Site Investigation & Groundwater Monitoring

Former Dye Works Biddulph

Client

KEYWORKER HOMES

Environmental Consultant

envirotreat®

Site Background & History

The Biddulph site is bounded to the north by a small brook flowing from the east and partly culverted through the part of the site known as the Ecology Area. Water from this brook was used during the operational period of the site for the dye production. To the east of the site is woodlands and fields, the south some dwellings and fields and to the west is the Biddulph brook and the Congleton to Biddulph road.

The former dye works which operated on the site had been closed and the site remained vacant for over 30 years following demolition. Numerous site investigations undertaken to support planning applications for redevelopment of the site for residential purposes. However, due the sites complex and varied contamination issues, none had been successful in fully understanding the issues / contamination linkages for site. Therefore, the Regulators (Stafford Moorlands District Council and the Environment Agency) were unable to approve discharge the relevant planning conditions relating to the requirement for a Site Investigation.

"A site investigation scheme, based on the information already provided to support a detailed assessment of risks to all receptors that may be affected, including those off site"

The former dye works site has been defined as being three separate / distinct areas with potential linkages between all three.

The northwest part of the site is where the main production works were situated. Here, dyes were produced using (amongst others) ferro-cyanide and strontium compounds. Within this part of the site was the former water treatment works, this consisted of a series of settlement tanks where metal contaminants were precipitated out using pH control. Upon which the final liquor was discharged into the adjoining brook. This part of the site had historically been shown to contaminated with ammonia, heavy metals, TPH, chlorinated hydrocarbons and cyanide-based compounds, all potentially impacting the adjoining brooks and certainly a risk to human health.

Figure 1 – Site overview

The precipitate / sediment from the water treatment operations were placed in a lagoon in the northeast part of the site (known as the Ecology Area). The proposed development plan does not include developing out this part of the site as it had become a wildlife habitat for badgers. Previous site investigations have shown extremely elevated concentrations of heavy metals and complex cyanide contaminants within the capped lagoon. To date no one had demonstrated the fate of these compounds and how they were affecting /impacting the rest of the site and offsite receptors.

The third part on the site (southern area) had formally been a lagoon / pond (used to store production water). This pond had long been drained and backfilled during the operational period of the site. Again, there was limited information of the pond size / construction and what material had been utilised in backfilling it. This was in part due to the fly tipping of several hundred tonne of shredded plastic onto this part of the site.

Figure 1 – Former lagoon in southern part of the site

Supplementary Site Investigation

The requirement for further site investigation was discussed with the Environment Agency and local authority The proposed scope of supplementary site investigation was confirmed in writing prior to commencement.

The principal objectives of this supplementary site investigation were to assess

- the impact, if any, that the fly tipped shredded plastic had had on the southern area of the site,
- fully characterise the fill material in the northeast (ecology area) of the site,
- fully characterise the fill material in southern development area parts of the site,
- further site investigation of the northwest development area and
- investigate the hydrogeological regime at the site.

Site Works

The exploratory techniques chosen were based on economic efficiency and technical merit. Trial pits were chosen as the primary means of investigating Made Ground due to cost and the ability to inspect ground conditions. Windowless drilling was adopted for the installation of groundwater and ground gas wells due to the speed of drilling.

The additional intrusive works consisted of the drilling of 23 No. windowless boreholes, excavation of 13 No. trial pits, undertaking two rounds of groundwater sampling, one round of surface water sampling and 3 No. rounds of ground gas monitoring.

The results were used to complete a factual report, generic human health risk assessment and generic controlled waters risk assessment.

The sampling strategy was based on laboratory analysis and on-site screening. The purpose of the onsite screening was primarily to support the selection of representative samples for laboratory analysis. A handheld X-Ray Fluorescence Analyser (XRF) was utilised for screening of soils. A Geiger counter was used for the protection of site staff using the XRF and to rapidly screen arisings for radiation above background levels. It was believed that some of the strontium compounds used on site may have been radioactive The Photo Ionisation Detectors (PID) was used to screen for Volatile Organic Carbons (VOC's) to assist in subsampling for laboratory analysis.

Figure 2 – Trail Pit excavations in the Ecology Area showing blue and red staining associated with complex iron cyanide and strontium compounds respectively

Groundwater monitoring wells were purged during the intrusive phase of works. This was completed using a WaSP pump. Wells were purged until turbidity reduced to low levels or until the wells had run dry three times.

During purging, recharge across the northwest and northeast parts of the site was noted to be generally very poor and turbidity was high. Recharge in wells screened across the infilled pond in the southern development area was good.

Figure 3 – Windowless borehole installation, northwest development area.

Hydraulic Conductivity Testing

In-situ permeability testing was undertaken on a number of boreholes in accordance with BS5930:2015. A RuggedTroll 100© datalogger was placed towards the base of the borehole and sequential rising- and falling-head tests were completed through the submersion and removal of a nylon slug.

The results of the tests were analysed using AqteSolve software.

Topographic Surveying

A topographic survey of borehole locations was undertaken. The survey was completed using GPS and elevation and location data were collected. Borehole elevations were taken from cover level.

Groundwater Sampling

Two rounds of groundwater monitoring were undertaken on 23rd and 24th November and 6th and 7th December 2021 respectively.

Figure 4 – Groundwater monitoring by low-flow.

Groundwater depths were gauged using an electronic dipmeter. Groundwater was pumped from the midpoint of the water column using a peristaltic pump through disposable nylon and silicone tubing. Pumped groundwater was run through a flow-cell containing a YSI multimeter and well-head parameters recorded. Samples were collected in laboratory prepared glass and plastic containers once the well-head parameters had stabilised.

