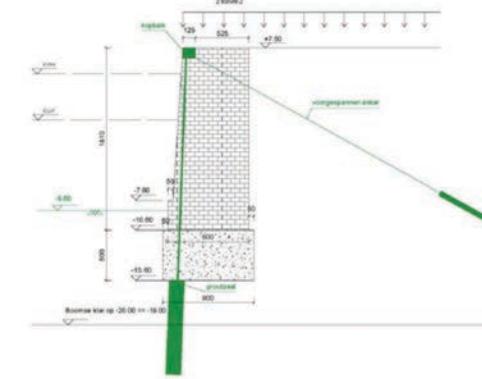
# Masterplan Scheldt Quays Antwerp

## What happened so far?

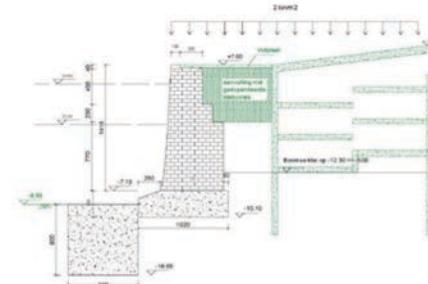
TIMING	ACTION
2005	Treaty of intent: collaboration DVW & City of Antwerp
2007	International architecture competition: PROAP & WIT
2008 - 2010	Participation of citizens
2010	Masterplan Scheldt Quays Antwerp
2010	GO Detailed design SAZ and following areas
2014	Start execution stabilization works
2017	Start execution new water barrier and public domain

# Masterplan Scheldt Quays Antwerp Adapted stabilization concepts

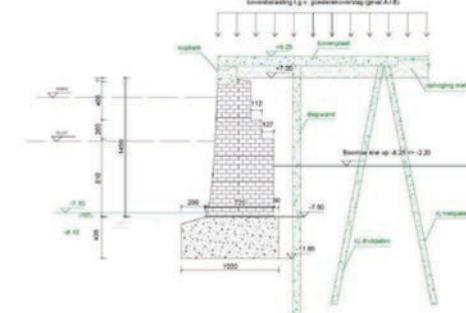
- Depending on
  - Type cross section (design adapted during construction)
  - Geology
  - Current state of construction
  - Cost efficiency
  - Wishlist future use:
    - Mooring possibilities
    - Underground parking
    - Heavy weight events
    - Heritage guidelines



VHP grouting/Injection Anchors Discharging Floor with straight piles



Light material/Drain/Underground



New Quay wall

Technical assessment of 37 renovation varieties, 21 feasible

# Sint Andries en Zuid: 'soft renovation'



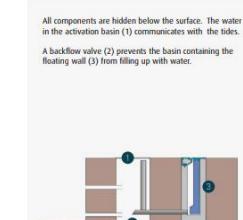
# Masterplan Scheldt Quays Antwerp

## How do you integrate water barrier?

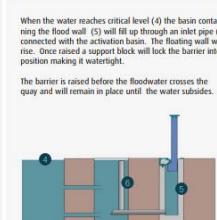
1. Restore ancient connection  
Antwerp-Scheldt
2. Attractive place
3. Improve accessibility
4. Respect maritime history
5. Integration of wishlist  
citizens
6. Adapted to specific area



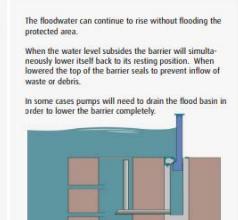
- 1. Fixed water barrier**
  - Dike
  - Building
  - Heightening ground level
  - Urban furniture
  - Park
- 2. Mobile water barrier**
  - Increase spacial quality
  - Safety access to quays
  - Risk analysis required



All components are hidden below the surface. The water in the activation basin (1) communicates with the tides. A floating wall (3) will rise through an inlet pipe (6) when the water reaches critical level (4). A backflow valve (2) prevents the basin containing the floating wall (3) from filling up with water.



When the water reaches critical level (4) the basin containing the floating wall (3) will fill up through an inlet pipe (6) connected to the floating basin. The floating wall will rise. Once raised a support block will lock the barrier into position making it watertight.



The barrier is raised before the floodwater crosses the quay and will remain in place until the water subsides. In some cases pumps will need to drain the flood basin in order to lower the barrier completely.

