High Efficiency In Situ Treatment Technology

BACKGROUND

HEISTT was a collaborative project part funded by the European Commission, which aimed to create an innovative system for injecting remedial chemicals into the subsurface for the purpose of treating contaminated groundwater.

The HEISTT project focused on proof of concept and development of an early prototype for a unique ultrasonic-assisted piling rig which can be adapted to be mounted off a standard excavator arm.

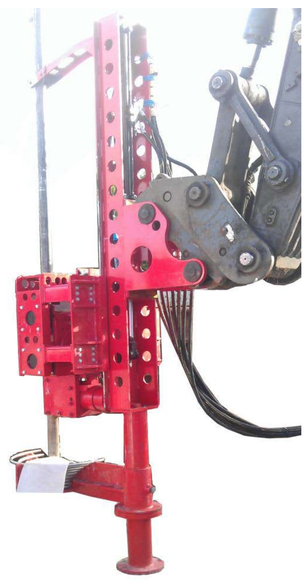
Design modelling was carried out to estimate the extent ultrasonics can fluidise soil during the driving process. The probe has been made in stainless steel and titanium alloy and contains sensors which relay information back to the Control System permitting the operator full control.

As part of the drive-piling process, treatment chemicals will be left in the ground to bring about remediation, via the mechanism of diffusion through a geotextile well liner, anchored at the base of the driven hole. Different designs of geotextile well liner and sacrificial anchor have undergone laboratory trials, prior to site trialling.

This poster presents details of the piling rig and indicative results from the first field trial.

NEW TREATMENT RIG DELIVERS ENHANCED WELL CREATION AND INJECTION

The HEISTT groundwater treatment system offers the force of a Dawson excavator mounted vibrator (EMV), enhanced soil fluidisation from a Sinaptec ultrasound enhanced piling tip, an Afitex geotextile well lining system and reagent injection function which can be used together to provide a single operation remediation solution or as standalone modules depending on site specific requirements.



HEISTT SIDE GRIP EMV

The HEISTT Side Grip EMV (excavator mounted vibrator) builds on the industry gold standard supplied and built by Dawson Construction Plant Ltd. The new grip provides a firm hold for cylindrical piles. This permits the system to index vertically along a leader facilitating continuous piling of longer length stems. The leader also allows the crowd force of the EMV to be deployed without the vibration function.

ULTRASOUND ENHANCED PILING TIP

The combined design of the pile stem and ultrasound tip facilitates the delivery of both power/control for the ultrasound tip and liquid injection.

A comprehensive in-line diagnostic and tuning system allows the system to be tuned in line with the ground resistance being encountered. Site treatment results reported via the HEISTT database will inform pre-set modules which will be available in commercial models supplied with Sinaptec's NexTgen Ultrasound Power Pack.

Sample piling rates from early trials of the HEISTT system compare extremely well with those achieved by comparative technologies used previously by our remediation partners.

GEOTEXTILE WELL LINING & LIQUID INJECTION

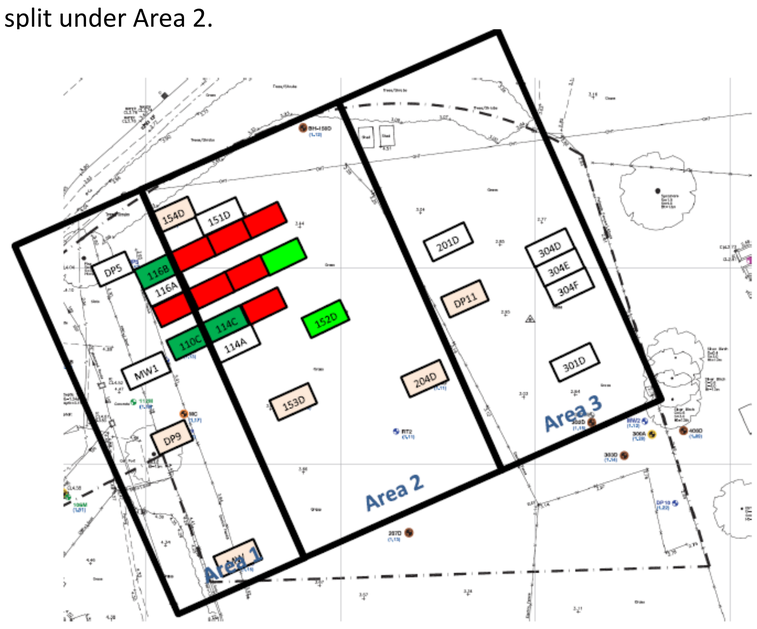
The high performance geotextile from Afitex has a multifunctional role, providing a low friction casing for the drill string during piling/extraction and facilitating targeted application of remediation chemicals. The geotextile is durable and can be inserted in to the well with no further well liner required in many cases.

