TDP 12 - Bioremediation of the Coke Works and Former Colliery at Askern, Doncaster

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Executive Summary

Askern Colliery is located in the town of Askern, approximately 10 miles north of Doncaster, South Yorkshire.

Askern Colliery was a derelict colliery and coke works, consisting of two shafts with the associated process and ancillary installations. The site was identified, with many other colliery sites in Yorkshire during the 1980s, as requiring redevelopment to encourage local economies and prosperity. The responsibility of the redevelopment was placed with the relevant regional development agencies. Askern Colliery fell under the jurisdiction of Yorkshire Forward.

Many of the former colliery sites have severe soil and groundwater contamination issues and this was also the case at Askern. The coke works closed in 1986 and the colliery shortly afterwards. Geotechnical and contamination investigations commenced in 1993. The contract for the remediation of the site was tendered in 2001 and was won by Mowlem Remediation. The consultant engineer was Carl Bro Group and the bioremediation was carried out by Ecologia Environmental Solutions.

The general geology of the site was reported as being deposits of made ground which are over thin lenses of drift deposits of glacial sand and gravel which are underlain by solid deposits of marl and magnesian limestone.

Prior to the bioremediation of the contaminated soils, the contaminated area was mapped and investigated by Mowlem to allow the accurate segregation of the materials at the site. This had the effect of reducing the volume of material requiring treatment or disposal from an estimated 52,000 m^3 to 24,000 m^3.

Aerial view of the two biopiles at Askern

Bioremediation was selected as an appropriate technique to remediate the contamination at the site, which was predominantly made up of hydrocarbons. Bioremediation is the use of bacteria to metabolise hydrocarbon contamination and is employed in a variety of technologies. The type of bioremediation used by Ecologia at Askern was biopiles.

Biopiles are static, engineered, soil piles which have aeration lines installed to facilitate the active transfer of gases through the soil, thereby providing oxygen for the bacterial population. At Askern the aeration was induced with a vacuum blower.

The biopiles were constructed on an impermeable base formed from colliery spoil which was present at the site. The nutrient content and moisture content of the contaminated soils were adjusted during the formation works and the biopiles were then covered to prevent saturation. Proprietary bacterial products were not added, as the biopiles were designed to remove limiting factors for the bacterial population present rather than replace it.

Side of the biopile showing aeration pipes

Composite samples of the contaminated soils were taken during the formation works to provide a contamination baseline and subsequent samples were taken every four weeks for the twenty week duration of the project. For sampling purposes the 22,000 m^3 of soil undergoing treatment were sub-divided into 1,000 m^3 lots.

The gases within the biopiles were monitored on a weekly basis. The gas monitoring showed that the oxygen content, and therefore the biodegradation within the soils, is highly dependent upon the active aeration system. The monitoring also showed that very few volatile hydrocarbons were lost during the project.

The chemical analysis revealed that 20 of the 22 lots achieved the risk assessment target values. Two of the lots remained above the 1,000 mg/kg target for total petroleum hydrocarbons (2,600 mg/kg and 1,800 mg/kg) and were placed in a part of the site over marl bedrock to comply with the risk assessment.

This project has demonstrated that bioremediation can be shown to remediate hydrocarbon contaminated soils. Careful monitoring can allow the process to be controlled and validation data produced.

Conclusions

The biopiles that were designed, constructed and operated by Ecologia Environmental Solutions Ltd at Askern Colliery were designed to conform to the basic principles of removal of limiting factors while retaining control of the process. The data contained in this report show that it is possible to monitor the system in various inexpensive ways, such as temperature and gas monitoring, so that potential problems can be identified and the process can be studied. When the monitoring is coupled with the standard chemical analysis of the contaminants it is possible to demonstrate the bioremediation of the hydrocarbons. For instance, combining process monitoring of gases with chemical analysis of the soil will demonstrate the fate of the volatile organic compounds (VOCs). The implementation of a vacuum aeration system allows the amount of VOCs to be quantified. The system which Ecologia built inhouse allowed the airflow to be kept to a minimum thus reducing the volatilisation. The biopile system also allows the implementation of a VOC abatement system, as all the exhaust is emitted from a single pipe, therefore, off gases can be easily passed through a biofilter.

The analysis of the gases within the biopile enabled Ecologia to undertake respiration tests to assess the level of biological activity. The tests showed that there was a rapid production of carbon dioxide and utilisation of oxygen, consistent with an active aerobic bacterial population.

Although the project demonstrated that it is possible to achieve the effective bioremediation of contaminated soils through careful monitoring of the process, it did not conclusively show that bioremediation is an effective remediation option for the removal of polycyclic aromatic hydrocarbons (PAHs). Although the PAH concentrations declined during the treatment, they were already below the target concentrations at the start of the project.

Other problems which became apparent during the project were the weather and vandalism, both of which had a large cost implication. One problem which was identified following the first heavy rainfall event was

that the bio-treatment area of the site did not have adequate drainage for surface water. On several occasions the treatment system had to be switched off due to flooding, the main concern of which was the contact of the surface water with the contaminated soil, thereby contaminating it. On several occasions high winds caused some of the covers to be blown off the biopiles which left the soil beneath exposed to the rain. Extensive damage caused by vandalism and theft was encountered during the biopile formation works that necessitated the employment of night time security.

Overall the project has shown that successful bioremediation is possible given the correct planning and design. An important part of this design is a good system of excavation and sorting of the contaminated material. This is especially important at sites such as former coking works where non-biodegradable material such as coal tars exist. The fact that the majority of the material selected for bioremediation at Askern Colliery contained relatively few PAHs is testament to the success of the excavation programme implemented by Mowlem, which was in turn vital to the success of the bioremediation, as the inclusion of material which is not biodegradable leads to the failure of bioremediation. This was experienced to a certain extent at Askern in the cases of Lots G and H, which did not reach the target concentration for total petroleum hydrocarbons and required special risk assessment, and subsequent agreement from the Environment Agency before the material included in these lots could be incorporated into the earthworks programme at the site. With the exception of Lots G and H the bioremediation at Askern was successful and the monitoring programme implemented by Ecologia has shown that it is possible to monitor large bioremediation projects using inexpensive, quick methods that do not require a large amount of laboratory analysis.

Lessons Learned

1. The excavation programme is vital to the success of the bioremediation programme. A poor excavation programme with no planning or material segregation will lead to non-biodegradable material, such as coal tars, being included in the material due for treatment, and ultimately the failure of the treatment system.

2. Inexpensive and rapid monitoring of the temperature and gases allow the bioremediation to be monitored on a daily basis which can predict problems, identify the end point and provide data to verify the process.

3. Bioremediation using biopiles allows the control of potentially polluting effects of bioremediation such as leachate formation and VOC loss to atmosphere to be effectively monitored and controlled.

4. The waste management licensing system can be used effectively. It was possible to gain approval of a site-specific licence within one month of submission through preplanning and a good understanding of what is required in a site-specific licence document.

5. Severe problems can arise from adverse weather conditions. Adequate systems for the collection and removal of large amounts of rainwater are required and this should be included in the pre-project planning. A site may require discharge consents to be sought from the Environment Agency in the case of a discharge to a controlled water or the local water company in the case of discharge to foul sewer.

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