The Clay Research Group

RESEARCH AREAS

Climate Change ◆ Data Analysis ◆ Electrical Resistivity Tomography
Time Domain Reflectometry ◆ BioSciences ◆ Ground Movement
Soil Testing Techniques ◆ Telemetry ◆ Numerical Modelling
Ground Remediation Techniques ◆ Risk Analysis
Mapping ◆ Software Analysis Tools

The Clay Research Group
www.theclayresearchgroup.org

May 2008

The Clay Research Group

"Dear Diary …"

We were invited to deliver a talk to the HBOS engineers in Nottingham last week, and sat in on their soils training, delivered by Ian Hanson.

It was one of the best talks of its sort, and made use of Morph to explain what 'plastic behaviour' was, and how, when Morph stood in water, he dissolved into a slurry, but when baked in the oven at Regulo 6, he became hard and brittle – and shrunk.

The message was understood by everyone, even the non-geotechnical engineers and Ian actually managed to make soils interesting.

ASTON UNIVERSITY
BIRMINGHAM

12th June 2008 and a good attendance is expected. We will be listening to a speaker from the British Geological Survey, Glenda Jones from Keele, Tony Greenfield from Plexus Law, Kieron Hart, Marishal Thompson and Peter Osborne putting the case for the tree, with Richard Rollit overseeing events.

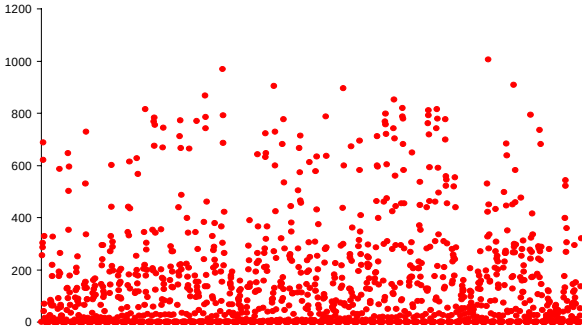
POST EVENTS
Subsidence EXPO
19 June 2008
Victoria Park Plaza
London

The Clay Research Group will be represented at this years annual Post Subsidence Expo event at Victoria Park Plaza, London on the 19th June, 2008.

We will be talking about modelling root induced subsidence in fine grained soils and looking at alternative methods of claim resolution aimed at retaining the tree and repairing the building.

Solar Radiation Sensor

Cyril Nazareth has added a Solar Radiation Sensor to the weather station, with funding provided by Marishal Thompson.



This added dataset will be of use to Southampton University as part of their Climate Change study and may reveal a pattern for our own work in the understanding of the predictive drivers behind event years.

This Edition

Predicting heave is a problem for many of our colleagues and we outline a simple technique that will allow subsidence engineers to enter data on a web application to derive a sensible estimate.

The intervention technique is discussed and reference made to Partial Root Drying. Work is due to start on site shortly.

We query the traditional view of drying root zones and appear to have support from the work being undertaken by Glenda Jones at Keele. Glenda has produced her 2nd Year report and suggests a seasonal drying pattern and a distinct 'drought stress' pattern.

Dr Allan Tew has provided a brief Case Study and we welcome hearing from anyone with unusual cases involving trees and clay soils. In this paper Allan describes the case of a 'swelling dumpling' beneath a recently erected extension, resulting in a rather unusual crack pattern.

Finally we draw support for modelling from an unexpected source. Plexus provide a commentary on Raphael –v- London Borough of Brent.

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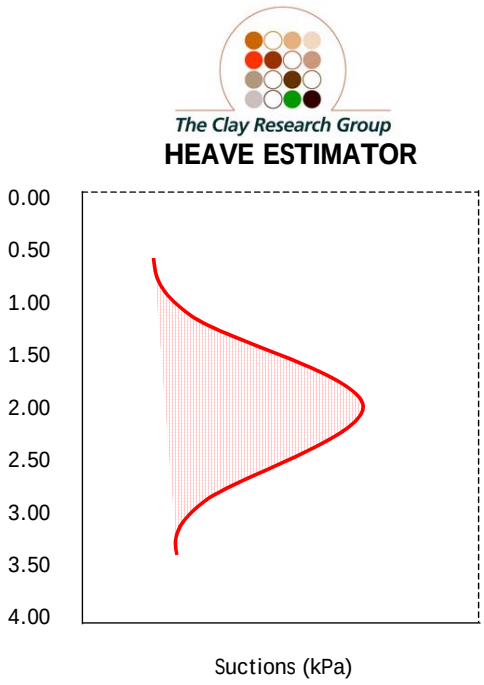
Estimating Heave

Many of our colleagues have expressed frustration when trying to estimate heave.

