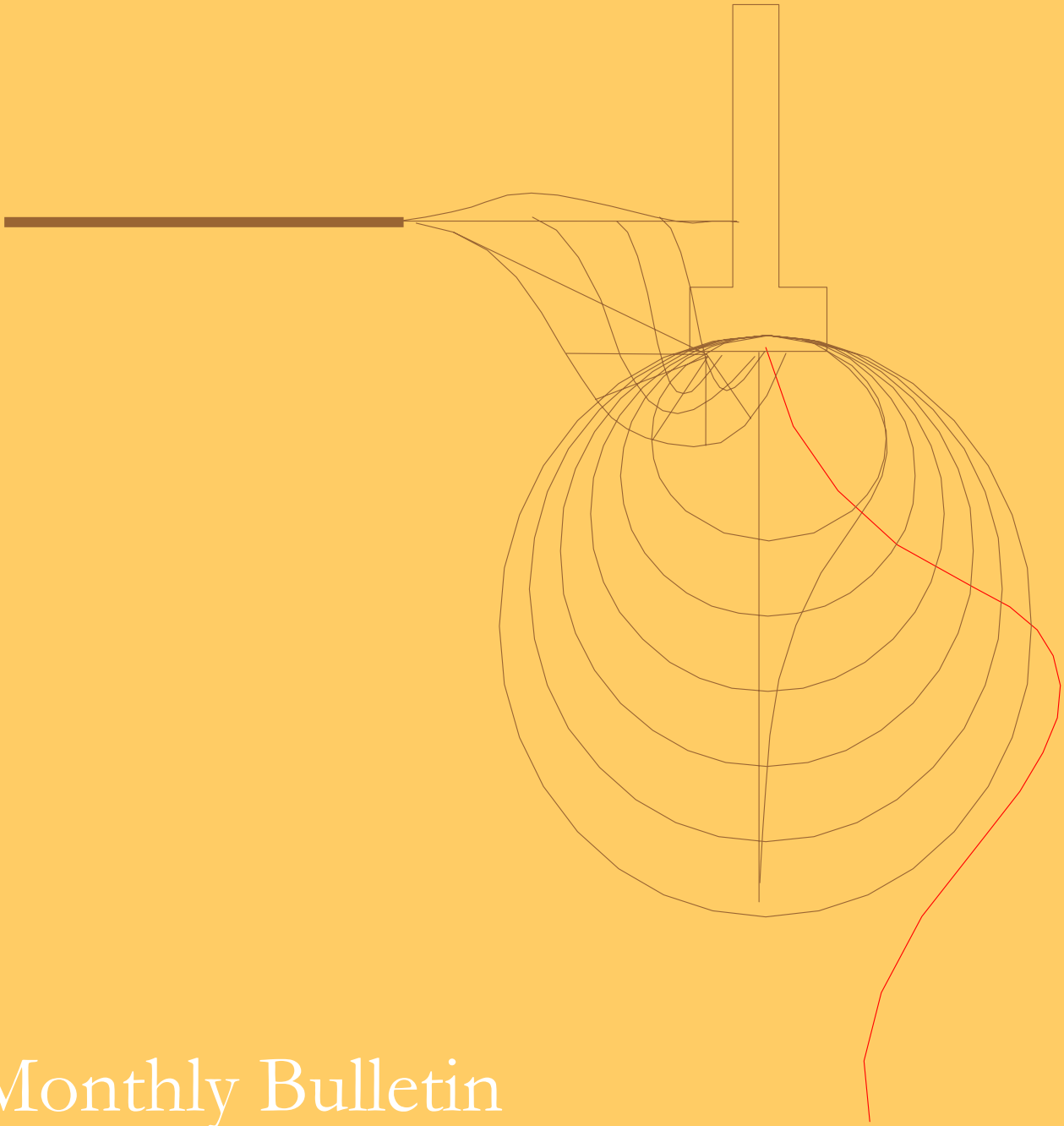
The Clay Research Group



Monthly Bulletin

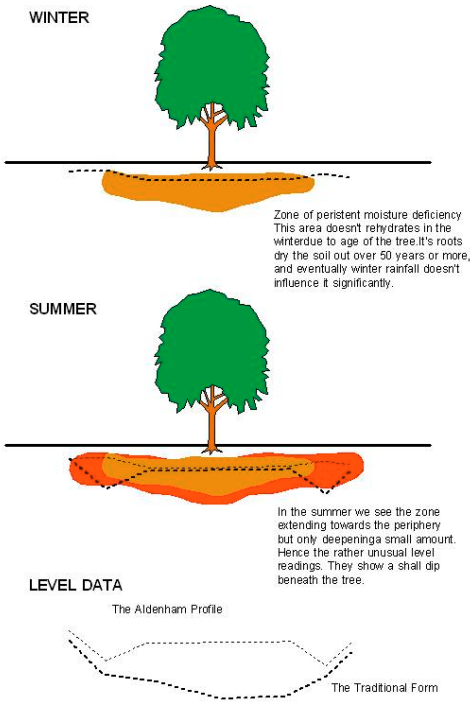
Modelling – taking account of the site

October 2006.

