



Rijkswaterstaat
Ministry of Infrastructure
and Water Management

Protecting the Netherlands from flooding

The Afsluitdijk Project



Regeneration

A large part of the Netherlands lies below sea level. That makes our country vulnerable to flooding. Since 1932, the Afsluitdijk has protected large parts of the Netherlands from flooding by the sea. However, the dike is due for regeneration. It no longer complies with current legislated water safety standards. In addition, greater amounts of water must be drained. This is why Rijkswaterstaat (the executive agency of the Ministry of Infrastructure and Water Management, dedicated to promote safety, mobility and the quality of life in the Netherlands) is working on reinforcing and renovating the Afsluitdijk. This way the Netherlands will also be protected against water in the future.

Why is it necessary to reinforce the Afsluitdijk?

The climate is changing. As a result, sea levels are rising and the frequency of extreme weather conditions is increasing. The dike must continue to protect us against flooding under changing conditions.

The task: to reinforce and renovate the dike and all of its components across its entire length.

Why do we need to drain greater volumes of water?

When the water level in the Wadden Sea is lower than in the IJsselmeer (also known as Lake IJssel), we use the discharge sluices in the Afsluitdijk to drain water from the IJsselmeer. Due to the rise in sea water levels, we are not able to drain the water as often as needed this way. Furthermore, increasingly greater volumes of water are draining into the IJsselmeer from rivers and surrounding lands. This is why we have to be able to drain greater volumes of water.

The task: constructing pumping stations and new discharge sluices.



Afsluitdijk near Den Oever, Stevin locks



Crown

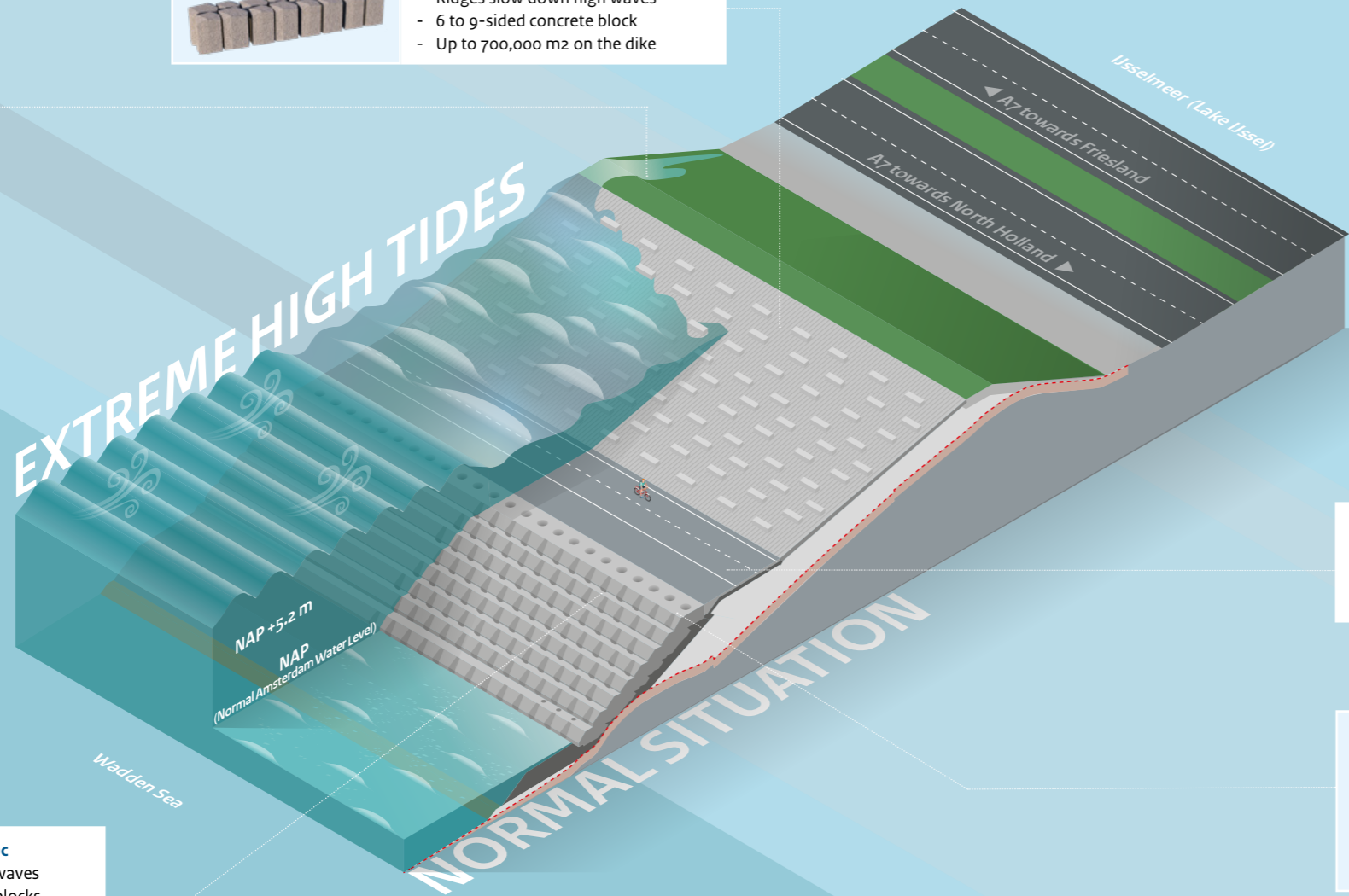
- Approx 2 m higher
- Enables surge overflows
- Can drain 10 litres of water per second per metre
- The water first flows over the dike. Once this is saturated, the water flows over the road.



