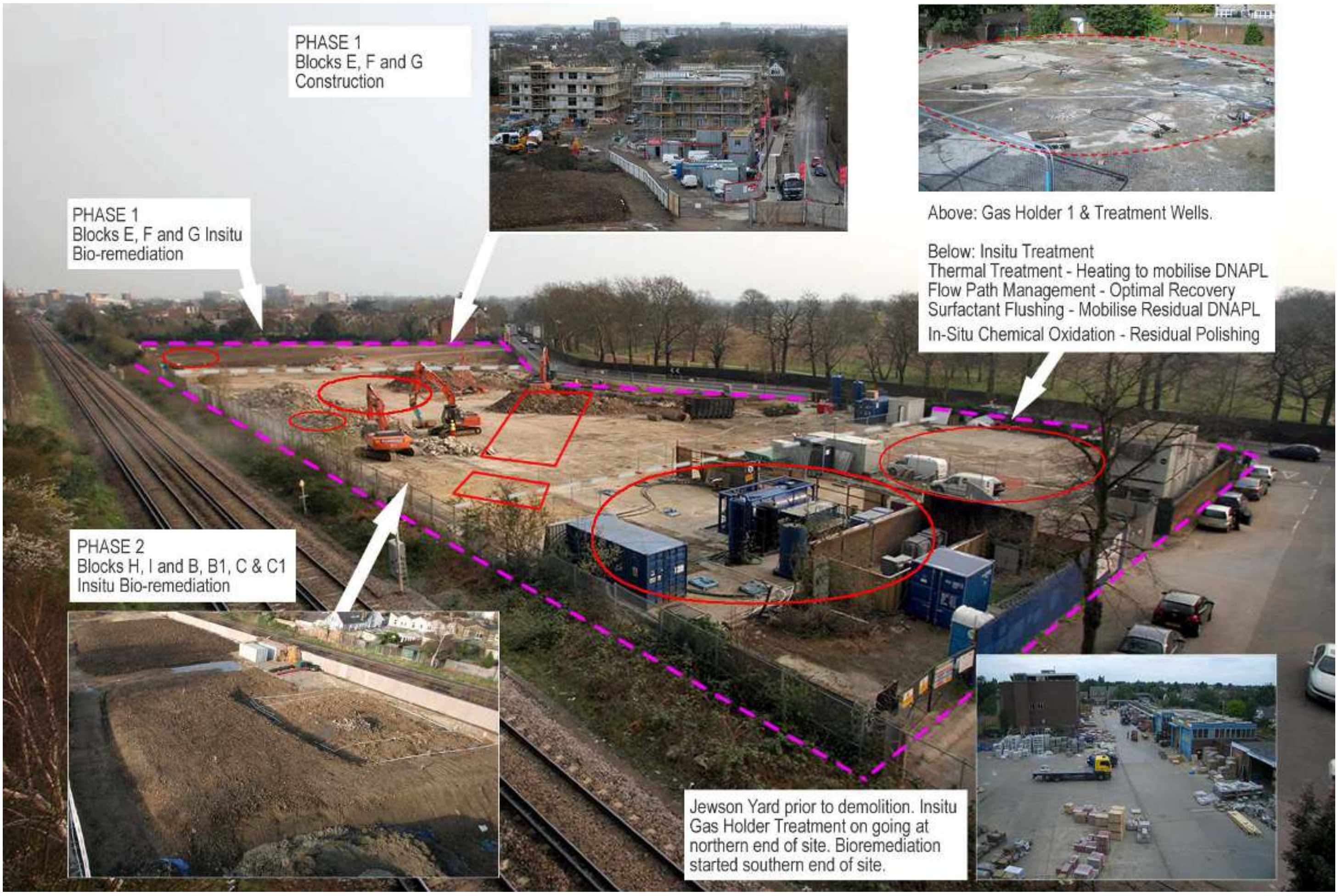
Gas Works Remediation for Mixed-Use Development



Introduction

This 2 hectare site encompasses the whole of a former gas works, which operated from 1852 to the mid 1970s (Figure). Historical studies showed the gas works were complex and contained up to five gasholders as well as range of underground and production structures. Part of the site was used more recently as an Electricity Board Depot and, thereafter, the majority of the site comprised a builder's merchant yard (approx 1.37ha), whilst the remaining area was redeveloped with an office building and car park (approx 0.51ha). An area of overgrown waste ground remained in one corner (0.19ha).

