

Waterdunen

An aerial photograph of the Waterdunen project. The image shows a large, intricate network of blue water channels and ponds interspersed with green grassy areas. To the left, a sandy beach meets the sea. In the background, a town with red-roofed buildings is visible, along with a large body of water under a clear blue sky. The overall scene depicts a unique blend of natural water features and human-made infrastructure.

A truly unique nature and recreation area

This document contains the English translation of information about the Waterdunen project from the Waterdunen website

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1. Introduction

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Waterdunen is an icon for Zeeland. It proves that our approach to water has changed. Waterdunen is a so-called Delta Work, but unlike the Eastern Scheldt barrier or other works that protect Zeeland from flooding, Waterdunen combines nature, recreation, tidal effects, and safety in an innovative way.

1.1 Reason

Waterdunen came from a combination of circumstances. The West Zeeland Flanders region was struggling with a number of problems, such as an ageing population as well as a decline in employment. In addition, flood defences had to be reinforced to be able to withstand a superstorm. Moreover, the unique tidal nature in the Western Scheldt is under pressure and to restore it, international agreements had been made. These three factors enabled the creation of Waterdunen.

1.1.1 Economic boost

One of the important goals of Waterdunen is to contribute to a stronger economy in West Zeeland Flanders. In the late 1990s, the region was faced with some socio-economic problems. Partly due to an ageing population and job losses in agriculture, fisheries and the financial sector, the area's liveability was declining. Area plan Naturally Vital was developed to give the area a new perspective by boosting the economy and improving nature, the landscape, cultural history, as well as the habitational and recreational environment. Not only was Waterdunen developed for recreational users, nature experts and birdwatchers, it also attracts visitors to West Zeeland Flanders all year round. In doing so, Waterdunen reinvigorates residents, institutions as well as regional entrepreneurs.



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1.1.2 Coastal reinforcement of Weak Links

Waterdunen is part of the so-called West Zeeland Flanders Weak Links. This means that coastal defence in this region was insufficiently strong to withstand a superstorm, which is expected to occur once every 4,000 years. The West Zeeland Flanders Weak Link ran from Breskens to Cadzand-Bad. Waterdunen fulfils the twin objectives of Weak Links: coastal reinforcement, and stronger spatial quality. The existing dyke at 't Killetje was raised, and on the landward side a new dune was built: the climate dune. This dune was largely constructed with soil from the excavation works carried out in Waterdunen. At a later stage, it was covered with a layer of North Sea sand.



1.1.3 Tidal nature and coastal birds

The tidal nature that gives the Western Scheldt its unique identity is in danger of disappearing. Salt marshes and mud flats are steadily becoming smaller, and with them the area's exceptional wealth of birds and plants. With the development of Waterdunen, a muted tidal area has been created behind the sea dyke, using a tidal culvert. This solution was inspired by the Marquenterre recreational nature reserve in northern France. With its mudflats, salt marshes, tidal flats, and shallow water, Waterdunen is an important refuelling station for birds and a breeding ground for fish. In doing so, Waterdunen contributes to the nature restoration objective in the Western Scheldt, which the province of Zeeland is carrying out at the request of the Dutch central government. Waterdunen provides a significant part of the tidal nature that contributes to the Western Scheldt Nature Package.



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1.1.4 Joining of parties and goals

Each of the various partners acting together in Waterdunen had their own specific goals they were keen to achieve. In the late 1970s, the then owner of Napoleon Hoeve campsite, which is now part of Molecaten, was already facing coastal reinforcement plans. The recreational entrepreneur was looking for an opportunity to improve the quality of their campsite with the next coastal reinforcement. The Zeeland Landscape Foundation (in Dutch Stichting Het Zeeuwse Landschap, or HZL) was looking for an area for the development of large-scale saline nature, particularly for coastal breeding birds. The Province of Zeeland saw opportunities in combining the spatial and coastal reinforcement task with that of the Western Scheldt Nature Package. With the development of Waterdunen, the municipality of Sluis aimed to address the infrastructure in the area and provide sufficient parking facilities along the coast. Water board Scheldestromen was responsible for coastal reinforcement at West Zeeland Flanders. The Province of Zeeland brought the various parties together and commissioned works that were not included in the coastal reinforcement activities, such as nature design and recreational development.

Parc du Marquenterre

The Marquenterre recreational nature reserve, in northern France, served as a source of inspiration for Waterdunen. Near Abbeville, at the mouth of the river Somme, salt water from the sea was allowed to flow into a former agricultural area. Within a few years, the area was transformed into a beautiful nature reserve including a bird park, attracting many tourists every year.



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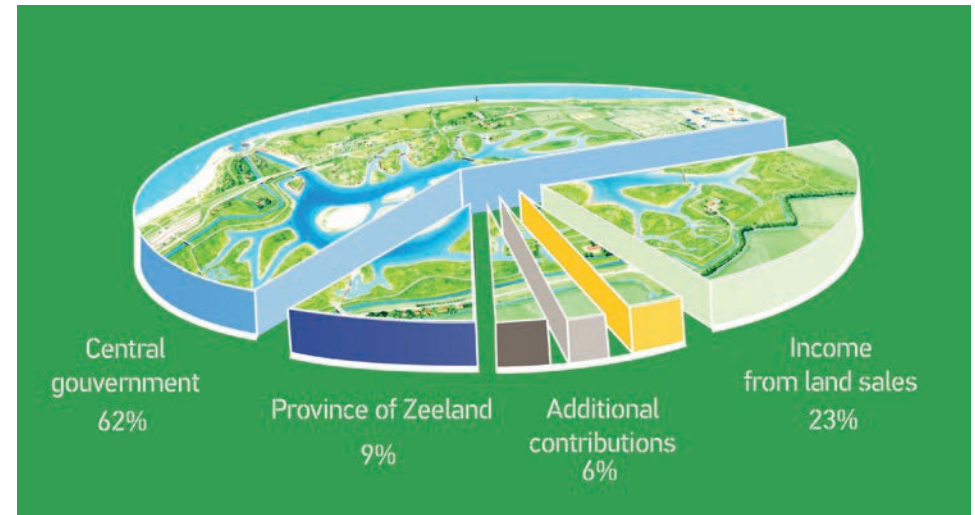
1.2 Financing

Waterdunen is a comprehensive project to which all partners have contributed. The State paid for the coastal reinforcement part, Water board Scheldestromen owns and manages the tidal culvert, and Molecaten is responsible for the financial side of the project. When Waterdunen was constructed, the Province of Zeeland managed the land utilisation, and invested in the development and accessibility of nature. HZL contributed to the bird watching and recreational facilities in Waterdunen, manages the newly landscaped nature, and oversees the realisation of the so-called Coastal Laboratory project.



