REPORT

Quickscan Ecology and Ecotoxicology Prototype North Sea

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Royal HaskoningDHV
Enhancing Society Together

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1 Introduction

The Ocean Cleanup is developing a method to remove plastic from the ocean. It is a passive mechanism using floating barriers to stop and collect marine litter. Since the start of the Ocean Cleanup in 2013 several studies have been undertaken to improve the method. Currently a life size prototype of the floating barriers is available. In the summer of 2016, this prototype will be tested along the Dutch coast on its sustainability and logistics. The next phase of the study will take place along the coast of Japan. This phase will include the collection of plastics.
The Dutch Government 'Rijkswaterstaat' has asked The Ocean Cleanup to examine the impacts of the Prototype North Sea on the marine environment, in order to achieve a permit for the 'Waterwet'. Both physical and toxic impacts may occur, these impacts are set out in this report.

This quick scan describes the possible impact of the Prototype North Sea on the marine environment and assesses the impacts on the local species and habitats. Hereby we take into account the conservation objectives of The Birds and Habitats Directive and the protection of individual species through the Dutch Flora and Fauna Act.

The Prototype North Sea is only a fraction of the size of the floating barrier, which will be used in the future to collect plastic in the Pacific Ocean. It should be noted that other species occur in these remote areas of the Pacific Ocean compared to the species found in the North Sea. Therefore the results in this report cannot be extrapolated for future developments of the floating barrier.

The next chapter describes the Prototype North Sea in more detail e.g. choice of material, the pilot location, size etc. Thereafter a description is provided of the location and the distribution of marine species in this area and what impacts the Prototype North Sea may have on these species. The Ecotoxicological study is set out in the appendix.

Plastic soup

Approximately 300 million tons of plastic are produced world wide of which a fraction ends up at sea. Large pieces of plastic degrade slowly into smaller plastic particles. However, plastic will never fully degrade. These plastic particles adversely affect marine life. For example, birds eat the plastic as they mistake the objects for food. Plastic will accumulate in the birds' body as its digestive system is not able to break down the plastic material. The bird risks starvation as the plastic accumulates in its body. Microplastics are known to disrupt the hormonal system of several species. In addition, some organisms get tangled in large pieces of plastics which can cause them to drown.

The great ocean gyres concentrate the plastic in certain areas at sea. At these locations where the plastic concentrates, a passive structure can be used to collect the debris. The Ocean Cleanup wants to focus on these areas to clean up plastic.

2 Description of the Prototype North Sea

2.1 Technical description

The Prototype North Sea is made up of two buoys and a 100-metre long screen with ballast weights (see figure 1). The buoys are placed at the extreme ends of the screen and will be held in place by four anchors on the seabed. In total the Prototype North Sea is about 2.5 metres high, of which 1.5 metre is below sea level. This Prototype is not meant to collect plastic. Due to changing currents, it is also not possible to collect plastic at the pilot location. The Prototype North Sea will only be used to test the logistics, construction and material.

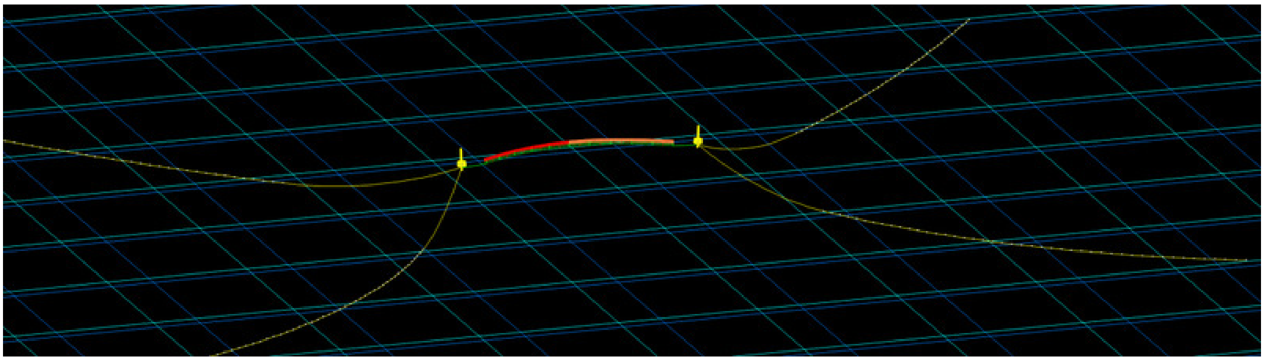

Figure 1. A model of the Prototype North Sea, an oil screen between two buoys, held in place by four anchors. (reference: www.theoceancleanup.com).

The screen is made of individual compartments filled with air. Every compartment has a maximum length of 3.5 metres and a diametre of 1.3 metre (when inflated) (figure 2). The screen is comparable to and made of the same material as oil containment booms, which are used to prevent oil from spreading. The screen is made of volcanic neoprene rubber with an outer layer of elastomer (RO–clean DESMI). When one of the compartments deflates, the neoprene screen can keep the barrier floating. Most tension is on the outer layer which will prevent the growth of algae.

A hanging flexible vertical screen of 5 mm TPU (Thermoplastic Polyurethanes) is located beneath the floating air-filled oil screen. The height of the screen is approximately 1.3 metre. A ballast weight has been applied to keep the screen vertical in the water column. At this moment, two possible options for the ballast weight have been proposed:

1) A chain with links of 1.3 to 3.4 centimetres connected to the screen.
2) A cable made of polyproprene positioned max. 60 centimetres below the screen.

At this time a decision is yet to be made as to which of the two options will be applied. Therefore both options have been assessed in this quick scan.

Motion sensors, cameras and tension metres are placed on the prototype to monitor the screen. In addition the screen will frequently be inspected.

A ‘Flug’ anchor or something comparable will most likely be used to attach the screen to the seabed. Each anchor covers a surface area of 4x4 metres and has a weight of 2.5-3 tonnes. The type of anchor proposed is known as a ‘drag embedment anchor’ (Kamp, 2015). Meaning it is an anchor that burrows/engraves itself into the soil, including when the current changes direction.

Figure 2. An oil containment boom (RO-BOOM 3500) in use. A similar boom will be used for the Prototype North Sea (picture from Ro-Clean Desmi 2001).

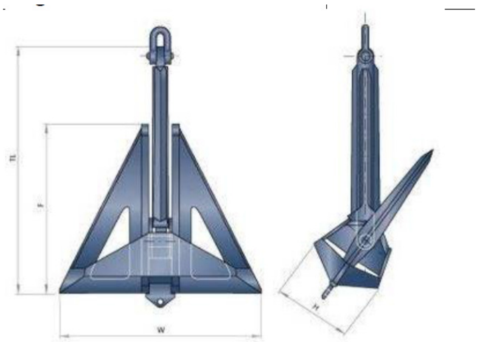

Figure 3. Flug Anchor (Flipper Delta Anker), which will be used to anchor the Prototype North Sea.

2.2 Project phases

The Prototype North Sea test is made up of three different phases.

Placement/construction phase
To place the Prototype North Sea several vessels will be required. The amount of vessel movements required to install the Prototype North Sea is dependent on the size of the vessels. At the moment it is still uncertain which vessels will be used and which vessels will be available at the time. The ships that are considered are RWS Arca, a Multicat ship and a tug. Two campaigns will be required to install the anchors and to attach the buoys and the screen.

The port where the preparation works will take place has not been selected at this stage. TOC is considering either the port of Scheveningen which is 23 km from the pilot location or Rotterdam, which is approximately 26 km away.

During construction the anchors will be placed, buoys attached and the oil screen inflated and placed between the buoys.

Operational test phase
Regular inspection and monitoring is required while the Prototype North Sea is in operation. The Prototype North Sea can be slightly altered during the operational phase if required. The placement of buoys can be adjusted and some of the segments of the screen may require replacement. Vessels will be required for maintenance. During the operational phase, data will be collected on i.e. wave height, movement of the prototype and the positioning of the anchor.

Figure 4. Different types of vessels that can be used to place the Prototype (Kamp, 2015).Top left a multicat, Bottom left the Arca of Rijkswaterstaat and on the right the Coastguard ship of Rijkswaterstaat.

Deconstruction/demobilisation phase

After 3 to 12 months the Prototype North Sea will be demobilised. During the deconstruction phase the different compartments will be removed and returned by vessel to the port of Scheveningen or Rotterdam.

2.3 Location and planning

The pilot location of the Prototype North Sea is approximately 23 km off the coast of Scheveningen, the coordinates are 52°12’34’’N en 04°00’04’’E (figure 5). The water depth at this location is 23 metres (LAT1). The prevalent current is North East (parallel to the coast).
The prototype will be tested in the summer of 2016. The installation of the prototype will take place in the first weeks of June with demobilization likely to take place in the second half of September. During the three months between the two phases the prototype will be tested.

In this period the wave height is relatively low (average per month is 2.75 metre and 3.75 metres) and the water temperature is high (average per month is 14.3 C and 19.0 C) (Kamp, 2015)

There is a possibility that the Prototype North Sea test phase will be extended by a few months with a maximum of 12 months.

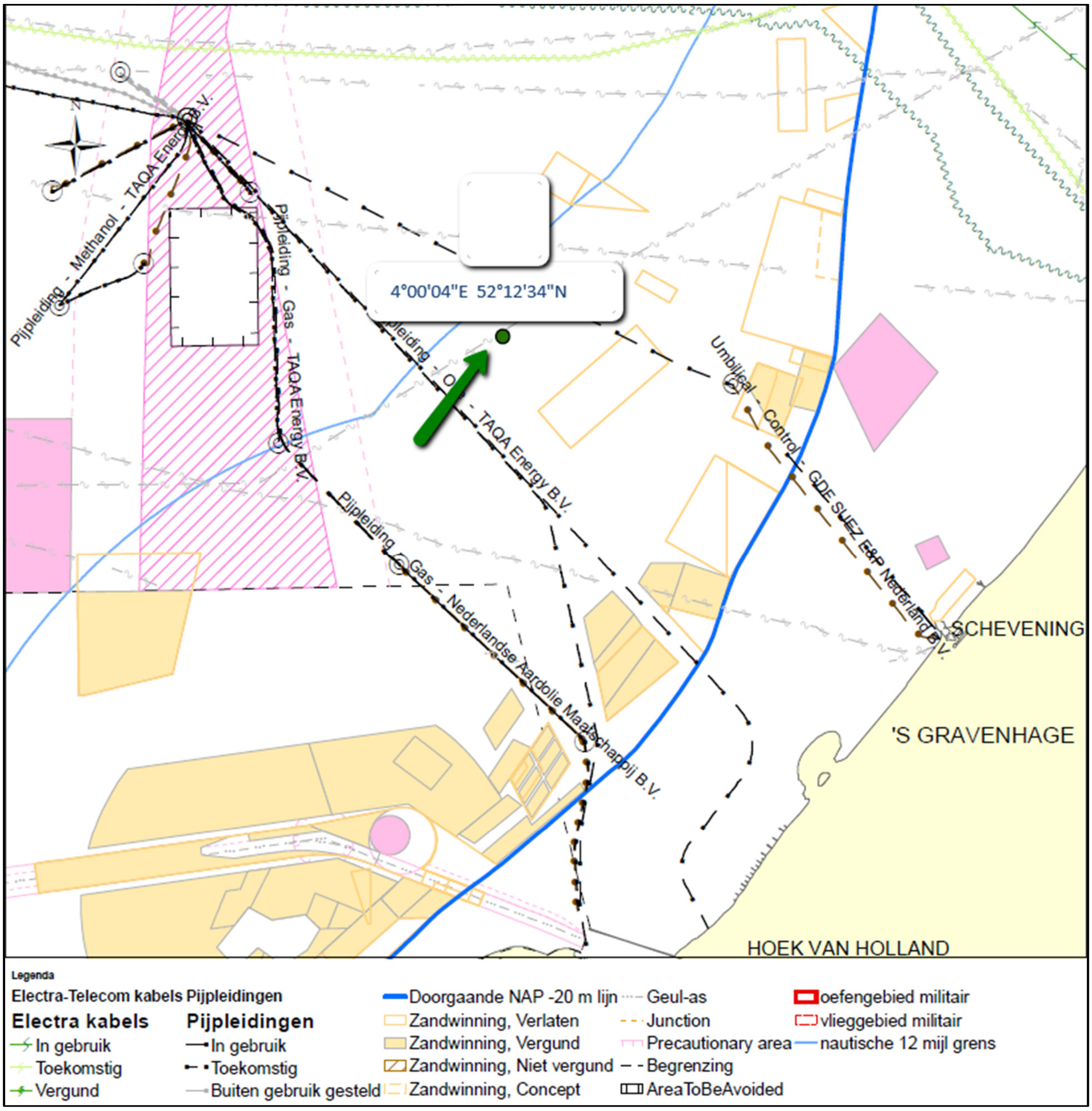

Figure 5. Location of the Prototype North Sea (green dot).

3 Ecological importance and impact on ecology

A description of the impact of the Prototype North Sea on species that may be found in the study area is provided in the following chapter. This is followed by an assessment of the impacts on these species.

3.1 Possible impacts

Placement, testing and removing the Prototype North Sea may have the following impact on marine species in the vicinity of the object: disturbance of species (worst case an organism becomes entangled), contaminate the water and impact on the soil conditions.

3.1.1 Disturbance

The Prototype North Sea screen
The top of the screen floats on the sea surface and the bottom of the screen is approximately 1.5 metre below the surface. The screen may block migrating species travelling through the area. The migrating species have to avoid the Prototype North Sea by swimming around the object or diving under the screen which will require extra energy.

When designing the Prototype North Sea special attention was paid to making sure animals will not get entangled. However, it is a new object which has not been tested before in this way. Organisms may become entangled in the neoprene cable that is attached 60 cm below the screen as ballast weight (option 2). Entanglement is not expected due to the chain structure within the TPU sleeve which is directly attached to the screen.
Possible entanglement requires to be a focus point when monitoring the prototype. If there is any chance entanglement will occur the screen will be altered. If alterations are not possible at sea, the test will be stopped.

Shipping and human presence in the area
During the construction and demobilization phase vessels will be required. Vessels will also be required during the test phase for maintenance and monitoring. Vessels produce noise above water as well as underwater. In addition, the presence of vessels and their crew may impact certain animal species through disturbance. The amount of trips made by vessels will be kept to a minimum. It is anticipated that two campaigns will be required to construct and demobilize the Prototype North Sea. The increase in the amount of vessel traffic due to the pilot is considered insignificant when compared to the daily vessel traffic in the study area along the North Sea coast.

3.1.2 Contamination

Leaching of substances from the screen
Potentially substances can leach from the screen and have an eco-toxicological impact on the marine species in the area. The screen of the Prototype North Sea is made up of volcanic rubber and neoprene. During the production of vulcanized rubber a large amount of substances is used and substance bonds are created. The majority of these substances will not react with seawater and the screen will therefore retain its original form. The other fraction of the substances can leach into the sea water and cause possible harm to marine species.
To assess the impact of the substances leaching into the environment a worst case assumption has been made that all substances will have completely leached out into the seawater after three months. Even when these extreme conditions are considered, the concentrations of substances that can have a toxicological impact remain far below toxic levels. In Appendix A a more detailed description is provided.