Quattroblock

- Ridges slow down high waves
- 6 to 9-sided concrete block
- Up to 700,000 m² on the dike

EXTREME HIGH TIDES



Levvel-bloc

- Breaks waves
- 75,000 blocks
- 6,500 kg per block
- 2.3 m x 2.8 m x 1.1 m

Roadside

- Breaks waves
- Cycle path and footpath
- 6-9 m wide



Bermbloc

- Modified Levvel-bloc
- Keeps the Levvel-blocs in place
- With openings for optimal water drainage
- 11,000 kg per block
- 4.77 m³

Withstanding a Super Storm

We are reinforcing the Afsluitdijk, so that at extremely high water levels and large waves it still provides protection. In a combination of spring tide and a long-lasting heavy north-eastern storm the water is pushed high up against the dike and the waves crash on the dike. The dike must not collapse under the assault of such a super storm. This is why the Afsluitdijk will be raised by almost 2 metres and will be given new revetment on the Wadden Sea side.

Dike Reinforcement

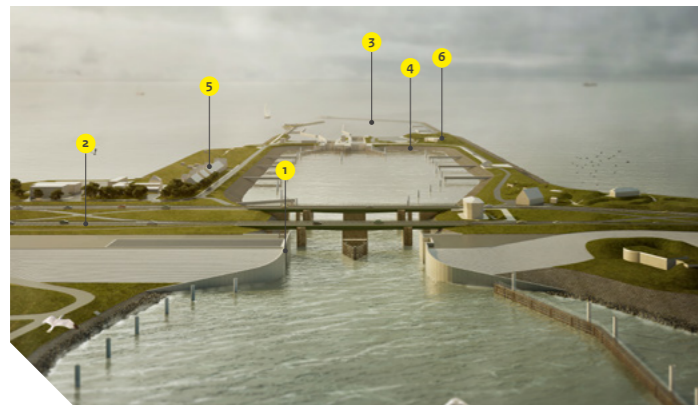
We will be reinforcing the dike on the Wadden Sea side with 75,000 innovative concrete blocks – Levvel-blocs – especially developed for the Afsluitdijk. These blocks are so strong that they are able to withstand the waves that may crash against the dike during a heavy storm. In addition, the dike will be able to withstand surge overflows. This means that it is not serious when water surges across the dike during a heavy storm. The dike's inner side, on the IJsselmeer side, is able to withstand a wave surge of 10 litres of water per second per metre.