They are put off when they look at the complex formula's referring to geotechnical parameters like void ratios, the slope of the loading/unloading line etc., which can make calculations difficult.

The CRG are developing a simple, web based application to help engineers make a quick assessment when they have soils data.

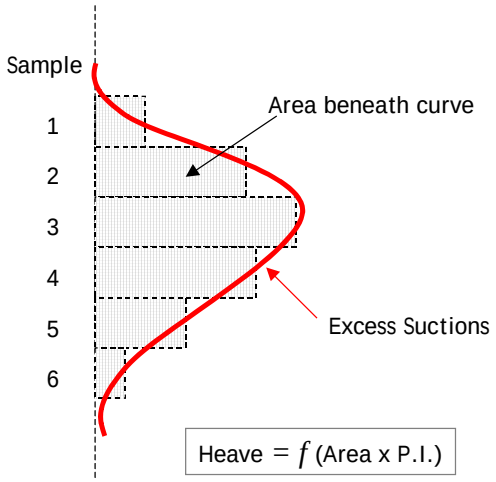
Enter the depth of sample, P.I. and excess suction or strain and the application will deliver a sensible estimate of ground movement.



We use the term 'sensible' because the application has an empirical base. It uses stochastic modelling rather than geotechnical parameters.

Using an 'area-moment' approach, and understanding the upper boundary condition - we know the sort of bulge that produces 150 – 200mm of ground movement – is far easier than comparable, more complex techniques.

The 'area-moment' method



200mm of ground movement would require high suctions over the depth of the bore and soils with a high P.I.

This is the upper boundary condition.

We know that soils with a high P.I. shrink and swell more than soils with a lower P.I.

Given that even the most sophisticated geotechnical modelling using highly expensive testing techniques only provides a best-guess, this simplified approach is adequate for routine cases involving domestic properties.

Hopefully the application will be ready for testing in the next month or so and we look forward to hearing from anyone willing to participate in the initial trials.

NOTE - If the tree is younger than the property, then there is no risk of heave – but consider extensions etc.

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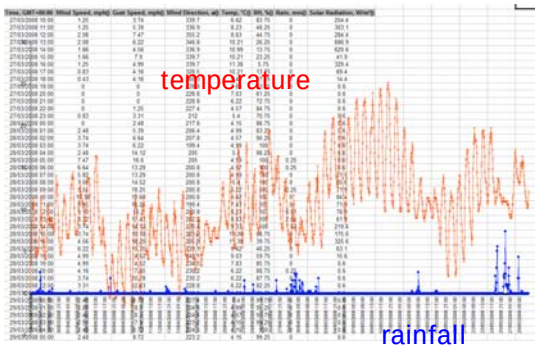
CLIMATE

Below is an extract from the Aldenham weather station, showing temperature (red) and rainfall (blue). The dry, hot weather at the beginning of May was replaced by heavy rainfall and more moderate temperatures at the end of the month.



Our climate model plots this data against the characteristic signatures of event and non-event years. On the face of it, 2008 is unlikely to see high claim numbers and this is supported by the Soil Moisture Deficit values provided by the Meteorological Office.

2006 proved to be the exception to this pattern and the data in May pointed towards a 'normal' claims year initially, but a sudden rise in the SMD in July produced a busy claims year and for that reason we will be tracking events closely.

Whilst everyone is naturally focused on whether we predict event years correctly, the real power is identifying both event and non-event years and over the last 20 years, the model has been over 90% accurate in its forecast.

Joel Smethhurst from Southampton is correlating ground movement with the moistures values obtained from the neutron probe, and elsewhere in the newsletter we see the contribution Glenda Jones is making using the ERT values.

Ground Treatment

Development work on ground treatment is now well advanced and we will be holding trials throughout 2008 on various sites where trees have caused damage to buildings on clay soils.

The treatment is thought to offer several advantages, namely…

1. Rehydration of the ground allowing repairs to be undertaken early in the following year. Instead of waiting years in cases where mature trees are involved, the homeowner could be reinstated within 12 months.

