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NATURAL CAPPING OF THE LANDFILL VOLGERMEERPOLDER  
A SUSTAINABLE METHOD USING ECOLOGY TO ISOLATE CHEMICALS IN SOIL

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SUMMARY

The Volgermeerpolder is a former dumpsite of 105 hectares, near Amsterdam in a marshy polder with shallow groundwater, open water and peaty soils. It was used as a landfill for domestic and industrial waste. This included large amounts of chemical waste, making it one of the most severely contaminated areas in Western Europe.

The severely polluted landfill was considered a 'chemical time bomb'. After the Volgermeerpolder closed in 1981, the local authorities took 20 years to plan and action remedial measures. The remediation works started in 2001. Only in 2006 it was discovered that no groundwater pollution was detected in the surrounding marshy polder, it was concluded that the deep peaty soils surrounding the landfill acted as a natural barrier that prevented spreading of contaminants. The decision was taken that for remediation of the Volgermeerpolder it would be sufficient to cover the landfill, and that a complete isolation of the waste by means of a steel pile wall around the dumpsite and a bottom liner would not be required. This 'saved' around EUR 150 million.

During the remediation, the Advisory Combination Volgermeerpolder (ACV) found the peat soil surrounding the Volgermeerpolder to function as a 'carbon filter', which prevented spread of organic pollutants. To avoid replacement of a standard cover in the long run, ACV developed a surprisingly simple and effective concept: the 'natural cap'. This concept consists of a gradual, functional replacement of the standard cover (of soil and a synthetic liner) by a natural layer of living, organic material.

The 'natural cap' is a surprisingly simple and effective concept with great potential for large-scale land remediation. It is considered a sustainable and effective alternative for standard remediation solutions and thus a valuable contribution to cost-effective remediation of a vast number of landfills and mine tailing deposits all over the world.

## INTRODUCTION

### **History**

The Volgermeerpolder is an area of approximately 105 hectares, which in the twentieth century was used as a dumpsite for domestic and industrial waste. This included large amounts of chemical waste, for instance 30,000 barrels of waste from pesticide production, making it one of the most severely contaminated areas in Western Europe. The Volgermeerpolder (52°44' N, 5°15' E) is located 5 kilometer north-east of the City of Amsterdam, in a marshy polder with shallow groundwater, open water and a deep peaty soil.

In the 1970s a fear emerged that it would only be a matter of time before the toxic waste would spread uncontrollably into the surrounding environment. The dumpsite was considered a 'chemical time bomb'. After the Volgermeerpolder closed in 1981, the local Authorities took the initiative towards remediation. Still it took some time to find a suitable solution and commence the remediation.

### **Before remediation**

In the period between the end of use of the Volgermeerpolder as a dumpsite and the start of the remedial action, nature had the opportunity to establish a new status quo. On the wet low-lying areas with large quantities of industrial waste, a thick growth of poplar, willow, elderberry and brambles arised. The higher dry areas, containing mainly domestic waste, resulted in a vegetation of mostly grass and brambles. Surprisingly, the surface water in the waterways on the Volgermeerpolder was of good quality. This inspite of the heavily contaminated sediments and percolation water less than a metre from the surface water.

The groundwater surrounding the Volgermeerpolder was monitored over a period of more than 30 years. Monitoring was intensified during the last five years. Scrutinising the monitoring data, however, revealed that the waste had not polluted the groundwater in the surrounding 'marshy polder'. Somehow, the continuous peat layer surrounding the landfill acted as an impermeable natural barrier for organic contaminants. The deep peaty soil prevented the lateral and vertical spread of organic contaminants. This led to the conclusion that the Volgermeerpolder could be remediated without a complete isolation of the waste by means of a steel pile wall around the dumpsite and a bottom liner. In 2009, the decision made in the remediation plan (2000) to install an interception system was re-evaluated, and deemed no longer necessary. The installation of the top cover was sufficient, in combination with monitoring.

## REMEDICATION OF THE VOLGERMEERPOLDER

### **Remedial planning and design - the Eco-variant**

Around 1998 the remediation of the Volgermeerpolder received a new stimulus. The so-called 'eco-variant' was developed. The eco-variant had the following specific aims: (1) preventing contact risks, (2) prevention and control of waste spread, and (3) creating conditions for developing natural wetlands. The original remediation plan opted for a standard cover with soil and HDPE foil in order to prevent contact risks and risks of waste spread. It also included the implementation of a buffer zone surrounding the landfill for groundwater monitoring. This to enable timely detection of the spreading of contaminants.

The Advies Combinatie Volgermeerpolder (ACV)<sup>1</sup> started remedial planning and design for the Volgermeerpolder in 2001. In addition to the remediation of the polder and adjacent areas, this included the structural design of a rehabilitated landscape, including 59 sawas (shallow ponds) with the purpose to eventually create a new and natural wetland.

### **The standard cover**

The remediation of the Volgermeerpolder started in 2005, with covering the landfill with various surface sealing layers. The first layer consisted of soil (that became available from large-scale excavation works in the region), which was then covered with an HDPE liner. On top of this HDPE liner a second soil layer was placed. The existing waterways were also covered with HDPE liner and soil. On the 60 hectare wet low-lying areas a wetland was created by making a system of shallow ponds – 59 sawas and existing waterways – with embankments on top of the soil/HDPE cover. The remaining 40 hectare was considered a dry area. As part of the remediation a buffer zone is created around the Volgermeerpolder in which the groundwater quality was (and still) is intensively monitored.

