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TDP 9 - Design, Installation and Performance Assessment of an Air Sparge Curtain System

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Executive Summary

The study site is a 0.7 hectare former coal-gas manufacturing works (1850 - 1964) located in the northwest of England. The site has been extensively characterised, with principal contaminants identified as coal tars and other hydrocarbons present in both soil and groundwater. SecondSite Property Holdings (SPH) undertook a voluntary remediation programme to address historic contamination at the site.

Site geology typically comprises up to 2 m of made ground overlying 2 m - 10 m of silty sand above stiff red brown clay and silts. Groundwater flows in an easterly direction, with divergent flows on the eastern side of the site, the flow being to the northeast in the north of the site and to the southeast in the south of the site. Two water features to the east of the site, a brook and an area of low-lying marshy ground, were identified as potential receptors at risk from contaminants on site.

To address the risk to the receptors, a risk-based remediation strategy was adopted, comprising an initial source removal phase, followed by the installation of an air sparging curtain at the eastern site boundary. The sparge curtain acted as the treatment zone, removing contaminants from groundwater before it moved off site.

Air sparging is an *in situ* technique for remediating volatile and/or biodegradable contaminants within the saturated zone. Air sparging is a widely accepted groundwater remediation technology, because it can offer enhanced clean-up rates relative to groundwater pump and treat methodologies, and can be cost effective by comparison.

The air sparging curtain, consisting of 22 vertical air injection points, creating a linear treatment zone inside the eastern and northeastern site boundaries,

SVE extraction pipework laid horizontally

was combined with a soil vapour extraction (SVE) system to capture and treat off-gas. The integrated system was installed at the site in August 1999 and operated for over 3 years and was finally decommissioned in January 2003. The installation works were carried out under a Mobile Plant Licence granted by the Environment Agency (EA).

At the conclusion of sparging, performance criteria had been met at 13 of the 14 key monitoring locations. The system successfully removed, and appropriately treated, contaminated soil vapours from the subsurface, with the peak rates of contaminant removal occurring in the first week of system operation, and then rapidly declining thereafter. After 9 weeks of operation, all monitoring points had soil vapour contaminant concentrations below detection limits, and this was maintained for the remainder of the project. Over 80 % of the hydrocarbon mass removed by SVE was benzene.

The groundwater remediation criteria were achieved at most of the key locations in the zone of air movement within one month of system startup and contaminant concentrations remained below the target criteria for the duration of the project at most locations. Overall, target criteria were met on 155 out of a possible 168

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occasions since June 2000.
Results of the post-shutdown groundwater monitoring, carried out 4 months after conclusion of air sparging, showed that in the former northern plume area, key contaminant concentrations were below their respective remediation criteria. In the southern plume, exceedences of the remediation criteria were recorded at three locations. However, the groundwater modelling exercise used to develop the 1998 criteria has re-evaluated to incorporate anaerobic biodegradation processes, from which it was shown that, given current groundwater contaminant concentrations on site, concentrations of key contaminants at the southern receptor (the river) would be between 2 and 5 orders of magnitude below the UK Environmental Quality Standards (EQS) respectively.

Costs for the remediation project as a whole compare favourably with the other technically feasible remediation options considered. Estimated costs for remediation by excavation alone were approximately £1.1 M, whereas the air sparging project was completed at a cost of approximately £0.7 M, hence achieving a cost saving of approximately £400,000.

At this site, air sparging was a success from both a technical and financial perspective. As the Mobile Plant Licence regime was new, care was taken by both the operator and the EA to ensure that it was implemented correctly, although it is possible that legislation covering this type of system will be covered by the proposed Single Regeneration Licence (Remediation Permit Working Group, 2002).

Lessons Learned

Introduction

The overall project was successfully executed and completed on budget. However, certain elements required unexpectedly greater attention and effort to complete. The following comments represent issues which proved to be key, and are divided into regulatory, technical and financial issues.

Regulatory Issues

At the time of project conception, the current Mobile Plant Licensing (MPL) regime had not been introduced. Discussion with the EA at this initial stage concluded that the project could commence without an MPL, but that one should be pursued. Although an MPL was finally acquired for the air sparging system, this took longer than anticipated because the MPL regime was new both for the regulator and the operator, and care was therefore taken on both sides to ensure it was implemented correctly.

In situ remediation systems such as air sparging do not fit comfortably within the MPL regime. The MPL was originally conceived to cover the treatment of waste soil. Although air sparging can be said to have a positive impact on soil in the subsurface (contaminant mass is removed), it is not always implemented with this as the primary goal. It is possible that authorisations covering this type of system will ultimately be covered by the proposed Single Regeneration Licence (Remediation Permit Working Group, 2002).

Technical Issues

Site specific pilot scale testing was a crucial part of the project. Not only does pilot testing demonstrate whether sparging is applicable to site conditions, it also provides information which is immediately transferable into the design process (well spacing, treatment zone width etc). Pilot scale testing costs totalled approximately £25,000, which is 10 % of the total cost of the air sparging phase of the remediation.

The SVE system was a significant part of the mass removal process for the initial period of operation, but its importance diminished over time. It was operated for the duration of the project because vapour capture was a principal criterion in the Mobile Plant Licence although, with hindsight, operational costs could have been reduced if the SVE system was switched off when it was no longer needed, although this would have required negotiation with the EA as it would have constituted a departure from the agreed MPL conditions.

Financial Issues

A financial breakdown of the project is shown in Section 12. However, a number of cost issues are considered to be worth additional emphasis. Other than installation, the two greatest cost elements are operation and maintenance, and monitoring (35 % of the Phase II budget in total).

The operation and maintenance budget covered costs for replacement parts, scheduled maintenance visits and unscheduled visits to restart the system following automatic shutdowns. These costs can be minimised by robust design but should not be underestimated. The sparge system comprises a number of high cost items (sparge compressor, SVE pump, complex telemetry) and the system design successfully ensured that none of these items became irreparably damaged.

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