2. For the class of claim we are investigating (high value root induced clay shrinkage), ground treatment will be much cheaper – and in most cases, simpler – than alternatives.

3. In many cases, the tree will be retained.

4. The application will take between two and three days at most.

5. It is environmentally friendly and makes most use of a limited resource – water. No reliance on a mains feed or water storage tanks.

6. The treatment is aimed to trigger a natural response in the tree, taking maximum advantage of our understanding of Partial Root Drying and production of the stress hormone, ABA.

7. We hope the repair will offer a permanent solution, without prejudicing further action at some future date if required, unlike alternatives - piling or underpinning.

8. The method uses the various models we have developed, including the weather prediction and disorder models.

At each site we will fit electrolevels to detect very fine movement and install the TDR ground moisture sensors.

It is a green solution. The aim is to retain the trees. Like any research project there is a risk that it may not deliver the result we hope for but we will be issuing copies of the monitoring data to anyone interested.

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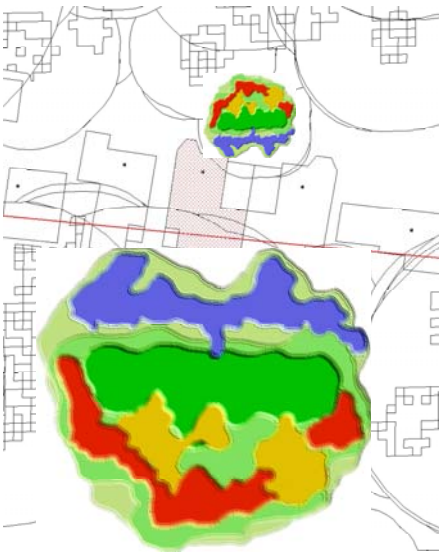
Partial Root Drying

Our early work was concentrating on how we might dry the soil to trigger the production of ABA, but more recently we have come to the view the reverse is needed.

Taking street trees as an example, even though they are less of a problem than private trees, over half of their root zone is covered by tarmac from the road, concrete drives or paving.

Our more recent work has been to understand the need to introduce water, but not by turning the garden hose on. Clearly that isn't sensible or practical in the long term.

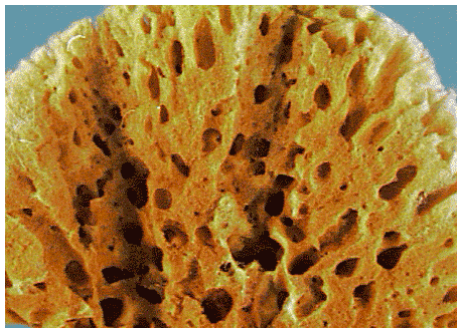
The water has a specific purpose, and that is to raise the pH in the xylem and transport the hormone 'from root to shoot'. The root zone is already depleted in dry weather. The hormone is being produced, but transporting it to the apoplast – the cells surrounding the stoma guard cells – is less efficient than it might be.



The current work identifies a material that can hold onto moisture and release it at a root induced negative pressure to deliver it where it has maximum benefit.

Partial Root Drying

Imagine having a material – a sponge – that retains moisture throughout the wet period, and 'drip feeds' the underlying soil when it is dry. The material would need to have electro-chemical properties that binds moisture to it, but releases it under gravity.

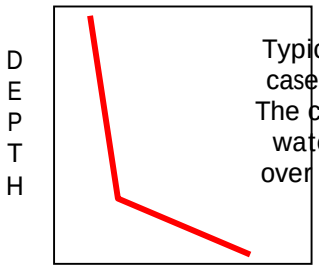


The dryer the underlying soil, the greater the pull and yet it has to keep in balance tree root suctions. The roots mustn't take moisture from the sponge too quickly, and yet the sponge must release it at a gradual rate to retain some form of equilibrium.

It sounds a little like clay soil. A clay soil overlying sand, where gravity draws moisture from the clay at a steady rate depending on the degree of saturation.

If we can change the properties of clay a little, reduce the electro-chemical force enough to retain the moisture whilst releasing it before large volumetric changes take place, it could be helpful we would imagine.

This is the first of several sites and our thanks to Crawford & Co.



Typical suction profile in cases of under-draining. The clay strata holds onto water, releasing slowly over time due to gravity.