● Land utilisation

A land utilisation budget plan was created for Waterdunen. This budget plan mapped both the costs and revenues of a spatial development plan. The costs, for aspects like preparing the land for construction and landscape design, were offset by sufficient income, largely coming from government contributions. In total, the land utilisation budget plan amounted to €90 million. The coastal reinforcement was financed from the Flood Protection Programme. Recreational entrepreneur



► The broad outlines of the funding of Waterdunen

Molecaten independently invests in the development of the recreation park. To substantiate the land utilisation budget, a Social Cost Benefit Analysis (SCBA) was carried out. It showed that the whole of the Netherlands would profit from a public investment in Waterdunen.

The State contributed about €22 million from the National Policy Document for Spatial Planning. Since Waterdunen helps to restore nature in the Western Scheldt, about €33 million of the Western Scheldt Nature Package was used for financing the project. The State has invested heavily in Waterdunen, from various budgets; its contribution amounts to over 62 per cent of the funding. In addition, the Province of Zeeland contributed another €8 million from its own resources, accounting for about 9 per cent of the budget. Additional revenues came from land sales, accounting for about 23 per cent of the funding. These, combined with revenues from European funds, a contribution for the clearance of Explosive Remains of War (OOR), and other, small revenues accounted for about €5.5 million, which is over 6 per cent of the total funding. Broadly speaking, the breakdown of the Waterdunen funding is as follows:

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- **European support**

In addition to funding from the National Policy Document for Spatial Planning and the Western Scheldt Nature Package, Waterdunen received support from other schemes, including €300,000 from the Natura People project of the Royal Society for the Protection of Birds, the Province of Zeeland, the Province of West Flanders, and Nature and Recreation Board de Grevelingen. Natura People is engaged in creating an international network to increase awareness of Natura 2000 sites. Natura People is part of the Interreg 2 Seas programme. This European programme promotes cooperation between regional areas in a variety of countries.

In addition, the Province of Zeeland received €1.8 million from the OP-Zuid programme (Operational Programme for the southern Netherlands) for the construction of the tidal culvert in the dyke at 't Killetje. OP-Zuid is a subsidy programme from the Provinces of Limburg, North Brabant, and Zeeland. OP-Zuid promotes competitiveness, sustainable economic growth, and employment in the southern Netherlands.



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1.3 Cooperation between five different parties

The five parties that worked together on Waterdunen are the Province of Zeeland (being the project initiator), the municipality of Sluis, Water board Scheldestromen, as well as two private parties: recreation entrepreneur Molecaten and HZL.

● Province of Zeeland

Waterdunen is one of many projects developed by the Province of Zeeland in the field of economic development, (sustainable) growth, and the renewal of Zeeland. The Province was the project's catalyst and director. Additionally, the Province invests in the development of nature and the accessibility of Waterdunen. For more information about the Provincial activities, visit www.zeeland.nl



● Zeeland Landscape Foundation (HZL)

HZL manages nature reserves, historical buildings, and other heritage in Zeeland. In Waterdunen, the foundation contributes to bird watching facilities and recreational experiences. HZL also manages the landscaped nature and the Coastal Laboratory in Waterdunen. For more information, visit www.hetzeeuwselandschap.nl.



● Molecaten

Recreation entrepreneur Molecaten operates recreation parks on beaches, in forests and on lakes, both in the Netherlands and abroad. In Waterdunen, Molecaten is building a recreation park with cottages, glamping tents, a camping site, and motorhome sites. Molecaten is the financier of the residential recreation facilities in Waterdunen. For more information, visit www.molecaten.nl/waterdunen.



● Municipality of Sluis

The Waterdunen area falls within the municipality of Sluis. The municipality has nearly 24,000 inhabitants and attracts millions of visitors and tourists every year. Sluis manages the parking facilities around Waterdunen and contributes to the recreational facilities in the area. For more information, visit www.gemeentesluis.nl.



● Water board Scheldestromen

Water board Scheldestromen manages and maintains Zeeland's dykes and is, among other things, responsible for sewage treatment in Zeeland. On behalf of the State, Scheldestromen carried out the coastal reinforcement in Waterdunen and, on behalf of the Province, simultaneously constructed the tidal culvert. For more information, visit www.scheldestromen.nl



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1.4 Pillars of Waterdunen

Waterdunen proves that nowadays, Zeeland is dealing differently with water than before. Apart from being a beautiful, outstanding natural and recreational area, Waterdunen is a so-called Delta Work. However, it distinguishes itself from other Delta Works like the Eastern Scheldt storm surge barrier and other large waterworks that were built to protect Zeeland from flooding.



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- **Coastal reinforcement**

Waterdunen improves safety and strengthens the coastline between Groede and Breskens, which is part of the Weak Link West Zeeland Flanders. The ground-breaking coastal reinforcement activities carried out here were completed in 2015. In Waterdunen, with safety as a precondition, tidal nature and coastal reinforcement are combined with recreation. On the landward side of the dykes, on the fields surrounding The Coastal Laboratory, entrepreneurs are allowed to experiment with saline crops, partly thanks to the innovative tidal culvert.