To shape the geotextile it is passed through a funnel shaped former which wraps the textile around the pile as it is inserted. A sacrificial anchor is used to couple the geotextile to the drill string during piling.

FIRST FIELD TRIAL OF NOVEL HEISTT INJECTION RIG WITH ORC ADVANCED

The site, managed by the UK Environment Agency, is a horse paddock bordered by a former petrol filling station to the left of Area 1 and a public water supply facility with a potable water extraction point just 75m from site to the right of Area 3 (see site plan below). Area 2 is an open paddock determined as a Special Site under Part 2A of the Environmental Protection Act 1990.

In 2001 unleaded petrol leaked from tanks at the then active filling station adjacent to the site resulting in a benzene and phenol plume which has prevented use of the site since 2002. The removal of the offsite source and the closure of the extraction well allowed the plume to split under Area 2.



Dark green – HEISTT treatment design: injection dose of 80kg ORC per point over 10m depth (Approx 8kg per metre)
Bright green – HEISTT treatment design: injection dose of 30kg ORC per point over 3.75m depth (Approx 8kg per metre)
Red – Traditional treatment design
Pink – Other monitoring wells

The plume is 4m to 40m deep with approximately 4-5m soils on river terrace deposits overlying Nottingham Castle Sandstone. Groundwater contamination remained present within the divided plume with benzene and toluene concentrations of: benzene (5392µg/l), toluene (2836µg/l).

The HEISTT rig was used to inject ORC Advanced to address contamination in groundwater, with the caveat that the Nottingham Sandstone base was not to be penetrated. Subject to this clause, any remediation achieved on this site is seen to be beneficial by the regulatory body and a small injection trial with a remediation target of 25% reduction in benzene was agreed.

REMEDIATION APPROACH

The small scale site saw the first trial of a new well creation technology developed by the HEISTT project team. ORC Advanced was selected as the reagent. Instead of the more traditional 4m x 3m injection grid, requiring 12 injections points, an optimised Modflow model, specially designed for use with the HEISTT technology, was used to create the treatment design. ORC was injected into a small trial area overlaying Areas 1 and 2.

RESULTS

Groundwater monitoring events conducted at two week and six week interval post treatment indicated successful remediation was underway (see Table 1 below). In Area 1 groundwater concentrations were significantly reduced after six weeks; benzene (54%) and toluene (57%) (i.e. >50% reduction in 10-15% of the typical treatment time). It should be noted at there was less than 1cm of rainfall during the trial period. Concentrations in Area 1 were successfully reducing a very short period of time after ORC Advanced injection, with levels for benzene having fallen below the 25% reduction target within two weeks of injection. In Area 3, an overall reduction in benzene levels of over 42% was achieved at six weeks post treatment, with toluene achieving a 22% reduction.

Table 1	Contaminant concentrations (µg/l), % reductions given in brackets			
	MW1 / Area 1		304E in Area 3	
Sampling time	Benzene	Toluene	Benzene	Toluene
Immediately prior to injection	5392	2836	4363	2087
2 weeks post	3874 (28%)	2146 (24%)	3777 (13%	1792 (14%)
6 weeks post	2504 (54%)	1214 (57%)	2542 (42%)	1628 (22%)

Historical site remediation data suggest benzene attenuation was occurring naturally over time but that this process has been aided significantly by the injections of ORC Advanced during the HEISTT piling trial. This is broadly evidenced by a reduction in benzene concentrations over time (particularly in the area of remedial injections), the absence of near surface pollution, and by supportive in situ geochemical data, such as substantially altered dissolved oxygen and pH profiles.

ORC Advanced typically delivers oxygen to the subsurface for periods of up to 9 - 12 months on a single dose so it is anticipated that the site owner will continue monitoring for at least one year post trial in order to fully quantify the benefits delivered.

Trade Associations

SME Supply Chain

Environmental Consultants

Research Providers

Sweeney R. [1], Birnstingl J. [2], Brown D. [3], Durkheim Y. [4] Favata F. [5], Mitchell S. [6], Ockier P. [7], Osjamets M. [8], Senduran C. [9], Wallace G. [10], Tiberiu M. [11], Tierce P. [12],
1 CL:AIRE, London. UK. Email: rob.sweeney@claire.co.uk
2 Regenesis, UK **3** Dawson Construction Plant Ltd, UK **4** Afitex sarl, France **5** Idea srl Tecnologie Ambientali, Italy **6** UK HERI, UK **7** European Committee of Environmental Technology Suppliers, Belgium **8** Maves Ltd, Estonia **9** TUBITAK Marmara Research Centre, Turkey **10** European Chemistry Industry Council, Belgium **11** Technosam srl, Romania, **12** Sinaptec, France

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