CONTENTS

Persistent Deficiencies

Aldenham has one drawback only. It isn't a typical site with typical trees – if any such site exists. Below we see how the persistent moisture deficit is interfering with our results. In the winter, the soil remains dry beneath the tree. To the bottom of the illustration we can see how it is influencing the precise levels.



This zone doesn't replenish seasonally, which leaves the periphery of the root system (middle picture) more 'sensitive'.

However, we are learning something from this, and it is how roots and soils might interact below paving, where similar conditions probably exist. Rainwater doesn't enter the ground, and movement is probably less beneath tarmac than in someone's front garden for example.

It is also likely that, in some cases at least, although proof would be elusive, paving extends the effective root zone.

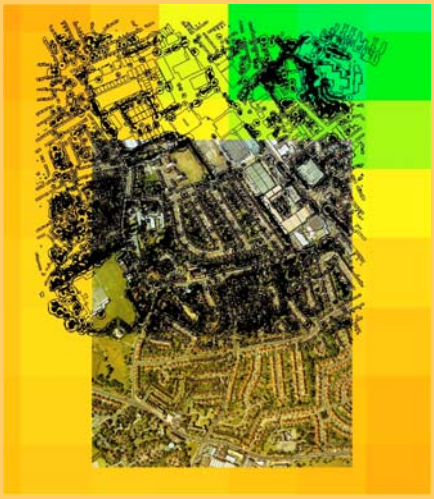
This 'random uncertainty' has provided useful guidance when building a model – see 3.

Modelling – 'drag and drop' applications

October 2006.

Model Launch

We were in a supporting role when Addressology launched their house-by-house subsidence risk model at Lloyds in London on the 3rd September.

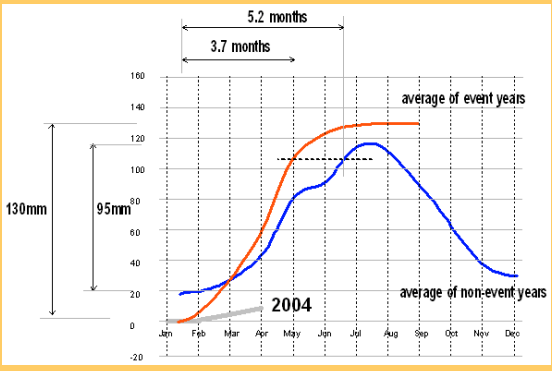


The CRG have built a unique geology (tiled grid above) representing risk across the UK from clay shrinkage and have been involved in the validation of the tree model and corroborating the LiDAR imagery.

The geology map interpolates values from actual claims investigations on a 250m tiled grid at the highest resolution available as far as we are aware.

Climate Modelling

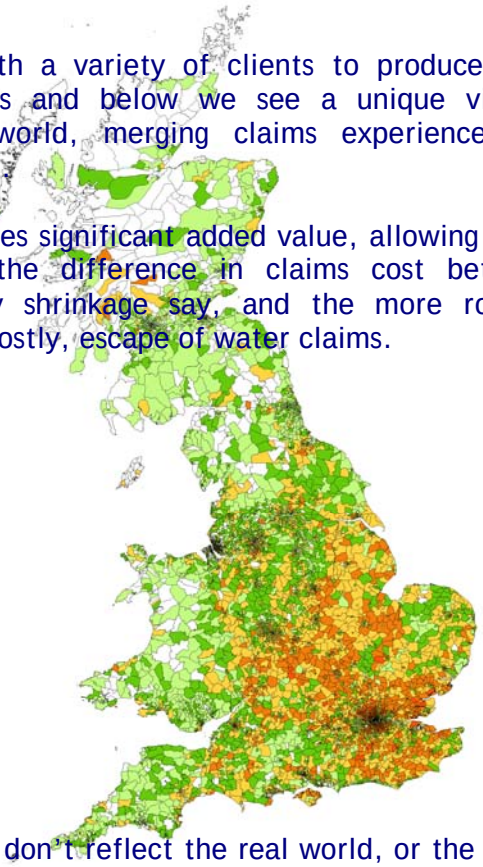
2006 has been busy, but not an event year, as we predicted in May, which is good news.