- **Tidal nature**

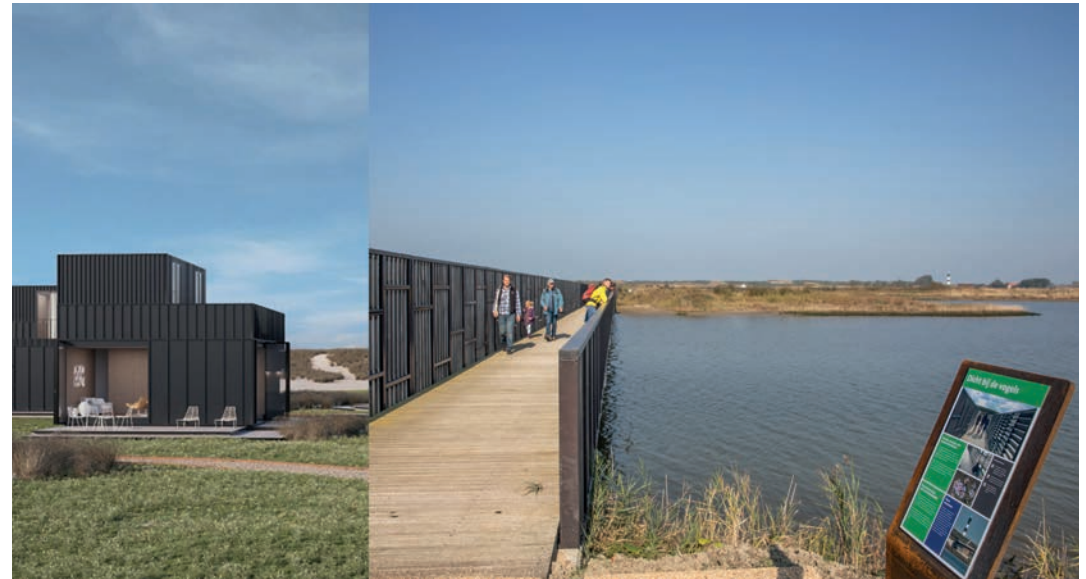
In Waterdunen, nature is determined by the tides. The innovative tidal culvert ensures a constant exchange of high and low water behind the dyke. The development of tidal nature helps create a specific kind of landscape with mudflats and salt marshes, salt-tolerant plants, and saline crops. The landscape is attractive to coastal birds since it is a quiet place to feed and breed. Waterdunen's location at the mouth of the Western Scheldt makes the area a European 'airport' for migratory birds on their long journey along the North Sea coast.



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● Recreation

Waterdunen is an attractive nature area with high-quality residential recreational opportunities. This makes Waterdunen a developing area of interest for recreationists, nature experts, and birdwatchers alike. Footpaths run through the nature reserve, taking visitors from cabin to cabin, enabling them to watch birds up close without disturbing them. To learn more about the extraordinary plants and birds in Waterdunen, visitors can join guided walks. Molecaten is building recreational houses in Waterdunen that are embedded in the landscape. Experiencing nature is one of the park's important values.

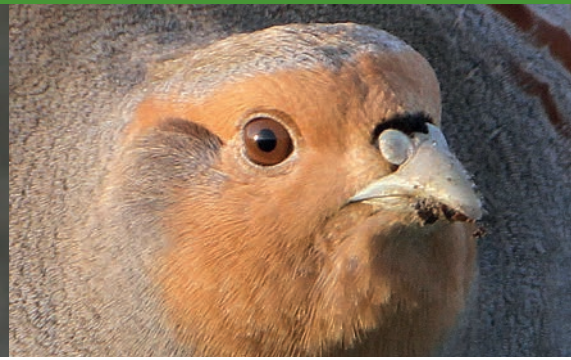


● Saline cultivation

The tides allow salt-tolerant plants to grow on the salt marshes and create saline grasslands, boasting beautiful purple sea aster fields and red glasswort banks in late summer. This special area between land and sea also enables the innovative cultivation of saline vegetables and aquaculture. As a result, the cultivation of plants, crustaceans, and other marine animals on saline soil or in saltwater ponds is on the rise in Zeeland. Waterdunen shows that inner-dyke saline cultivation can go hand in hand with landscape and nature.



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2. From idea to plan



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Before the start of the Waterdunen project, several plans were drawn up. Prior to this, various studies were carried out, a preliminary design was created, the required land purchased, and the funding worked out.

Waterdunen could be created thanks to a confluence of circumstances. Not

only is Waterdunen an extraordinary nature and recreational area, significantly contributing to the economy in West Zeeland Flanders, but it also serves as a dyke reinforcement. In addition, on the fields surrounding the Coastal Laboratory, entrepreneurs can experiment with saline crops, thanks to the way the area was designed, as well as the construction of an innovatory tidal culvert.



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Naturally Vital, the 2004 area plan for West Zeeland Flanders, describes possible solutions to problems related to the region's ageing population, the decline in employment, and the withdrawal of the population. Naturally Vital formed the basis of several projects, including Waterdunen. At the same time, the State drew up the Weak Links Policy Framework for Planning Studies, with the aim of better protecting the Netherlands from flooding. This resulted in a fundamental document entitled Coastal Reinforcement West Zeeland Flanders (2005). It concluded that coastal safety and the development of nature, landscape, and recreation in Waterdunen could best be combined with wide, robust dunes. Due to the Western Scheldt channel, seaward reinforcement was not an option.

The next step was the drafting of the EIA Waterdunen (Coastal Reinforcement and Area Development in the Jong- and Oud-Breskenspolder). The EIA Waterdunen described the desired measures, alternatives, and the effects of these alternatives. Going through the EIA procedure was mandatory since it involved modification of the sea dyke, the construction of recreational and tourist facilities, and the layout of the rural area. In 2007, the EIA went through the public participation process. Subsequently, the performance contract was signed. The Province of Zeeland took the lead in the preparatory phase.



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The further elaboration of the Waterdunen project ran via a variety of tracks. In February 2008, the draft coastal reinforcement plan started. That same year, preparations began for the drawing of the development plan. To complete the financial side of the project, the matter of land utilisation was further elaborated. Also in 2008, it was examined whether Waterdunen could be part of nature restoration activities in the central area of the Western Scheldt, as described in the Western Scheldt Nature Package (NPW). As a result of the positive answer to this question, Waterdunen also received funding from NPW.

An important factor in the creation of Waterdunen was the acquisition of the required amount of land in the area. Between 2006 and 2012, extensive talks with

landowners took place. Eventually, in 2012, the Province of Zeeland managed to conclude agreements with all the landowners involved.

At a meeting held in October 2009, the Provincial Executive of Zeeland released the preliminary draft of the Provincial Zoning Plan Waterdunen for public participation and consultation. At the same meeting, the development plan prepared for Waterdunen was adopted. This plan, which gives an impression of the future look of Waterdunen, was made available for inspection, together with the preliminary draft zoning plan. The Waterdunen development plan became irrevocable in February 2012. Work could begin.



3. Realisation of Waterdunen



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The construction of Waterdunen has been a journey spanning many years. Because of the different ways of funding and agreements on land use after purchase, implementation was spread out over a long period of time. Moreover, digging and groundwork sometimes had to be temporarily halted to allow the soil to settle. Accessibility, weather conditions, breeding seasons, as well as the tourist season had to be taken into consideration. The development of Waterdunen allowed additional works to be carried out in the surrounding area, thus combining works with works.



