Risk management and contaminated land

A multi-phased approach

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MODERN landfill sites are well planned, well regulated affairs. The areas within which waste deposition is permitted are carefully engineered to mitigate the risk of pollution, while legislation requires that an environmental management plan be put in place to ensure the site is returned to something approaching its natural state when landfill operations are ended. Indeed, remediation efforts and monitoring schemes can bring beneficial results to the surrounding environment with long-term benefits for wildlife and recreational use of the restored site.

However, these controls are a relatively recent introduction. A legacy of landfill sites exists that were subject to few controls and inadequate monitoring. A study by SUFALNET, (a pan-European consortium formed to examine the possibility of sustainable use of former and abandoned landfills) estimates the number of closed landfills across Europe to be approaching 150,000.

The strategy developed by SUFALNET, based upon best practice from 12 European countries, advocates an approach based upon the concept of risk-based land management, in line with current environmental legislation. When assessing and managing any form of risk, the key to a successful outcome is to ensure the best possible information is acquired regarding the types of risk that might exist, so that any plan proposed is effective.

The following case study outlines investigations undertaken by Met Geo Environmental regarding a proposed development site where landfill was known to have taken place. A multi-phased approach was implemented which combined a range of investigation techniques. This produced a conceptual site model and a plan for managing the risk effectively to allow development to proceed on the site.

Phase 1 non-intrusive assessment and topographical survey

The investigation began with a detailed review of published historical, hydrological, geological and environmental information. A map regression exercise was undertaken, while Environment Agency data and geological data were reviewed to allow a determination of the potential for hazardous substances to exist on or near the site, and which might affect the future redevelopment of the site. Environmental and geological information was also examined to determine the underlying bedrock and presence of aquifers, in preparation for a hydrological risk assessment to be undertaken.

A topographical survey was carried out to provide an accurate base plan and levels across the site. A GIS approach was then used to overlay historic map data on to the topographic survey to determine exact areas where disturbance had taken place and made ground should exist.

This method of analysis revealed a complex history of land use and reworking on the site, with a number of developments taking place, the last being a brickworks which was present for approximately 35 years. During this time a series of clay pits was excavated in various parts of the site. All the pits were shown to have been infilled prior to 1984, although no information was available as to whether all or some of the pits had been used for landfill.

This analysis was carried out in order to allow the design of a detailed intrusive

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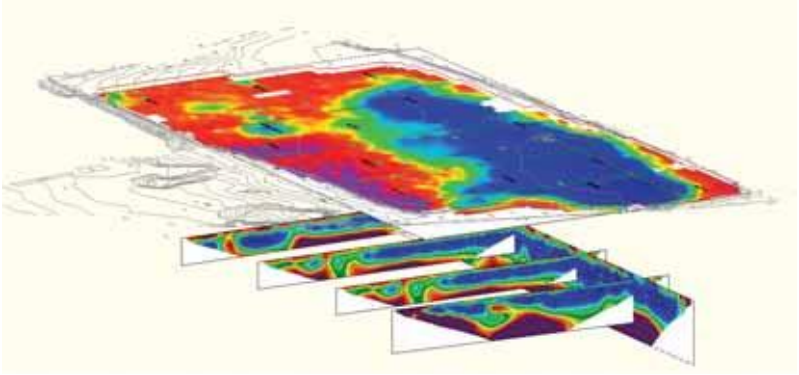
investigation to be carried out in phase II and targeting specific areas of the site. Because of the complex history and limited available information, a limited scope trial pit investigation was undertaken as an extension of the phase I assessment. Intrusive investigations as part of the phase I element enabled recommendations for founding stratum to be provided, allowing the developer an early insight into the redevelopment potential for the site. It also afforded a clearer picture of the different ground conditions present across the site.

At this stage, a number of questions remained unanswered. Landfill deposits had only been encountered in two of the 15 trial pits dug while the depth of the landfill in these pits could not be proven as it exceeded the maximum depth able to be excavated. A series of soil samples had been tested for contamination. However, it was not clear how the values obtained related to the different soil profiles existing on the site.

Benefits of non-intrusive geophysical investigation

In order to determine the proper extents and depth of the landfill, an extensive and costly borehole survey would have been required, as locations would need to be closely spaced to provide a good definition of the landfill. In the early stages of considering a site for development, this is not always a cost that can be justified. Rather than a borehole investigation, it was decided that a non-intrusive geophysical survey would provide the best value in terms of financial outlay versus information acquired. Geophysical techniques can provide for rapid reconnaissance of a site, with no requirement for any disturbance of the potentially contaminated deposits, thereby avoiding the risk of creating new contaminant pathways. However, geophysical techniques must be carefully chosen to suit site conditions, as not all techniques are effective in all situations. It is also important to consider the desired outcomes of a survey — if a method is used that is incapable of providing the information needed to answer the questions raised, then a geophysical survey has very little chance of success.