Adaptive Delta Management

The renovated Afsluitdijk will comply with current legislated water safety standards until at least 2050. By implementing smart measures now, it will be possible to further reinforce the dike in the future with relatively simple interventions. This is what we call Adaptive Delta Management. For example, the revetment on the dike's sea side will last at least one hundred years. Furthermore, should this be necessary in the future, greater wave surges can be accommodated by further reinforcing the IJsselmeer side of the dike.



Den Oever storm surge barrier (looking from the Wadden Sea towards IJsselmeer)



Kornwerderzand storm surge barrier (looking from the Wadden Sea towards IJsselmeer)

Storm Surge Barriers

Den Oever

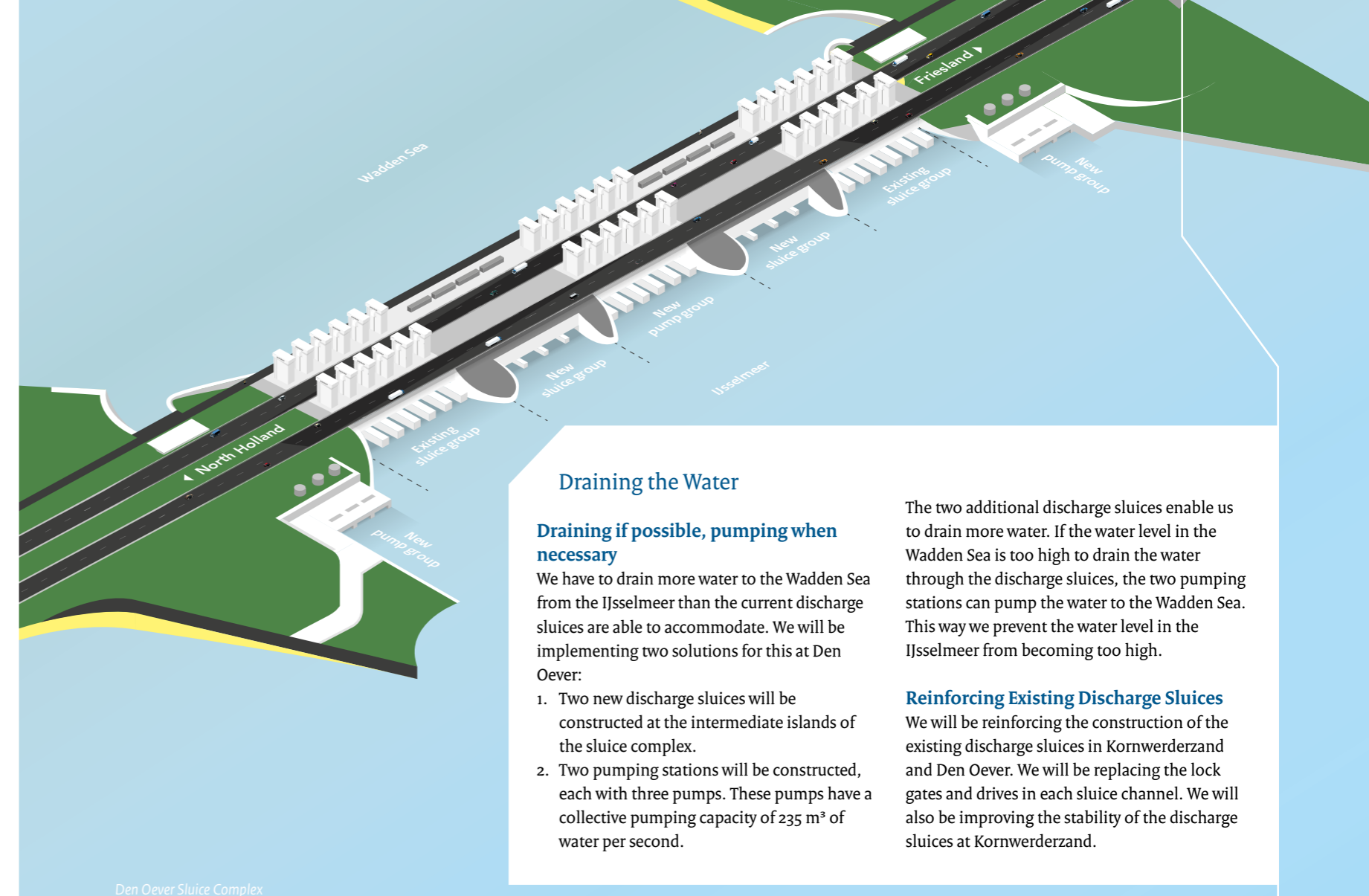
At Den Oever, in the Province of North Holland, we will place a storm surge barrier in front of the navigation lock. Under normal circumstances the storm surge barrier will be open, allowing ships to pass through. The storm surge barrier will be closed when the water level in the Wadden Sea becomes too high. This protects the hinterland.