3.1 Preparation

After enough land had been acquired, in 2012, the area needed to be cleared. The site of the former Napoleon Hoeve campsite was emptied, and house connections, gas, water, electricity, sewage, and telecommunication mains and cables were

rerouted. Through roads and watercourses were rerouted as well. Unexploded remnants of war were removed from the soil and archaeological research was carried out. During the work, special flora and fauna had to be considered. Groundwater management and the structural condition of the surrounding houses and roads were mapped to establish a baseline situation.

3.1.1 Clearing of the Napoleon Hoeve

Coastal reinforcement is an important facet of Waterdunen. Within the Weak Links project, the coast near Groede-Breskens had to be reinforced. The sea dyke needed to be raised and widened. With the Western Scheldt channel so close to the coast, dyke reinforcement could only take place on the landward side of the dyke. As a result, the Napoleon Hoeve campsite, located directly behind the dunes, had to give way.

The clearing of the Napoleon Hoeve site took place at the end of 2012. The dyke reinforcement was carried out by reshaping the area, with room for a new layout of the recreational area.



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3.1.2 Cables and pipes, sewerage

In the Waterdunen area, several cables and pipes ran along roads and towards homes. Many of them were rerouted. Future developments were considered by enhancing the capacity of several pipes.

Many of the remote homes had septic tanks instead of being connected to a sewage system. In some individual cases, other kinds of wastewater treatments were applied. These homes were connected to a pressurised sewer ring system. Scattered around the area were old utility pipes and communication cables. The new pipes were brought together in a single bounded section as much as possible.

3.1.3 Water management, roads, and parking facilities

Across the area to be redeveloped were several drainage ditches, intended for Schoneveld and part of Breskens. A large ditch was constructed around Waterdunen, separating the Waterdunen water system from its surroundings. The construction of a new water system created an opportunity to improve the drainage of the built-up area around Waterdunen. The water in the ring ditch is pumped towards the Western Scheldt by pumping station Nieuwe Sluis.



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3.1.3.1 The ring ditch

in 2013-2014, a wide ring ditch was constructed around the area. The edge of the ring ditch on the side of the creeks serves as a boundary for the salt water in Waterdunen. This water is not connected to the drainage system of the surrounding polder.

The salt water is connected to the Western Scheldt via the tidal culvert and the inlet creek. The ring ditch serves as an outlet for both polder water and water from a part of the built-up area of the city of Breskens, towards the pumping station at the tidal culvert. The Zwartegat creek was dredged, and a large new culvert was constructed in the Puijendijk to ensure the flow of polder water.



3.1.3.2 Modification of motorways

In and around Waterdunen, motorways were modified. Highways were partially removed, and new highways were built.

The through roads in the area had to go. To this end, the procedures for the removal of roads were followed. During the works, the roads were kept in use for work traffic for as long as possible.

To create a new route to the coast between Breskens and Groede, the Nieuwe Slikkenburgseweg was constructed, including a separate cycle path, in 2014. The road connects the Nieuwe Sluisweg with the Langeweg and forms the eastern border of Waterdunen. At the end of 2017, the final section of the Langeweg was no longer accessible to the public. In 2019, the through roads were permanently removed.



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3.1.3.3 Parking facilities

From 2013 to 2018, many different works related to the construction of a new infrastructure were carried out. The construction of three car parks means an improvement in parking conditions along the coast.

On the western side of Waterdunen, on the Walendijk, a large car park was constructed. For this purpose, the road on the north-western side of the area had to be redirected. The Walendijk was largely reconstructed in 2014. Next to holiday park Schoneveld, on the Nieuwe Sluisweg, is a smaller car park.

In early 2017, the Puijendijk along the southern side was renovated. This important access route was widened, and a new bicycle crossing allows cyclists to safely cross the road. Near the junction with the Noordweg, a new bicycle crossing was created, including a refuge on the central reservation. The viewing point at the beginning of the Puijendijk offers passers-by an outstanding panorama of Waterdunen.



3.1.3.4 Cycle paths

Around Waterdunen, cycle paths were constructed on the crest of the dyke between Breskens and Cadzand, past the lighthouse and the bird-watching station, as well as on the tidal culvert.

At an earlier stage, along the Nieuwe Slikkenburgseweg, a cycle path had already been constructed. Since the path is elevated, it offers cyclists a wonderful view over Waterdunen. The path has been extended along the Langeweg towards Breskens and then bears to the south, parallel to the ring ditch. The cycle path emerges at the Nolletjesdijk, at a lower level, next to the dyke. Here it continues, always offering a nice view of the saline landscape. The southern part of the cycle route was completed in 2015.



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3.1.4 Remnants of war

At the end of 2012, a survey for Unexploded Remains of War (ORW) began in almost the entire Waterdunen planning area. In World War II, the Battle of the Scheldt was fought here, making it a regular target for bombing and heavy fighting.

Because of the geological foundation of the area, unexploded bombs can be found up to more than 10 metres underground. The area was systematically combed over to locate and defuse the remnants of war so that excavation work could be carried out safely. The harvest of the survey was significant, including, among other things, grenades of all sizes, ammunition boxes, incendiary bombs, sometimes buried after the war and dumped in deep pits.

The most impressive remnants of war that were found were four bombs, 500 kilos each, and the remnants of a British airplane. The Explosive Ordnance Disposal Service (EOD) regularly came to the area to defuse the explosive material. The clearance of two bombs required the evacuation of a large part of Schoneveld park and the residential area Het Heem. By the end of 2013, most of the war material had been

removed. During all subsequent excavation activities in Waterdunen, additional searches for possibly overlooked objects were carried out. Many other objects were found during the surveys as well, including a large quantity of horseshoes. Several types of soil contaminations were also discovered (oil, pesticides, asbestos) which were cleaned up according to the appropriate procedures.



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3.1.5 Archaeology

Before construction work began, additional archaeological research was carried out at several locations in Waterdunen. The survey focused on evidence of the construction, habitation, and use of earlier polders. Traces of farms land development, for example, and the 19th-century Fort Napoleon fortification. Indications were found that the oldest embankment in the area dates from the 16th century. Further examination of the dykes showed the stratification in their construction. The aim of the study was also to establish whether in those days the dykes were built on wooden foundations. This turned out not to be the case.

