LIFE+ project Vopak ExperO3

Newsletter nr. 4 – August 2015

Abstract

At the Vopak Terminal ACS a soil and groundwater contamination with chlorinated aliphatic hydrocarbons, BTEX and petroleum hydrocarbons is present. The contamination is being treated by means of in situ remediation using ISCO since April 2013. The first phase of the in situ remediation, regarding the former drum storage area, was successfully completed in November 2013. The second phase, focusing on the source area around the former excavation zone, is on-going since then. Due to emission issues, the remediation works were temporarily halted begin 2014. Field emission tests were carried out and, based on the results, optimal injection regimes that eliminate emissions were defined. Also, the liquid tight concrete cover was restored. The injections have been resumed in June 2014. At the same time, the treatment of the plume area in the midway was initiated. Beginning 2015, less than 9 months after the injections have started, the remediation targets were reached in certain areas of the midway. Injections in these areas have been stopped. Since March 2015 injections in the small source area in the tank farm are started.
The remediation is now ongoing in and around the former excavation zone, in a part of the midway (close to the tank farm) and in the small source area of the tank farm. It is planned to initiate the last phase of the remediation, the perozone injections in the large source area in the tank farm, next month (October 2015).

Project description

Given the different physical and chemical characteristics of the contaminants in the soil and groundwater at the Vopak terminal ACS, remediation using traditional techniques would result in a time-consuming and expensive process. ISCO therefore offers a promising alternative for the simultaneous remediation of a cocktail of organic contaminants. With this technique, an oxidant is injected in the subsoil, causing oxidation of the contaminants into harmless products. Perozone, a mixture of hydrogen peroxide and ozone, is capable of oxidizing all types of organic contaminants.

Since the presence of strong oxidants causes major issues with regard to health and safety on explosion sensitive (EX-rated) sites, the development of an extensive health and safety plan and continuous monitoring of health and safety parameters during the remediation activities are of prime importance for the project.

This LIFE project focuses on a cost efficient, energy efficient and environmental advantageous innovative remediation technology that can be the solution for in situ remediation of complex contaminations in industrial and high risk areas where it is usually difficult and expensive to remediate using traditional techniques.

Remediation progress

The initial remediation concept comprises a combination of excavation, ISCO and MPE, as shown in the map.

Since the start of the in situ remediation works, some changes have been made to the original concept. As the MPE was shut down due to environmental permit issues, the contamination is now being treated by only ISCO combined with SVE.

Currently, the remediation targets are reached in the former drum storage and in parts of the midway. The remediation is ongoing in the area in and around the excavation zone (where concentrations have already drastically reduced), in the area of the midway close to the tank farm an in the small source area in the tank farm.

This is also visualized in figure 1.