- 1 storm surge barrier
- 2 navigation lock

Kornwerderzand

At Kornwerderzand, in the Province of Friesland, we will place a storm surge barrier on the Wadden Sea side of the swing bridges. This storm surge barrier protects the hinterland against extremely high tides. The opening of the storm surge barrier is 53 metres wide. By constructing the storm surge barrier on the Wadden Sea side, we infringe as little as possible on this cultural-historical area.

- 1 storm surge barrier
- 2 A7 motorway
- 3 outer harbor
- 4 navigation lock
- 5 homes
- 6 casemate museum



Draining the Water

Draining if possible, pumping when necessary

We have to drain more water to the Wadden Sea from the IJsselmeer than the current discharge sluices are able to accommodate. We will be implementing two solutions for this at Den Oever:

1. Two new discharge sluices will be constructed at the intermediate islands of the sluice complex.
2. Two pumping stations will be constructed, each with three pumps. These pumps have a collective pumping capacity of 235 m³ of water per second.

The two additional discharge sluices enable us to drain more water. If the water level in the Wadden Sea is too high to drain the water through the discharge sluices, the two pumping stations can pump the water to the Wadden Sea. This way we prevent the water level in the IJsselmeer from becoming too high.

Reinforcing Existing Discharge Sluices

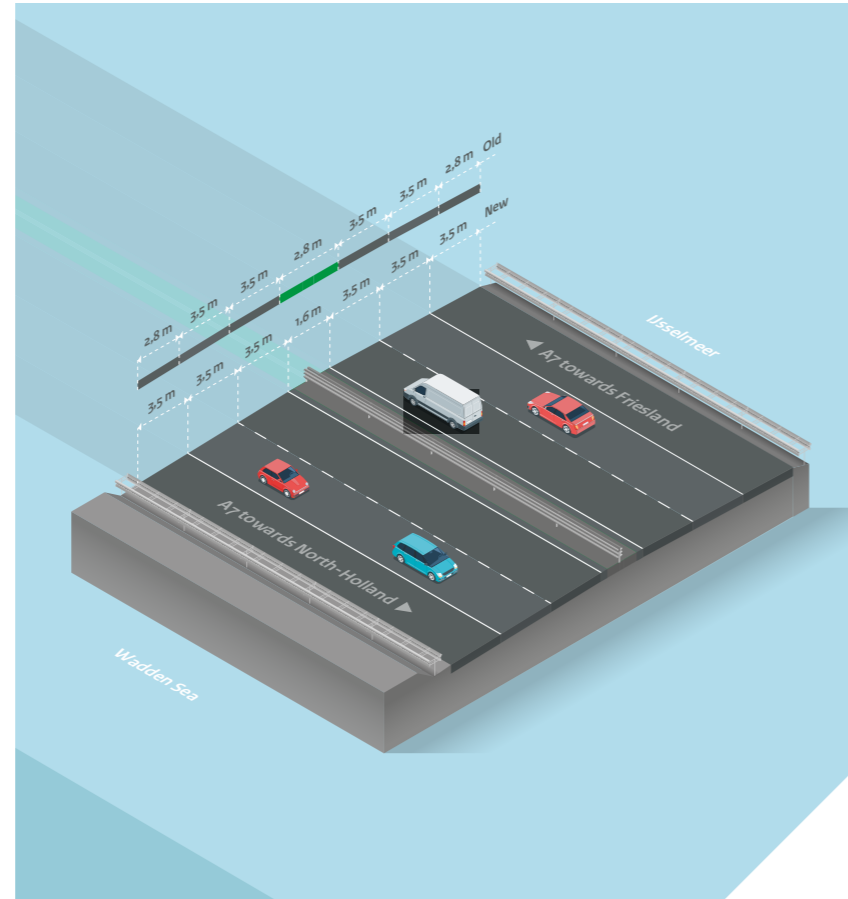
We will be reinforcing the construction of the existing discharge sluices in Kornwerderzand and Den Oever. We will be replacing the lock gates and drives in each sluice channel. We will also be improving the stability of the discharge sluices at Kornwerderzand.

