



GIP determined that metallic pollutants (particularly lead and arsenic), total petroleum hydrocarbons [TPH], trimethylbenzene and polycyclic aromatic hydrocarbons [PAHs] were present in shallow made ground at concentrations that potentially posed a risk to human health. In the eastern part of the site a TPH concentration of 16,200 mg/kg was noted (in close proximity to the River Rea).

GIP also determined that TPH and PAHs were present in groundwater at concentrations which potentially posed a risk to controlled waters. TPH and PAHs were identified at maximum concentrations of 26,400µg/l and 1,250µg/l respectively. Other pollutants were present at concentrations marginally above the generic screening criteria for protection of controlled waters.

There was no recorded historical activity on the site to indicate the source of the contamination. It is understood that there is an offsite TPH contamination source migrating onto the site and that the TPH contamination may also be due to the site being previously utilised as a vehicle parking area. The PAH and metal contamination is assumed to be associated with imported fill material historically used on-site for level raising purposes.

Remediation Objectives

Enviro-treat were commissioned by Mansell Construction Services Limited [Mansell] to undertake the following:

1. Formulation and approval of a remediation strategy to satisfy both planning and EA requirements
2. Management and implementation of an integrated remediation strategy comprising of both source and pathway treatment to protect human health and controlled water receptors. The prime controlled water receptor is the River Rea on the eastern boundary of the site

Site Background & History

The site is located within the grounds of Warwickshire Cricket Club in Edgbaston, Birmingham and occupies 0.45 hectares. The site is bounded to the north by residential properties, to the south by buildings / stands and to the west by a grassed area of land belonging to WCC. The eastern side of the site is bounded by the River Rea, which is 2-3m below the level of the site.

The site has planning permission for the development of residential properties – this is the first phase of the overall development which will comprise of 79 three and four bedroom houses.

GIP had previously carried out site investigations which confirmed the presence of elevated hydrocarbon and metal concentrations in both soil and groundwater in excess of generic screening criteria.

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3. Excavation and treatment of contaminated soils and associated groundwater by E-Clay Stabilisation (source treatment)
4. Design and installation of an E-Clay permeable reactive barrier to treat contaminated groundwater migrating off the site in the direction of the River Rea (pathway treatment)
5. Management (and implementation) of the reuse of treated and validated soils on site – soils to be reused as a substitute for imported fill
6. Environmental monitoring during the remediation works
7. Preparation and submission of a comprehensive validation report to satisfy the requirements of the Council and the EA.

Methodology

Enviro-treat produced a Method Statement outlining the site history, contamination issues, proposed remediation strategy & technical rationale, environmental protection measures required during remediation works and validation protocols for the treatment element of the works.

Approval was obtained to undertake the proposed remediation works following a consultation period with Birmingham City Council and the Environment Agency.

The first phase of the remediation works involved the excavation and subsequent *ex-situ* treatment of contaminated soils and associated groundwaters from contamination ‘hot-spots’ on the site (as previously identified by GIP).

Four distinct ‘hot-spots’ were identified - three of these hot-spots comprised of primarily soil contamination; the other ‘hot-spot’ comprised of primarily groundwater contamination – this ‘hot-spot’ was excavated by Mansell due to the proximity of known live services.

The excavated soils from this ‘hot-spot’ were assessed by Enviro-treat and considered not to be contaminated. The contaminated groundwater within the excavation was collected and utilised within the treatment process (it was estimated that 10,000 litres of contaminated groundwater was utilised and treated).

The three remaining ‘hot-spots’ were excavated and validated by Enviro-treat to demonstrate effective source removal (by sampling / testing the sides and bases of each excavation). A clinker type material was encountered within each ‘hot-spot’ (see Figure 1 below) – this material typically exhibited a strong hydrocarbon odour (in the surface layers i.e. 1.0-1.5m bgl). No free phase product was encountered during the excavation works.

Figure 1 – Clinker Type Material



The excavated materials were treated by E-Clay Stabilisation and reused on-site following successful validation - the treated materials were redeposited within the voids created by the excavations.

The E-Clay Stabilisation Process utilised a site-specific formulation of E-Clay and cementitious materials.

Approximately 200m³ of contaminated soils were excavated, treated and re-used on site. The treatment area is shown in Figure 2 below.

Figure 2 – Treatment Area



The permeable reactive barrier was installed along the northern and eastern boundaries of the site – the barrier was designed to intercept and treat the natural flow of groundwater migrating from the site with the aim of protecting the prime controlled water receptor (the River Rea) from the risk of pollution from residual groundwater contamination associated with the site as a whole.