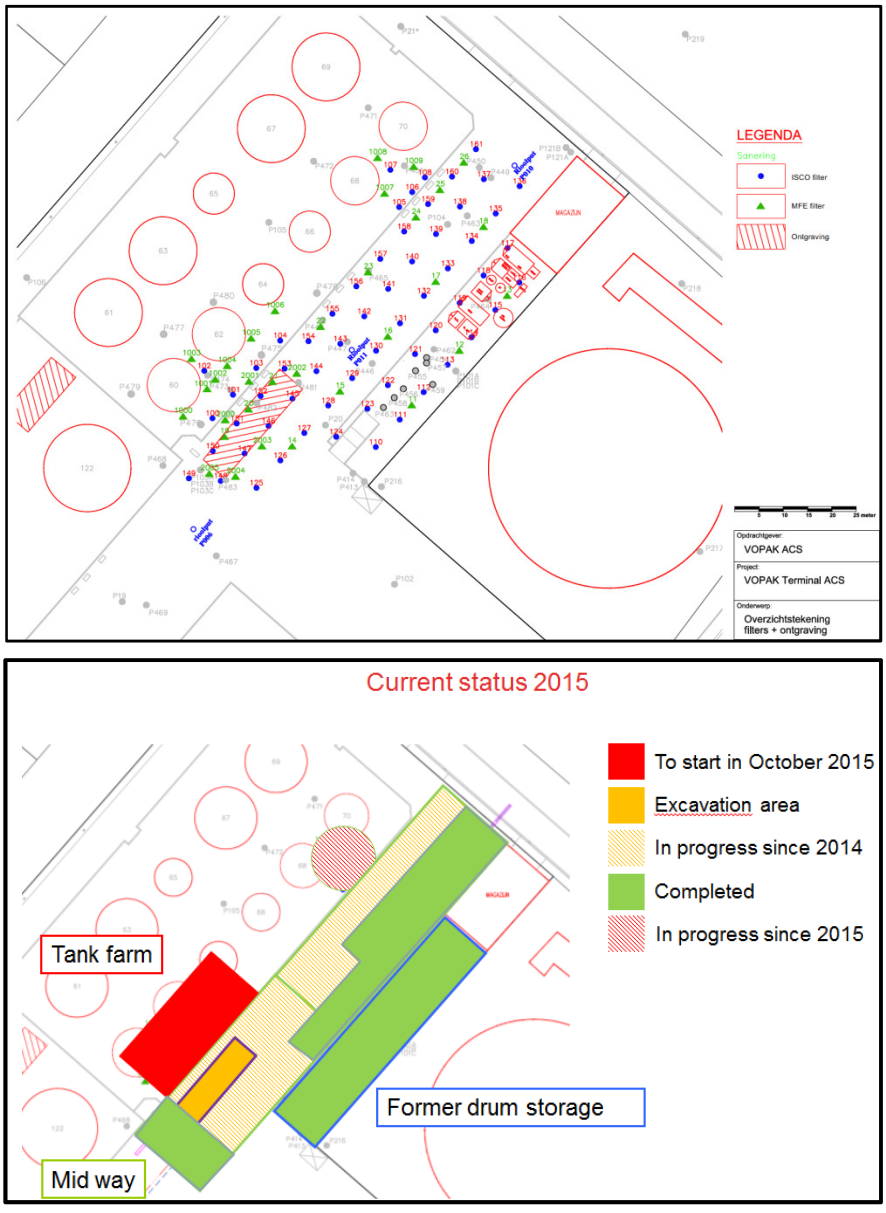


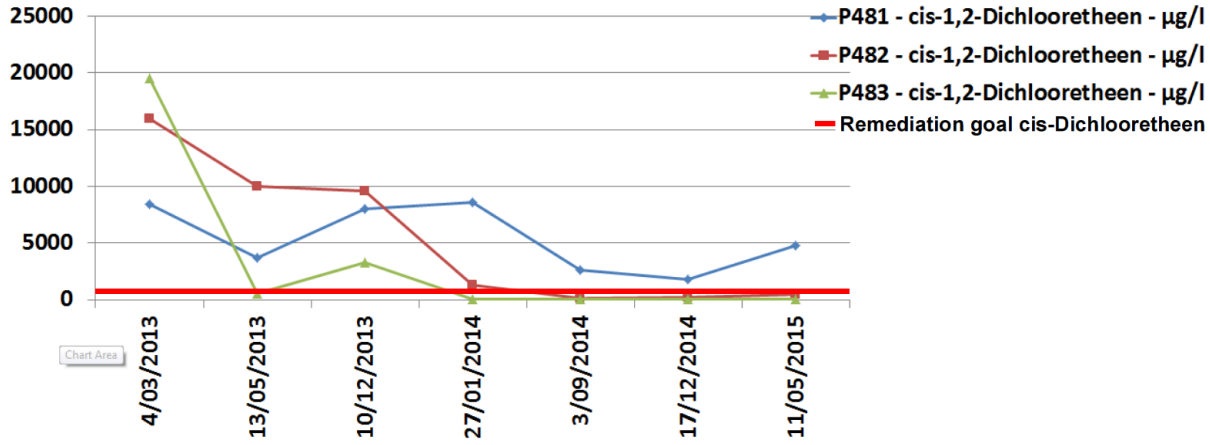
Figure 1. Remediation concept and overview of the remediation progress.