Ecotoxicological impacts on marine species as a result of substances leaching from the Prototype North Sea are not anticipated. These impacts are therefore not considered further in this document.

Nitrogen deposition from vessels
Vessels emit nitrogen dioxide. The deposition of nitrogen can have an impact on certain species and habitats. The North Sea and the marine species associated with the North Sea are not sensitive to an increase in nitrogen. However, the dunes along the coastline are sensitive to an increase in nitrogen.

The number of vessels used for this project will be reduced to a minimum with the ships being relatively small in size (see figure 4). The amount of vessel traffic in the study area, the area between the coastal zone and the port of Rotterdam/Scheveningen and IJmuiden, is high. The increase in nitrogen emissions from a few small vessels is considered negligible. In addition, the study area is too far away from the dunes along the coast to have an impact on these sensitive habitats.

Therefore, adverse impacts as a result of nitrogen deposition are not anticipated.

3.1.3 Alteration of soil conditions

At the location where the screen will be anchored the sediment composition will locally be influenced. The seabed in the study area primarily consists of sand. The seabed provides a substrate for several different species of benthic fauna and in shallow waters it also provides a habitat for primary producers. Due to the anchor, benthic species may be disturbed and some individuals may be lost. This may have an impact on species higher in the food chain such as fish and marine mammals.

3.1.4 Influencing currents

The screen may locally alter currents. However, the Prototype North Sea is a temporary and very small object. Currents at the site are driven by the tide and wind. Therefore, at this location and with this Prototype no changes in currents are anticipated. Consequently, no impact is anticipated on the organisms living in this area from altered currents. This impact is therefore not considered further in this document.

3.1.5 Marine Litter

If suitable the Prototype North Sea will be reused following the pilot in the next phase of the project. If the material is not suitable for reuse it will be processed in a sustainable manner. Thus making sure it will not have an adverse impact on the environment.

The dominant current in the study area is North Eastern, flowing parallel to the coast. During calm weather floating debris and organic material can collect around the screen. The debris can attract animals that are in search of food. In the worst case situation these animals may become entangled due to the accumulation of plastic and other marine debris. However, this is considered highly unlikely as the current in the study area is variable due to changing winds. In addition the length of the screen is small and will therefore not lead to a large amount of plastic accumulating.
Adverse impacts as a result of marine litter are not anticipated and are therefore not considered further in this document.

3.1.6 Summary of possible impacts

The table below provides a summary of the possible impacts that may occur while testing the Prototype North Sea in the chosen study area. These impacts will be assessed in the following paragraphs.

Table 1. Summary of possible impacts of the Prototype North Sea

Impact	Can impact occur?
Disturbance	Yes
Contamination	Negligible
Alteration of soil conditions	Yes
Impacts on current conditions	Negligible
Marine Litter	No, assuming the material will be reused and disposed of in a sustainable manner.

3.2 Species distribution and presence and assessment of impacts

The impact of Prototype North Sea due to disturbance and/or alterations to the sediment composition on the marine species will be assessed per species category in the following paragraphs.

3.2.1 Benthic fauna

When attaching the screen to the seabed using an anchor the benthic fauna can be disturbed or damaged. The benthic fauna that may occur in the area are (bristle) worms that live in the sediment, crustaceans, echinoderms and molluscs. The biodiversity is low in the study area (figure 7) and is not an area of high ecological importance (Lindeboom et al, 2005). The seabed in the study area is flat and sandy. It is regularly disturbed by other human activities such as anchors of vessels, bottom trawling and sand winning (e.g. dredging) (CBS et al., 2015a; figure 5). Due to this, most species that occur in the area are tolerant to stress. These species are characterized by fast growth and fast colonization. The species that do occur do not have a long lifespan (see figure 6). To keep the screen in place a maximum of 4 anchors will be used. Species with a low tolerance to stress do not occur in the area, it is therefore not considered that populations of species will be adversely affected. Impacts higher up the food chain are therefore also not anticipated.

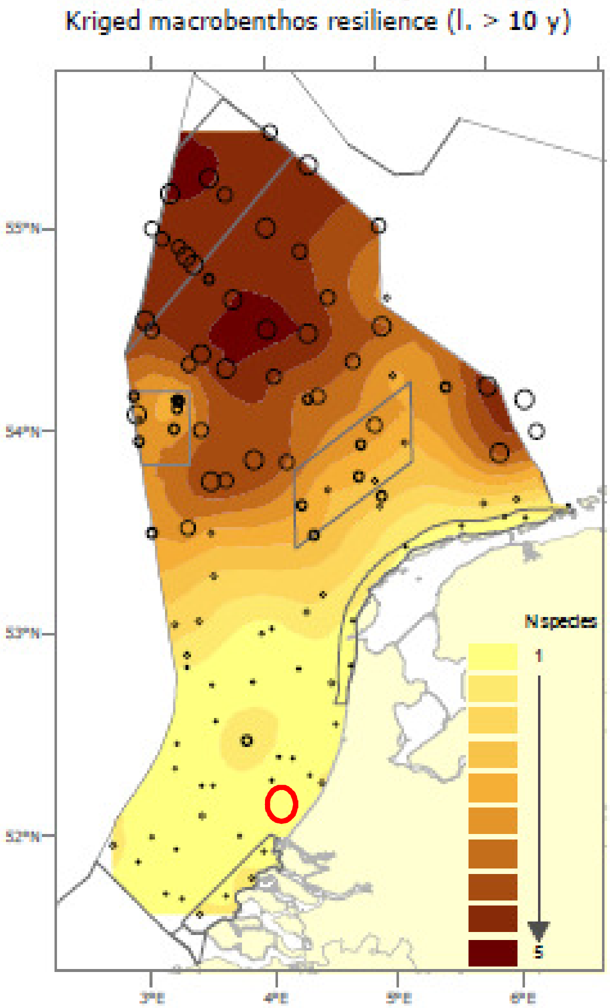

Figure 6. Amount of macro benthic species with a long lifespan (longer than 10 years) at the Dutch Continental Shelf (Bos et al, 2011).

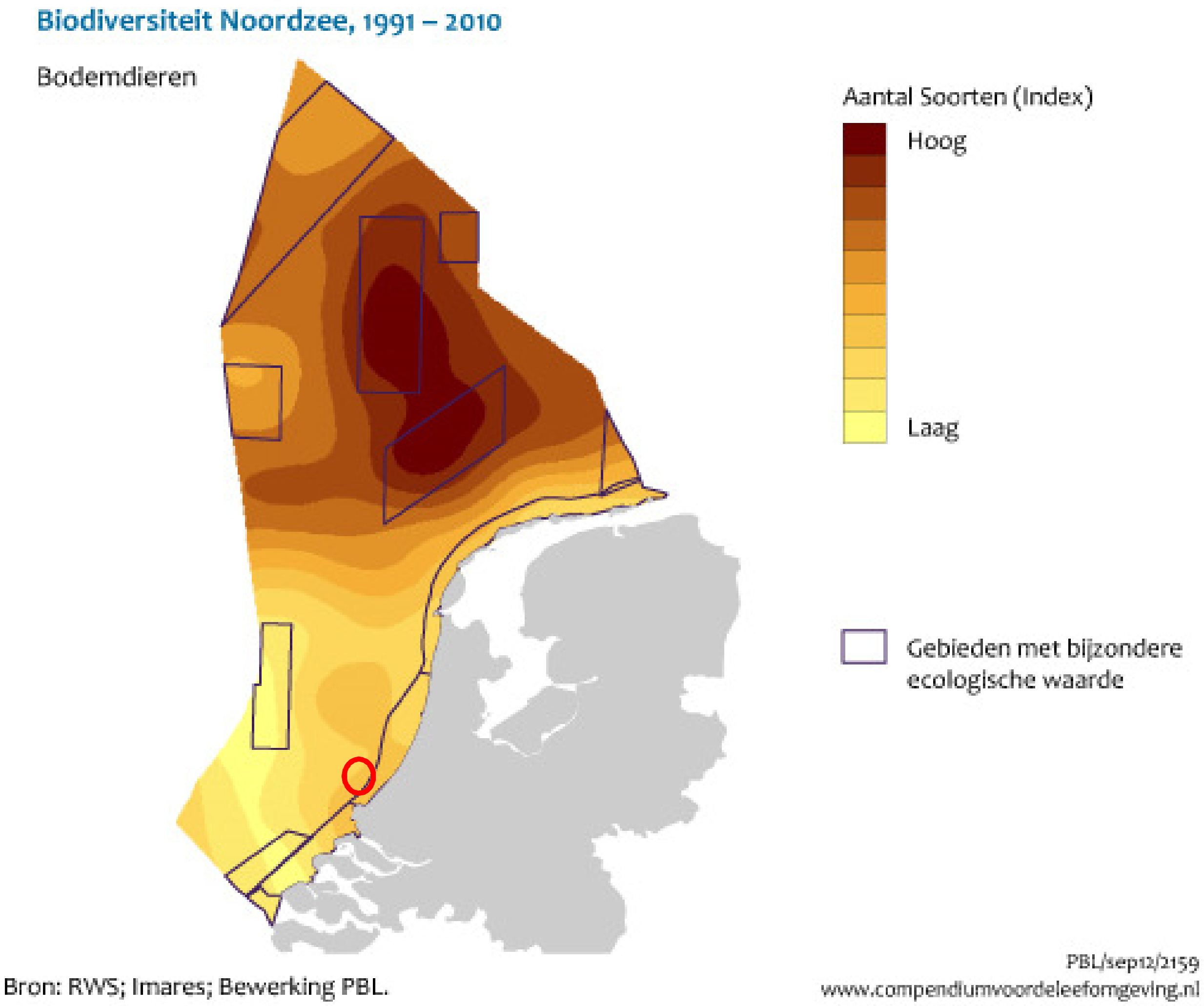

Figure 7. Biodiversity of the benthos at the Dutch Continental Shelf based on research from 1991 to 2010 (Bos et al. 2011 – Picture from CBS et al. 2012b).

Conclusion

It is unlikely that the anchors that are used to keep the Prototype North Sea in place will have an adverse impact on the population of benthic species in the study area.

3.2.2 Marine mammals

Harbour porpoises, common seal and grey seal can be found in the study area. The following paragraphs provide an assessment of the impacts on these species. Other marine mammals such as white-beaked dolphin only occur incidentally in the coastal are of the Dutch North Sea. The impact on these species is therefore not described separately but considered to be comparable to the impacts on harbour porpoise. The harbour porpoise is the smallest whale/dolphin subspecies.

Harbour porpoise

The harbour porpoise (*Phocoena phocoena*) is the smallest toothed whale in the world. It is a coastal species and has a preference for relatively shallow water where it can forage for fish. Harbour porpoise have historically not been found as far south as they currently are. In the last 10-15 years the harbour porpoise distribution has been observed to be more southerly making harbour porpoise a regular visitor along the Dutch coast. Aerial counts have been used to estimate the population size in the Netherlands. In July the population is estimated between 26,000 (July 2010) and 76,000 (July 2015 individuals (Geelhoed 2015). The population size is highest between December and March in the Dutch North Sea (Geelhoed 2013).

Harbour porpoise are evenly distributed across the Southern North Sea. There are no particularly important areas in the Dutch North Sea for harbour porpoise. Presence of harbour porpoise in the area demonstrates that the fish feeding conditions are likely to be good (Brasseur et al., 2008, Camphuysen & Siemensma 2011). The population density of harbour porpoise in July 2015 shown in the figure below is a random moment in time.

Harbour porpoise have a high requirement for energy. They are not able to use a fat reserve to store energy, they therefore need to continuously feed (Geelhoed et al, 2011).

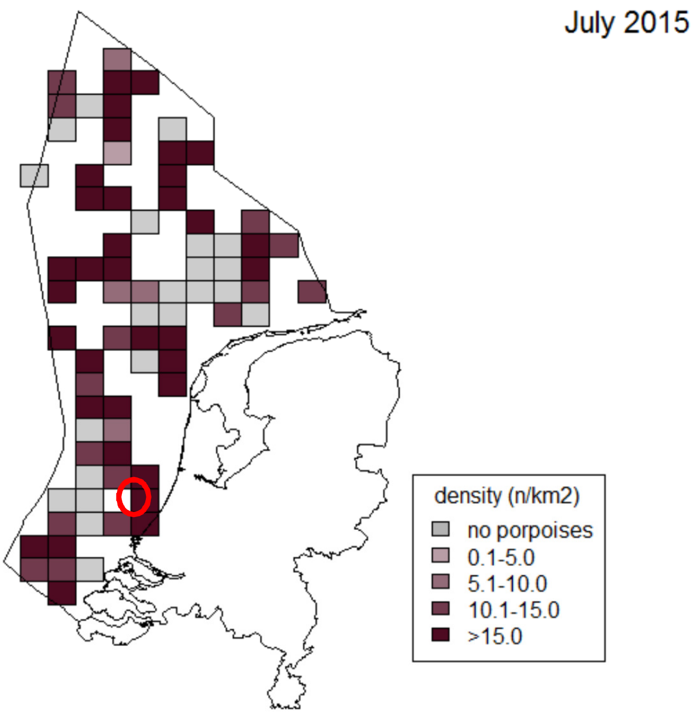

Figure 8. Density of harbour porpoise based on aerial counts in July 2015 (Geelhoed et al. 2015). The location of the Prototype North Sea is marked with the red circle. (Picture harbour porpoise: Martine van Oostveen).

Disturbance

The Prototype North Sea will be tested during the summer between June and September. In the summer the number of harbour porpoise is low. However, over the years harbour porpoise counts have fluctuated. The testing phase will possibly be extended to 12 months, so there is a chance the Prototype North Sea will be present in March, the period in which the population of harbour porpoise is highest.

It can be assumed that during the period that the Prototype North Sea is tested harbour porpoise will be observed in the vicinity of the prototype. It is likely that harbour porpoise will dive under the prototype or swim around it. The energy used to avoid the screen is negligible when considering the small size of the screen (100 metres wide).

The neoprene ballast chain hangs 60 centimetres below the screen and is attached to the screen at 2 metre intervals. It is anticipated that harbour porpoise will identify the screen when using sonars as the screen is made up of impermeable material. However, the chain might be less easy to detect. The size of an adult harbour porpoise is between 1.35 and 1.90 metres with a diametre of 80 centimetres. This means that a harbour porpoise may become entangled within the ballast chain. Since the ballast chain is flexible it is likely that harbour porpoise will be able to manoeuvre and escape. This will however cost a lot of energy. It is important to monitor the prototype for possible entanglement cases.
The prototype is small and will only be tested during a short period of time, so the risk of entanglement is minimal and it is not considered to have an adverse impact on the population of harbour porpoise.