3.1.6 Special flora and fauna

In preparation for the works, the flora and fauna of the area were surveyed. Based on this, measures for the works to be performed were prescribed and included in the implementation permits.

Nest boxes for the little owl found in the area were installed, and a former orchard in the eastern part of Waterdunen was modified. Measures were also taken to protect orchids growing on several dyke slopes. When felling trees, consideration was given to bats that use the trees as landmarks on their flight routes.



3.1.7 Monitoring

Before the start of the construction works, several measurements were taken. The houses and roads around Waterdunen, for instance, were checked for damage before, during and after the works. The separation of fresh and salt water in the groundwater was measured as well.

In 2011, groundwater monitoring wells were installed around Waterdunen to monitor water levels and data on the occurrence of salt groundwater. The hydrological impact of Waterdunen on water management in the area was investigated as part of the Waterdunen EIA. It concluded that the risk of changing the area's hydrology, particularly the separation of fresh and salt groundwater, is highly limited. The Province also drew up a scheme for compensating demonstrable damage due to the works or to the changing hydrology of Waterdunen. A monitoring programme was developed in consultation with residents and agricultural representatives. The Province made agreements with landowners and will continue to carry out its monitoring task until the end of 2024.



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3.2 Coastal zone design

After a period of preparation, the different parts of Waterdunen were constructed. Many activities in the field of coastal reinforcement, the landscaping of the nature reserve, and the creation of the Waterdunen park landscape were combined.

3.2.1 Coastal reinforcement

Waterdunen, being a part of the West Zeeland Flanders Weak Link, not only improves safety but also reinforces the coast, thanks to the implementation of innovative measures.



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- **West Zeeland Flanders: a weak link**

In the second High Water Protection Programme, the coast near Waterdunen was designated as one of the ten Weak Links. This implicated that the seawall between 't Killelje and Zandertje was not strong enough to withstand a possible superstorm. Due to the presence of a deep channel off the coast in the Western Scheldt, the dyke could not be reinforced on the seaward side. Therefore, the seawall was reinforced on the landward side by means of a so-called climate dune.

The climate dune is 300 metres wide, and its highest point is 18 metres above sea level. With an average height of 14 metres, the climate dune should provide protection for the next 200 years.

From 2013, after a large proportion of the Investigation of Unexploded Remains of War (OOO) had been completed, the first trenches were dug. Between 2013 and 2016, the soil that was dug up in the process was mostly used to reinforce and raise the sea dyke, as well as to build the climate dune.

North Sea sand was used to create a dune area. With the installation of dust screens and the planting of sea buckthorn, marram grass and other dune vegetation on the climate dune, the coastal reinforcement was completed in early 2016.



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3.2.2 Bird observatory

The old bird counting station had to make way for coastal reinforcement. In April 2014, the renovated bird counting station, located on the dyke on the Nieuwe Sluisweg, was opened. From a distance, the new bird observatory looks like a ship.

It was co-designed by birdwatchers who regularly use it. The structure is set up like a cross to provide shelter from all wind directions. The bird-watching station is perfect for enjoying the wide views of the Western Scheldt, the creeks, and the Waterdunen bird area.



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3.3 Construction of the Waterdunen area

After the necessary preparatory work had been completed, large amounts of soil were moved. With the excavation of creeks and channels and the construction of bird nesting islands, the contours of Waterdunen began to emerge.

3.3.1 Design of the creek system

In 2014, 2015 and 2016, the creek system and islands were constructed. The area is on an important migration route of birds that use tidal flats, mudflats, and salt marshes as resting and foraging areas. Waterdunen is a wetland, subjected

to the rhythm of the tides. Large creeks with gentle banks provide resting places. At low tide, drying salt marshes and mud flats offer an abundance of food.

3.3.2 Tidal culvert and soil protection

With the excavation of the creek system and the construction of the tidal culvert, in 2014, a next step was taken towards the creation of a connection between the Western Scheldt and Waterdunen. For this purpose, measures were taken both on the landward and the seaward side of the dyke.



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3.3.2.1 Tidal culvert

Water board Scheldestromen constructed the tidal culvert on behalf of the province of Zeeland during 2014-2015. Constructing this passage in the flood barrier was a massive and extraordinary job.



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● How does the tidal culvert work?

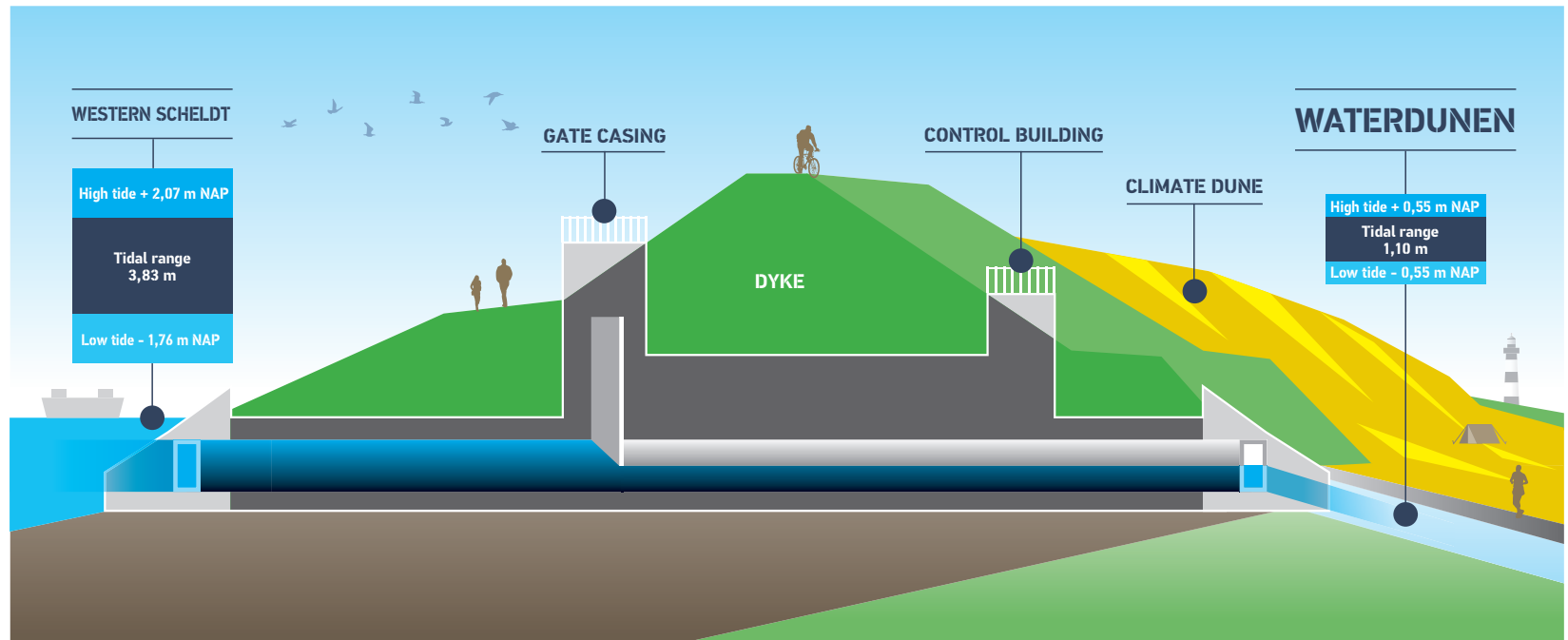
The culvert has four tubes, each of which is four metres wide and three metres high. Three tubes create the muted tide in Waterdunen. This allows Western Scheldt water to flow into and out of the area. Tube number four is connected to the Nieuwe Sluis pumping station and drains polder water into the Western Scheldt. There is no connection between the salt water in Waterdunen and the water of the surrounding polders. On top of the tubes, on the landward side, is a control room. A gate casing is located on the seaward side. The figure below shows the structure of the tidal culvert.