Den Oever Sluice Complex

Road Improvements

The A7 motorway across the Afsluitdijk is an important connection linking the provinces of North Holland and Friesland. Approximately twenty thousand vehicles travel across this road each day. The road requires improvement for reasons of traffic safety. The road has a narrow, 2.8 metre-wide emergency lane on both sides, while the current standard is 3.5 metres. Because the road is 'locked in' between the IJsselmeer and the dike, the emergency lanes cannot be widened easily. By narrowing the central reserve, which can be done by installing an innovative guardrail, we can create space for wider emergency lanes.

A new water discharge system had to be designed because the central reserve is going to be paved and because of the new road profile. Instead of a twin convex profile, whereby both lanes taper at a slight transversal slope as a result of which the rainwater flows to the sides, as well as to the central reserve, the A7 lanes will have a single convex profile. In this configuration, the central reserve will be located at the same height as the road's highest point. As a result the rainwater no longer flows to the central reserve, but only to the left and right sides of the road. A completely new rainwater discharge system will be constructed. The rainwater will flow below the road deck to the IJsselmeer.



Spatial Quality

Not only is the Afsluitdijk a masterpiece of Dutch hydraulic engineering, it also has a unique spatial image. The classical sea dike as a straight line between the Wadden Sea and the IJsselmeer, the buildings and lifting towers designed by the architect Roosenburg, the Monument designed by the architect Dudok, the military fortifications and the protected villagescape of Kornwerderzand all come together to form a high-quality ensemble. The government and the region treat it with care. The Image Quality Master Plan for the Afsluitdijk sets out the principles that serve as the basis for the meticulous design of all of the renovations of the dike, locks and Monument. An independent quality team monitors the spatial quality. This attention ensures that the character of the dike and its surroundings will be preserved and reinforced.

Dudok Monument

Nature

The Afsluitdijk forms a separation between the Wadden Sea and the IJsselmeer, two unique nature reserves. We take this into consideration during the planning and execution of the work as much as possible. For example, we create conditions on the Wadden Sea side that make it possible for the special vegetation to return here. This way the unique salt tolerant plants can make a comeback on the dike because we collect the seeds and we will re-sow them on the dike after the work is complete. An ecological layer has been applied on top of the Banaan, a banana-shaped dam near Den Oever, so that the colony of spoonbills can once again breed here. The Level-blocs have a rough upper side and two notches that can hold water. This gives small organisms the chance to grow here.