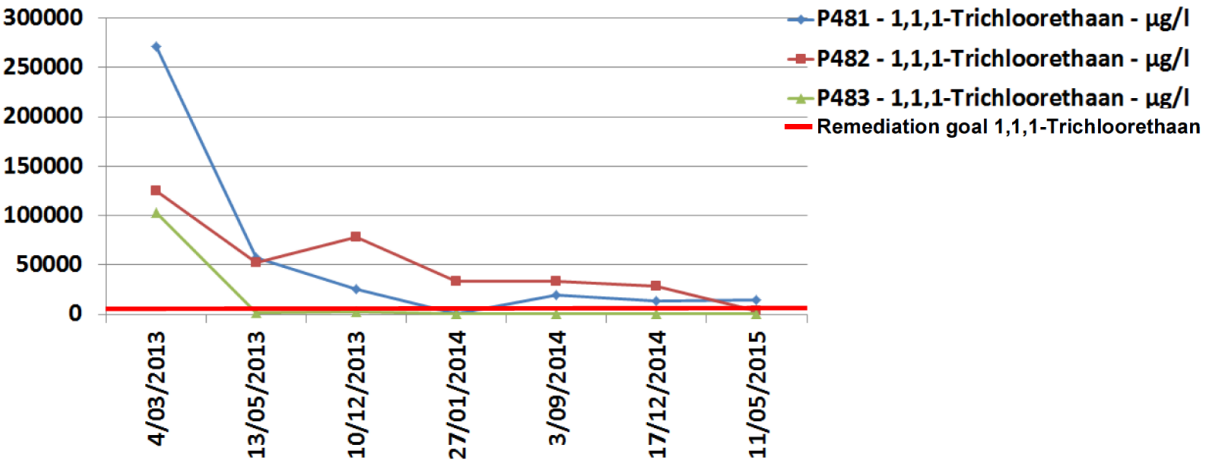
Source area “excavation zone”

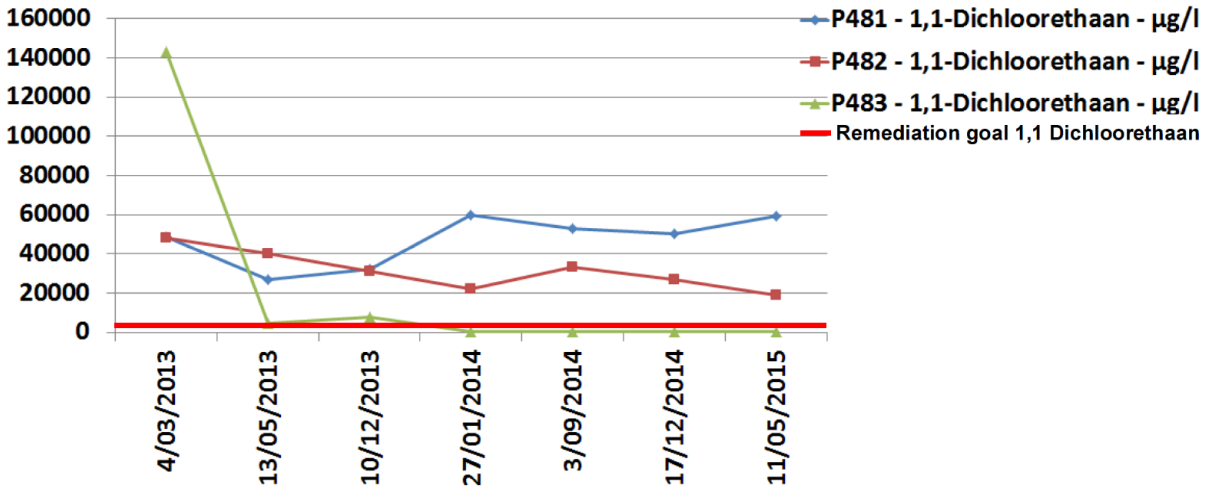
The in-situ remediation using ISCO combined with SVE (soil vapour extraction) in the source area near the excavation zone was started in November 2013. Only ozone is being injected instead of perozone, in order to test the effectiveness of ozone as a sole oxidant in source areas with a high contamination load.