Regeneration

The redevelopment comprised: 198 residential apartments incorporating communal soft landscaping; a 72 bed Nursing Home; and 800m² of mixed use including offices and a crèche. The development also incorporated access roads, parking (including a semi basement car park), and pedestrian access. The time taken from the beginning of the remediation to the first residential sale was a period of 20 months.

Community and Stakeholder Acceptance

The site is located in a highly sensitive residential area, adjoined by a busy mainline railway. At the outset, considerable objections were raised by a local resident action group. Extensive consultations were held with the residents, Environment Agency (EA), Environmental Health Officer (EHO), and Planning Authority (PA) from a very early stage. The Specialist Remediation Contractors were also closely involved in the process. An investigation strategy was discussed up front and submitted for approval. The regulators were consulted throughout the investigation and monitoring phases; conceptual design; pilot and laboratory trials.

Southern Testing Head Office
East Grinstead
Tel: 01342 333100
enquiries@southerntesting.co.uk

ST Consult Midlands
Northampton
Tel: 01604 500020
creaton@stconsult.co.uk

ST Consult North West
Warrington
Tel: 01925 661 700
warrington@stconsult.co.uk

ST Consult South West
Swindon
Tel: 01793 441 522
swindon@stconsult.co.uk

FS 29280 EMS 506775 OHS 506776
www.smasltd.com

Site Characterisation

We carried out several phases of investigation and monitoring to determine the scope of remedial works required to meet planning conditions. Analysis showed the site to be heavily contaminated with Arsenic, Cyanides, PAHs, TPH, BTEX compounds and SVOC's, largely correlating with the location of historic gas works structures.

A shallow fluvial aquifer that underlies the site is classified as a Principal Aquifer and, therefore, sensitive to potential groundwater contamination. Characterisation of the groundwater contamination beneath the site formed an important part of the investigation and risk assessment process. BTEX compounds, Naphthalene and BaP were identified as critical contaminants. Elevated concentrations of these contaminants were found at the northern end of the site, associated with the below ground gas holders. There was a lesser degree of contamination at the location of a sunk liquor-tank. Monitoring showed that significant concentrations were not present at the downgradient site boundary. Modelling of the contaminants was in good agreement with the measured distribution and showed no significant off-site migration. Therefore, no specific groundwater remediation was required. However, groundwater was the most sensitive receptor in elements of the risk assessment, and was the controlling factor in setting a number of key remedial targets for the soils remediation.

Assessment of Remedial Options

A dig and dump solution was considered to be unsustainable, excessively expensive, and unacceptable given the sensitive surroundings. Both in-situ and ex-situ techniques were considered. An innovative and sustainable treatment system was designed which incorporated elements of in-situ bioremediation, stabilisation to aid excavation for treatment (figure 4), and a multi-phased in-situ approach to DNAPL recovery from the gasholders. Treatability trials were carried out for bioremediation and stabilisation. Overall, it was felt that bioremediation would be beneficial on a site of this nature, given the generally granular nature of the soils and the heterogeneous distribution of the contamination. Excavation in order to place the material in treatment, would also deal with physical obstructions, thereby facilitating development, and improving the overall validation process. The other in-situ techniques offered additional benefits in that they minimised the visual impact in a sensitive residential environment, reduced the need for prolonged open excavations or stockpiles, and so allowed odours to be more effectively controlled.

Other components of the scheme included: hydrocarbon vapour membranes within floor slab construction, with well-ventilated sub floor voids; suitably resistant utility services and drainage pipes; and an engineered clean cover layer, comprising a capillary break and imported topsoil, to soft landscaped areas.

Technical Innovation

The combined treatment system we proposed provided a flexible solution and allowed for variations in anticipation of unknown ground conditions, site access restrictions, environmental risks, and phased site hand-back. The construction deadlines imposed by the Client were met.