Risk Data

We work with a variety of clients to produce models of varying types and below we see a unique view of the subsidence world, merging claims experience with the geology layer.

This introduces significant added value, allowing the user to understand the difference in claims cost between root induced clay shrinkage say, and the more routine, and usually less costly, escape of water claims.



Claims alone don't reflect the real world, or the exposure in terms of cost. The geology layer adds a degree of refinement.

TDR Sensors

SPPS are adopting the TDR sensors that we are testing (see picture, right), along with the telemetry solutions for monitoring properties remotely.

This is good news, and the next stage – due very shortly – is a software package to interpret a range of data.

Data from the TDR sensors will be published monthly, along with the other information. Correlation with the neutron probe readings is being carried out by Southampton University.

Modelling – Allowing for Disorder

October 2006.

Uncertainty

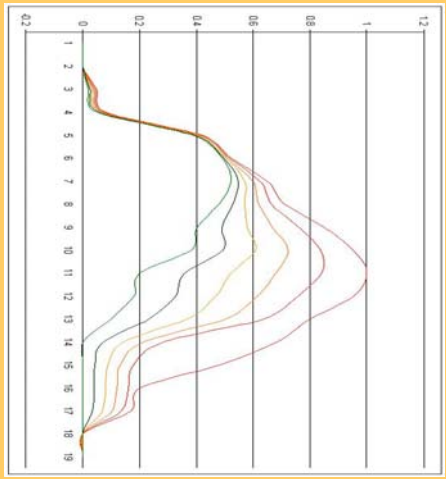
Modelling the interaction between soils, climate and trees of varying species and height poses a problem. The relationships between them aren't linear. If there is a pattern it is more likely to take the form of a periodic and irregular sine wave.

This sine wave appears in all of the elements. Weather patterns, SMD values, claim numbers, suction bulges all follow a similar (although variable) pattern, but the timeline may be slightly out of alignment.

The amplitude varies. Compare event years with normal years, or the suction bulge of a Laburnum with an Oak. Add different times of the year, and modelling can present significant problems.

This is where the concept of 'stepping back' to view the world in the round, makes life easier.

We do know that 75% of valid claims are root related. The summer months are riskier than the winter months. We know the general form of the root zone, if not the detail on individual cases. We also recognise that highly shrinkable clays are more of a threat than non-shrinkable soils. There are tables to inform us which trees pose the greatest threat, and some understanding of rank order.



We need to account for randomness to reflect the general, rather than the particular. Taking a 50mm diameter sample from a root plate that is, in many cases, 18mtrs across illustrates the problem.

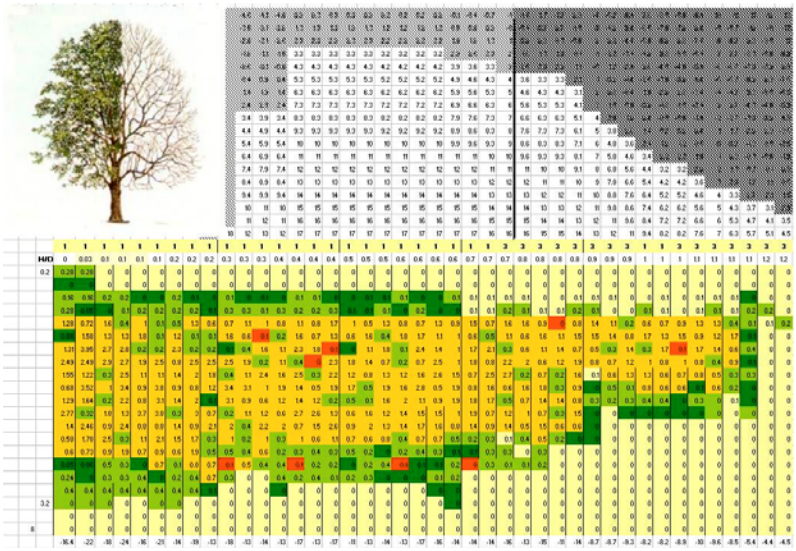
Modelling is a principle we seem able to accept when we see an arborist assessing the influence of trees without knowing where the roots are, but something we distrust when we wrap it up into an application. Hopefully testing will provide reassurance. We would welcome details of actual claims to assess its 'accuracy' and refine the output.