Monitoring results

The evolution since 2013 of groundwater concentrations of the most important contaminants is illustrated in the charts below. The red lines indicate the remediation goals as defined in the remedial action plan. Each graph shows the evolution of one contaminant for the three monitoring wells in and around the excavation zone.







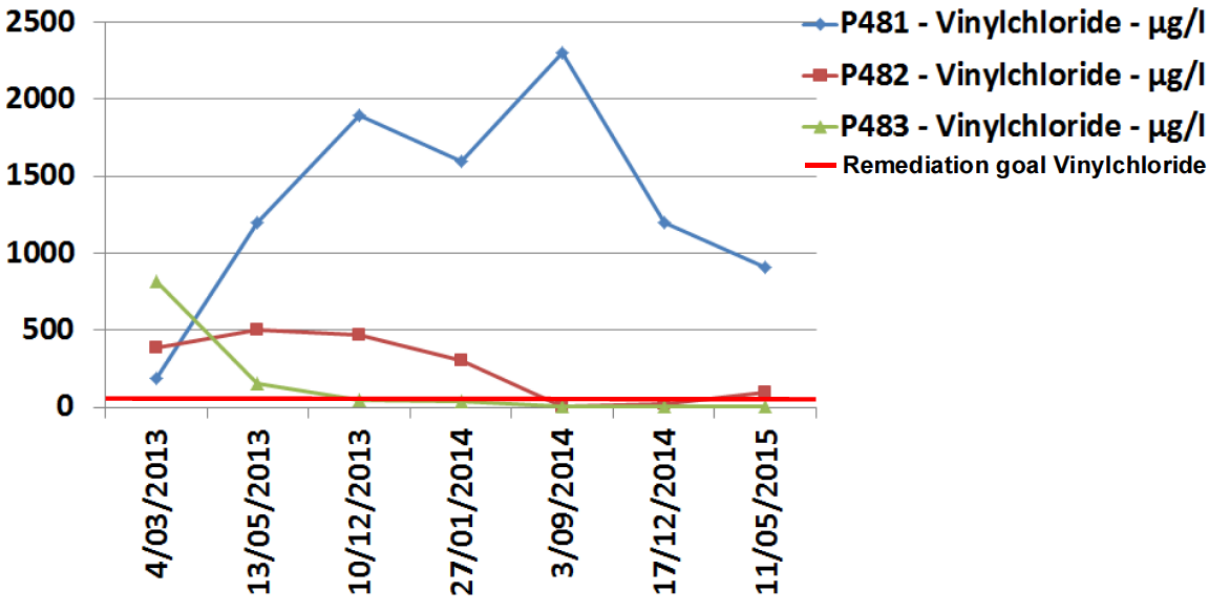


Figure 2. Charts showing the evolution of groundwater concentrations in the monitoring wells during the in situ remediation in the source area around the excavation zone.

Since the start of the remediation beginning 2013, the results can be considered spectacular. An initial strong decrease after the excavation was noticed in the 3 monitoring wells. After a more or less stable period between end 2013 and end 2014 a further decline is obtained for most of the parameters in wells 481 and 482. Only the chloro-ethanes still stay more or less stable. In P482 the remediation targets for all contaminants, except 1,1-DCA and vinylchloride, are reached. The contaminant concentrations in the groundwater around P481 is still high (especially for 1,1-DCA), but has over-all already decreased with about 90% compared to the initial concentrations of beginning 2013. It was expected that the concentrations would stabilize at a certain (high) concentration as long as a high mass is present in the soil (as pure product). At a certain moment, when the mass load and hence the dissolution rate will be reduced enough, the groundwater concentrations will decrease (more strongly).
The third well (P483) shows a spectacular improvement shortly after the excavation. A few months after the ozone injections started the remediation target values were reached, Based on the results of the monitoring events of September and December 2014, the perozone injections around the area of P483 are stopped. The groundwater monitoring of May 2014 confirmed that the concentrations remain stable and that all remediation target values are met, even after Perozone injections were stopped.