# Masterplan Scheldt Quays Antwerp

## Use Mobile water barrier?

*"The use of a mobile water barrier may not cause a risk elevation of flooding"*

### 1. Failure water barrier

Fixed water barrier:	Mobile water barrier:
Environmental conditions	Environmental conditions
Construction strength	Construction strength
	Closing procedure



### 2. Urban context : 0 risk increase

- Boundary conditions need to be set
- volume inflowing water < "acceptable" volume



- Stock capacity
- Overflow depth



- Max. acceptable volume
- Height barrier
- Probability of storm surge occurrence

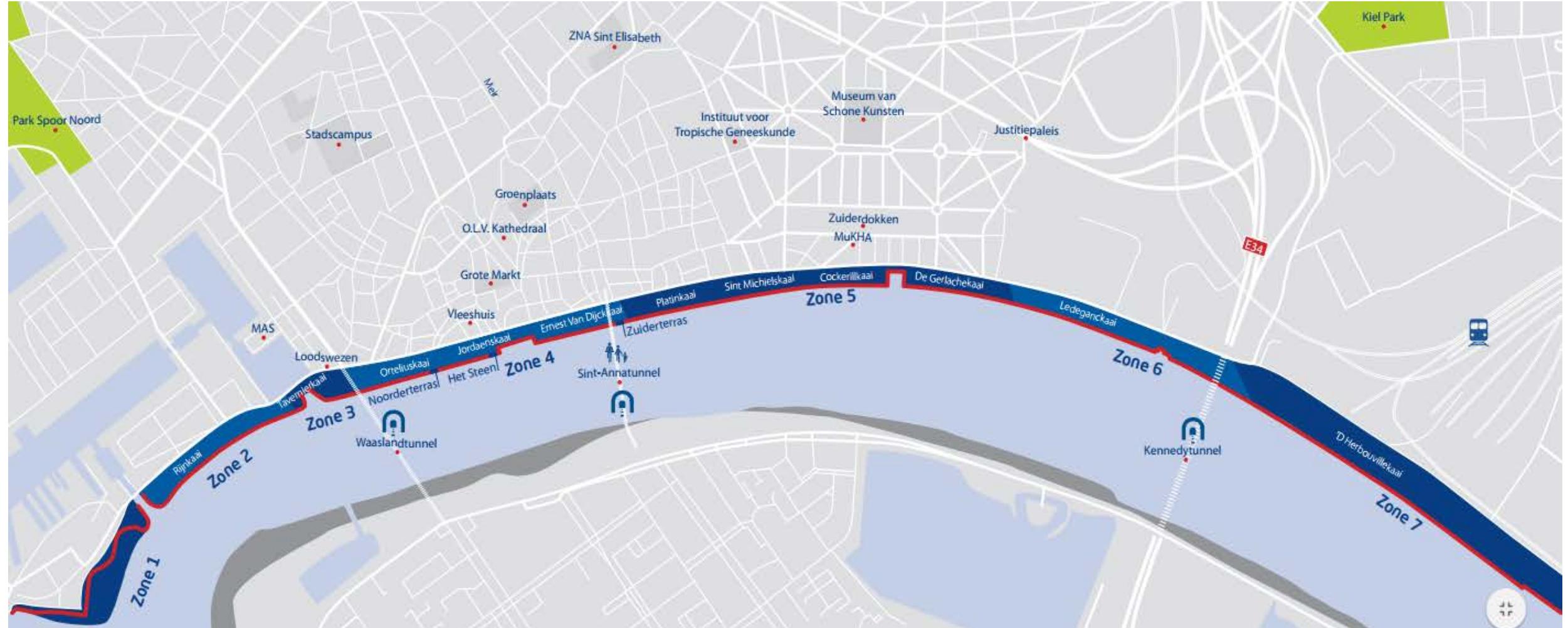


Fixed threshold 7,80mTAW

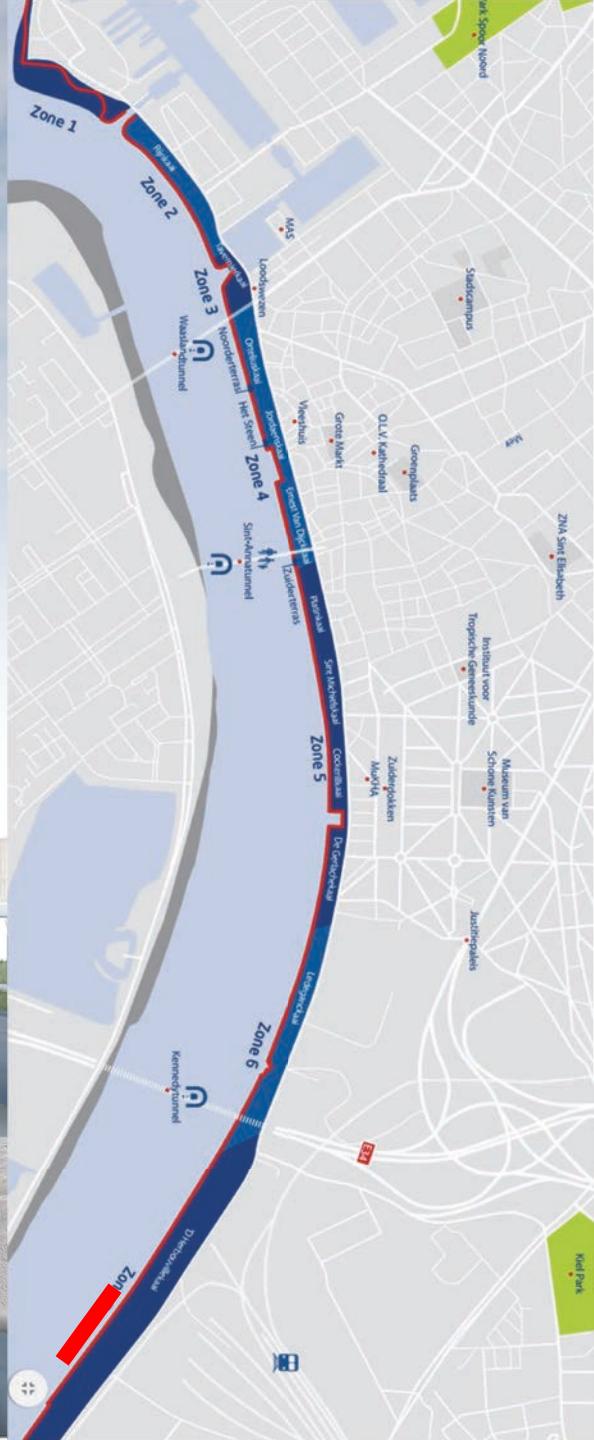
Maximum length 850m

# Masterplan Scheldt Quays Antwerp

## Where are we now?



# Blue Gate Antwerp



# Blue Gate Antwerp



New quay wall – only area transhipment of goods

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200 meter loading and unloading quay

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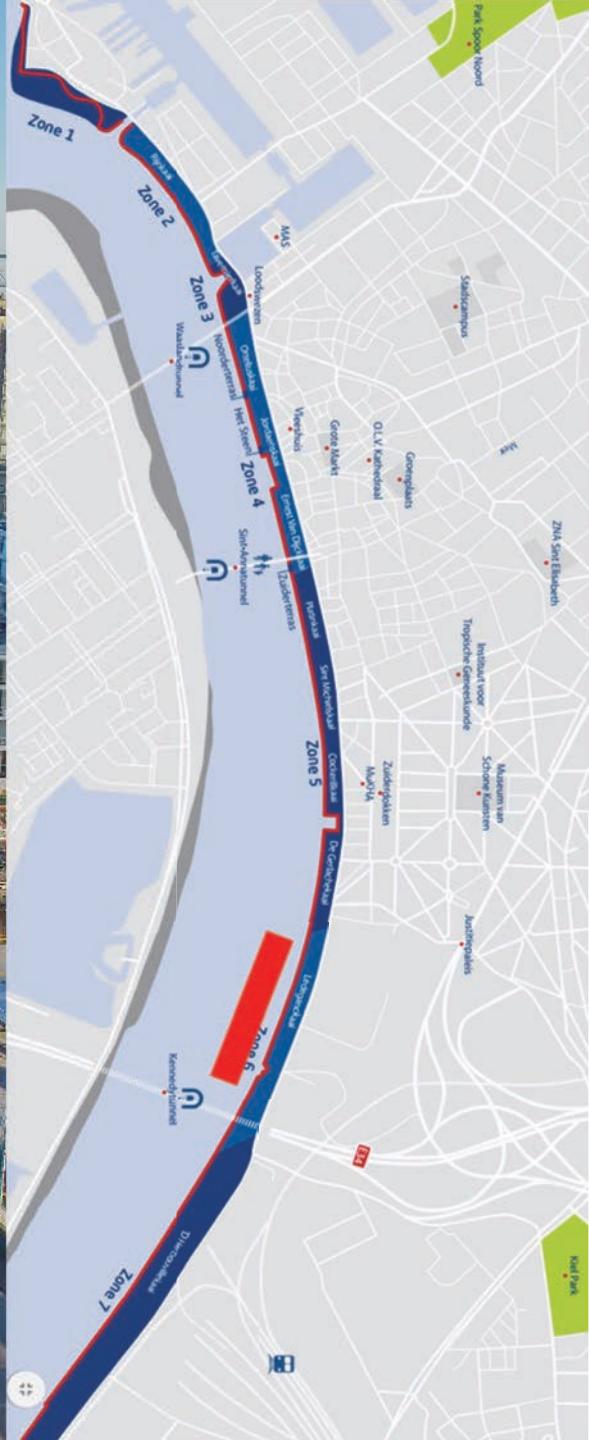
2015