The result of the groundwater monitoring before remediation was confirmed during the actual remediation of the Volgermeerpolder. The groundwater in the buffer zone showed virtually no spread of contamination. The surrounding peat soil inhibited the spread. This led to the conclusion that the chemical waste, unintentionally, was dumped in a very favourable place.

The standard cover on the Volgermeerpolder was completed in 2010. The remediation was followed by a management phase, which is currently ongoing. The standard cover, however, has a limited life span between 50 and 100 years. The remediation plan described the aftercare that is necessary after a period of approximately 30 years: replacement of half of the standard cover (50 hectares). A large scale replacement would again require considerable effort and resources, cause considerable nuisance for those living nearby, and have a negative impact on redeveloped flora and fauna.

## **NATURAL CAPPING**

### **Introduction of the ‘natural cap’**

To avoid replacement of the standard cover, ACV developed a new concept: the ‘natural cap’. This concept consists of a gradual, functional replacement of the standard cover (of soil and a synthetic liner) by a natural layer of living, organic material.

The ‘natural cap’ is considered a sustainable and durable solution and a surprisingly simple and effective concept with great potential for landfill remediation. It is based on the fact that one can use the time after remediation - the management phase - to create an alternative for the replacement of the standard cover, which is the case for every isolated landfill site.

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<sup>1</sup> Advies Combinatie Volgermeerpolder is a consortium of Witteveen+Bos and Tauw. More information can be found on [www.naturalcap.eu](http://www.naturalcap.eu).

## **A natural cap of ‘peat’ on top of the Volgermeerpolder**

The ‘natural cap’ on top of the Volgermeerpolder is created during the management phase (> 2010) by actively stimulating peat growth in the sawas of the wetland. Peat grows naturally and has added value for the development of nature. Peat is known to have a low permeability for water and works as a natural carbon filter for organic contaminants. It is therefore expected that a peat-layer in the sawas will contribute significantly to reducing the risk of spread. In the long run, the developed peat layers in the wetland system will take over the impermeable function of the HDPE liner. Consequently, the HDPE liner does not have to be replaced anymore.

## **Lessons learned – integration of design, remediation and management**

One of the lessons learned during the remediation of the Volgermeerpolder is that further integration of design, remediation and management is necessary to make a wetland less sensitive to nutrient loading. Because of the agricultural use of the surrounding polders and the high nutrient load, the water from outside the Volgermeerpolder is not suitable for use in the sawa system. For the wetland, the ideal situation would be a system fed only by rainwater.

Almost at the end of the remediation of the Volgermeerpolder it is necessary to take a critical look at the surface layer and the quality of the applied soil in the sawas. To prevent a negative influence on the quality of the surface water in the new water system, the amount of nutrients in the soil in direct contact with the surface water should be limited. Depending on the soil quality, measures might be necessary to keep the nutrient loading from the surface soil under the critical nutrient level for specific parts of the system to keep a sufficient water quality for the formation of peat.

## **The long term development and validation of the natural cap**

The challenge after remediation is to manage the area in such a way that peat can form on the clean surface layer or a peat bog can be transplanted and maintained in the sawas. Time is required for forming a sufficient layer of organic material that can take over the environmental, physical and hydraulic functions of the HDPE liner. To answer the main question whether the peat layer eventually is sufficient for taking over the functions of the HDPE liner validation is necessary.

To validate the ‘natural cap’ as a sustainable solution, the processes that are involved, particularly in the boundary layer between the landfill and the surrounding peat soil need to be understood. In this respect the question as to whether a peat layer is capable of sufficiently buffering the spread of contamination is particularly relevant. In cooperation with the Centre for Wetland Ecology<sup>2</sup> and the City of Amsterdam, ACV is conducting further research to continue the development of the ‘natural cap’ concept, and further optimize the design for the Volgermeerpolder.

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<sup>2</sup> The Centre for Wetland Ecology is a partnership of the Netherlands Institute of Ecology (NIOO-KNAW), Radboud University Nijmegen (RU), Utrecht University (UU) and the University of Amsterdam (UvA). More information can be found on [www.wetland-ecology.nl](http://www.wetland-ecology.nl)

## CONCLUSIONS

### **The natural cap, an example of green remediation**

The 'natural cap' is a surprisingly simple and effective concept with great potential for large scale land remediation. It is considered a sustainable and effective alternative for a standard remediation and thus a valuable contribution to the cost-effective remediation of a lot of landfills in the Netherlands and abroad, but also for mine tailings.

The peat landscape that will arise over the years on the Volgermeerpolder is very attractive from a landscape point of view. The landfill will fit in the surrounding Dutch landscape and fulfill recreational purposes. With the development of peat also significant amounts of CO<sub>2</sub> is captured. Furthermore, the creation of this new wetland will provide scientists knowledge about peat development, which can provide answers to stop degeneration of peat and consequently the lowering of the soil surface. Natural capping with peat is therefore, not only an innovative and cost-effective ecological remediation method, but might also be a 'natural' answer against climatological effects. When in the long run the 'natural cap' on top of the Volgermeerpolder replaces the functions of the standard cover, it also avoids considerable future costs and the disruption of newly developed nature.