Emissions

After the renewal of the concrete floor no more emissions towards the atmosphere have been noticed.

Plume area midway

The remediation target values have been reached in the monitoring wells near the former drum storage area (P446, P449 and P463A). Based on the results of the monitoring events of September and December 2014, the perozone injections in the Midway along the former drum storage are stopped (see Figure 1).
The low groundwater concentrations measured in the monitoring well P463 in May 2015 confirm that the remediation target is reached in the area around this well and no rebound occurs after Perozone injections were stopped.

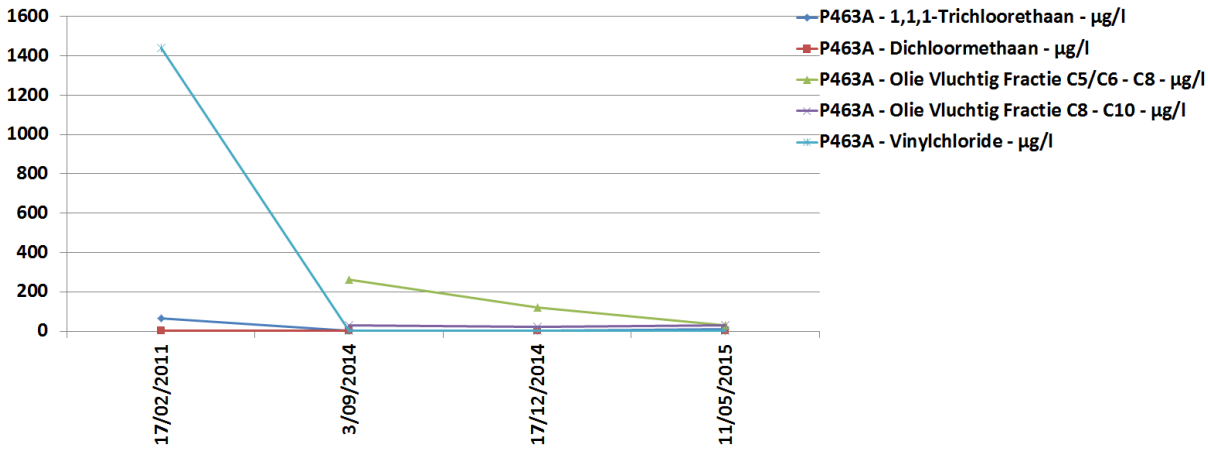
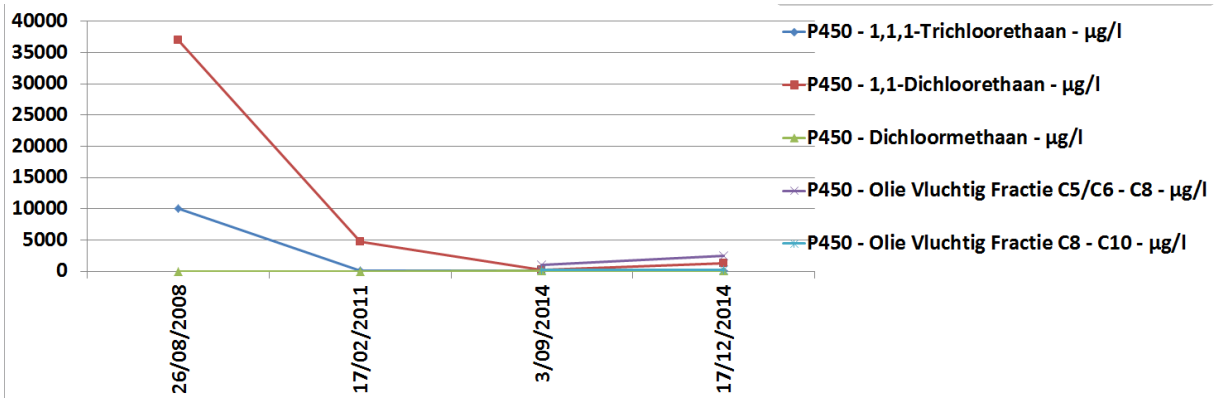


Figure 3. Chart showing the evolution of groundwater concentrations in monitoring well P463A during the in situ remediation (plume area midway).