The tidal culvert was commissioned in September 2019. For the first time, salt water was flowing into and out of the area. The first few months were used to test the flow velocities in the inlet creek and at 't Killetje, as well as to adjust the tide controls. The tide in Waterdunen is muted. This means that at low tide, the water level in Waterdunen varies, though not as much as in the Western Scheldt. The

average high and low tide levels in the Western Scheldt are about +207 cm NAP and -176 cm NAP. At spring tide, the tide in Waterdunen will vary from -75 cm NAP to +75 cm NAP, and at neap tide from +30 to -30 cm NAP.

The gates regulate the water level in the tidal area. The larger the opening of the gates, the more water is allowed to flow into or out of the area. The gates are controlled according to measurements of the water levels in both the Western Scheldt and Waterdunen. Several measuring points have been installed, which continuously transmit information. The gates are set by means of a computer system to obtain the right tidal curves in Waterdunen. In addition, the tidal culvert is equipped with automatically controlled safety systems whose action is based on the measured water levels. If the water in Waterdunen is about to reach its maximum level and water is still flowing into the area, the gates close. In case of an emergency as well as for maintenance reasons, the tidal culvert can be operated manually.

► Tidal culvert infographic Waterdunen



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- **Optimal safety guaranteed**

The tidal culvert is part of the flood barrier. This places high demands on its functioning. If necessary, for example in the event of an extreme storm surge, the culvert can be closed. That is why each culvert has two gates. The automatic control system also carries out partial closures based on the height of the water levels, for example when the water level in Waterdunen rises too fast, when the maximum or minimum level has been reached, or when the flow velocities in either 't Killetje or the inlet creek have reached an extremely high level.



- **Fish harvesting**

Before the tidal culvert was brought into use, the water in the creeks was brackish. When the tidal culvert opens, salt water enters Waterdunen. This would mean the end for the fish living in the area. To prevent this from happening, in July and August 2019, as many fish as possible - mainly carp, (pike) perch and roach - were caught from the creeks by a specialist fishing firm. The fish were subsequently released into the Markiezaatsmeer near Bergen op Zoom.



- **Official opening of the tidal culvert**

The tidal culvert connects the saline nature area of Waterdunen to the Western Scheldt, allowing water from the Western Scheldt to flow into and out of the area twice a day. The area surrounding the culvert is a focal point for residential and daytime recreation. On 26 September 2019, the tidal culvert was officially opened by the five parties cooperating on the Waterdunen project.



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- **2023 and 2024 adjustments**

Before the tidal culvert was put into service, the system was extensively tested. The technical monitoring phase mainly looked at whether the flow rate of the water at the inlet and outlet had been calculated correctly. Another focal point was whether the stone revetment of the inlet creek and that at 't Killetje would remain in place, and whether the system of the tidal culvert itself was functioning properly.

The tests showed that the design of the inlet creek and 't Killetje was appropriate. The tidal culvert, however, appeared to be not yet fully functional. This was solved by implementing a set of measures including modification of the (software) operating system, and additional reinforcement of the hydraulic system. Water board Scheldestromen will implement these adjustments in 2023 and 2024.



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3.3.2.2 Soil protection

Without soil protection measures, the inflow and outflow of water could potentially cause soil erosion. To prevent this as well as not to endanger the stability of the flood defence, measures were taken, both on the seaward side of the Western Scheldt (Killetje Buiten) and in the inlet creek on the landward side of the dyke.

● Killetje Buiten, on the seaward side

The Waterdunen tidal culvert was built at 't Killetje. When the gates are opened, seawater flows into and out of the area with great speed after the gates are opened. To strengthen the outflow channel on the seaward side of the culvert, the bottom of 't Killetje was deepened, resulting in a 4-metre-deep outflow channel. The excavated section was then protected with a layer of armour rock, deposited on fascine mattresses and corbels. In total, some 12,000 tonnes of armour rock were used for this purpose. Some adjustments were made above the water. Earlier in the process, the eastern ridge had been tackled. Now the western ridge was slightly shortened. As a result, the outlet channel is in line with the tidal culvert, allowing the water to flow easily.



Finally, the wave-breaking pile rows were moved. Work was carried out from May to September 2017. Due to the open nature of the Western Scheldt, this had to be done to the rhythm of the tides. The advantage of the seaside location was that much of the required armour could be brought in by boat.

● Inlet creek, on the landward side

Excavation of the inlet creek began in the second half of 2018, commissioned by the Province of Zeeland. The creek had to be capable of withstanding periodically high flow rates of Western Scheldt water, flowing through it at the change of tides. The inlet creek is about 500 metres long. Close to the tidal culvert, the channel is relatively narrow, about 12 metres. Towards the channels, the inlet creek becomes increasingly wider, up to 75 metres. The soil that was released when digging the inlet creek was used to finish several recreational islands in Waterdunen.