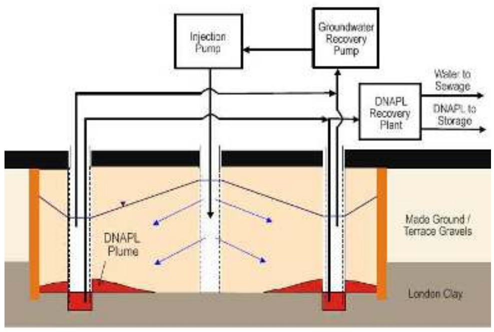
Remediation started at one end of the site, while the other remained in use, and progressed as access became available. Soil treatment was undertaken by Specialist Contractor utilising a multi component scheme that took into account the level, and type of contamination, the environmental risk and site circumstances. As a consequence of the restricted working space and environmental concerns, the bioremediation comprised below ground (in-situ) biopiles.

Figure 1 – Gas Works Layout

Figure 3 – Excavation of Tar Tank Structure

Figure 4 – Stabilisation to aid Excavation

Figure 5 – Flow Path Management



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The approach for the general site area entailed a "blanket" excavation, sorting and onsite treatment of all materials within the upper 3m. Treatment was carried out in below ground biopiles. Amendments were added as necessary and a 20 week treatment period achieved. The treatment included collection and treatment of waters encountered during excavation and from rainfall, discharge to foul sewer under consent.

Two 9m deep gas holder bases were located on the northern half of the site, within the operational builder's yard. Full access to this part of the site was not available but the treatment approach allowed for remediation works to commence much earlier. The Specialist Contractor undertook remediation within the gasholders with all pipe work and wells installed below the site surface, and fully instrumented containerised treatment and recovery (Figure 10). The objective was to remove as much DNAPL (coal tar) as possible and improve the water quality using a combination of best available conventional and innovative technologies. It was thought to be the first time this combination of techniques was used in the UK for this purpose. Techniques included – Tar Pumping; Flow Path Management (FPM) (Figure 5); In-situ Conductive Heating (ISCH); Soil Vapour Extraction (SVE); and Surfactant Flushing, with a final phase of In-situ Chemical Oxidation.

Following in-situ treatment, the gas holder walls were broken down to 2m below ground level and the top of the structures sealed with a compacted clay cap, to prevent the ingress of any surface water.

Sustainability & Reduction of Pollution

A total of 60,000m^3 of soils was excavated from across the site, and approximately 40,000m^3 successfully treated to meet strict validation criteria for reuse onsite. Most of the remainder met re-use criteria and did not require treatment. Only 3,000 tonnes of contaminated soil, which was mainly cyanide-impacted and not treatable, was segregated. 2,200 tonnes was pre-treated to Non-Hazardous levels and the remainder sent off-site for soil washing. The treatment achieved significant pollution reduction with PAH contamination reduced by 90% and TPH by more than 80%, as well as the near total elimination of BTEX.

The gasholder base treatment successfully removed 114,420 litres of coal tar, and it is estimated that 99.7% of all recoverable tar was removed prior to chemical oxidation. Holder base water samples indicated 78%, 69% and 92% reductions of dissolved phase EPH, BTEX and PAH respectively, compared to initial concentrations.

Cost Effectiveness and Durability

The cost of specialist remediation was a third of an alternative dig and dump scheme.

The durability of the scheme comes from the massive reduction in contamination loading below the site, thus providing a permanent solution, as opposed to a containment approach that would have a limited life span.

Validation and Monitoring

Proper environmental controls were implemented during the remediation. These included visual assessments and regular monitoring of dust, VOC and noise onsite and in the surrounding area. Groundwater monitoring was carried out throughout the remediation and construction phases.

We undertook an extensive sampling and validation exercise to demonstrate that the remediation scheme was properly implemented. All target criteria were successfully achieved.

Figure 7 – Schematic In-situ Biopile

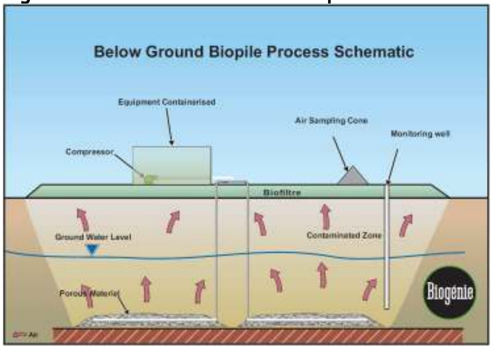

Figure 8 –In Situ Biopile Collector Pipework

Figure 9 – Below ground (In-situ) Biopile

Figure 10 – Insitu Treatment of Gasholders

Figure 11 – Phase 1 Complete.