In the monitoring wells along the tank farm (P447, P448, P450 and P465) the remediation target values are reached for almost all contaminants except for volatile TPH in most wells and chloro-ethanes in P448 and P465. In P448 1,1-dichloroethane and 1,1,1-trichloroethane have increased (unexpectedly). This needs to be checked in the next monitoring event. P450 has not been sampled in 2015 because the remediation targets were reached in September 2014.



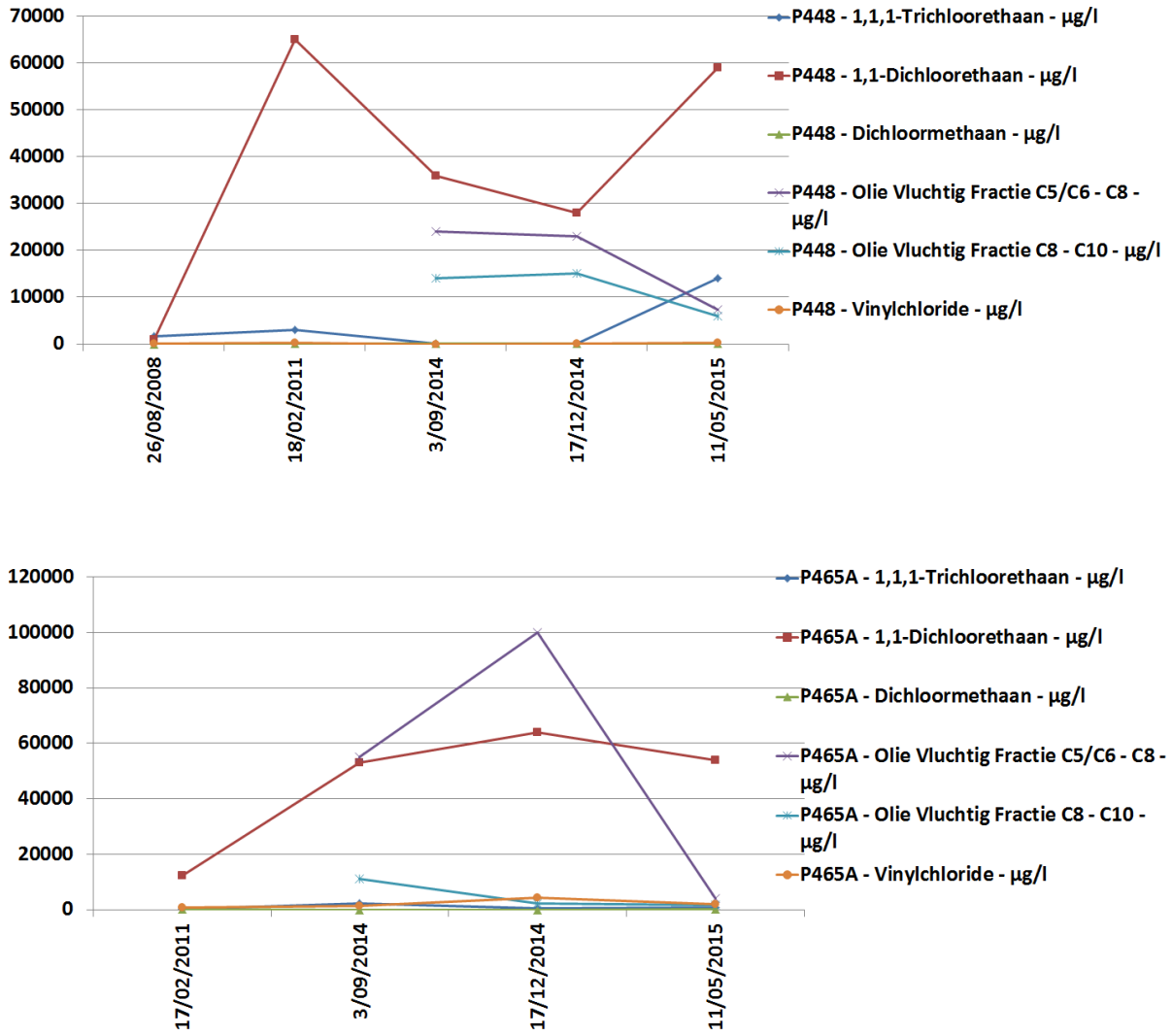


Figure 4. Charts showing the evolution of groundwater concentrations in the monitoring wells during the in situ remediation in the plume area midway.

Emissions

During the Christmas holiday period an ozone odor was detected near the container of the soil vapor extraction system. There was also a strong sound inside the container. The injection system was stopped immediately and the extraction system was turned off a little later (to ensure that all possible ozone emissions could be captured).

The cause of this ozone odour has been investigated and identified. The blowers of the SVE installation inside the container were no longer airtight due to corroded seals. The 4 blowers have been replaced.
As a consequence of this occurrence, the inspection frequency has been intensified from two times per month to weekly.

End February 2015, the injections have been restarted in the Midway. The ozone concentration in the extracted soil vapour was increased (0,05-0,5 ppm). The injection wells have been tested individually and these tests showed that the elevated ozone concentrations were caused by some individual wells. Fortunately these wells were located in areas where the remediation target was (almost) reached and they have been bypassed. At the same time, also well-functioning injection wells that are located in areas where the remediation targets have been reached, have been bypassed. After this adjustment, the ozone concentrations in the soil vapour extraction decreased again to the normal low values. The ozone concentration will be monitored more intensely in the first period after the restart.

Small source area in the tank farm

Preparation

End 2014 phase 3, the remediation by ISCO of the small source area in the tank farm, has been prepared. One of the main risks in the tank farm is the corrosion of the tank floor due to ozone emissions. The tank farm itself is liquid tight but the storage tanks are built on a foundation of stabilized sand and hence the tank floors may come in contact with ozone.

Two soil vapor monitoring wells have been installed in the tank farm. The 2 wells are installed just next to the two storage tanks that are situated in the injection influence radius. Possible ozone emissions should be captured by the vertical soil vapor extraction wells/MFE-filters (1007-1009) situated around the injections wells (see figure). The efficacy of this system will be monitored by the two soil vapor monitoring wells. If ozone concentrations or increased oxygen concentrations are detected in the vapor monitoring wells, the injections will be stopped immediately and additional actions have to be implemented to prevent contact of ozone with the tank floors.