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Sustainable hub, water-bound industrial terrain



# Nieuw Zuid



# Final solution: 'hard renovation'







# Sint-Andries en Zuid



















# Schipperskwartier & the City Centre

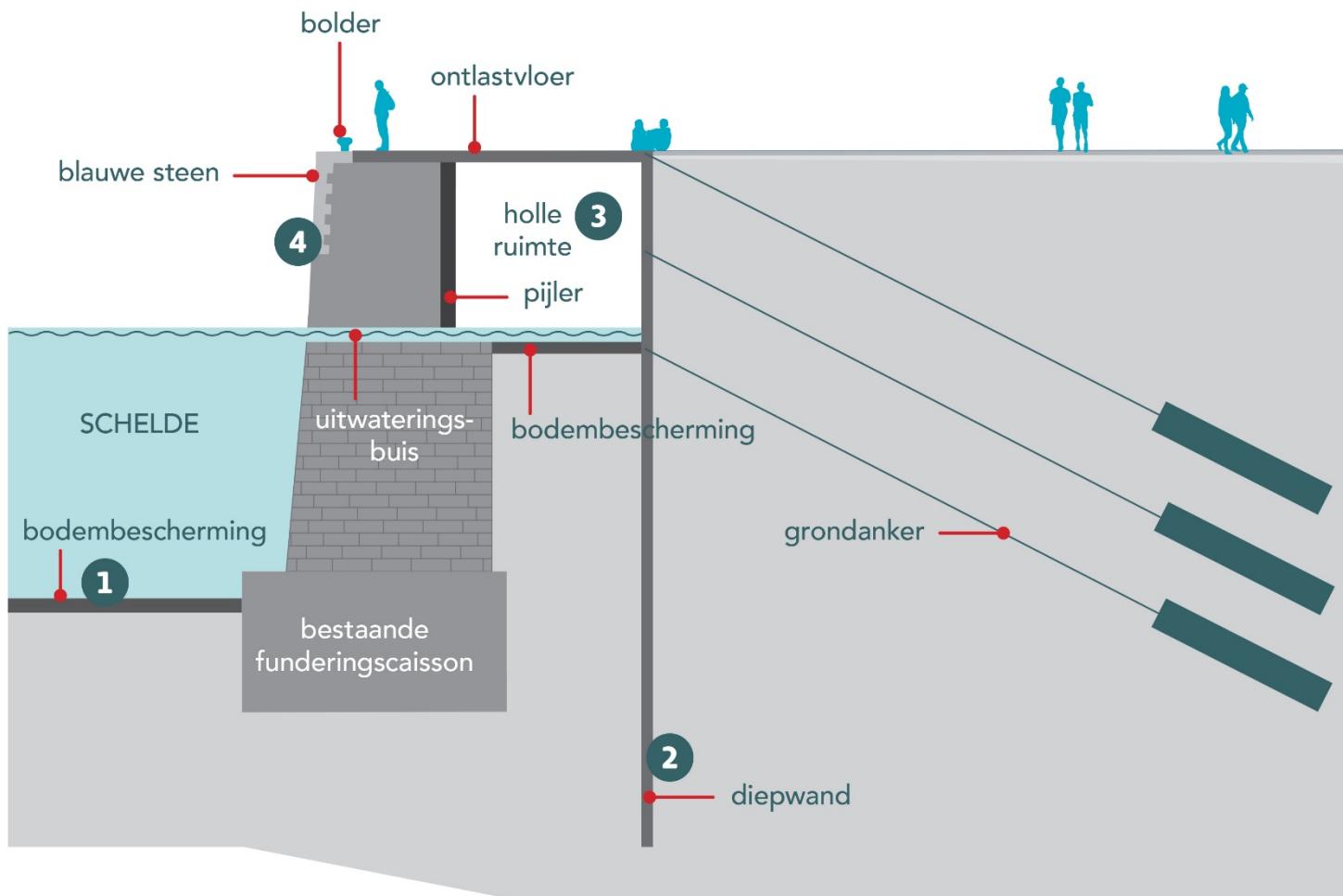






# Loodswezen and Bonaparte Dock



**1**

### Stevige basis

We brengen allereerst een extra beschermingslaag aan. Die bestaat uit breuksteen, afgedekt met verstevigende asfaltmatten. De bodembescherming zal de kaaimuur nog beter op zijn plaats houden.