As the water flows through the inlet creek at a high speed, to prevent erosion, the banks and bottom were reinforced with braided mattresses and covered with armour rock.



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Close to the tidal culvert, over a length of dozens of metres, the armour rock was further reinforced with colloidal concrete: a concrete mortar thickened with an adhesive-like substance, making it suitable for underwater application. For safety reasons, a fence and hazard signs warning against the high flow rates were installed on both sides of the inlet creek. The works were completed by June 2019.



3.3.3 Bird nesting islands

In addition to the creeks and in combination with coastal reinforcement, other creeks and islands were constructed in Waterdunen. The soil released from the excavation of the channels and creeks was used to construct the islands.

In the western part, bird nesting islands for ground nesting birds can be found. Ground nesting birds build their nest, hatch their eggs, and raise their chicks on bare ground. The bird nesting islands were covered with a thick layer of shells to provide a suitable nursery for coastal birds. The works were completed in June 2017. The tidal culvert helps prevent flooding of the bird nesting islands during the breeding season. At the same time, the islands are meant to flood regularly to prevent rats from settling and thus endangering the next breeding season. It also prevents freshwater vegetation from developing and helps to keep the islands as bare as possible.



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3.3.4 Walking paths

Work on the walking paths in Waterdunen has been taking place since spring 2019. Some of the paths run through the nature reserve, whereas others run across the Waterdunen recreation park.

The central path, consisting of bridges and a boardwalk, runs from north to south across three islands. On two of them are birdwatching cabins, built by HZL.



Subsequently created footpaths allow visitors to walk through Waterdunen in a large circle.

All other paths consist of asphalt. They were finished with a yellow top layer to make them accessible to wheelchair users. Another reason for choosing asphalt are the cows living in the area. Asphalt is more resistant to regular cleaning than other materials. In cattle grazing areas, cattle grids were installed.

Viewing screens along some parts of the routes allow visitors to watch birds up close. Only in the easternmost part of Waterdunen leashed dogs are allowed. Dogs are not welcome on most footpaths, to minimise disturbance to the birds. Cycle parking spaces have been created at the various entrances to Waterdunen. Part of the Waterdunen paths run through the nature reserve, others run across the Waterdunen recreation park. The paths are open to the public within the rules set by the managers of the area. A special part of the pedestrian network is the so-called 'boulevard' along the inlet channel. It offers visitors a clear impression of the force of the water as it flows through the inlet channel.



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3.3.5 Cabins and facilities

Several viewing cabins were constructed in Waterdunen, each of them with its own theme. More facts about Waterdunen can be found on the information panels in the area.

● Bird watching cabins

The colony cabin located at the central path overlooks the water and bird nesting islands. Information panels show the variety of birds that can be found here. In spring, large numbers of terns and seagulls nest on the islands, occasionally turning the island white.

The migratory bird cabin, also located at the central path, overlooks the water in the direction of Breskens. At high tide, the water almost reaches the cabin. At low tide, a muddy edge remains. Here, birds forage for food. With a bit of luck one can spot a bird scurrying around right in front of them.



● Recreational information services

More facts about Waterdunen can be found on the information panels in the area. They give information about, for example, the tides, the various birds one can encounter, and the development of nature. Along the way, cabins allow visitors to take a closer look at the birds. The signage in Waterdunen is made of rough, sturdy materials such as concrete, wood and Corten steel.



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3.4 Linking opportunities

The construction of Waterdunen created the possibility of combining construction activities with several other opportunities and wishes from the surrounding area. Some of these were meant to solve specific problems, others add value to Waterdunen.

3.4.1 Zwarte Gat dredging project

The construction of Waterdunen created an opportunity to address the problems concerning the Zwarte Gat, near Groede. In consultation with Water board Scheldestromen, the Province of Zeeland made space available in Waterdunen for released dredging sludge.

In the Zwarte Gat, a significant part of the creek bottom fell dry. At times, an inadequate flow of water caused odour problems. Constructing a dredging depot in Waterdunen allowed the main drainage to be adjusted to the benefit of both Waterdunen and the Zwarte Gat. For this purpose, the Province has built a new culvert through the Puijendijk.



3.4.2 Coastal Laboratory and oyster gully

The Coastal Laboratory is an initiative of HZL. It aims to demonstrate that experimenting with inland saline cultivation can very well take place in harmony with the surrounding landscape and nature.



- **Saline cultivation**

To this end, HZL has set up the area surrounding 't Hof Waterdunen, a restored farmhouse. Here, salt-loving plants are grown on saline soil and shellfish bred by using seawater, in such a way that it is attractive to pioneering entrepreneurs, students, residents, and tourists.

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● Construction of the Coastal Laboratory

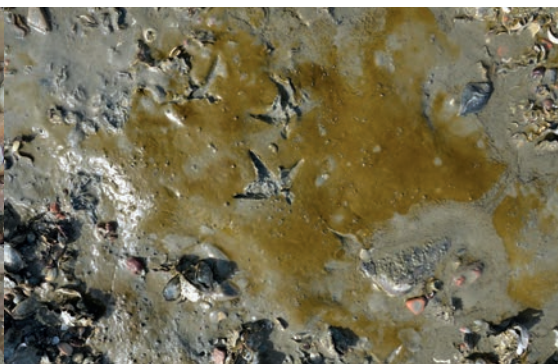
The construction of the Coastal Laboratory began in late 2016. The building is made of sustainable materials and is energy neutral. The Coastal Laboratory is in the yard of 't Hof Waterdunen, a restored farmhouse serving as Waterdunen's nature management centre. As part of the Coastal Laboratory, an extra stretch of land was excavated between two creeks, where oysters can be grown: the Oestergeul. Its banks were reinforced with armour rock. The gully has a concrete lane at the bottom, allowing a vehicle to drive into the gully to move the baskets of oysters at low tide. Three paddle wheels in the gully ensure sufficient flow and refreshment of the water.

3.4.3 Saline areas and sweet pools

In 2019, HZL started work on a saline marsh wetland in the west of Waterdunen as well as in a couple of freshwater pools on the southern side. Here, small-scale breeding islands were created. The freshwater pools lie outside the saline creek system and attract bird species that are new to the area. HZL hopes the bittern will also settle here. To the east of Waterdunen is a salt pan. In this pool, after high tide, a layer of saltwater remains at the bottom. Here, evaporation may result in the formation of a thin layer of salt. For the creation of these areas, HZL receives a financial contribution from Vogelbescherming Nederland.