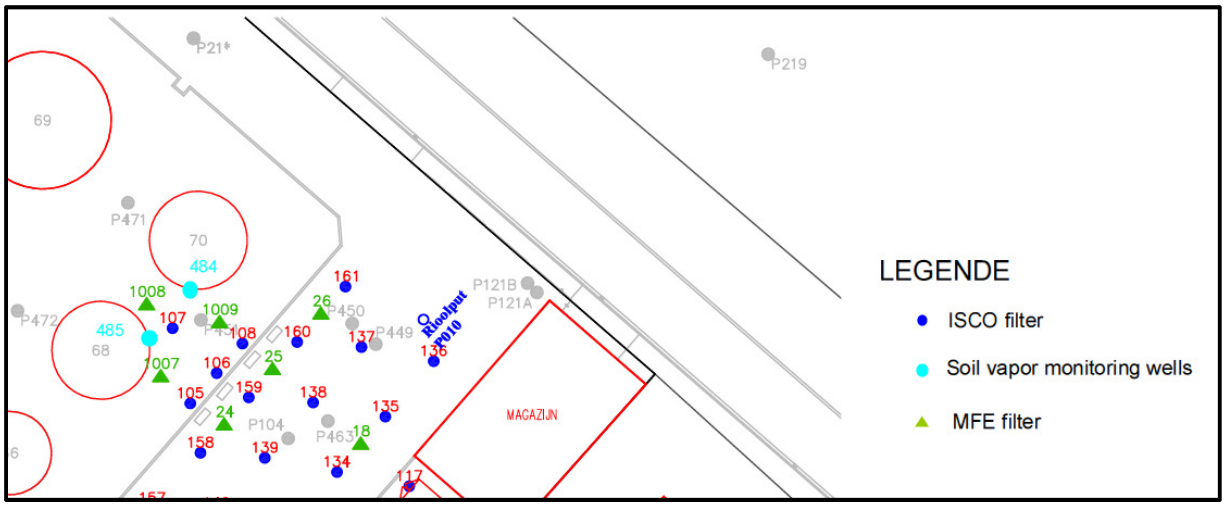


Figure 5. Indication of the positions of the soil vapor monitoring wells in the tank farm.

Start up

Since a safe situation was observed and confirmed during the injections in the Midway the remediation of the small source area in the tank farm started in the beginning of March 2015. As a first step the soil vapour extraction was started via vertical wells in the tank farm and the extracted air was monitored for 4 days. As a second step, air (without addition of perozone) was injected and all process and safety parameters were closely monitored during 48 hours.
The monitoring of the air injections showed that the soil vapor extraction system worked properly and that no emissions are expected. So the perozone injections in the small source in the tank farm were started.

Monitoring results

After only 2 months of injections in the small source area of the tank farm (P451) the concentration of volatile total petroleum hydrocarbons has decreased remarkably. The chloroethanes and chloroethenes remain more or less stable.

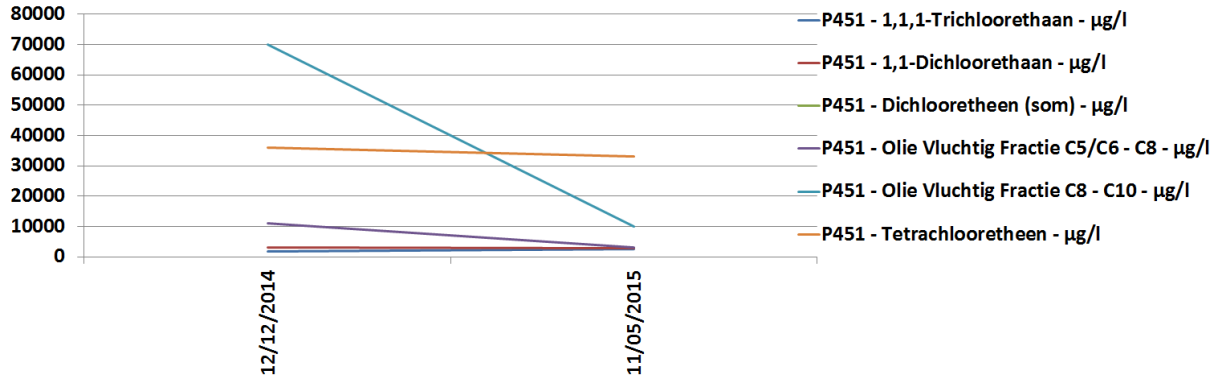


Figure 6. Charts showing the evolution of groundwater concentrations in the monitoring wells during the in situ remediation in the small source area in the tank farm.

Next steps

The injections in the excavation zone around P481 and 482, in the Midway along the tank farm and in the small source area in the tank farm will be continued. The injections in the large source area in the tank farm will be prepared and started in October 2015. New tests will be conducted to investigate if the injection regime in the different areas can be increased without causing emissions in order to accelerate the remediation.

The next monitoring event is scheduled in November 2015.

Project presentation at international conferences

In the summer of 2014 the Life project has been presented at the 9th European Conference on Ecological Restoration in Oulu, Finland.
In June 2015 the project project has been presented at the 13th International UFZ-Deltares Conference on Sustainable Use and Management of Soil, Sediment and Water Resources in Copenhagen, Denmark.
The abstracts of the presentation and the slide packs can be found on the website www.vopak-experO3.be under "Publications".

Figure 7. Project presentation at international conference in Oulu, Finland.

More information

More information can be found on the project website www.vopak-experO3.be.