Modelling the Root Zone

Part of our research is refining the existing models (OSCAR and VISCAT) using a statistical approach. We defer to Martin Culshaw of the British Geological Survey (BGS) who said recently in an issue of Ground Engineering that one of the problems many engineers face is "stepping back and looking at the bigger picture".

We don't have to know exactly where roots are, or how the lithology changes to build a predictive modelling application suitable for insurers.

The basis of the model is a database of 70,000 claims, 30,000 trees and in excess of 20,000 actual investigations. It takes account of tree species, height, soil values, depth and so forth to build a grid of possible suction values.



We have added a permeability factor to take account of paving, and this can be varied across the site, as can the index properties, which are dealt with by layer.

We can add foundations of varying depth, and we are adding the ability to model water leakage from drains.

The grid allows us to visualise the possible influence of a variety of trees, on a variety of soils, across the root plate. It has a known degree of uncertainty built in to match the heterogeneous nature of the topic we are studying.

Add the building and relate it to the change in levels to see where the zone of limiting tensile stresses occur – a guideline to where we might expect to see cracks appearing. See the grey shaded areas above.

If anyone is interested, the model is being offered for sale later in the year.

Telemetry Study

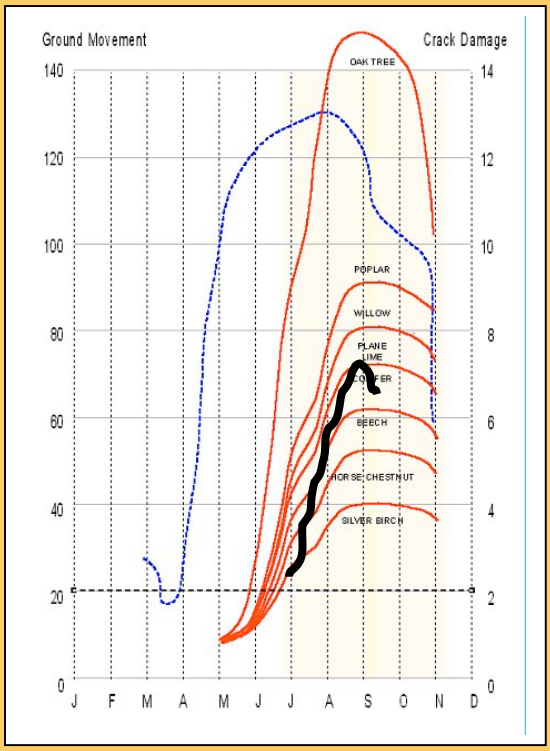
October 2006.

The Template

The image below shows several periodic signatures. The blue line plots the SMD for a particular area in North London.

The red lines represent the ground movement associated with extreme boundary conditions of several species of trees, listed in rank order. Here we have referred to published case histories and interpolated the 'missing species' – trees where no data is available - using the risk tables published by Biddle and the BRE.

The published works we refer to include Cheney, Chattenden (felling of the Poplar trees) and Biddle.



The 'x' axis plots the timescale – January through to December. The vertical axis plots ground movement.

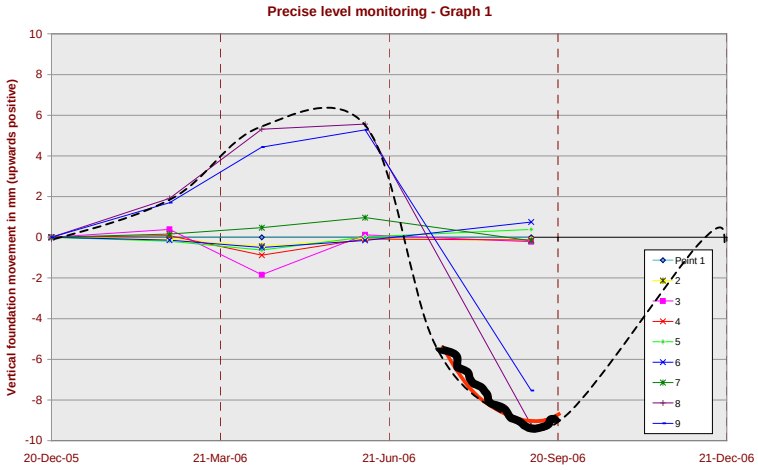
The bold black line plots the electro-level data. Here we have used the individual data – the daily figures – whereas the image to the right (red) plots the smoothed linear trendline.