Where well recharge was insufficient for low-flow sampling, i.e., where drawdown was noted at low pumping rates or where small volumes were present in the wells, grab samples were collected. The sample containers were prepared by the laboratory and contained preservatives for the cyanide testing. Each sample container was labelled with the sampling location and date and stored in cool boxes until collected for transport to the laboratory. Groundwater samples were sent to The Environmental Laboratory (ELAB).

Ground Gas Monitoring

The gas monitoring program comprised 3 No. visits over three weeks. This being in addition to gas monitoring undertaken during previous site investigations onsite.

Figure 5 – Ground gas monitoring by using a GFM438 MCERTs Landfill Gas Analyser

Wells were monitored for bulk ground gases, VOCs (volatile organic compounds) and Hydrogen Cyanide (HCN). The wells were monitored for flow rate. Methane, carbon dioxide, carbon monoxide, oxygen and hydrogen sulphide using a GSM infra-red gas analyser.

Findings

On completion of the site works, Envirotreat was able to produce a comprehensive Site Investigation report which addressed the “data gaps” previously identified by the Environment Agency and Local Authority.

Ground model conditions across the development area were broadly consistent with the previous phases of site investigation works. However, the depth of sediment infill of the former lagoon in the northeast part of the site (Ecology Area) had been found to exceed that previously reported. This conclusion being supported by innovative use of field analysis of metal concentrations with a handheld XRF.

Elsewhere, ground conditions in the southern part of the site were dominated by the infilled pond. This area contained loose tipped material and high groundwater levels, which exhibited fast recharge. The pond was found to have been infilled with demolition materials, general waste material and chemicals, as had been reported anecdotally before.

The northern part of the site was shown to be underlain by a wedge of Made Ground that increased in thickness towards the western and northern boundaries. The underlying Glacial Till and mudstone bedrock increased in elevation from west to east, which was consistent with pre-development valley topography.

Groundwater exhibited a steep west-north westerly gradient down towards the surface waters. This was consistent with the predevelopment and surrounding topography.

Given the gradient and elevation of groundwater along the western boundary, groundwater beneath the site it was considered to be in hydraulic continuity with the surface water receptors. Deterioration of surface water quality past the site supports this conclusion and implies groundwater base flow into the rivers.

Human Health Risk Assessment

Concentrations of metals were encountered across the development area above Generic Assessment Criteria (GAC) adopted for the protection of future residents. Whilst highly elevated concentrations of metals and a single concentration of free cyanide, were noted above these GAC in the northeast part (Ecology Area) of the site, risks were shown to be largely mitigated by the presence of a clay cap.

Tetrachloroethene (perchloroethylene, PCE or PERC) was noted in groundwater in one location at a concentration that could present a risk via vapour intrusion. Free cyanide was noted in groundwater, but below the adopted GAC. Asbestos had been noted across the site. This was in the bound form (cement bound ACM), with no free fibres detected.

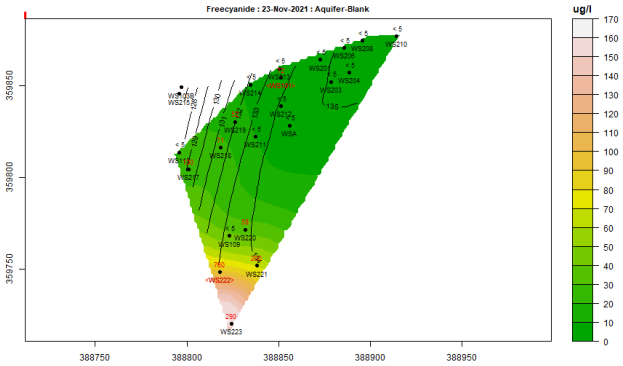
Supplementary gas monitoring showed concentrations of bulk gases were typically low, and no HCN was measured, high flow in one borehole has resulted in the site being classified as CS3.

It was concluded that remediation of the site was required to ensure that no unacceptable risks are posed to human health.

Controlled Waters Risk Assessment

The surrounding surface water receptors had been identified as the principal-controlled waters receptors. Concentrations of metals were encountered in groundwater, principally beneath the development areas, that exceed the Water Quality Standards (WQS). Free cyanide had been noted across the site, including in boreholes adjacent to surface waters. Ammoniacal nitrogen had also been noted across the site. Surface water quality was noted to deteriorate past the site, notably the metal content. Whilst the results have not exceeded the WQS at this point, they do indicate that impacted groundwater is entering the brook.

Figure 6 – Groundwater / contamination modelling undertaken to support the site investigation.



Envirotreat was able to clearly demonstrate that the contamination recorded within the northeast part (Ecology Area) of the site was stable, with little or no significant leachate being generated from the emplaced water treatment sediment

In addition, Envirotreat demonstrated that no groundwater pathways existed between the northeast ecology area and the rest of the site, therefore negating the requirement to undertake further remediation on this part of the site (minimal risk as no pathway existed).

From the findings of the supplementary site investigation, Envirotreat was able to update the previous site investigation Conceptual Site Model (CSM) and develop a suitable remediation strategy to address the contaminants of the concern and associated contamination linkages.

The works completed and submission of the Site Investigation Report enabled the effective discharge of Planning Condition 23(i)

Subsequently, Envirotreat in conjunction with Keyworker Homes developed a technically and commercially robust Remediation Strategy that will effectively address the identified pollution linkages and provide a site suitable for redevelopment,