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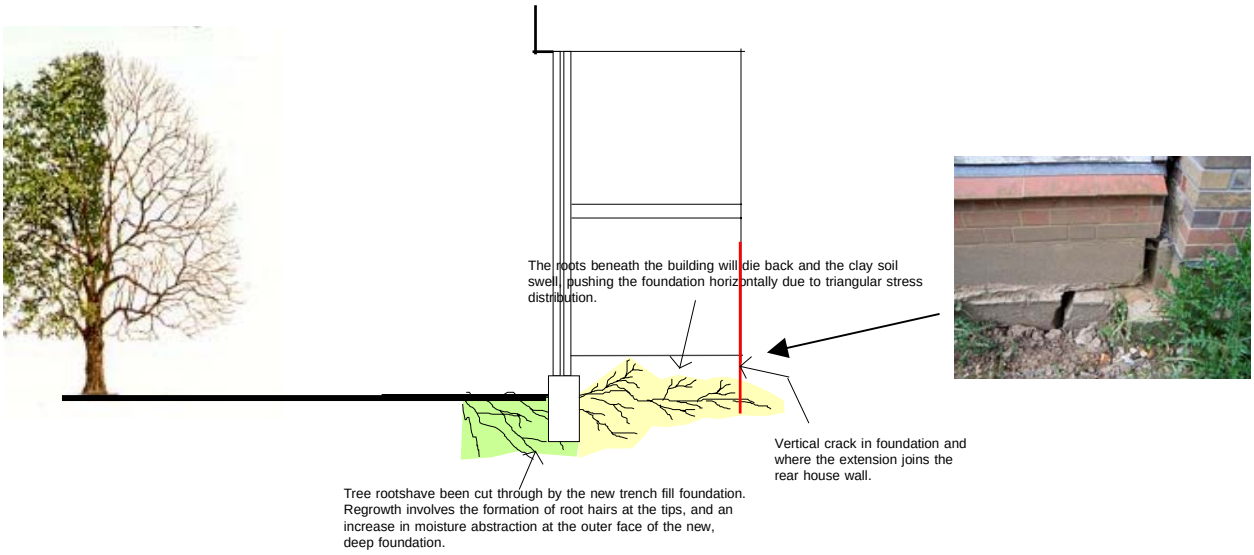
Case Study

~ Vertical Cracking between Extension and House. Rayleigh, Essex ~

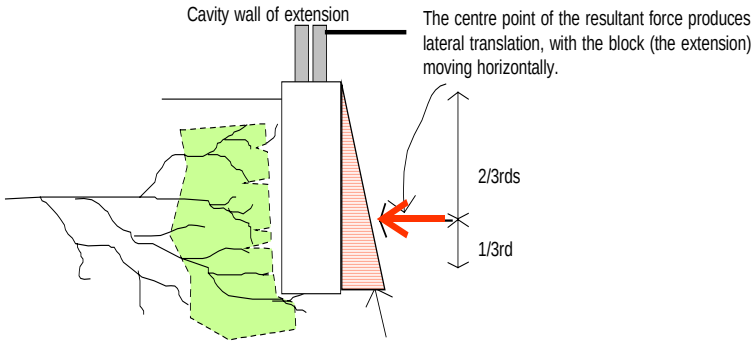
Dr Allan Tew has provided the following Case Study involving quite wide (up to 40mm), predominantly vertical cracks that had appeared between a recently constructed extension and the original house. The soil is a highly shrinkable clay (average P.I. 48%), and the builder/designer has used a deep trench foundation (1.6mtrs bGL) to cater for a nearby Ash tree, recognising that its roots would extend beneath the new structure.

The mechanism of failure indicated horizontal, translational movement which explained the vertical nature of the cracks - and was due to vertical pressure on the inner face of the deep trench fill foundation resulting from severing of the tree roots. See sketch bottom right.



The mechanism is described in a B.R.E. Digest and the correct solution would have been to incorporate compressible boarding on the inner face of the foundation at the time of construction.

As movement has apparently ceased (monitoring over one winter would provide evidence in support of this) the appropriate solution would be to dowel the structure and repair, incorporating a movement joint between the extension and the original house.



If you have a case study you would like to share, involving trees and clay soils, we would be interested to hear from you.