Spoonbill



Fish Migration River

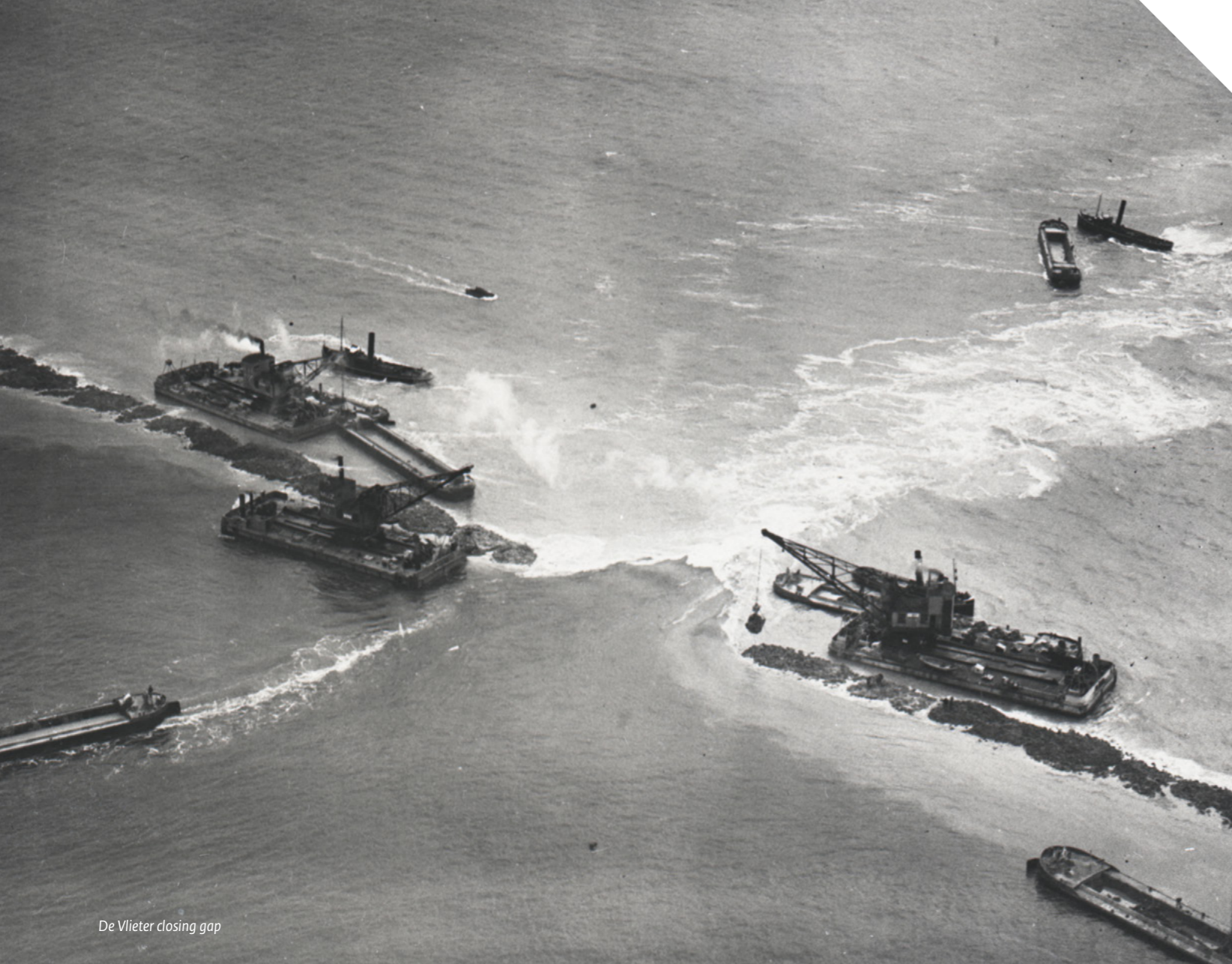


Gates of Light

Collaboration

In this project, Rijkswaterstaat primarily focuses on the dike's safety and on water drainage. De Nieuwe Afsluitdijk (a partnership between the provinces of North Holland and Friesland, and the municipalities Súdwest-Fryslân and Hollands Kroon) focuses on projects relating to the economy, ecology and sustainable energy.

