



## **Arnold's Field**

### **Technical Note on Site Investigations**



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## 1 Introduction

Jacobs Engineering UK Ltd (Jacobs) has been instructed by the Environment Agency (EA) to provide technical services in relation to investigations being undertaken at a site known as Arnold's Field. Arnold's Field is an old mixed use landfill site near Rainham, Essex which was filled following completion of mineral extraction works at the site. The site is located to the west of Launders Lane which is a minor road branching north off the A1306 (formerly A13) to the east of Rainham. The national grid reference of the site is TQ541819. The site is bordered by a common water course on the west and north, Launders Lane on the east and the A1306 on the south.

Following closure of the landfill, the site was reportedly used for the illegal tipping of further waste. This has been the subject of a number of complaints and Environment Agency (EA) officers have monitored the site since August 2011. Currently all activity on site has ceased and no machinery is left on site. The previous operator of the site has vacated the site.

In August 2011, EA officers accessed the site to undertake site reconnaissance and observe areas where waste had potentially been buried. Five separate areas of ground subsidence, each approximately 5m<sup>2</sup> in area, were identified which, according to the EA, appeared consistent with burial pits for waste material. The EA reported that no evidence was visible on the surface of anything other than soils and poor quality hardcore.

Based on the EA's initial findings, further works were considered necessary to assess the five identified areas of subsidence and investigate other areas of the site for potential buried waste. It was considered that excavating trial pits in these areas would be an appropriate means of further investigation. It was also considered that during the investigations, it would be beneficial to have the ability to collect and test soil samples to assess for possible contamination and to estimate the volume of any waste materials identified. In order to facilitate the further works, Jacobs was requested to:

- Prepare a brief for the site investigation works,
- Supervise the site investigation,
- Prepare a short technical note to summarise the findings.

The site investigation brief was prepared by Jacobs in January 2012 and Costain Geotechnical Services were commissioned by the Environment Agency, acting as the Employer, to undertake the site investigation works with Jacobs acting as the Engineer in accordance with the ICE Conditions of Contract, Ground Investigation Version, 2<sup>nd</sup> Edition, 2003.

This report presents the short technical note of the works undertaken.

## 2 Summary of Work Undertaken

The site works were undertaken by Costain Geotechnical Services between 6th and 10th February 2012. A member of the EA's Environmental Crime Team and a member of Jacobs' Geoenvironmental Risk Management team were present throughout the works. Thirty five mechanically excavated trial pits were excavated to a maximum depth of approximately 4m. The locations of the trial pits were targeted at the five observed subsidence areas and also generally across other parts of the site. The trial pit locations were agreed on site by the EA, Costain and Jacobs. The locations of the trial pits were surveyed by Costain using Trimble GPS equipment. Exploratory logs of the excavations were also made by Costain. Soil samples were collected by Costain for chemical testing at the sub-contracted laboratory, Scientific Analysis Laboratories, Manchester.

A factual report has been produced by Costain giving details of the coordinates and ground levels of each trial pit relative to Ordnance Datum, the trial pit logs, photographs of the investigation, a trial pit location plan and chemical test results of soil samples collected during the investigation works (see Costain report Factual Report on Ground Investigation At Arnolds Field, Rainham, For Environment Agency Contract No: 018936/5316, March 2012).



### 3 Ground Conditions

The Geological Map (Sheet 257 'England and Wales, Romford, Solid and Drift Geology, 1: 50 000 series', 1996) shows the presence of Worked Ground and Made Ground including wholly or partially backfilled pits at the site. This is shown to be underlain by Quaternary drift deposits consisting of a combination of Taplow Gravels (River Terrace Deposits) and Head. Alluvium may be present in the area closer to the common water course on the west and south of the site. The Quaternary deposits are underlain by Palaeocene solid deposits consisting of the London Clay Formation underlain by the Lambeth Group and the Thanet Sand Formation. The Cretaceous deposits underlying the Palaeocene deposits comprise Upper and Middle Chalk.

Trial pit logs describing the materials encountered during these investigations are given in the Costain factual report. No undisturbed natural ground was encountered at any of the investigation locations and therefore it was not possible to confirm the presence of River Terrace Deposits, Alluvium or London Clay at the site. Made Ground or recent landfilled waste material was encountered at all investigation locations. The Made Ground typically comprised a brown sandy gravelly clay or sandy clayey gravel which had been placed over either recently deposited landfilled waste or further Made Ground comprising typically a dark brown to black, clayey, sandy gravel with ash or peat and brick and concrete fragments with some evidence of decayed vegetation. It is thought that this deeper Made Ground may be waste deposited into the original landfill.