Vessel traffic (human presence and noise underwater and above water) during construction, maintenance and demobilization of the prototype may cause a disturbance to harbour porpoise in the area. The study area is close to the two large harbours, Rotterdam and IJmuiden, which means that the shipping intensity in the area is high. The extra vessels that will be used for this project are not comparable to the high number of vessels that occur on daily basis. In addition it is a temporary project and the pilot is not situated in an area of high ecological importance for harbour porpoise. If harbour porpoise are disturbed, there are many areas to which they can temporarily relocate.

Alteration to sediment composition
There will be a temporary and local alteration to the sediment composition due to the anchors that will be used for the buoys and the screen. The alterations of sediment composition are minimal and will only impact a few square metres. The impact is therefore considered negligible when comparing the impacted area to the total habitat size on the Dutch Continental shelf. Impacts on sediment composition will not be noticeable higher up the food chain. Harbour porpoise will not be affected. The sediment and benthic fauna will be restored to their original state when the screen is removed.

Common seal and grey seal

Common seal (*Phoca vitulina*) are found in North Atlantic and Northern Pacific coastal waters. They are most likely to be found close to the coast and near deltas where they can rest during low tide on sand banks and rocks and forage for fish during high tide. In the Dutch coastal waters the species is most commonly found in the Wadden Sea. There is also a small (sub) population found in the Delta. Common seal migrate along the North and Southern Dutch coast between the two (sub) populations. The prototype is located on this migration route. Seals may also use the location to forage. However, it is not considered an important foraging area.

At the moment there are 7000 common seals in the Dutch Wadden Sea (Glatius et al, 2014). The density of seals is highest along the coast (Wadden Sea and Voordelta). In this area sand banks appear during low tide where seals can rest. In the open sea the concentration of seals is low (see figure 9).

Compared to the common seal the grey seal population is smaller in Dutch coastal waters. In 2014 approximately 400 grey seals were counted in the Wadden Sea and Delta (Brasseur et al, 2015). Grey seal are also mostly found in the coastal waters and found in lower density in the open sea (see figure 10).

More than 90% of the grey seals are found in the western part of the Dutch Wadden Sea between Texel and Terschelling (Brasseur et al, 2008). The sand banks in this area are essential for the seals to rest, reproduce and moult. Grey seals can travel a longer distance to forage when compared to common seal. They have been observed swimming over 200 km to forage. Exchange between Dutch and Britisch populations occur, however it is still uncertain if there are specific migration routes (Brasseur & Reijnders, 2000; Brasseur et al, 2008). It is possible that this species may occur in the study area of the prototype and use it as a foraging area.

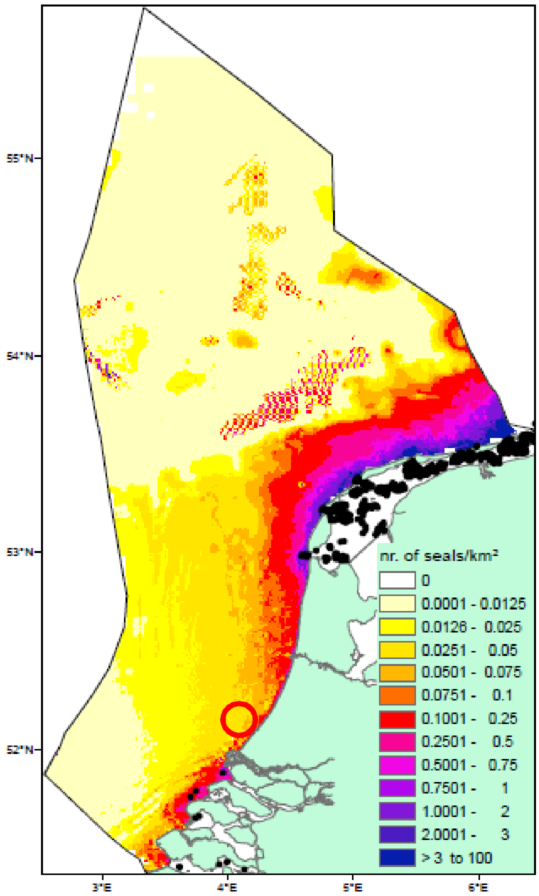

Figure 9. Modelled dispersion of common seal (Brasseur, 2012). The location of the Prototype North Sea is marked with the red circle.

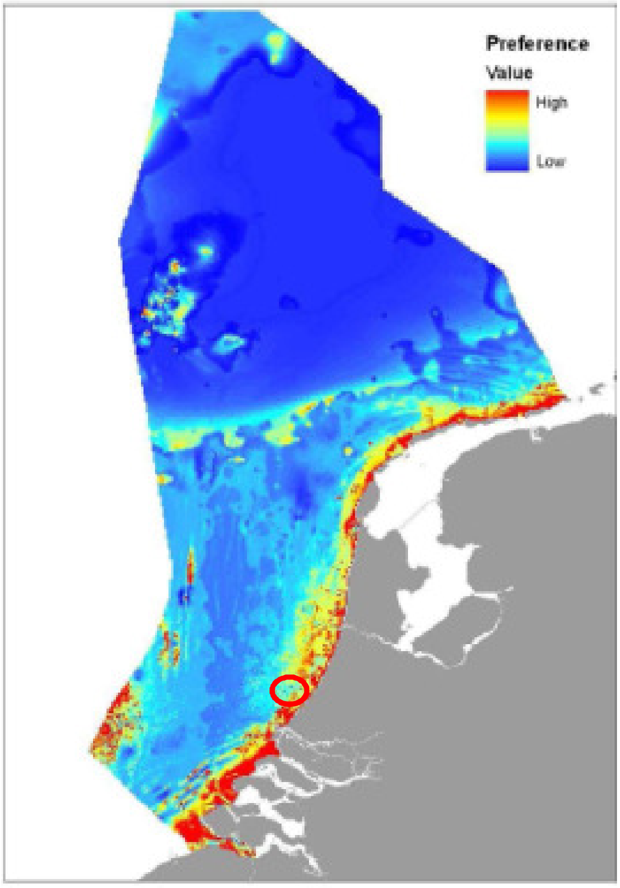

Figure 10. The predicted dispersion of grey seals (Brasseur et al. (2009) if resting areas are no limited factor. The location of the Prototype North Sea is marked with the red circle.

Disturbance

Traffic from shipping (human presence and noise underwater and above water) during construction, maintenance and demobilization of the Prototype North Sea may cause disturbance to seals that are present in the study area. This impact is temporary and localised. In the area there is already a high level of shipping traffic, therefore the disturbance impact due to the Prototype North Sea is negligible compared to the current activity in the area.

Like harbour porpoise, seals can become entangled in the neoprene ballast chain below the screen. An adult common seal is between 1.2 and 1.9 metres in length. Grey seals are larger than common seals, the length of adult grey seals being between 1.7 metres and 2.5 metres. This means that the seals may become entangled within the ballast chain. Since the ballast chain is flexible, it is likely that the seal will be able to manoeuvre and escape from the ballast chain. This will however cost a lot of energy. It is important to monitor the prototype for possible entanglement cases.

The presence of the screen in the water may be intriguing to seals. They will however not be disturbed by the screen. There are enough alternatives for the seal to forage in the area. In addition the small size of the Prototype North Sea (100 metres in width) will not cause the seal to lose energy due to avoidance.
It is not expected that the presence of the screen will have an adverse impact on the behaviour of seals.

Alteration to sediment composition
There will be a temporary and local alteration to the sediment composition due to the anchors that are used for the buoys and the screen. The alterations of sediment composition are minimal and will only impact a few square metres. The impact is therefore considered negligible when comparing the impacted area to the total habitat size on the Dutch Continental shelf. Impacts on sediment composition will not be noticeable higher up the food chain. Seals will therefore not be affected. The sediment and benthic fauna will be restored to their original state when the screen is removed.

Conclusion

No significant adverse impacts are anticipated on marine mammals in the study area.

3.2.3 Bats

Bats, like the Nathusius' pipistrelle, are known to travel across the North Sea. The activities due to the Prototype North Sea will lead to a negligible increase in light disturbance from vessels. Compared to the amount of shipping that currently takes place in the area, the impact of the vessels required for the Prototype North Sea is negligible. In addition there bats will not collide with the Prototype North Sea as there are no permanently high objects being installed.

Conclusion

The activities associated with the Prototype North Sea will not have an impact on the behaviour and/or wellbeing of bats.

3.2.4 Birds

In 2015, the trend and distributions of sea bird population on the Dutch Continental Shelf were described for the period 1991-2013. Based on that data it became evident that the common tern (*Sterna hirundo*), arctic tern (*Sterna paradisaea*) and lesser black-backed gull (*Larus fuscus*) are the only sea birds that frequently use the study area in the period June to September (Arts, 2012). Other species that have been observed incidentally in the summer are the herring gull (*Larus argentatus*), Northern fulmar (*Fulmaris glacialis*) and the Northern Gannet (*Morus bassanus*). These sea birds search for food by flying over the sea searching for fish and diving to catch them.

Disturbance
Presence of humans in the area during construction, maintenance and demobilization of the Prototype North Sea are limited in time and space and therefore won’t cause a disturbance to foraging bird species. Especially considering the existing shipping intensity in the area.
The oil screen may be used as a resting place by birds during the test phase. This won’t cause any harmful or adverse impact on the sea birds present.

Alteration of the sediment composition
There will be a temporary and local alteration to the sediment composition due to the anchors that will be used for the buoys and the screen. The alterations of sediment composition are minimal and will only affect a few square metres. The impact is therefore considered negligible when comparing the impacted area to the total habitat size on the Dutch Continental Shelf. Impacts on sediment composition will not be noticeable higher up the food chain. Birds will therefore not be affected. The sediment and benthic fauna will be restored to their original state when the anchors of the screen are removed.

Conclusion

Adverse impacts on sea birds are not anticipated.

3.2.5 Fish

Pelagic fish

Pelagic fish species are fish species that are found within the water column. It is not anticipated that these species will be disturbed by the Prototype North Sea during construction, maintenance and demobilization. They might be briefly disturbed by vessel movements and the underwater noise that is produced by vessels. However this is a negligible impact when compared to the impact of the current shipping traffic in the area. The screen only protrudes into the water column to a maximum depth of 1.5 metre. This will not affect the pelagic and migrating species in the area. Fish will be able to swim underneath the screen or around it.

Demersal fish

Demersal fish are fish species that live in the benthic zone on or near the seabed. In the area surrounding the Prototype North Sea the sediment is sandy and regularly disturbed by anchors of vessels, trawling and sand winning (e.g. dredging) (CBS et al., 2012a; Figure 5). The 'sleep' anchors used to keep the Prototype North Sea in place will alter the habitat of the demersal fish temporarily and locally. The fish will only be temporarily disturbed as they are able to swim away from the impacted area. The demersal fish population will not be impacted.

Conclusion

Adverse impacts are not anticipated on fish species.

3.2.6 Reptiles

Sea turtles are the only reptiles that can be found in the Dutch part of the North Sea. There are four species that have incidentally been observed in the Netherlands: the green turtle (*Chelonia mydas*), leatherback turtle (*Dermochelys coriacea*), loggerhead turtle (*Caretta caretta*) and Kemps Ridley turtle (*Lepidochelys kempii*). Occurrences of these species at the location of the Prototype North Sea are very rare. Sea turtles swim and forage beneath the sea surface and have to come up for air every few minutes. When the turtles come up for air they can possibly come into contact with the Prototype North Sea. Sea turtles will be able to swim around the screen without requiring additional energy due to the small size of the screen.

There is a minimal risk that sea turtles will become entangled in the ballast chain. Since the ballast chain is flexible, it is likely that the turtle will be able to manoeuvre and escape from the ballast chain if this happens. This will however cost the turtle energy. It is important to monitor the prototype for possible entanglement cases.

Conclusion

Adverse impacts are not anticipated on reptiles.

4 Conclusion

The testing of the Prototype North Sea is limited in time and space. The Prototype North Sea will be tested for 3 months (with a maximum extension up to 12 months) in a part of the North Sea with a high intensity of shipping traffic. The location of the study area is not within an area of high ecological importance. However, (protected) species can be found in the area such as harbour porpoise, seals, birds, fish and sea turtles. The benthic ecology in the area is poor, largely due to the seabed frequently being altered by human activities.

Species that can be found in the area will experience a temporary, localised negligible adverse impact from the Prototype. The vessels that are used to place the anchors may for example have an impact on certain species. The ballast chain attached to the screen of the Prototype North Sea has been considered. Due to the flexible chain with large openings, entanglement of species is not considered likely. However it cannot be ignored completely. It is important that the Prototype North Sea is monitored to avoid entanglement. If it is considered likely that entanglement may occur, the screen will be adjusted.
After the test phase the area will restored to its original state.

A permit or exemption from the Dutch Nature conservation laws is not required.

5 References

Arts, F. (2015). Trends en verspreiding van zeevogels en zeezoogdieren op het Nederlands Continental Plat 1991-2013. RWS Waterdienst.

Bos, O., R. Witbaard, M. Lavaleye, G. van Moorsel, L.R. Teal, R. van Hal, T. van der Hammen, R. ter Hofstede, R. van Bemmelen, R.H. Witte, S. Geelhoed & E.M. Dijkman (2011). Report number C071/11. Imares.

Brasseur, S.M.J.M., M. Scheidat, G.M. Aart, J.S.M. Cremer & O.G. Bos (2008). Distribution of marine mammals in the North Sea for the generic appropriate assessment of future offshore wind parks. IMARES report C046/08.

Brasseur, S.M.J.M., Polanen Petel, T. van; Scheidat, M., Meesters, H.W.G., Verdaat, J.P., Cremer, J.S.M., Dijkman, E.M. (2009). Zeezoogdieren in de Eems Evaluatie van de Vliegtuigtellingen van zeezoogdieren tussen oktober 2007 en september 2008. IMARES, (Rapport C061/09) - 23 p.

Brasseur, S.M.J.M., Aarts, G., Meesters, E., Van Polanen Petel, T., Dijkman, E., Cremer, J. & Reijnders, P. (2012). Habitat preferences of harbor seals in the Dutch coastal area: analysis and estimate of impacts ofoffshore wind farms. IMARES report C043/10.

Brasseur S.M.J.M, van Polanen Petel T.D., Gerrodette T., Meesters E.H.W.G., Reijnders P.J.H., Aarts G. (2015). Rapid recovery of Dutch gray seal colonies fueled by immigration. Marine Mammal Science 31:405-426.

Camphuysen C.J. & M.L. Siemensma (2011). Conservation plan for the Harbour Porpoise Phocoena phocoena in The Netherlands: towards a favourable conservation status. NIOZ Report 2011-07, Royal Netherlands Institute for Sea Research, Texel.

CBS, PBL, Wageningen UR (2012a). Ecologische duurzaamheid van de bodemvisserij op de Noordzee, 2007-2011 (indicator 2093, versie 02, 20 september 2012). www.compendiumvoordeleefomgeving.nl. CBS, Den Haag; Planbureau voor de Leefomgeving, Den Haag/Bilthoven en Wageningen UR, Wageningen.