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4. Management of Waterdunen



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In Waterdunen, public authorities and private parties are jointly constructing and managing recreational facilities, nature, and coastal reinforcement. Good management is important for nature, residents, as well as recreational users. It

helps to keep Waterdunen an extraordinary breeding and foraging area for coastal birds, keeps its recreational facilities accessible and attractive, and helps to keep residents involved in the project.



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● Managers

Since the final land transfer performed by the Province of Zeeland, by the end of 2022, Waterdunen has had four managers: Water board Scheldestromen, the municipality of Sluis, recreational entrepreneur Molecaten, and HZL.

Waterdunen has multiple functions. The main ones are coastal defence, recreation, core nature, recreational nature, and the Coastal Laboratory (saline crops). The latter three fall under the management of HZL, Water board Scheldestromen manages flood defence, and entrepreneur Molecaten manages their recreational houses and dune campsite.



● Zeeland Nature Management Plan 2021

The Province of Zeeland has included Waterdunen in the 2021 Plan Amendment of the 2016 Nature Management Plan. This has given Waterdunen the status of 'existing nature, management type Sea and mudflats and Dune and salt marsh landscape'. The area is included in both Nature Network Zeeland (NNZ) and Nature Network Netherlands (NNN) and therefore receives planning protection.

● Waterdunen management plan

The various parties cooperating in Waterdunen have jointly drawn up a management plan to maintain Waterdunen's natural values and enable recreation. The management plan provides clarity on management, maintenance, and the associated costs. Based on this, the parties have agreed on the costs of management.

● Waterdunen management platform

An important step was taken with the signing of the Waterdunen Management Platform, on 8 June 2022. In the coming years, Waterdunen will continue to develop in terms of tidal nature, water management, recreation, and saline crops. To properly align these developments, the partners in the area will continue to work through this new platform.

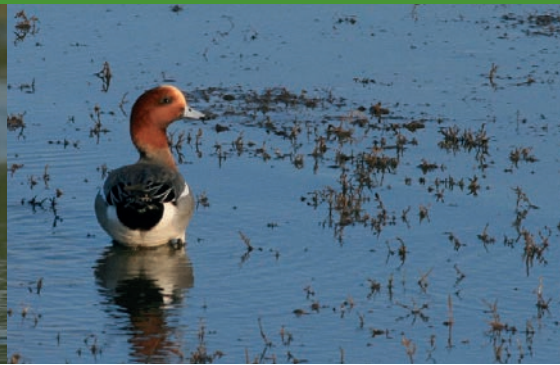
Under the umbrella of the management platform, the four partners discuss developments in the area, align the objectives of Waterdunen with their own organisational goals, and make Waterdunen-related organisational agreements. The parties have agreed that HZL will guide the process by providing the chairperson as well as secretarial support.

The purpose of the platform is:

- ▶ Informing each other about the ins and outs of the different parts of Waterdunen;
- ▶ Aligning the management and maintenance of the various properties in the area;
- ▶ Apart from the management and maintenance performed by each individual party on their own property, the management platform can zoom in on aspects that need coordination;
- ▶ Evaluation and coordination of area monitoring and water level management.

Nature, water safety, recreation, and saline crops are strongly intertwined in Waterdunen. Therefore, strong cooperation and coordination between the various parties is important. The partners consider Waterdunen as one area, in which they carry out activities from their own objectives within the agreements made.

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5. Glossary of terms and definitions



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- ▶ **Delta Works** - the Netherlands' largest defence system against high water from the sea; consists of storm surge barriers, locks, and dams
- ▶ **Tidal nature** - nature influenced by the tides
- ▶ **Tides** - the alternation of high and low tide: two high tides and two low tides every 24 hours
- ▶ **Muted tidal area** - the tide in this area is muted because seawater flows in and out through the tidal culvert in a controlled way. On the landward side, the water is less high at high tide, and less low at low tide than on the seaward side
- ▶ **Weak Links** - a national programme developed to strengthen ten flood defence sections along the Dutch coast. At ten locations, sea defences were reinforced by the Ministry of Transport, Public Works, and Water Management. The programme was completed in 2016
- ▶ **Climate dune** - a dune landscape as part of the seawall, designed to meet coastal protection safety standards for longer periods of time
- ▶ **Western Scheldt Nature Package (NPW)** - a recovery programme drawn up by the State to restore the health of the Scheldt estuary. At the request of the State, the Province of Zeeland is carrying out the expansion of estuarine nature (salt marshes and mud flats) at several locations in Zeeland Flanders
- ▶ **Coastal reinforcement** - measures to benefit the entire coast strip that contributes to ensuring flood safety of the hinterland
- ▶ **Tidal culvert** - a culvert in the seawall, being a part of the flood defence system
- ▶ **Land utilisation** - a budget identifying the costs and revenues of a spatial development plan
- ▶ **Land design plan** - the graphic description of the desired spatial development in an area. Describes, among other things, the desired morphological and functional structure of the area
- ▶ **Survey Unexploded Remnants of War (OOO)** - investigation concerning the possible presence of First and Second World War explosive remnants of war in the seabed or soil
- ▶ **Explosive Clearing Service (EOD)** - service of the Dutch armed forces whose task is to defuse unexploded fireworks, bombs, mines, and other explosives and ammunition, both on land and on water
- ▶ **Bird counting station** - observation point for watching and systematically counting passing birds. The data obtained here are used for research into bird migration patterns on a European or even a global scale
- ▶ **Water barrier** - a barrier protecting land from flooding
- ▶ **In/outflow gully** - gully created in a water bed or soil by flowing water
- ▶ **Inlet creek** - a stone-reinforced channel that connects the Waterdunen creek system to the tidal culvert, connecting Waterdunen to the Western Scheldt
- ▶ **Bird nesting island** - an island consisting of sand and, if necessary, covered with a layer of shells, giving birds the opportunity to nest, rest, and forage
- ▶ **Birdwatching cabins** - small buildings from which birds and their behaviour can be observed
- ▶ **Coastal Laboratory** - an initiative of The Zeeland Landscape Foundation (HZL), an testing ground for the practical development and testing of saline cultivation concepts



Colophon

Province of Zeeland

Justification illustrations
Province of Zeeland (www.beeldbank.zeeland.nl)

For more information visit:
Waterdunen | Province of Zeeland

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