A unique Fish Migration River will be constructed near Kornwerderzand to allow fish to move back and forth between the salt water Wadden Sea and the fresh water IJsselmeer. The navigation lock and the bridges near Kornwerderzand will be widened, so that larger ships can come and go from and to the IJsselmeer. You can also visit the Afsluitdijk Wadden Centre at Kornwerderzand. In addition, a recreational walking and cycling path will be created on the Wadden Sea side of the Afsluitdijk, the public space around the Monument will be redesigned and Daan Roosegaarde has given the lifting towers of the discharge sluices a new dynamic with his artwork Gates of Light. This way we are building a safe, sustainable, attractive and future-proof dike together.



De Vlieter closing gap

Hydraulic Engineering History

Plans to dam the Zuiderzee (this was an estuary in the northwest part of the Netherlands) go back as far as the 17th century. It was only after World War I that the cabinet seriously considered plans to construct the dike. Due to the hunger suffered during that war, the call to become self-sufficient in food production became more pressing. This required additional fertile agricultural land, which could be reclaimed if the Zuiderzee were to be closed off. Due to the major flooding in 1916, closing off the Zuiderzee became urgent. There were fatalities, people lost their homes and the economic damage was immense. In 1917, engineer Cornelis Lely submitted his plans for the Zuiderzee Works and in 1918, Parliament approved the Zuiderzee Act. Construction work on the Afsluitdijk started in 1920. After a short interruption due to a deteriorating economy, work resumed at full speed in 1925. Workers came from far and wide because the work paid well. On 28 May 1932, the final gap in the Afsluitdijk was closed.

Military History

The construction of the Afsluitdijk resulted in a straight-line connection between the provinces of North Holland and Friesland. To be able to defend this link, military fortifications were constructed on both sides of the dike at the time of its construction. Islands for concrete casemates with artillery were created. A heavy defence beam was installed along the discharge

sluices to protect against shelling and colliding ships. Kornwerderzand is the only spot in the Netherlands where the Germans were halted in the May invasion of 1940. At that time 225 Dutch soldiers managed to halt some 17,000 German troops. The disappointment was great when they nevertheless were required to surrender. After World War II the casemates were kept in service until the sixties as part of the Cold War.



Casemate at Kornwerderzand



Sustainability

The Afsluitdijk offers numerous opportunities for innovation and sustainable projects. Up until 2018, water turbines were developed and tested in the Den Oever sluice complex. In Breezanddijk there is a test site for Blue Energy: the generation of energy out of fresh and salt water. A large wind farm will be constructed in the IJsselmeer, with a transformer station on Breezanddijk and an electricity cable that runs through the dike towards the Province of Friesland. By making smart use of materials, the renovation of the Afsluitdijk will minimise CO₂ emissions. In addition, our use of energy and materials will be as efficient as possible. All materials released will be reused in the dike's reinforcement. The energy consumed by the discharge sluices and the huge new pumps near Den Oever will be sustainably generated using solar power on and around the Afsluitdijk.



The Afsluitdijk
Facts and Figures

<p>The Afsluitdijk</p> <p>32 kilometres in length</p>	<p>Discharge Sluices</p> <p>60 monumental lifting towers grace the sluice complexes</p>	<p>Level-blocs</p> <p>6.500 kilo the weight of a single Level-bloc, the dike's new revetment</p>
<p>Pumping Stations</p> <p>235 m³ water per second. The collective capacity of the 2 pumping stations with 3 pumps each</p>	<p>Fish Migration River</p> <p>4 kilometres the length of the Fish Migration River, which runs straight through the Afsluitdijk</p>	<p>Traffic</p> <p>20.000 vehicles per day cross the Afsluitdijk</p>

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