CBS, PBL, Wageningen UR (2012b). Ruimtelijke verdeling biodiversiteit in de Noordzee, 1991-2010 (indicator 2159, versie 01, 25 september 2012). www.compendiumvoordeleefomgeving.nl. CBS, Den Haag; Planbureau voor de Leefomgeving, Den Haag/Bilthoven en Wageningen UR, Wageningen.

Galatius A, S.M.J.M. Brasseur, P.J.H. Reijnders, T. Borchardt, U. Siebert, M. Stede, S. Ramdohr, L.F. Jensen & J.Teilman (2014). Trilateral Seal Expert Group (TSEG). Aerial surveys of Harbour Seals in the Wadden Sea in 2014. The highest pup count recorded yet. Common Wadden Sea Secretariate (CWSS).

Geelhoed, S., M. Scheidat, G. Aarts, R. van Bemmelen, N. Janinhoff, H. Verdaat & R. Witte (2011). Shortlist masterplan wind aerial surveys of harbour porpoises on the Dutch Continental Shelf. Imares rapportnr c103/11.

Geelhoed S., M. Scheidat, R. van Bemmelen & G. Aarts (2013). Abundance of harbour porpoises (Phocoena phocoena) on the Dutch Continental Shelf, aerial surveys in July 2010-March 2011. Lutra 56(1): 45-57.

Geelhoed S. Scheidat, M., van Bemellen, R. (2014). Marine mammal surveys in Dutch waters in 2013. Imares rapportnummer: C027/14.

Geelhoed, S.C.V., S. Lagerveld, J.P. Verdaat (2015). Marine mammal surveys in Dutch North Sea waters in 2015. Imares rapportnr c189/15.

Kamp, R. (2015). Prototype pilot project North Sea. Project execution plan: Installation. The Ocean Cleanup.

Lindeboom, H., Geurts van Kessel, J. en Berkenbosch, L. (2005). Gebieden met bijzondere ecologische waarden op het Nederlands Continentaal Plat. Rapport RIKZ/2005.008. Alterra Rapport nr. 1109. RIKZ, Den Haag. Alterra, Wageningen.

RO-CLEAN DESMI (2001). RO-BOOM 3500, Extreme offshore oil containment boom. Productflyer, RO-CLEAN DESMI A/S, Denmark.

Vryhof Anchors (2015). Anchor Manual 2015, The Guide to Anchoring. Vryhof Anchors BV, 2015.

A1 QUICKSCAN LEACHING OF TOXIC MATERIALS PROTOTYPE NORTH SEA

SUMMARY

The Prototype North Sea is made of the same type of material that is used for an oil containment boom. Based on the substances used to produce the oil containment boom the chance of toxic chemical leaching is assessed. This study is based on the material choice of the Prototype North Sea (i.e. conventional synthetic rubbers), and does not reflect the material composition of the eventual cleanup system.
The main source of information used for this ecological study is from the European Chemicals Agency. The worst case assumption has been made that all the substances in the screen will leach out into the seawater within three months. Using this assumption the concentration of substances in seawater is calculated using the MAMPEC model. Even when considering the worst case, it appears that the concentrations of selected compounds remain under the toxicological thresholds. Ecotoxicological impacts are therefore not considered likely due to leaching of substances from the Prototype North Sea.

A1.1 Introduction

The client wants to know whether toxic substances will leach into seawater if the same material used for an oil containment boom is used for the Prototype North Sea.
According to the producer of the oil containment boom the screen is made up of synthetic rubber with an outer layer of Hypalon. This combination has been specifically designed to withstand extreme weather conditions out at sea and long term exposure to oil. The composition of the rubber is described as chloroprene, and Hypalon is a polymer based on chlorosulfonated polyethylene.
A large amount of substances is used to produce the volcanic rubber. These substances bind to the polymer structure. A fraction of the substances does not react and remains in its original state. When the Prototype North Sea is placed in seawater, these substances can leach and spread into the seawater and potentially harm marine species. In the case of an oil spill this adverse effect will be negligible compared to the effects of the oil spill. However when using the oil containment boom for another purpose, in this case to collect marine litter, the impact of leaching of substances requires to be considered.

A1.2 Method

A quantitative assessment is required for a detailed analysis of the number of leached substances over time. However, since it concerns a pilot project it is not possible to conduct such an in depth study. Thus for this ecological assessment a few assumptions have been made. If the results of this study show that there are no ecotoxicological impacts, then it is not anticipated that further research will be required.

The following approach was taken:

1. DESMI, the oil containment boom producer, was asked to provide information on the substance composition of the material and the potential for leaching. A list of substances with CAS numbers and composition were provided by the producer.
2. Information on the toxicity of certain relevant substances was collected, such as classification and labelling and/ or threshold values for environmental toxicity. To find this information the database of the ECHA (European Chemicals Agency) was used. Based on this information four indicator substances have been selected for the assessment.

3. To assess the spreading of the leached substances into the marine environment the MAMPEC model was used. MAMPEC is a hydrodynamical model that also models environmental chemistry behaviour and as such predict concentrations in the marine environment. The model was originally designed to assess the environmental impact of antifouling paints. The model has been verified and adjusted to the local condition of the pilot project. The emission scenario “shipping route at sea” in MAMPEC is used to calculate the concentrations.
4. The substance concentration results have been compared to information regarding toxicity. In this manner an assessment has been undertaken to assess the impact of the leached substances on the marine environment.
5. After the first assessment, DESMI provided us with new product information. DESMI provided a list with approximately 20 different substances. An additional assessment was conducted for the impact of these substances on the marine environment. The same method was used to assess the impact as described in step 2. The addition research in combination with the results in step 3 and 4 from the first assessment showed not additional risk to the environment. Consequently, steps 3 and 4 were not conducted for the second list of substances.

A1.3 Structure and composition of the Prototype North Sea

A1.3.1 References

The information on the structure and substance composition of the screen of the Prototype North Sea (same material as an oil containment boom) was provided by Mr. Last Boldt Rasmussen[2].

A1.3.2 Structure of the screen

The Prototype North Sea consists of an outer layer of Hypalon (CSM compound) and a neoprene inner layer (CR compound). The structure of the screen is presented in figure 11.

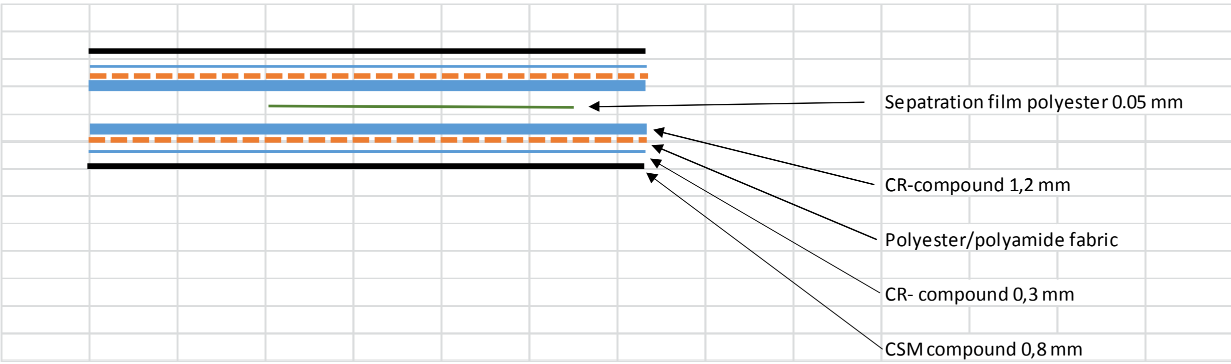

Figure 11. Cross section of the oil containment boom.

Hypalon outer layer (CSM compound)

The density of the Hypalon outer layer is 1.36 ± 0.03.
The weight of the Hypalon layer (0.8 mm) of 1.2 is calculated:
10 dm * 10 dm * 0.8 mm * 10^{-2} * 1.36 kg/dm^3 = 1,088 kg

The Prototype North Sea will cover a length of 100 metre. The ‘boom’ diametre is 1.5 metre and the height of the screen is 1.33 m. Knowing the diametre of the boom is 1.5 metre the circumference of half of the circle is $(2\pi r/2)$, π * 0,75 = 2.36 m. Total circumference is thus (1.33 + 2.36) m * 100 m = 369 m^2.

The Hypalon layer is used on two sides. The total area that is exposed to sea water is therefore 737 m^2. The total mass of Hypalon is 801.85 kg.

Neoprene inner layer (CR-compound)

The given density of the neoprene inner layer is 1.36 ± 0.3.
The thickness of the neoprene inner layer is (0.3 + 1.2) = 1.5 mm. One square metre (single sided) contains 10 dm * 10 dm * 1.5 mm * 10^{-2} * 1.36 kg/dm^3 = 2,040 kg of neoprene.

According to the above calculations the area of a single side is 369 m^2. Therefore, the total area which is exposed to seawater is the area of two sides which is 737 m^2. The total mass of neoprene is **1503.48 kg**.

A1.3.3 Substance composition

Hypalon (CSM compound)

Tabel 2 shows the list of substances used to produce Hypalon. The ECHA database was consulted using the CAS number to investigate whether the substances were classified as a hazardous to the environment. Some of the substances were registered under REACH, thus the environmental classification in the REACH dossier was used. The C&L Inventory was used for the environmental classification of all other substances. Not all substances can be found in the ECHA database. Therefore no information was found for these substances. This mostly concerns polymers.

MBTS and TMTD are well known chemical reactive bonds that will mostly disappear during the production process. A H412 classification is given to the substance *Polyethylene Homopolymers* by the producers. However there is no additional evidence to support this classification. In general polymers are not biologically available and therefore this ingredient has not been further investigated.

In addition the substance *di(2-ethylhexyl) sebacate* and *Coumarone-indene* (resin) seem to be of interest. For the latter there is no REACH dossier available. There is information on *di(2-ethylhexyl)*, however it is not registered as a substance that is hazardous to the environment.

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Table 2. Components of Hypalon (CSM compound)

Name	CAS number	%	Environment C&L
CSM (chlorosulfonated synthetisch rubber)	9008-08-6 *	47	n.a.
High 1,4-cis polybutadiene	40022-03-5	4	n.a.
Calcium Carbonate	471-34-1	9	Reg: none
$(CH_2)_8(COOC_8H_{17})_2$, or di(2-ethylhexyl) sebacate	122-62-3	6	Reg: none
Stearic Acid	57-11-4	2	Reg: none
Coumarone-indene resin	63393-89-5	3	C&L: none
Polyethylene Homopolymers	9002-88-4	1	C&L: H412 Aq. Chronic 3
Carbon Black-N774	1333-86-4	23	Reg: none
N-Oxydiethylene-benzothiazole-2-sulfenamide (MBTS)	120-78-5	1	Reg: H400 Aq Acuut 1 H410 Aq Chron 1 (M=1)
Elastomag (grade of magnesium oxide made from magnesium chloride brine and dolomitic lime for rubber and plastic applications)	82375-77-7	2	n.a.
Sulfur powder	7704-34-9	1	Reg: none
Anti ozone wax	8002-74-2	1	Reg: none
TMTD (Thiram)	137-26-8	0.2	Reg: H400 Aq acuut 1 H410 Aq Chron 1 (M=10)

* corrected (was mentioned as 6-8-9008)
n.a.: the CAS number is not known in the ECHA database
Reg: substance is registered under REACH.
C&L: no REACH registration, but mentioned in C&L inventory
H400: "Very poisonous for organisms living in water"
H410: Classified as " Very poisonous for organisms living in water, with long lasting impacts". M is an extra factor for the toxicity.
H412: "Harmful for organisms living in water, with long lasting impacts".

Neoprene (CR-compound)

A list of components used to produce the neoprene inner layer can be found in table 3. The ECHA database is used for classification of the substances.
Zinc oxide and triaryl phosphate are environmentally hazardous substances. There is no CAS number available for naphthalene oil. The concentrations of PAK in the oils is ≤ 1 mg/kg according to the factsheet[1], it does not have a hazard classification.

There is no dossier available on the octyl diphenylamines. However in an Asian MSDS (material safety data sheet) a classification is given similar to that of H412 (Aquatic chronic 3, the least toxic class). No further information of toxicity information was available.

[1] *Kennzeichnungsfreies dunkles Prozessöl 1 08/01 (944 07/02) http://www.orthwein-oel.de/PDFs/Enerthene%201849-1.pdf*

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Table 3. Components of neoprene (CR compound)

Name	CAS number	%	Environment C&L
Polychloroprene	9010-98-4	48	n.a.
High 1,4-cis polybutadiene	40022-03-5	3	n.a.
Monooctyl and dioctyldiphenylamine	37338-62-8	1	n.a.
Polyethylene Homopolymers	9002-88-4	2	Reg: none
ZnO	1314-13-2	2	Reg: H400 Aq Acuut 1, H410 Aq Chron 1 (M=1)
Stearic Acid	57-11-4	1	Reg: none
Naphthalene oil	No data	5	C&L: none
Triaryl phosphates, isopropylated	68937-41-7	6	Reg: H410 Aq Chron 1 (M=1)
Carbon Black-N774	1333-86-4	16	Reg: none
Silica	99439-28-8	13	C&L: none
Elastomag® is a grade of magnesium oxide made from magnesium chloride brine and dolomitic lime for rubber and plastic applications.	82375-77-7	2	n.a.

n.a.: the CAS number is not known in the ECHA database
Reg: substance is registered under REACH.
C&L: no REACH registration, but mentioned in C&L inventory
H400: "Very poisonous for organisms living in water"
H410: Classified as " Very poisonous for organisms living in water, with long lasting impacts". M is an extra factor for the toxicity.
H412: "Harmful for organisms living in water, with long lasting impacts".

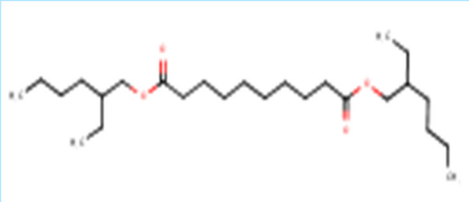
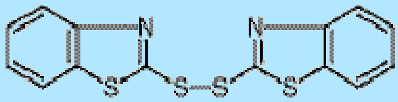
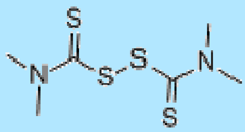
A1.4 TOXICITY AND ENVIRONMENTAL IMPACT

A1.4.1 Hypalon

Information on the ecotoxicity and its impact on the environment is described for three components of Hypalon in table 4.
The ECHA database provides the toxicological threshold level of two out of three substances: Dioctyl Cebacate and MBTS (in this case Predicted No Effect Concentration (PNEC)). However the levels are not calculated according to the method that is used for ecotoxicological research. The solubility in water for MBTS is divided by a factor of 10. A study on algae shows that this factor should be less which is more in line with the standard procedure and in line with the value for the somehow related substance TMTD. The PNEC for TMTD is not easy to find in the ECHA database as it has been rounded to zero.
The study summaries concluded that the value for fish should be used.
There are no studies that can be used to correct the PNEC value for Dioctyl Cebacate. According to predictions with ECOSAR[2] this ester is chronically less toxic than MBTS and TMTD. Therefore an assessment based on MBTS and TMTD is acceptable.