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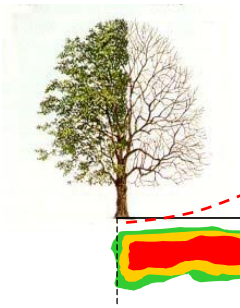
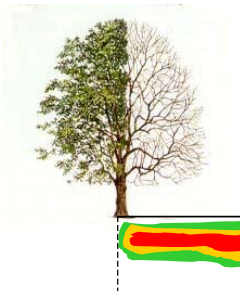
Root Zones of Mature Trees

Precise levels from beneath both the Oak and Willow at Aldenham have led us to reconsider the traditional view of ground movement beneath mature Oaks and Willows.

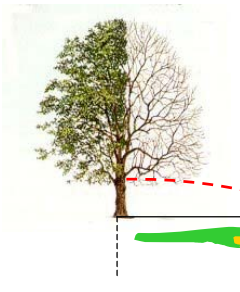
The crudely drawn images below illustrate the perhaps normally accepted view of how soils dry as a result of root induced desiccation (top).



Stage 1
A 'normal' soil stress profile with the ground profile subsiding closest to the tree, diminishing with distance. Red dotted line describes ground movement profile.



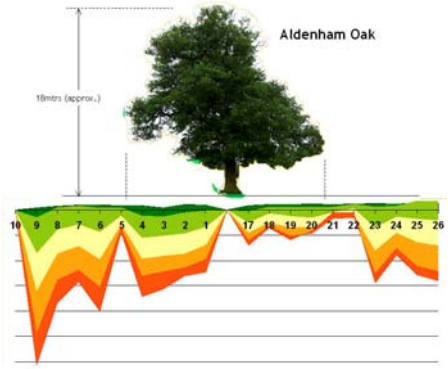
Stage 2
A combination of maturity, earlier episodes of ground drying and a few dry years can produce a persistent deficit, encouraging root growth towards the periphery.



Stage 3
The inner depletion zone remains fairly static, reversing the slope of the ground profile from that normally seen – top. The red dotted line describes the 'new' ground movement profile.

Is it the case that the roots, on depleting the zone closest to the tree, die off when there is a persistent deficit, with fresh ones extending further afield (bottom picture)? Or is it the response in a dry year, with more normal profiles being reinstated in wetter years?

Is it then the case that roots close to the tree are fewer, and less active, even if the deficit is replenished? These are the initial indications from Aldenham where there is far less ground movement close to both trees.



If this view has any merit, it might account for claims where we see more damage to the internal walls than the outer ones, even when the outer walls are closer to the tree.

Two such cases have been referred recently and one appears on Page 4 of this edition and was described more fully in the last newsletter – Edition 36.

The effect is also noted by Keele as part of their ERT study. Glenda Jones has plotted movement beneath the Willow and has recorded both seasonal and drought induced movement, with the latter influencing the soil at the root periphery.

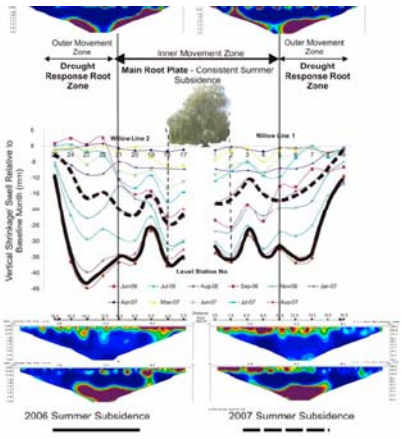


Figure 6 Summer Movement Zones

The normal seasonal pattern of drying produces a 'bowl' of ground movement more typically associated with subsidence.

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Second Year Report
Geophysical Imaging
~ Glenda Jones ~

Geophysical Imaging of Tree-Induced Subsidence, 2nd Year Report – May 2008

KEELE UNIVERSITY

06 May 2008

Geophysical Imaging of TIS (Tree Induced Subsidence) at Aldenham, Elstree, Hertfordshire, U.K.

Second Year Monitoring Results Report for InFront Solutions

Glenda M. Jones and Nigel J. Cassidy

Applied and Environmental Geophysics Group,
Research Institute for the Environment, Physical Sciences & Applied Mathematics (EPSAM)

School of Earth Sciences & Geography,
William Smith Building, Keele University, Staffs. ST5 5BG

Glenda has produced her 2nd Year Report and records the seasonal moisture changes beneath the Aldenham Willow and Oak tree at Aldenham using ERT, making comparisons with the precise levels.