The electromagnetic survey locating the extents of the landfill.

In this instance an electromagnetic survey was conducted across the whole site and survey profiles using electrical resistivity tomography (ERT) taken in key areas. It was considered both techniques would be sensitive to the key target — the landfill deposits — while also being able to provide additional information.

The electromagnetic survey provided rapid coverage of the site and was able to locate the extents of the landfill. The ERT survey acquired vertical profiles of the sections, allowing the depth of the landfill within these areas to be ascertained. The ERT survey lines were located across existing trial pit locations to allow for a certain level of depth calibration to be obtained without the need for additional intrusive works.

Phase II: Intrusive investigation

The results of the geophysical survey clearly defined the extents of the landfill, and showed it was confined to a discrete area rather than the whole site. Due to the clarity of these results, the scope of the phase II intrusive investigation could be reduced, allowing the targeting of key features and areas with a high level of confidence. A total of five boreholes and an additional twelve trial pits were excavated across the site, the majority in areas away from the landfill. Following installation of the boreholes, a programme of gas and water monitoring was carried out. Settlement is always a major concern

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when landfill material is placed in the ground. A number of settlement monitoring positions were installed to assess site stability with precise levelling carried out at regular intervals.

Conceptual site model

The combination of geophysical information, intrusive investigation and monitoring works enabled a conceptual site model to be produced in accordance with the contaminated land exposure model. By considering the source-pathway-receptors model, an assessment can be made as to whether the source contamination can reach a receptor. The degree and significance of any resulting risk is then determined.

If any of these elements (i.e. source contaminant, pathway or receptor) are absent or can be removed, then there is no resultant risk. Working on the basis of a source-pathway-receptor model, a number of contaminant risks on the site could be disregarded based upon the results of the monitoring and targeted trial pits. Resultant risks to the end-user from old landfill could be classified as low.

This allowed the classification of the site into two parts:

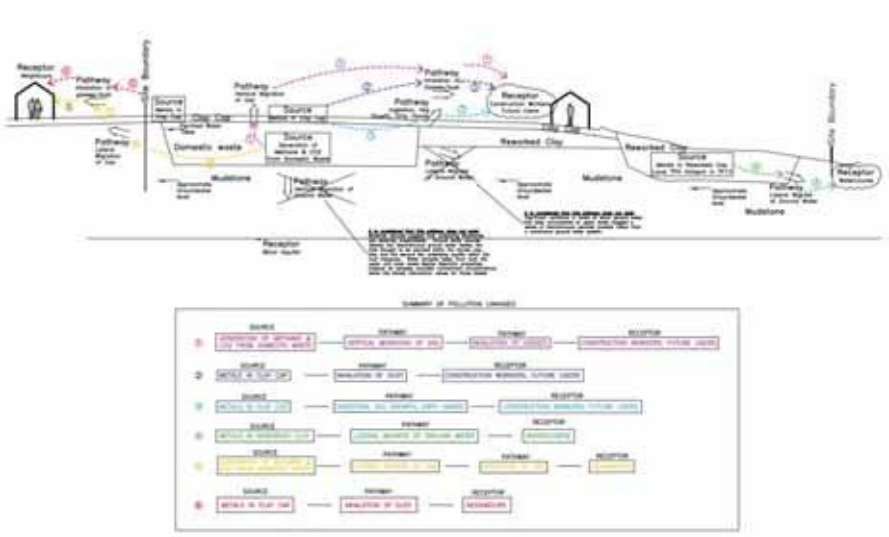
- An area suitable for development with minimal level of required remediation.
- The area previously used for landfill.

The remedial measures required for the first area could be outlined in full to allow a proper indication of the costs and timescales involved.

While only classified as a low risk, the cost of full depth remediation for landfill sites is often prohibitive. Having characterised the extent of the landfill, this area can be reserved as open space in any future development with good information available to the authorities on the nature of any associated risk.

Conclusion

A large number of former landfill sites exist across the UK and Europe. Many of these older sites were unregulated and operated as simple dumps, combining a wide variety of hazardous and non-hazardous wastes. These now constitute an unknown quantity with regard to potential contamination. Given the growing requirement to utilise brownfield sites in our urban spaces for the provision of new development, this unknown quantity can be a large and costly problem affecting developers and the public alike. Although local authorities and the Environment Agency compile registers of known and suspected sites, the precise scale and nature of these sites is often unknown. If information exists, it can often be inaccurate or misleading, making it very difficult to manage the risks and costs of any project involving the site.



The conceptual site model.

This case study illustrates the benefits of a combined and phased approach. From the starting point of a site about which little was known and considered a high risk, deploying a range of assessment and investigation techniques in conjunction with a risk management approach has provided a full site characterisation and a costed plan. The site has been transformed into a low risk option and a viable development opportunity.

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