[2] *ECOSAR, ECOWIN v100 2009 gives an estimation of the aquatic toxicity based on the molecular structure fragments (EPISUITE van US/EPA)*

Table 4. Characteristics of potential environmental toxic components of Hypalon (ECHA database)

Characteristics	Dioctyl Cebacate	MBTS	TMTD
Structure	 Dioctyl Cebacate MW = 426.67	 MBTS MW = 332.49	 TMTD MW = 240.43
Water solubility (WS)	< 0.05 mg/L	49 – 88 mg/L (pH 9 & 5)	17 mg/L, but falls apart at pH 9
Log Kow	3.74	4.5	~2,0
Hydrolyse	negligible	negligible	6,9 h at pH 9 3,5 d at pH 7
Biodegradable	good	Not clear	Poor in water, however a rapid primary degradation to e.g. CS2
Log Koc	2.863	3.7 – 5.75	3.3 – 4.1
Henry's Law Constant	No data.	No data	0.033 Pa.m^3/mol (25^{o}C)
Ecotox data and Predicted No Impact Concentration PNEC	No data <PNEC 0,005 mg/L (=0,1* WS)> @	72h-EC50 alg 0.7 mg/L No data <PNEC 0.027 mg/L (=0,1* WS)> @ Prov. **0.00007 mg/L** &	33d-NOEC fish 0.0046 mg/L 21d-NOEC Daphnia 0.02 mg/L 72h-EC05 algae 0.022 mg/L PNEC = **0.00005 mg/L** #
Classification for environmental hazards	none	H400 Immediate danger for aq. life, hazard cat.1 H410 (M=1) Chronic danger for aq. environment hazard cat. 1	H400 Immediate danger for aq. life, hazard cat.1 H410 (M=10) Chronic danger for aq. environment hazard cat. 1
PBT *	no PBT/vPvB	no PBT/vPvB	no PBT/vPvB

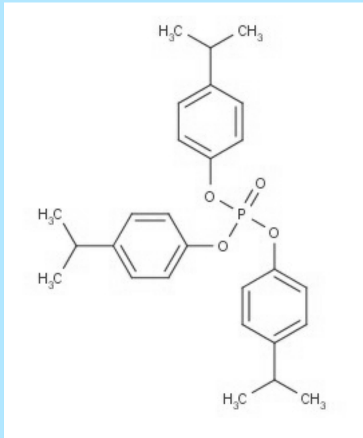
@ This justification is not in line with the ECHA Guidance [3]
\# The rounded to zero in the ECHA database seems to be an artefact. The used value is based on a 33d-study with fish (Assessment Factor AF 100, for aquatic environment).
& By lack of data is an estimated PNEC used (algae with AF 10000, for aquatic life)
* PBT/vPvB: persistent, bioaccumulating and toxic / very persistent and very bioaccumulating

[3] *https://echa.europa.eu/documents/10162/13632/information_requirements_r10_en.pdf*

A1.4.2 Neoprene

For two of the components found in neoprene with the highest environmental classification, information on the ecotoxicity is provided in table 5. Certain characteristics are irrelevant for the inorganic substance zinc oxide. The ECHA database provides a PNEC value for the marine environment. The ECHA database does not provide a PNEC value for the phosphate chemical bond. However the English Environmental Agency has assessed the environmental risk of this substance and gives a PNEC value for the marine environment. No relevant dossier for the non-classified naphthalene oil could be found.

Table 5. Characteristics of potential environmental toxic components in neoprene (CR-bonding rubber, ECHA database for ZnO and UK Env. Agency (2009) rapport for trisisopropylphenylphosphate[4])

Characteristics	Zinc oxide	Triarylphosphate, isopropyl
Structure	Zn=O MW = 81,4	 MW = 452,54
Solubility in water (WS)	2.9 mg/L	0.12 mg/L
Log Kow	n.v.t.	6,1
Hydrolyse	n.v.t.	Negligible
Biodegradable	n.v.t.	‘inherently biodegradable’
Log Koc	Log Kp = 5.04	3,65
Henry’s Law Constant		0,0087 Pa m3 /mol at 20℃
Ecotox information and/or Predicted No Impact Concentration PNEC	PNEC marine = 6.1 µg/L	PNEC marine = 0.06 µg/l
Classification for environmental hazards	H400 Aq Acuut 1, H410 Aq Chron 1 (M=1)	H410 Aq Chron 1 (M=1
PBT	Does not apply.	no PBT/vPvB

[4] *Environmental risk evaluation report: Isopropylated triphenyl phosphate (CAS nos. 28108-99-8, 26967-76-0 & 68937-41-7), Environmental Agency UK, Augustus 2009, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/290854/scho0809bqug-e-e.pdf*

A1.4.3 Choice of indicator substance(s)

Based on the available information MBTS, TMTD, Zinc oxide and Triarylphosphate isopropyl have been chosen as indicator substances for exposure of the ecosystem in the North Sea to environmental hazardous compounds.
There were no additional environmentally hazardous substances found on the second list of substances that was provided by the manufacturer. The substances were comparable to MTS and TMTD. The assessment of these two substances is representative for the substances mentioned in paragraph A1.8.

A1.5 MODELLING OF LEACHING

A1.5.1 Assumption used to modulate leaching

A few assumptions were required to be able to model the leaching of the substances. The concentration of the substances present in the product requires to be identified. For the chemical bond between MBTS and TMTD in Hypalon, the conservative assumption has been made that after the reaction only 10% of the substance remains. Zinc oxide and the phosphate chemical bond in neoprene have a different function and thus it is assumed that these will be 100% present after exposure.

The model MAMPEC was developed to predict the leaching of antifouling paint on vessels in to the marine environment. A ‘leaching rate’ value is required for antifouling paint for this model. In this case an estimate has to be made for the leaching rate of the selected substance from the Hypalon layer and the neoprene layers that are protected by the Hypalon. The estimate does not have to be accurate as long as the estimate represents a worst case scenario. If the worst case scenario shows no adverse impacts on the environment no further detailed research will be required.
The leaching rate of substances in Hypalon and neoprene are unknown. An emission scenario for paint uses a leaching rate of 0.75% per year whereas for PVC the numbers vary with a leaching rate of 30% of a lifetime of the product as highest assumption (UK-Env. Agency rapport 2009[(4)]).
In this study, we assume that 100% of the substances present will leach into the environment during the 3 months (maximum 12 months) that the Prototype North Sea is exposed to seawater. This is an extreme worst case scenario.

In paragraph A1.3.2 the area and the screen mass of Hypalon is calculated to be 737 m^2 and 800 kg respectively. TMTD is used as reactive substance of which <1% is added. The substance should disappear during the reaction. This means 10% remains of the <8kg of TMTD in the original composition, which equates to <800 g.

The 800 gram of TMTD will leach out for 100% over 90 days. This results in a leach rate of 8.9 g per day and 1.21 $\mu g/cm^2$/day.

The mass of neoprene was estimated to be1500 kg. Table 6 provides a conservative calculation for the leaching rate of the selected substances.

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Table 6. Leaching rate based on a leaching of 100% during pilot phase (90 d)

Ingredient	Conc. by production, % w/w	Assumptions	Mass in screen	Conservative leaching speed, µg/cm2/dag
TMTD	1	10% does not react 100% leaching from Hypalon	0,01 * 800 kg * 0,1 = 0,8 kg	0,8 kg/90d/737 m2 = 1.21
MBTS	2	10% does not react 100% leaching from Hypalon	0,02 * 800 kg * 0,1 = 1.6 kg	1,6 kg/90d/737 m2 = 2.41
Zinc oxide	4	Remains fully available 100% leaching from neoprene through Hypalon layer Zinc is 80% of Mol mass. zinc oxide	0,04* 1500 kg * 0,8 = 60 kg	60 kg/90d/737 m2 = 90.4
Phosphate link	12	Remains fully available 100% leaching through Hypalon layer	0,12 * 1500 kg = 180 kg	180 kg/90d/737 m2 = 271

A1.5.2 Environmental conditions

MAMPEC provides a scenario with dimensions and conditions for the shipping route on the North Sea (OECD Shipping Lane), see figure 12. This scenario is based on a location in the North Sea 10 km from the coast near Noordwijk[5]. The characteristics of water that are used in the OECD scenario to compare with the values for Noordwijk:

- SPM 6.6 ± 6.2 mg/L
- POC 0.5 ± 0.5 mg/L
- DOC 1.5 ± 0.3 mg/L
- Chlorofyl a 5.2 ± 10.2 ug/L
- Salinity 30.5 ± 1.5 psu
- Sediment org-C 1.6 ± 1.6 %

The values in the OECD scenario are slightly lower. Therefore the calculated concentrations in water will be slightly higher.

A1.5.3 Estimation of emissions

Originally the MAMPEC model is used to calculate the emission of antifouling paints on vessels. Therefore the area of the oil containment boom (737 m^2) is converted to a comparable area of the vessels that can be found in the area. This equals one vessel within the class 50-100 m, 2 between 20 and 50 m and 3 smaller vessels with a size of less than 10 metres. The spreading of the total emissions is calculated in the hydrodynamic model and gives concentrations (average, maximum, 90th percentile, etc.) of the substance in water and other environmental compartments. In this case, to assess the risk, the maximum concentration is compared with the PNEC (marine).

[5] *User Manual– Quick Guide MAMPEC 3.0, B. van Hattum et al., 2009. Deltares Delft and Vrije Universiteit Amsterdam*

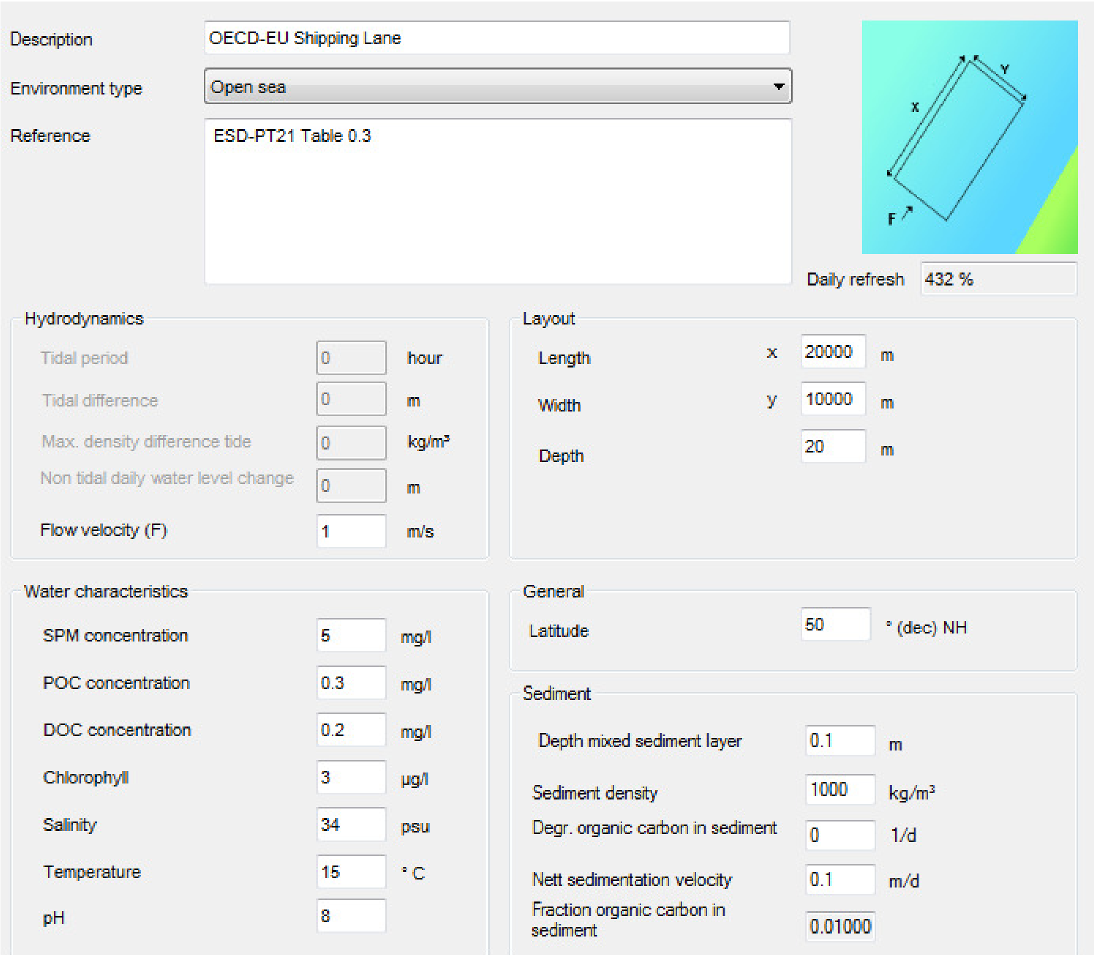

Figure 2. OECD scenario for vessel lanes.

A1.6 RESULTS AND CONCLUSION

For the risk evaluation the PEC (Predicted Environmental Concentration), is based on many extremely conservative assumptions, compared to the eco toxicological threshold level, the PNECmarine. The PNEC is based on the lowest value in toxicological research where there is no harmful impact on the environment in the long term, this includes an assessment factor. When doing a risk assessment the PEC is compared to the PNEC. When a value PEC/PNEC >1 there is a risk. When PEC/PNEC is < 1 there is no reason for concern. A summary of the results is given in table 7.