1st September 2006

The telemetry site shows movement has peaked, with evidence of levelling out commencing on the 1st September, 2006. See the graph below.

The characteristic signature of root induced clay shrinkage is plotted – left - and we have superimposed (bold black line) the electro-level plot with the dotted line representing curve fitting.

Below we have plotted the same line (inverted) onto the precise levelling, undertaken by GeoServ Limited.



Whereas the levels capture 5 readings over 10 months (one reading every two months on average), electrolevels capture around 100 in 2 months. We can identify the point of contraflexure very quickly, confirming tree root activity as the cause.

Precise Levelling

TREE STUDY

The xylem are the fine tubes that carry water to the leaves from the roots.

Their diameter and flow rates have been studied BY Zimmermann and Brown (1971), whose findings throw considerable light on why Oak trees are such a high risk.

We can see below their flow rates are significantly higher than any other species, and the Ash isn't far behind.

	Xylem Dia. (μm)	Velocity ($m\ h^{-1}$)
Oak	250	43.6
Ash	220	27.7
Chestnut	320	24
Laburnum	160	3.9

The surprisingly low consumption of the Laburnum accounts for it being classified as very low risk.

This is another way of looking at risk by species that has a good scientific background.

BioSciences

Nature reports that the first sequence of a tree genome has been mapped. The species is Black Cottonwood.

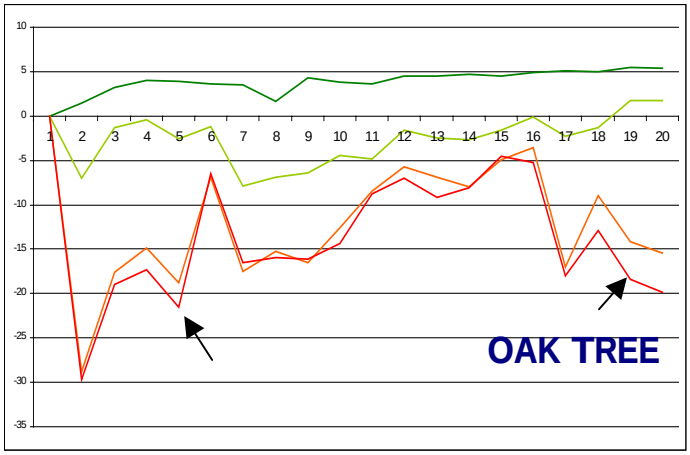
The agricultural community is looking at plant stresses and this links into the work we are doing. Glenda Jones, our PhD student on the ERT project, tells us the Australian farmers find inducing plant stress is beneficial for grape crop production.

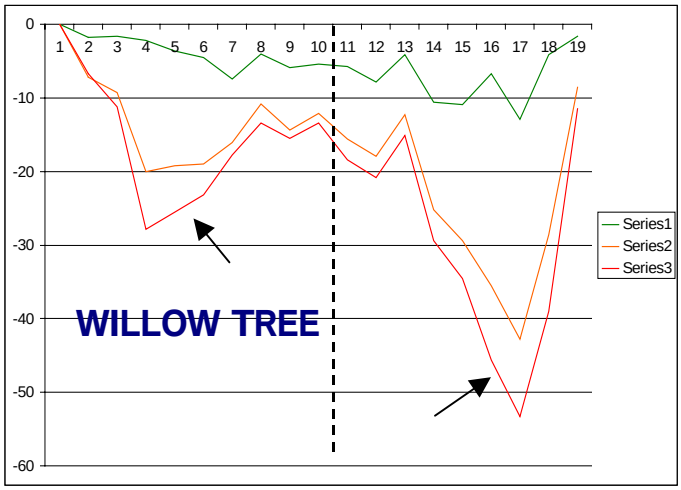
We share an interest. It is now widely recognised that the self-defence mechanism of a tree can be triggered, and its moisture uptake reduced.

This latest piece of the jigsaw will cast light on gene expression and the mRNA function that is involved with hormone production.

Precise Levelling Data 31/08/06

The levelling data shows a similar pattern to previous readings with greater amplitude of movement towards the root periphery.