The recent landfilled waste was encountered in 4 out of the 5 originally identified subsidence areas. The originally identified subsidence area trial pits were given designations TPS01 to TPS05. The TPS02 area did not encounter recent landfilled waste. An additional area of subsidence was identified while on site and designated TPS06. An area of suspect raised ground was also identified during the works and investigated by excavating TP07 to TP09. Recent landfilled waste was identified in these trial pits. The locations and estimated extent of the identified areas of recent landfilled waste are shown on the Site Layout Plan given in Appendix 2.2 of the Costain Factual Report. The extent of each area was estimated by trial pitting or by the topographical features present (such as bunding or embankments). The estimated extents were surveyed using Trimble GPS equipment and the co-ordinates have been used to provide the hatched areas shown on the Costain Site Layout Plan.

The recent landfilled waste comprised domestic and commercial waste including documents, wood, paper, glass, plastic, mattresses, pieces of furniture or equipment, cables, netting, clothing and other fabrics and occasional empty medical waste packaging. Little evidence of substantial decomposition of the material was observed indicating recent deposition. It was often possible to read dates from documents, newspapers or magazines. These were frequently dated as recently as 2011. The EA Environmental Crime Team officer collected samples of such materials in evidence bags.



**Plate 1: Newspaper Dated June 2<sup>nd</sup> 2011 Recovered From Waste**



**Plate 2: Typical Waste Material Excavated From Trial Pit**

On excavation, the waste was frequently observed to be warm and emitting vapour suggesting decomposition and the production of landfill-type gasses. The weather during the investigations was cold with a snow cover present throughout the week of the works. It was noted that snow melt frequently occurred in areas of recent waste, suggesting that the decomposition of the waste was warming the overlying ground.





***Plate 3: Area of Subsidence with Snow Melt Over Area of Recent Waste***

During the works it was not possible to prove the full depth of the recent landfilled waste. Trial pits excavated as deep as 4m below ground level (mbgl) did not reach the full depth of the waste.





*Plate 4: Waste Extended to the Base of Trial Pits*

Where trial pits encountered recently deposited waste, there was generally insufficient soil matrix present within the waste to collect soil samples. Once it was established that significant quantities of recently deposited waste are present at the site, the investigations focussed on identifying as many areas as possible during the site works where such waste was present. It was therefore not the intention of the investigation to undertake substantial soil testing across the site. If a detailed assessment of the soil quality across the site is required, more substantial investigations and soil sampling would be needed.

Never-the-less, soil samples were collected from soil near to the edges of areas of waste or from Made Ground encountered above the waste or from trial pits elsewhere around the site. The soil samples were collected by Costain at locations and depths agreed with the EA and Jacobs on site. Nine soil samples were collected for chemical analysis. These were collected from trial pits TPS01 to TPS06 and from TP07. The chemical test results together with the sample depths are presented in Appendix 6 of the Costain factual report.

The approach to assessment of the chemical results in this brief Technical Note has been to undertake an initial screening assessment against existing readily available screening criteria. The majority of determinands have therefore been compared to soil guideline values (SGVs) or other generic assessment criteria (GACs) for residential end use with gardens and commercial end use. Results below these guideline values for these end uses typically indicate negligible risk to human health.

The GACs used include Soil Guideline Values (SGVs) published by the EA / DEFRA and Generic Assessment Criteria calculated using the CLEA methodology and published by authoritative sources (LQM / CIEH 2<sup>nd</sup> Edition July 2009 and EIC/ AGS/ CL:AIRE GACs December 2009). In the absence of SGVs or other authoritative guidance, lead has been screened against the (now withdrawn) SGVs.

It is important to note that SGVs and GACs are used here as initial generic screening criteria. Exceedance of the SGV or GAC does not mean that there is a significant possibility of significant harm to end-users, but that further assessment may be required.

In general, most of the parameters tested for did not exceed readily available screening criteria.

A lead concentration of 1600mg/kg found in TP07 at 1.2mbgl exceeds the (withdrawn) GAC for commercial use of 750mg/kg and the (withdrawn) GAC for residential use of 450mg/kg. Benzo (a) pyrene was detected at 2.1mg/kg in TPS01 at 1.2mbgl exceeding the GAC for residential end use of 1mg/kg. This implies that, in these areas, material exists which could pose a risk to human health in an industrial or residential end use scenario.