Site constraints prevented the use of specialist soil mixing plant (e.g. soil cutters / augers) – a conventional excavator was therefore employed for the barrier installation. The barrier installation involved a combination of *ex-situ* treatment of the shallower soils (which were excavated and re-emplaced following treatment) and *in-situ* (in-place) treatment of the deeper soils to a maximum depth of 4.5m bgl keying into the underlying impermeable layer – this was demonstrated by the presence of relatively impermeable clay (Mercia Mudstone) at the base of the barrier installation.

The barrier medium was created by the addition of a pillared E-Clay slurry used in isolation – the slurry was mixed with the surface soils in the above ground treatment plant (*ex-situ* treatment).

The E-clay slurry was pumped into the excavation created by temporary removal of the shallow soils for subsequent soil mixing (*in-situ* treatment) with the deeper soils. The installed barrier length was circa 130m.

The *in-situ* installation of the permeable reactive barrier is shown in Figure 3 below.

Figure 3 – E-Clay Reactive Barrier Installation



The barrier installation in the south eastern corner of the site and the reinstated treated 'hot-spot' in this area are shown in Figure 4 below (demonstrating the integrated treatment approach).

Figure 4 – Integrated Treatment – Barrier Installation and 'Hot-Spot' Treatment



The remediation works were undertaken and completed within a three week timescale.

Validation

The works were undertaken in accordance with the approved Method Statement.

Samples of the sides and bases of the excavations were tested to demonstrate the effective removal of contamination – the residual concentrations were demonstrated to be acceptable.

It was agreed that the suitability of treated material for reuse on site would be determined by compliance with leachate target values agreed with the Environment Agency. The treated materials were seen as a necessary part of the works - the material would replace the requirement to utilise imported fill to return the site to pre-remediation formation levels. The material was identified as having a specific purpose - any deficit of material would result in the necessity to import fill.

Following a suitable period of “curing” representative samples of treated soils were leach tested and compared with the derived leachate target criteria for TPH, BTEX and PAH. Representative samples were tested and all leachate values were compliant with the agreed remediation criteria. The treated material was therefore considered suitable for reuse on site and re-emplaced in the void spaces created by the validated excavations as a substitute for imported fill.

A new borehole was sited between the barrier installation and the River Rea to monitor groundwater quality post remediation. The monitoring results have demonstrated full compliance with the target values stipulated by the Environment Agency.

VOC, noise and dust monitoring were undertaken throughout the remediation works.

The full development is shown in Figure 5 below (in cross-sectional form) – the barrier was installed between the Block S development and the River Rea (the location is shown by a red marker).

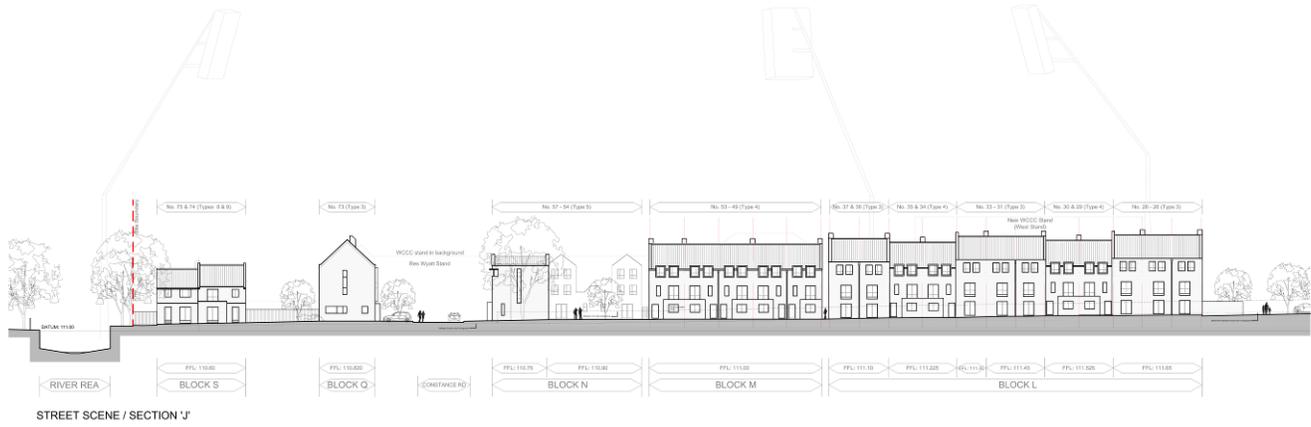
Conclusions

Enviro-treat successfully demonstrated, through a comprehensive Validation Report, that the overall remediation strategy had been successfully implemented.

The prime drivers for the remediation works were the protection of human health and controlled waters.

The relevant planning conditions relating to contamination issues were discharged enabling the development to proceed.

Figure 5 – Cross Sectional Plan of Proposed Residential Development



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Stabilisation • Bioremediation • Reactive Barriers • In-situ / Ex situ Remediation