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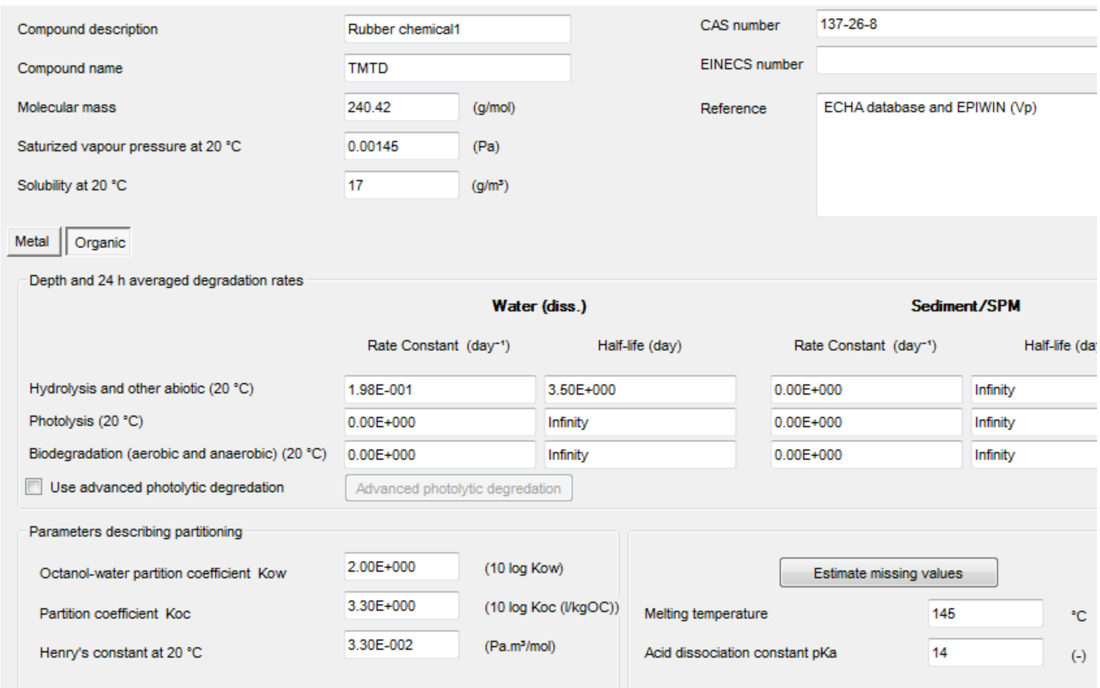
Table 7. A comparison of the predicted maximum concentrations (PEC) with PNEC marine

Substance	PEC (µg/L)	PNECmarine (µg/L)	PEC/PNEC
TMTD	1.71 E-006	0.05	3.4 E-005
MBTS	3.46 E-006	0.07	4.9 E-005
$Zn^{2}+$ (Zinc oxide)	1.3 E-004	6.1	2.1 E-005
Triarylphosphate, isopropylated	3.89 E-004	0.06	0.0065

The table shows that al substances have a risk level far less than 1. Even when considering the conservative assumptions there is no reason for concern. Note that the calculations for PEC are based on the simple assumption of the total mass of components in Hypalon and neoprene, and the total leaching rate over three months. These assumptions are very conservative but for this assessment are deemed appropriate.

A1.7 Attachment: Input and results for calculations in MAMPEC

A1.7.1 TMTD



Compound description	Rubber chemical1		CAS number	137-26-8
Compound name	TMTD		EINECS number	
Molecular mass	240.42	(g/mol)	Reference	ECHA database and EPIWIN (Vp)
Saturized vapour pressure at 20 °C	0.00145	(Pa)		
Solubility at 20 °C	17	(g/m³)		

Metal | Organic

Depth and 24 h averaged degradation rates

	Water (diss.) Rate Constant (day⁻¹)	Water (diss.) Half-life (day)	Sediment/SPM Rate Constant (day⁻¹)	Sediment/SPM Half-life (da
Hydrolysis and other abiotic (20 °C)	1.98E-001	3.50E+000	0.00E+000	Infinity
Photolysis (20 °C)	0.00E+000	Infinity	0.00E+000	Infinity
Biodegradation (aerobic and anaerobic) (20 °C)	0.00E+000	Infinity	0.00E+000	Infinity

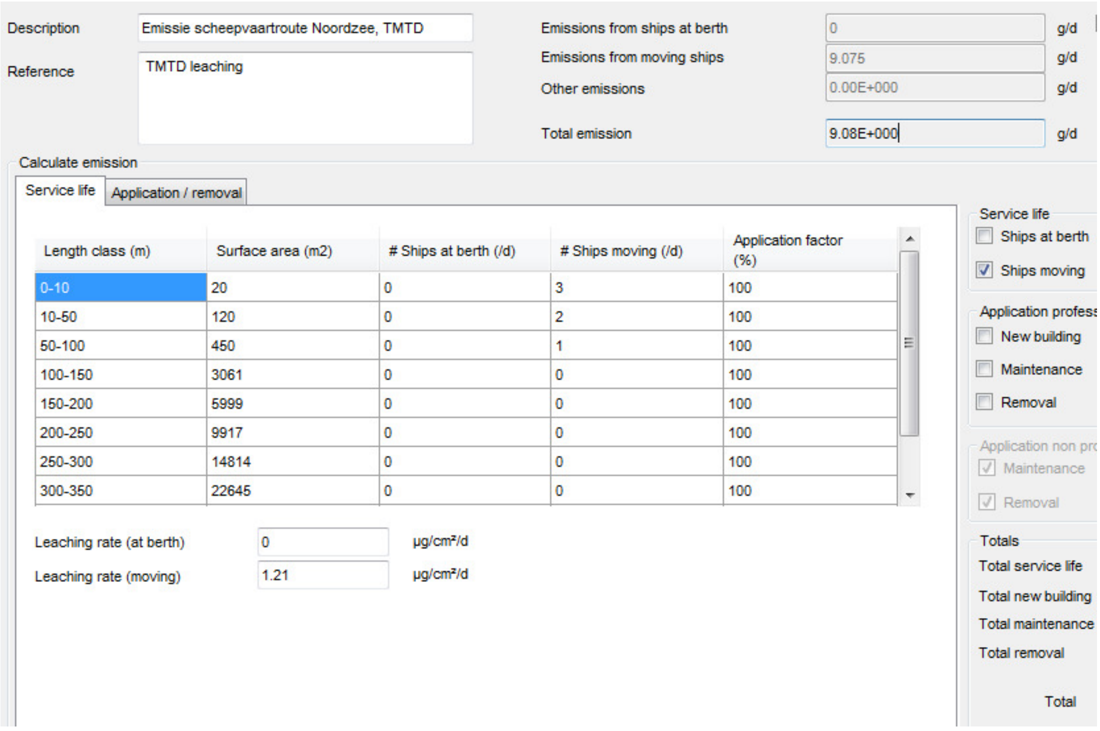
Use advanced photolytic degredation | Advanced photolytic degredation

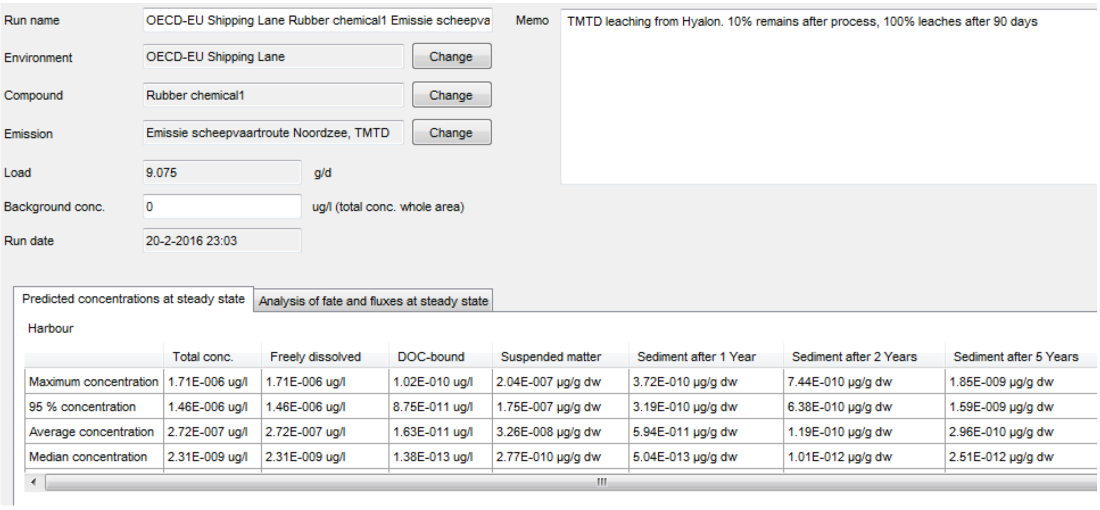
Parameters describing partitioning

Octanol-water partition coefficient Kow	2.00E+000	(10 log Kow)
Partition coefficient Koc	3.30E+000	(10 log Koc (l/kgOC))
Henry's constant at 20 °C	3.30E-002	(Pa.m³/mol)

Estimate missing values

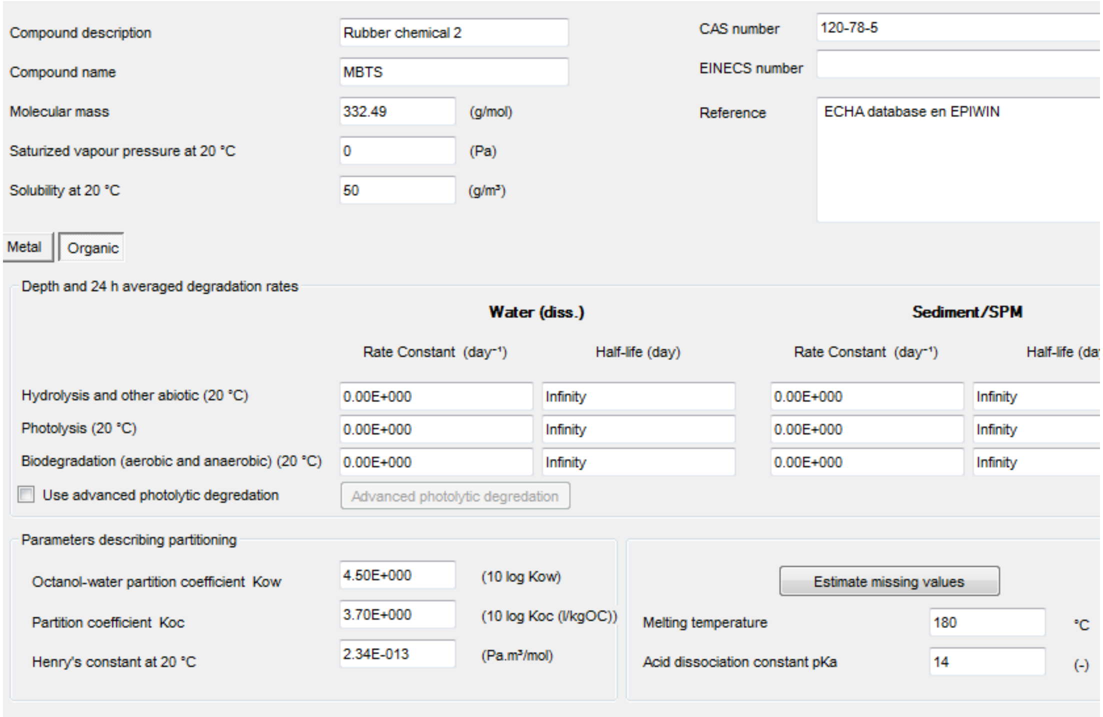
Melting temperature	145	°C
Acid dissociation constant pKa	14	(-)





	Total conc.	Freely dissolved	DOC-bound	Suspended matter	Sediment after 1 Year	Sediment after 2 Years	Sediment after 5 Years
Maximum concentration	1.71E-006 ug/l	1.71E-006 ug/l	1.02E-010 ug/l	2.04E-007 µg/g dw	3.72E-010 µg/g dw	7.44E-010 µg/g dw	1.85E-009 µg/g dw
95 % concentration	1.46E-006 ug/l	1.46E-006 ug/l	8.75E-011 ug/l	1.75E-007 µg/g dw	3.19E-010 µg/g dw	6.38E-010 µg/g dw	1.59E-009 µg/g dw
Average concentration	2.72E-007 ug/l	2.72E-007 ug/l	1.63E-011 ug/l	3.26E-008 µg/g dw	5.94E-011 µg/g dw	1.19E-010 µg/g dw	2.96E-010 µg/g dw
Median concentration	2.31E-009 ug/l	2.31E-009 ug/l	1.38E-013 ug/l	2.77E-010 µg/g dw	5.04E-013 µg/g dw	1.01E-012 µg/g dw	2.51E-012 µg/g dw

A1.7.2 MBTS



Compound description: Rubber chemical 2
Compound name: MBTS
Molecular mass: 332.49 (g/mol)
Saturized vapour pressure at 20 °C: 0 (Pa)
Solubility at 20 °C: 50 (g/m³)
CAS number: 120-78-5
EINECS number:
Reference: ECHA database en EPIWIN

Metal | Organic

Depth and 24 h averaged degradation rates

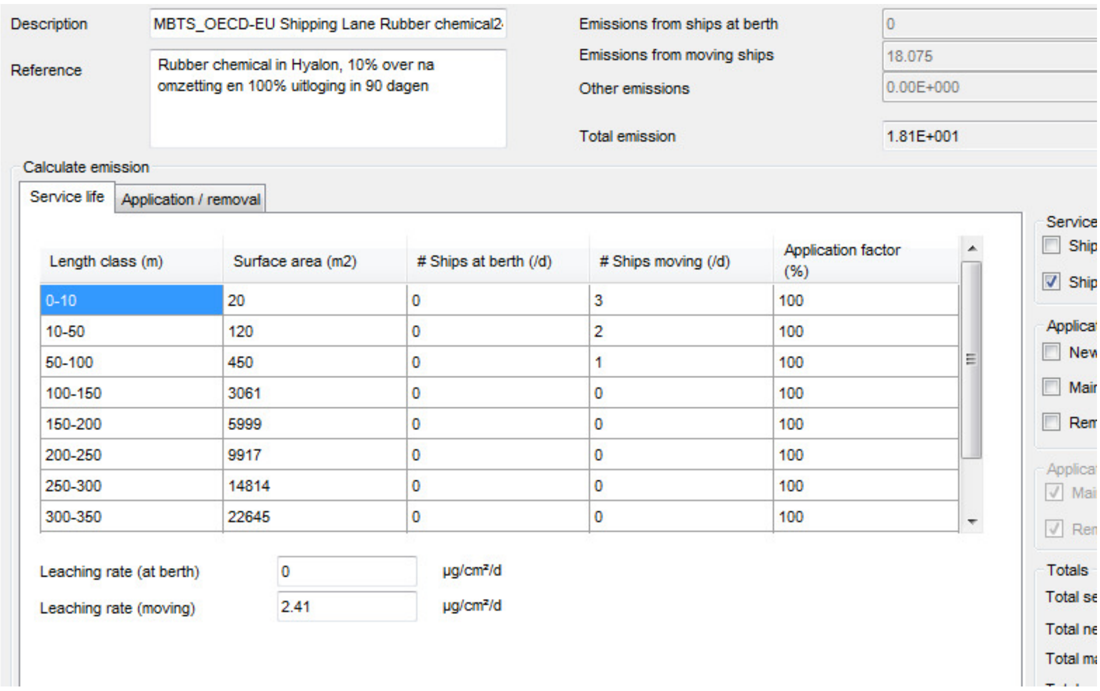
	Water (diss.)		Sediment/SPM	
	Rate Constant (day⁻¹)	Half-life (day)	Rate Constant (day⁻¹)	Half-life (da
Hydrolysis and other abiotic (20 °C)	0.00E+000	Infinity	0.00E+000	Infinity
Photolysis (20 °C)	0.00E+000	Infinity	0.00E+000	Infinity
Biodegradation (aerobic and anaerobic) (20 °C)	0.00E+000	Infinity	0.00E+000	Infinity