Waste Acceptance Criteria (WAC) testing was undertaken on one soil sample collected from TP06 at 1.5mbgl. The WAC leachate level for sulphate in inert waste was exceeded. If this result is generally representative of soil at the site or in this area, this could indicate that soil at this location may not be suitable for disposal to an inert waste landfill, but further testing would be required to confirm this.



The development of a Conceptual Site Model (CSM) is useful for understanding the environmental setting of the site. In order for contaminants to pose a risk to receptors, one or more pollutant linkages must exist. A pollutant linkage exists where a source or hazard is present that can have the potential to cause or is causing significant harm to a sensitive receptor via a pollution pathway.

The preliminary CSM is based on the source, pathway, receptor model and examines both the hydraulic regime and the contamination at the site.

The preliminary CSM considered appropriate for the site is presented below.

***Potential sources of contamination:***

The potential sources of contamination identified at the site are:

- The waste material previously deposited at the site during its operation as a landfill
- The waste material recently deposited at the site

***Potential receptors:***

- Redevelopment/restoration workers
- Current general and future site or nearby off-site users
- Groundwater within the Quaternary drift deposits
- Surface water in adjacent common water course
- Plants
- Animals
- Structures which may be built on the site

***Potential exposure pathways:***

- Inhalation, ingestion or skin contact with waste material
- Contact with animals which may carry diseases contracted from waste material
- Ingestion of contaminated water
- Plant uptake of contaminants
- Infiltration of leachate to groundwater
- Migration of landfill gas into future structures
- Run off of surface water contaminants

***Plausible Potential Source – pathway – receptor linkages***

It is considered that the following potential source – pathway – receptor linkages are plausible at the site:

- Previously or recently deposited waste could produce leachate which could impact surface water or groundwater or other off site receptors through run off or infiltration

- Burrowing animals or deep rooted plants could be adversely affected by previously or recently deposited waste
- New structures built on the site could be affected by the migration of landfill gas from recently deposited waste
- Current site users could be exposed to animals which may carry diseases from contact with recently deposited waste
- Redevelopment workers could be exposed to previously or recently deposited waste through excavations



The investigations undertaken at the Arnold's Field site set out to assess whether waste material had recently been deposited at the site. Based on the investigations undertaken, it appears that waste material was deposited at the site as recently as 2011.

It was not the intention of the investigations to undertake widespread chemical testing of soils at the site. Never-the-less, the testing which was undertaken of Made Ground encountered during the investigations did not yield substantial contamination of the soil in those areas tested albeit there was some contamination identified in three areas.

The investigations have identified 6 areas where waste appears to have been recently deposited. These areas are indicated on the Site Layout Plan given in the Costain report "Factual Report on Ground Investigation At Arnolds Field, Rainham, For Environment Agency Contract No: 018936/5316", March 2012.

It was not possible to determine the full depth of the waste encountered during these investigations and time and cost limitations precluded extensive investigations across the site. However, based on the investigations undertaken and Costain's Site Layout Plan which indicates the possible extent of recently deposited waste as estimated during the February 2012 site observations, it is considered that the volume of recently deposited waste could be in the order of 30,000 to 50,000 cubic metres based on assuming an average depth of waste of 4 to 5 metres. It is possible that the waste exists at greater depths. It is also possible that further areas of recently deposited waste exist at the site which were not identified by these investigations.

It is recommended that the extent of recently deposited waste is investigated further. There are various ways in which this could be done. It is considered that an effective method would involve a combination of geophysical investigations to estimate the lateral extent of waste across the site as a whole followed by a series of boreholes and trial pits to investigate the depth and composition of the waste where it has been identified.

It is also recommended that the potential impacts to surface water and groundwater and the gas generation characteristics of the waste are assessed at the same time as the above investigations. This would involve installing groundwater monitoring wells in strategically located boreholes and sampling any leachate/groundwater that was encountered. This would enable an assessment to be made regarding the potential long term impacts that the waste may have on surface water or groundwater in the region and whether any gas precautionary measures may be needed should any structures be considered at or near the site.

Due to the large amounts of relatively shallow waste present at the site, it is recommended that access to the site by the public is restricted to reduce the possible exposure of humans or pets to waste material (such as through dogs digging into waste) or adverse health effects from indirect contact with the waste (such as bacterial infections).