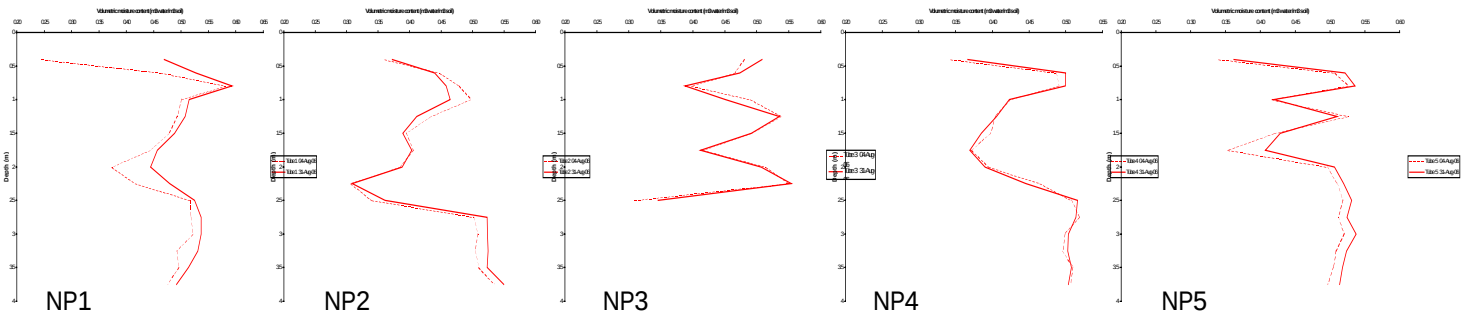
The tree sits in the centre of both graphs (bold dotted line) and the red line (arrowed) plots the latest readings. The results continue to show the presence of a zone of persistent moisture deficiency, and we see less movement directly beneath the tree, but more towards the root periphery as outlined on Page 1.

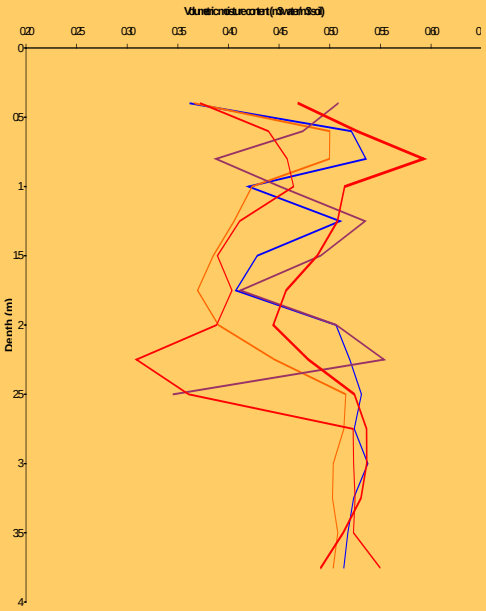
Next year we hope to re-hydrate one line of precise levels to provide evidence. The method will involve drilling holes to target the area of maximum desiccation as described by the investigation, and watering regularly the sand-filled holes.

It is a technique that has been used in the past and may have an application when resolving claims.

Neutron Probe Data

October 2006.





Composite Picture of the 31/08/06 Readings

Our thanks to …..

Our most sincere thanks to the academic teams from Southampton and Keel. Also of course Aldenham School, Hilary Skinner of the B.R.E. and our sponsors throughout the industry.

This year will see the site instrumented. We have delayed applying any site treatment following mixed results from our laboratory work, but otherwise we are on target.

This is very much a live project, with data being distributed monthly, as it is acquired. The Clay Research Group is an open forum providing a unique platform for anyone interested in clay soils to join and carry out research.

The only entry requirement is a willingness to share the data with others.

August Update

Joel Smethurst visited site on the 31st August to take a second set of readings – see above. The original readings (shown as broken line above) were taken on the 4th August and the latest readings are shown as a solid line.

The Oak is to the left of the image, with NP1 closest to the tree. NP3 was terminated at shallow depth due to striking gravel and sands – see note below.

Joel tells us there has been some modest recovery at depth (NP1, 2 and 5), and attributes this to water seeping along the casing and settling at the bottom of the tube.

The patterns are generally similar, as we would expect over the short term between readings.

NEUTRON PROBE LOCATION AND DEPTH

D = Distance from Tree
L = Length of Tube

Tube 1 – D = 5m. L = 3.8m. Grouted to depth = 3.0 m.
Tube 2 – D = 10m. L = 3.8m. Grouted to depth = 1.3 m.
Tube 3 - D = 15m. L = 2.5m*. Full length of tube grouted.
Tube 4 - D = 20m. L = 3.8m. Grouted to depth = 1.0 m.
Tube 5 – D = 25m. L = 3.8m. Grouted to depth = 2.0 m.

*power auger would go no further.