Use advanced photolytic degradation | Advanced photolytic degregdation

Parameters describing partitioning

Octanol-water partition coefficient Kow: 4.50E+000 (10 log Kow)
Partition coefficient Koc: 3.70E+000 (10 log Koc (l/kgOC))
Henry's constant at 20 °C: 2.34E-013 (Pa.m³/mol)

Estimate missing values
Melting temperature: 180 °C
Acid dissociation constant pKa: 14 (-)



Description: MBTS_OECD-EU Shipping Lane Rubber chemical2
Reference: Rubber chemical in Hyalon, 10% over na omzetting en 100% uitloging in 90 dagen
Emissions from ships at berth: 0
Emissions from moving ships: 18.075
Other emissions: 0.00E+000
Total emission: 1.81E+001

Calculate emission

Service life | Application / removal

Length class (m)	Surface area (m2)	# Ships at berth (/d)	# Ships moving (/d)	Application factor (%)
0-10	20	0	3	100
10-50	120	0	2	100
50-100	450	0	1	100
100-150	3061	0	0	100
150-200	5999	0	0	100
200-250	9917	0	0	100
250-300	14814	0	0	100
300-350	22645	0	0	100

Leaching rate (at berth): 0 µg/cm²/d
Leaching rate (moving): 2.41 µg/cm²/d

Service
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Applica
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Run name	OECD-EU Shipping Lane Rubber chemical 2 MBTS_OECD-EU	Memo	MBTS leaching from Hyalon, 10% remains after process, 100% leaches after 90 days
Environment	OECD-EU Shipping Lane	Change	
Compound	Rubber chemical 2	Change	
Emission	MBTS_OECD-EU Shipping Lane Rubber chem	Change	
Load	18.075	g/d	
Background conc.	0	ug/l (total conc. whole area)	
Run date	20-2-2016 23:55		

Predicted concentrations at steady state | Analysis of fate and fluxes at steady state

Harbour

	Total conc.	Freely dissolved	DOC-bound	Suspended matter	Sediment after 1 Year	Sediment after 2 Years	Sediment after 5 Yea
Maximum concentration	3.46E-006 ug/l	3.45E-006 ug/l	5.19E-010 ug/l	1.04E-006 µg/g dw	1.89E-009 µg/g dw	3.78E-009 µg/g dw	9.43E-009 µg/g dw
95 % concentration	2.96E-006 ug/l	2.95E-006 ug/l	4.44E-010 ug/l	8.87E-007 µg/g dw	1.62E-009 µg/g dw	3.23E-009 µg/g dw	8.06E-009 µg/g dw
Average concentration	5.49E-007 ug/l	5.48E-007 ug/l	8.24E-011 ug/l	1.65E-007 µg/g dw	3.00E-010 µg/g dw	6.00E-010 µg/g dw	1.50E-009 µg/g dw
Median concentration	4.73E-009 ug/l	4.72E-009 ug/l	7.10E-013 ug/l	1.42E-009 µg/g dw	2.59E-012 µg/g dw	5.17E-012 µg/g dw	1.29E-011 µg/g dw

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A1.7.3 Zinc oxide

Compound description	Rubber chemical 3		CAS number	1314-13-2
Compound name	Zinc (from zinc oxide)		EINECS number	
Molecular mass	65.4	(g/mol)	Reference	Oplosbaarheid gerelateerd aan Zn2+
Saturized vapour pressure at 20 °C	0	(Pa)		
Solubility at 20 °C	2.32	(g/m³)		

Metal | Organic

Copper compound

Kd 110 (m³/kg)

Description	Rubber chemical 3 Zink(oxide)	Emissions from ships at berth	0	g/d
Reference	concentraties zink	Emissions from moving ships	678	g/d
		Other emissions	0.00E+000	g/d
		Total emission	6.78E+002	g/d

Calculate emission

Service life | Application / removal

Length class (m)	Surface area (m2)	# Ships at berth (/d)	# Ships moving (/d)	Application factor (%)
0-10	20	0	3	100
10-50	120	0	2	100
50-100	450	0	1	100
100-150	3061	0	0	100
150-200	5999	0	0	100
200-250	9917	0	0	100
250-300	14814	0	0	100
300-350	22645	0	0	100

Leaching rate (at berth) 0 µg/cm²/d

Leaching rate (moving) 90.4 µg/cm²/d

Service life: Ships at ber | Ships movin

Application prof: New building | Maintenanc | Removal

Application non: Maintenanc | Removal

Totals: Total service lif | Total new buildi

Run name	OECD-EU Shipping Lane Rubber chemical 3 Rubber chemical		
Environment	OECD-EU Shipping Lane	Change	
Compound	Rubber chemical 3	Change	
Emission	Rubber chemical 3 Zink(oxide)	Change	
Load	678	g/d	
Background conc.	0	ug/l (total conc. whole area)	
Run date	20-2-2016 23:29		

Memo: Zink (ion) leaching from neopreen. 100% remains after process, 100% leaches after 90 days

Predicted concentrations at steady state | Analysis of fate and fluxes at steady state

Harbour

	Total conc.	Freely dissolved	DOC-bound	Suspended matter	Sediment after 1 Year	Sediment after 2 Years	Sediment after 5 Years
Maximum concentration	1.30E-004 ug/l	8.36E-005 ug/l	0.00E+000 ug/l	9.20E-003 µg/g dw	1.68E-005 µg/g dw	3.35E-005 µg/g dw	8.36E-005 µg/g dw
95 % concentration	1.11E-004 ug/l	7.15E-005 ug/l	0.00E+000 ug/l	7.87E-003 µg/g dw	1.43E-005 µg/g dw	2.87E-005 µg/g dw	7.15E-005 µg/g dw
Average concentration	2.06E-005 ug/l	1.33E-005 ug/l	0.00E+000 ug/l	1.46E-003 µg/g dw	2.66E-006 µg/g dw	5.32E-006 µg/g dw	1.33E-005 µg/g dw
Median concentration	1.77E-007 ug/l	1.14E-007 ug/l	0.00E+000 ug/l	1.26E-005 µg/g dw	2.29E-008 µg/g dw	4.58E-008 µg/g dw	1.14E-007 µg/g dw

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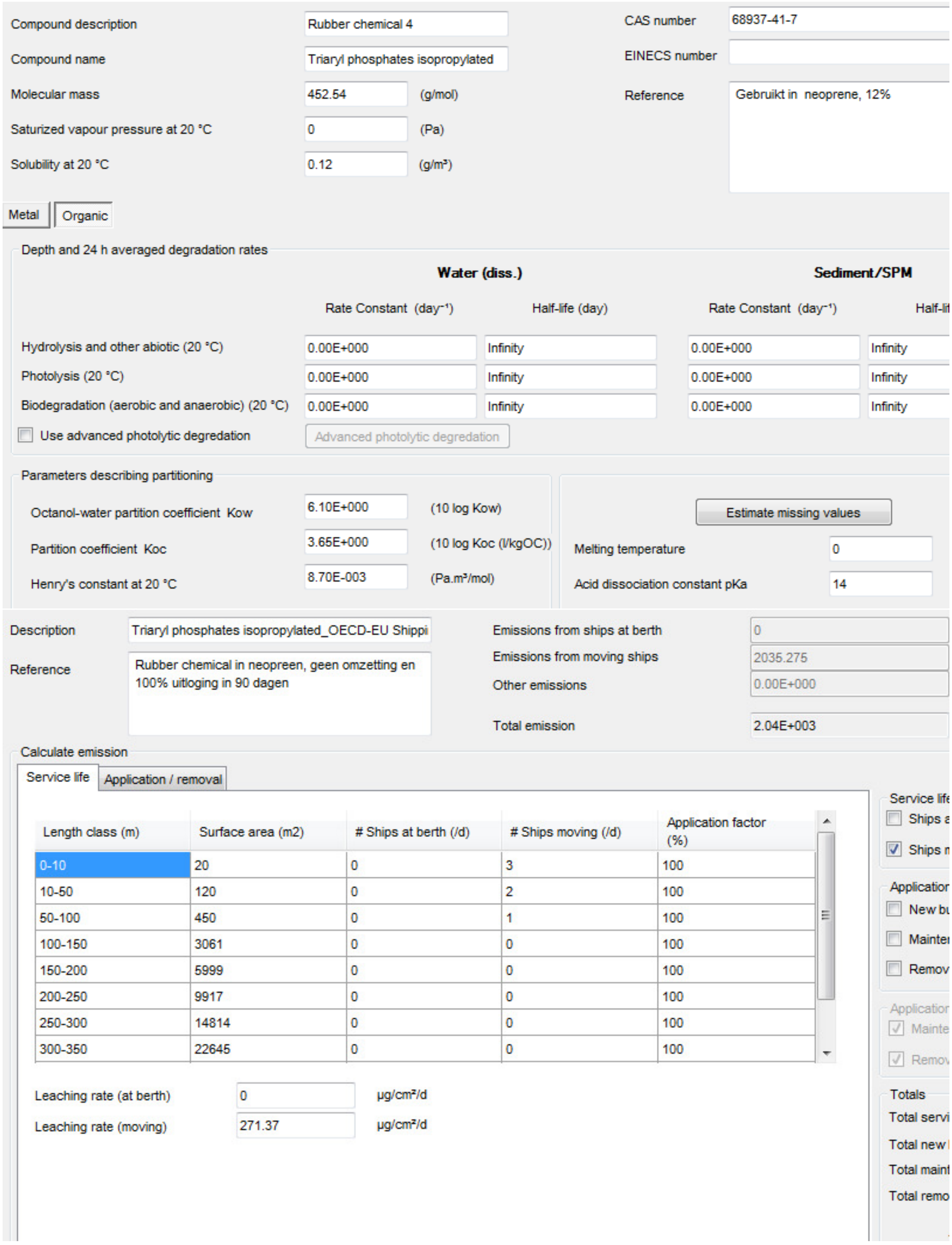
A1.7.4 Triaryl phosphates isopropylated



Compound description	Rubber chemical 4		CAS number	68937-41-7
Compound name	Triaryl phosphates isopropylated		EINECS number	
Molecular mass	452.54	(g/mol)	Reference	Gebruikt in neoprene, 12%
Saturized vapour pressure at 20 °C	0	(Pa)		
Solubility at 20 °C	0.12	(g/m³)		

Metal | Organic

Depth and 24 h averaged degradation rates

	Water (diss.) Rate Constant (day⁻¹)	Water (diss.) Half-life (day)	Sediment/SPM Rate Constant (day⁻¹)	Sediment/SPM Half-li
Hydrolysis and other abiotic (20 °C)	0.00E+000	Infinity	0.00E+000	Infinity
Photolysis (20 °C)	0.00E+000	Infinity	0.00E+000	Infinity
Biodegradation (aerobic and anaerobic) (20 °C)	0.00E+000	Infinity	0.00E+000	Infinity

Use advanced photolytic degradation | Advanced photolytic degradation

Parameters describing partitioning

Octanol-water partition coefficient Kow	6.10E+000	(10 log Kow)
Partition coefficient Koc	3.65E+000	(10 log Koc (l/kgOC))
Henry's constant at 20 °C	8.70E-003	(Pa.m³/mol)

Estimate missing values

Melting temperature	0
Acid dissociation constant pKa	14

Description	Triaryl phosphates isopropylated_OECD-EU Shippi
Reference	Rubber chemical in neopreen, geen omzetting en 100% uitloging in 90 dagen

Emissions from ships at berth	0
Emissions from moving ships	2035.275
Other emissions	0.00E+000
Total emission	2.04E+003

Calculate emission

Service life | Application / removal

Length class (m)	Surface area (m2)	# Ships at berth (/d)	# Ships moving (/d)	Application factor (%)
0-10	20	0	3	100
10-50	120	0	2	100
50-100	450	0	1	100
100-150	3061	0	0	100
150-200	5999	0	0	100
200-250	9917	0	0	100
250-300	14814	0	0	100
300-350	22645	0	0	100

Leaching rate (at berth)	0	µg/cm²/d
Leaching rate (moving)	271.37	µg/cm²/d

Service life: Ships a | Ships m

Application: New bu | Mainter | Remov

Application: Mainte | Remov

Totals: Total servi | Total new | Total maint | Total remo

Royal HaskoningDHV

Run name	OECD-EU Shipping Lane Rubber chemical 4 Triaryl phosphate	
Environment	OECD-EU Shipping Lane	Change
Compound	Rubber chemical 4	Change
Emission	Triaryl phosphates isopropylated_OECD-EU S	Change
Load	2035.275	g/d
Background conc.	0	ug/l (total conc. whole area)
Run date	20-2-2016 23:39	

Memo: Fosfate compound leaching from neopreen. 100% remains after process, 100% leaches after 90 days

Ru

Predicted concentrations at steady state | Analysis of fate and fluxes at steady state

Harbour

	Total conc.	Freely dissolved	DOC-bound	Suspended matter	Sediment after 1 Year	Sediment after 2 Years	Sediment after 5 Years	Sediment afte
Maximum concentration	3.89E-004 ug/l	3.89E-004 ug/l	5.21E-008 ug/l	1.04E-004 µg/g dw	1.90E-007 µg/g dw	3.80E-007 µg/g dw	9.46E-007 µg/g dw	1.88E-006 µg
95 % concentration	3.33E-004 ug/l	3.32E-004 ug/l	4.45E-008 ug/l	8.91E-005 µg/g dw	1.62E-007 µg/g dw	3.25E-007 µg/g dw	8.09E-007 µg/g dw	1.61E-006 µg
Average concentration	6.18E-005 ug/l	6.17E-005 ug/l	8.27E-009 ug/l	1.65E-005 µg/g dw	3.02E-008 µg/g dw	6.03E-008 µg/g dw	1.50E-007 µg/g dw	2.99E-007 µg
Median concentration	5.32E-007 ug/l	5.32E-007 ug/l	7.12E-011 ug/l	1.42E-007 µg/g dw	2.60E-010 µg/g dw	5.19E-010 µg/g dw	1.29E-009 µg/g dw	2.58E-009 µg

A1.8 ADDENDUM: Screening environmental hazard of second list of substances

DESMI provided a second list of substances after the risk assessment was completed in A1.1-A1.6. A screening of the substances was done for the potential environmental risks and the status of the substance according to the REACH regulation. A summary is provided in table 8 and 9.

REACH status

A few substances in the list are not yet registered under REACH. All substances except one are preregistered. This means that manufacturers use the current production volume of these substances below the tonnage registration limit (100 ton/year). In 2018 they have to be registered. Since there is no REACH dossier there is no information available on the environmental risk of these substances. This concerns two substances that are added to the accelerator DPTT (dosed at 0-3%), talc (<1% in chloroprene rubber), Silane (0-3%), Calcit (10-15%), aging protector (0-3%), chlorine alkanes used as flame retardant and plasticisers (0-3%), the 'tackifier' petroleum distillate (0-3%) and fenolhars (0-3%).

One of the substances is not preregistered in REACH and can therefore not be used in the EU. This concerns CAR number 72017-86-8 (fifth substance in table 2), that is used in an anti-aging formula (percentage 8%) that is dose in 0-3%. Polymers are not included in the REACH regulation and can therefore not be found in the REACH database.