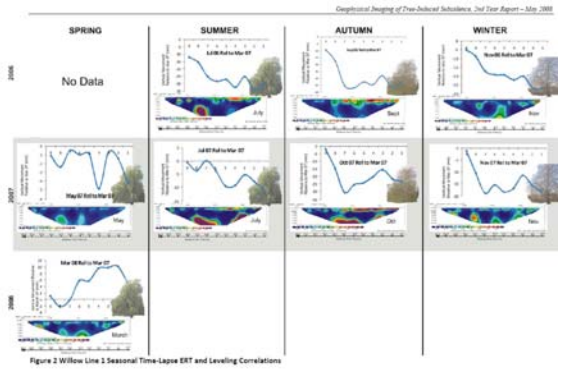

Figure 2 Willow Line 1 Seasonal Time-Lapse ERT and Leveling Correlations

Glenda is of the view that ERT provides a reliable means of detecting moisture change in fine grained soils and makes reference to much of the published work on tree root activity.

If you would like a copy, please make direct contact at the E-mail address …

g.m.jones@epsam.keele.ac.uk

Plexus Law
Case Report

Plexus report on Raphael –v- London Borough of Brent and there are important issues for the industry quite aside from the legal facts of the case.

The Technical Court arrived at a decision based on a 'balance of probability' view. They asked if it was plausible to lay blame at the foot of the tree (so to speak) based on evidence provided by precise levels alone.

plexus LAW

Raphael v London Borough of Brent

This March 2008 decision of the Technology and Construction Court within Central London County Court emphasises again the relative ease with which a claimant may prove causation in subsidence cases needing only to show that, on the balance of probabilities, the implicated tree is "an effective" cause of the damage.

In this case the Claimants alleged that the Defendant's plane tree had caused movement and crack damage to the front of their property. The Defendant denied liability.

The Defendant's view was that the Claimants' technical evidence was inadequate. Of the usual investigations only level monitoring had been undertaken. No trial pits or boreholes were excavated. No tree roots had been recovered. The experts agreed that the monitoring demonstrated seasonal movement caused by vegetation. On the basis of investigations at nearby properties the engineering experts were also able to agree the likely depth of the property's foundations.

The Defendant's position was that, absent further evidence, it was impossible to say what vegetation had caused the movement. It could equally have been caused by other smaller vegetation nearby. The Defendant's engineering expert's view was that the nature of the damage was such that it could not have been caused by the Defendant's plane tree.

The Judge found for the Claimants. He paid little attention to detailed analyses of NHBC recommendations and the Cutler and Richardson survey. He accepted the Claimants' expert's view that the plane tree was probably contributing to the movement, a view with which the Defendant's engineering expert eventually agreed during cross examination.

This decision is of interest for two reasons:

First, local authorities often request a checklist of evidence before accepting a claim or taking any action in relation to a tree. This usually includes borehole logs, soil analyses, root samples and monitoring. The Court in this case refused to take such a narrow approach on the basis that many of the relevant facts could be inferred from the monitoring results. The presence of roots could be inferred from the seasonal movement, taken together with the relative positions of the property and the vegetation.

Second, applying **Cambridge Water Co Ltd. v Eastern Counties Leather Plc** the Judge said:

"The fact that a defendant has taken reasonable precautions to prevent or minimise the risk will not of itself exonerate him from liability. Where a defendant can reasonably foresee that there is a real risk of damage to the claimant's property from the encroachment of his tree roots, allowing the tree to remain without taking such steps as to ensure that its roots will not cause damage to the claimant, is not a reasonable use by the defendant of his land. The defendant will accordingly be liable for damage sustained by the claimant however reasonable the precautions he in fact takes may seem to the outside observer."

This decision reflects a practical view that, in most cases, the presence of trees close to properties founded on clay soil is a calculated risk, whatever regular tree management is undertaken.

Plexus Law acted on behalf of the Claimants. Tom Montagu-Smith of 2 Temple Gardens, Temple, was instructed by Plexus Law.

Cases:

Raphael v London Borough of Brent [2008] TCC

Cambridge Water Co Ltd v Eastern Counties Leather Plc [1994]

For further information please contact: Anna Norrie, Partner
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Part of the Parabis Group

There was no soils data, no investigations were undertaken and no tree roots were recovered or identified.

The Courts held that the presence of roots and shrinkable soils could be deduced from the precise levels alone, sensibly enough.

Imagine the cost savings of modelling the soils, the zone of root activity and ground movement associated with desiccation, knowing the Courts are more likely to uphold a sensible diagnosis, supported by good evidence from precise levels.