**2**

### Nieuwe kaaimuur

Achter de historische kaaimuur bouwen we een met staal versterkte betonnen 'diepwand'. Die vangt de druk van het water op de historische muur op. De diepwand zetten we vast met grondankers. De wand doet dienst als nieuwe kaaimuur, zonder dat het uitzicht van de historische muur verandert.

**3**

### Buik vol water

Een holle ruimte van 4 meter breed binnenin de kaaimuur tempert de druk van de Scheldewater op de muur. Via een buis kan het Scheldewater in en uit die 'buik' stromen. Slib krijgt geen kans om te blijven plakken.

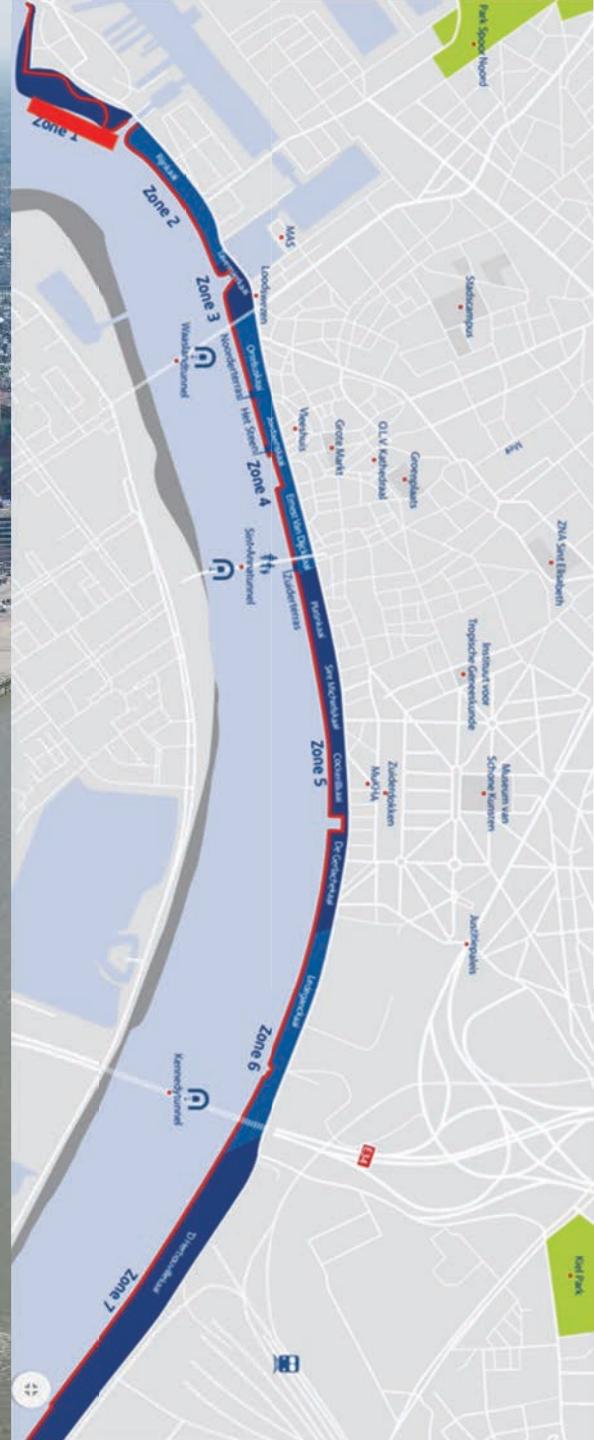
**4**

### Puntjes op de i

De bolders of aanmeerpalen en de typische blauwe steen worden tijdelijk weggenomen. We proberen ze zoveel mogelijk te recupereren en terug te plaatsen zodra de werken achter de rug zijn. De kaaimuur zal er dus precies hetzelfde uitzien als tevoren.



# Droogdokken



# Droogdokken



Green make-over of an industrial island

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Droogdokkenpark: ca. 15 hectare

Belvédère: hexagonal look-out, new quay walls and elevated water barrier

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Green, natural levee and natural mudflats and marshes





07/07/2019



# Questions?