Environmental risks

Two substances are classified with the highest risk category H400 and H410. These substances occur as byproduct in a formula with a dosage of 0-3%. Therefore the concentration of these classified substances is <0.03% and <0.21%. The last substance on the list, α-Methyl styrene dimer, CAS nr 6362-80-7, is also shown to comply with the criteria for PBT (persistent, bioaccumulation and toxic). The use of such substances is heavily restricted. It depends on the function and reaction of the substance during the production of the rubber, whether the substance is still present in the end product and can subsequently leach into the environment. The manufacturer has to provide this information. The concentration of the two substances with a H411 classification is <0.15%; the other is added between 0 and 3%.

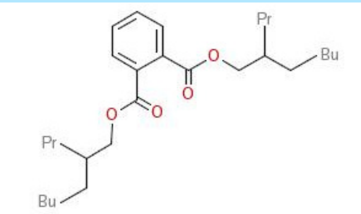
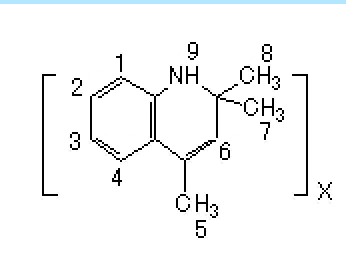
Conclusions

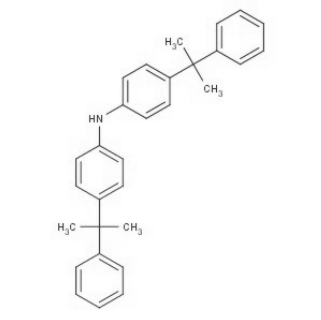
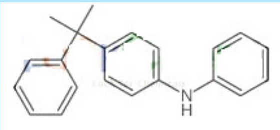
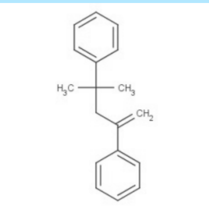
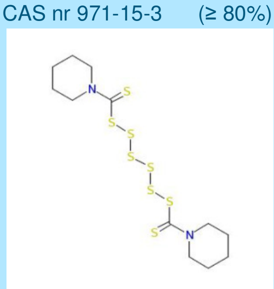
1. Compared to the substances assessed in the first phase no substances have been identified with a higher toxicity that are used in high concentrations. The assumption is that the mass of the 'cover' and the 'skim' is not significantly higher than the Hypalon outer layer and neoprene inner

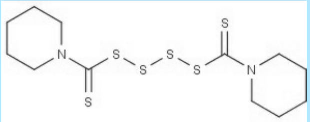
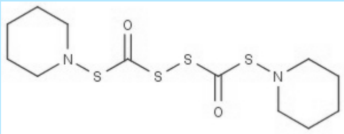
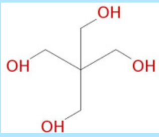
layer that was assessed earlier. As such the emission rates should be comparable. With the exaggerated conservative assumptions that are used for the risk assessment of substances in the first phase, the calculated risk characterisation was far below 1 and thus caused no reason for concern. The same conclusion can be drawn for the second group of substances.

2. Additional information should be provided for the presence of PBT. The use of such substances is only permitted under strict conditions. It depends on the function and reaction of the substance during the production of the rubber whether the substance is still present in the end product and can leach into the environment. The manufacturer has to provide this information.
3. One of the substances on the list is not (yet) preregistered in the REACH database. The use of a non-preregistered substance is not in compliance with the REACH regulation. In 2018 all the substances that are preregistered will have to be registered otherwise they cannot be used.

Table 8. Additional components in the ‘cover’

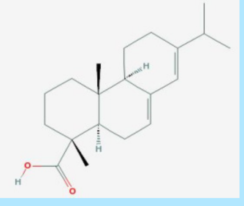
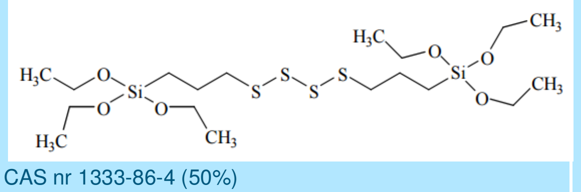
Name	Function	% (w/w) in solution	REACH status, CLP-environment@, PBT	Characteristics	PNEC and aq. tox
Chlorated polyethylene CAS nr 64754-90-1	polymere	4-7	Not in database (polymere)		
Silicium dioxide CAS nr 112926-00-8 $O=Si=O$		5-8	REACH C&L: none PBT/vPvB: no	WS ≥ 15 mg/L	no PNEC LL0 fish 10 g/L EL0 daphnia 1 g/L NOELgr 10 g/L
Bis(2-propylheptyl) phthalate / trimethyldihydroquinoline / TMQ CAS nr 53306-54-0 	plasticizer	5-10	REACH C&L: none	Log Kow > 6 **WS 0,002 µg/L** Foto DT50 in air 14 h Biodegradable (‘ready’) calculated BCF low	no PNEC 96h-LC0 fish > 10 g/L 48h-EC50 daphnia > 100 mg/L 21d-NOEC daphnia > 1 mg/L 72h-EC10 en EC50 > 100 mg/L, NOEC 25 mg/L
1,2-Dihydro-2,2,4-trimethylquinoline, oligomers CAS nr 26780-96-1 	Aging protector	0-3	REACH C&L: H412: Aq. Chron. 3 PBT/vPvB: none	Log Kow: 1,2 – 7,7, average. 5,8 WS < 0,2 mg/L Foto DT50 in air2 h Fotolyse DT50 in water 3 min Hydrolyse DT50 ca 16 h?? (sideimpact by foto-ox.) Non biodegradable BCFfish 100 – 1300, but some substances accumulate stronger	PNEC fresh water 0,056 mg/L PNEC salty water 0,006 mg/L (AF 10.000)
4-(1-methyl-1-phenylethyl)-N-[4-(1-methyl-1-phenylethyl)phenyl]aniline CAS nr 10081-67-1 (≥ 85%)	Aging protector	0-3	REACH C&L: H413: Aq. Chron. 4 PBT/vPvB: no	Log Kow 7.9 WS < 0,007 mg/L Partly biodegradable calculated BCF 888 L/kg Log Kow 6,54	(not accurate, requested longer study) PNEC fresh water0,1 mg/L PNEC salty water

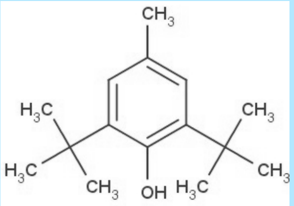
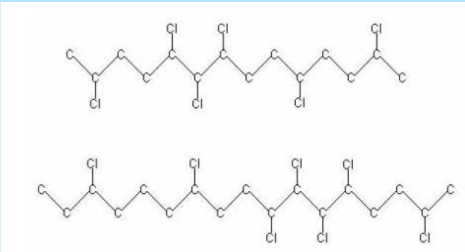
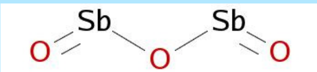
					0,01 mg/L (AF 10.000)
N-phenyl-4-(2-phenylpropan-2-yl)aniline CAS nr 72017-86-8 (≤ 8%) 			Not (pre)registrated (possibly a byproduct)		
1,1'-(1,1-dimethyl-3-methylene-1,3-propanediyl)bisbenzene [α-Methylstyrene dimer] CAS nr 6362-80-7 (≤ 7%) 			REACH C&L: H400: Aq. Acuut 1 H410: Aq. Chron. 1 **PBT: yes**	Log Kow 6,.2 WS 0,23 mg/L 'Inherent' Biodegradable (65% BOD) but not 'ready' BCF 300 – 4000 Log Koc 4,82	96h-LC50 fish > 0,092 mg/L 48h-EC50 = 0,057 mg/L 72h NOEC algae > 0,059 mg/L → PNECsaltywater# = 0,0059 µg/L (AF 10.000)
Bis(piperidinothiocarbonyl) hexasulphide (DPTT) CAS nr 971-15-3 (≥ 80%) 	Accelerator	0-3	REACH C&L: H413: Aq.Chron. 4 PBT/vPvB: no	log Kow 4,3 WS 10,48 µg/L Badly biodegradble log Koc 4,65	72h-EC50 algae > 7,9 µg/L (WS) (requested longer study)
Distillates (petroleum), hydrotreated light paraffinic (UVCB, C15-C30, low viscosity, large fraction saturated) CAS nr 64742-55-8 (1-2%)			REACH C&L: geen PBT/vPvB: nee (antrhaceen < 0,1%)	No information for Log Kow en WS biodegradable ('inherently')	21d-NOEL D. magna 10 mg/L (~WS) acute studies other > 100 mg/L
Sulfur CAS nr 7704-34-9 (≤ 5%)			REACH C&L: none	WS < 0.005 mg/L	96hLC0 fish > 100 mg/L (~WS) 48h-EC50 Daphnia > 100 mg/L (~WS) 21dNOEC > 100 mg/L, > 2,5 µg/L (WS) 72h_NOEC < 1,3

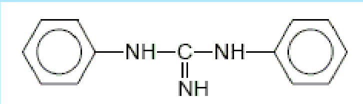
					mg/L; > 0,005 mg/L (WS)
Bis(piperidinothiocarbonyl) tetrasulphide CAS nr 120-54-7 (≤ 5%) 			Preregistration C&L: H411: Aq. Chron. 2		
Bis(piperidinothiocarbonyl) disulphide CAS nr 94-37-1 (≤ 5%) 			Preregistration C&L: none		
Pentaerythritol CAS nr 115-77-5 	Curatives for sat. polymers	0-3	REACH C&L: none PBT: no	Log Kow -1,7 WS 62 g/L Biodegradable ('ready')	PNEC freshw 1 mg/L PNEC saltw 0,1 mg/L (AF 10.000)

Royal HaskoningDHV

Table 9.Additional substances in the 'skim'

Name	Function	% (w/w) in solution	REACH status, CLP-environment, PBT	Characteristics	PNEC and aq. tox
Polychloroprene rubber CAS nr 25067-95-2	polymere	20-30	Not in database (polymere)		
Rosin CAS nr 8050-09-7 (<5%) 			REACH C&L: none PBT: no	(UVCB) Log Kow 2 – 7,7 WS 0,9 mg/L (major substances) biodegradable ('ready')	PNEC salty water. 0,0002 mg/l (AF 10.000)
Talc (Mg3H2(SiO3)4) CAS nr 14807-96-6 (<1%) $H_2Mg_3O_{12}Si_4$			Preregistration C&L:none PBT: n.a.	Very slightly soluble in water	No data
Silane CAS nr 211519-85-6 (50%) Polysulfides, bis(3-(triethoxysilyl)propyl)  CAS nr 1333-86-4 (50%)		0-3	Preregistration C&L: H412: Aq. Chron 3		
Limestone (Calcit) CAS nr 1317-65-3		10-15	Preregistration C&L: none PBT: n.a.		
Benzenamine, N-phenyl-, styrenated CAS nr 68442-68-2	Aging protector	0-3	Preregistration C&L: H412: Aq. Chron. 3		
Zinc salts unsaturated fatty acids,	plasticizer	0-3	REACH	Log Kow 6 – 8	Toxicity is determined by Zn

CAS nr 67701-12-6 (e.g more variaties possible)  consists: 2,6-di-tert-butyl-p-cresol (BHT) CAS no 128-37-0 (0.25 – 1%) 			C&L: none PBT: no REACH C&L: H400: Aq. Acuut 1 H410: Aq. Chron. 1 PBT: none	WS 214 µg Zn/L Biodegradable ('ready') Bioaccumulation Zn: intern regulated concentration (essential element) Log Kow 5,2 WS 1 mg/L Degradable in water based on light Badly biodegradable BCF 800-1300 Log Koc 3,9 – 4,2	PNEC saltw 6.1 µg/L (Zn, Stat. extrapol, AF 1) PNEC saltw 0,4 µg/L (AF 100)
Chloroalkanes (C14-C17) CAS nr 85535-85-9 (more structures possible) 	flame retardant, plasticizer	5-10	REACH C&L: H410 (M=1) Aq. Chron. 1 PBT/vPvB: no (discussion)	Log Kow 4,7 – 8,3 WS 0,005 – 0,027 mg/L Biodegradable dependent on chlorination level BCF 1087 – 349; BCF 3200 - 4400 log Koc 5 – 5,2	PNEC saltw 0,02 µg/L (AF 50)
Chloroalkanes (C18-C28) CAS nr 85535-86-0	flame retardant, plasticizer	5-10	Preregistration C&L: none		
Di-antimone trioxide CAS nr 1309-64-4 (>90%)  CAS nr 085535-85-9 (<10%) – see above	flame retardant	0-3	REACH C&L (harmonised): none C&L (dossier): H412: Aq. Chron. 3	WS 2 – 30 mg/L BCF large spread Log Kp 2m7 – 4,2	PNECsaltw 0,011 mg/L (AF 10.000)
Distillates (petroleum), steam-cracked, polymerized CAS nr 68131-77-1	tackifier	0-3	Preregistration C&L: H412: Aq. Chron. 3		
Phenolic resin (Formaldehyde, oligomeric reaction products with phenol)		0-3	Preregistration C&L: geen		

CAS nr 9003–35–4 0-3					
Mixture of fatty acid derivatives * CAS nr niet gegeven.		0-3			
MBTS CAS nr 120-78-5 0-3	Accelerator	0-3	see Tabel 2 en 4		
Sulfur CAS nr 7704-34-9		0-3	REACH C&L: none	WS < 0.005 mg/L	96hLC0 fish > 100 mg/L (~WS) 48h-EC50 Daphnia > 100 mg/L (~WS) 21d-NOEL > 100 mg/L, 21d-NOEC > 2,5 µg/L (WS) 72h-NOEL < 1,3 mg/L; 72h-NOEC > 0,005 mg/L (WS)
1,3-diphenylguanidine CAS nr 102-06-7 	Accelerator	0-3	REACH C&L: H411: Aq. Chron. 2	Log Kow 2,42 – 2,89 WS 325 mg/L Biodegradable (‘ready’) BCF < 20 Log Koc 2,5 – 3,14	PNEC saltw 3 µg/L (AF 100)

The PNEC in the ECHA database is rounded to zero
* Name not specific enough
@ Environmental hazard classification:
H400 – Immediate danger for aquatic life, hazard classification 1. " Very poisonous for organisms living in water."
H410 – Chronic danger for aquatic life, hazard classification 1. " Very poisonous for organisms living in water, with long lasting impacts."
H411 - Chronic danger for aquatic life, hazard classification 2. " Toxic to aquatic life with long-lasting effects."
H412 - Chronic danger for aquatic life, hazard classification 3. " Harmful for organisms living in water, with long lasting impacts."
H413 - Chronic danger for aquatic life, hazard classification 4. " May cause long-lasting harmful effects to aquatic life."