Managing Risks on Brownfield Sites

Breakfast presentation at CGL Exeter 18 May 2017
Today’s Speakers

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Agenda

- What is Brownfield Land?
- What are the risks associated with the development of Brownfield Land and how can they be managed?
- Some case studies
CGL Providing Ground Solutions

GROUND INVESTIGATIONS
• Desk studies
• Boreholes
• Trial pitting
• Window samplers
• Coring
• Factual reports
• Interpretative reports

GEOTECHNICAL
• Basement Impact Assessment
• Retaining walls and slopes
• Ground movement and settlement
• Temporary works
• Groundwater risk assessment

GEOENVIRONMENTAL
• Contamination assessment
• Waste management
• Soil gas risk assessment
• Due diligence
• Remediation design
Definition of Brownfield Land

“Land that has previously been developed” (NPPF)
What constitutes “Contaminated Land”

Part 2A of the Environmental Protection Act (1990):

“...any land which appears to the local authority in whose area it is situated to be in such a condition, by reason of substances in, on or under the land, that –

A) significant harm is being caused or there is a significant possibility of such harm being caused; or

B) pollution to controlled waters is being, or is likely to be caused;....”
Why Develop Brownfield Land?
2015 Government Strategy

Objective for 2020:

To have planning permission in place on 90% of brownfield land suitable for housing

2017 Government Strategy??
Planning Policy

In England, the National Planning Policy Framework states:

“Planning policies and decisions should **encourage the effective use of land by re-using land that has been previously developed (brownfield land), provided that it is not of high environmental value.**

Local planning authorities may continue to consider the case for setting a locally appropriate target for the use of brownfield land.”
Press release
First areas to push for faster brownfield land development

From: Department for Communities and Local Government, The Rt Hon Greg Clark, and The Rt Hon Brandon Lewis
Published: 10 March 2016

Pioneering councils are to help lead the way in bringing forward derelict and underused land for new homes.

Pioneering councils are to help lead the way in bringing forward derelict and underused land for new homes, Communities Secretary Greg Clark announced today (10 March 2016).

73 councils across England will pilot one of the new brownfield registers, which will provide house builders with up-to-date and publicly available information on all brownfield sites available for housing locally.
National Planning Policy Framework

“The planning system should contribute to and enhance the natural and local environment by.... remediating and mitigating despoiled, degraded, derelict, contaminated and unstable land, where appropriate.”

“...responsibility for securing a safe development rests with the developer and/or landowner”

Planning policies and decisions should ensure that:

“After remediation, as a minimum, land should not be capable of being determined as Contaminated Land under Part 2A...”

“Adequate site investigation information, prepared by a competent person, is presented”
Useful Guidance

Model Procedures for the Management of Land Contamination

Contaminated Land Report 11
Phased Approach

- Phase 1: Desk Based Assessment
- Phase 2: Ground Investigation
- Phase 2b: Quantitative Risk Assessment
- Phase 2c: Remediation Options Appraisal
- Phase 3: Remedial Design

Implementation
Verification

Underpinned by the conceptual site model:
- Source
- Pathway
- Receptor
What are the obstacles and risks to developing brownfield land?

- Cost and programme implications to the development?
- Technical knowledge to deliver?
- Implication for unforeseen ground conditions?
- Planning and regulator/building warrantor approval for a viable scheme?
- Security of funding?
- Marketability and divestment?
- Potential long term liability if development doesn’t go ahead?
Managing Brownfield Risks

When should the potential risks be considered?

- Pre-acquisition
- Planning application/masterplanning
- Detailed design and planning condition approval
- During construction
- Divestment/project completion
Pre-acquisition

Implications of not undertaking robust due diligence:

- Costly remediation and programme delays
- Unexpected reduction in land value
- Legal prosecutions and breach of regulatory compliance conditions
Pre-acquisition - due diligence

Environmental Risk Overview

CGL Environmental Risk Overview

Project name: 
Project number: 
Client: 
Review date: 

Introduction
A suitably qualified engineer from CGL has reviewed the attached computer generated site specific Groundsure report (Geosight, Environmental and Historical maps) in order to undertake a Bronze level Environmental Risk Overview to determine the potential risk to a perspective buyer under the following headings:

Key
Green - No significant risk from the identified environmental factor. No further work required.
Amber - Significant raised risk or unknown element requiring limited additional desk based research or enquiry.
Red - Immediate consideration of continued involvement caused or raised awareness of need for significant documentation to be made available by vendor.

Site historical development
On earliest maps site was part of Plywood Farm. By 1953 a Works with Tanks and Bristol Airport were located within 150m of the site. On the 1969 map an area of Angle was indicated across the eastern area of the site and the Airport was no longer indicated. By 1970 the site had become Playing Fields and Airport Road had been constructed along the southern boundary. On the maps from 2002 the site was indicated as its current layout with Roman Farm Road along the eastern boundary with an industrial area and Depot to the north and east. A residential development was located along the western boundary. Airport Road has become Hen grove Way and is noted to be within a cutting.

Environmental permits, issues and registers
One current Part B Environmental Permit registered to Hen grove Way Service Station for "unloading of petrol" - no enforcement information received.
One licensed discharge consent within 100m of the site relating to agriculture.

Landfill and other waste sites
One historic landfill site within 100m of the site. No further information regarding type of waste etc. provided.

Current and local land use
Current Industrial land use (Petrol and Fuel Station and Vehicle Cleaning Service) indicated on site.
12 other potentially contaminative industrial sites within 250m

Geology, hydrogeology and hydrology
Artificial/Made Ground indicated on site - potential source of contamination.
No superficial deposits recorded.
Bedrock - Charmouth Mudstone Formation - low permeability and unproductive strata.
The site is not located within a Source Protection Zone.
No surface water features within 500m of the site.

Flooding
The site is not at risk from flooding.

Environmentally sensitive sites
No environmentally sensitive sites are located within 1km of the site.

Natural hazards, mining and subsidence
The Groundsure report indicates that the site is located within the specified search distance of an identified mining area and that the Coal Authority should be contacted for further information. However, inspection of the Coal Authority risk maps for Bristol (as appended) indicate that the site is in a 'Development Low Risk' area and that there are no past shallow mine workings or mine shafts in close vicinity to the site.

Regulatory issues
CGL have contacted the Contaminated Land Officer at Bristol City Council. Discussion with the CLO indicates that the site is considered to be Category 4 (Low Risk) with regards to Part 2A in its current use and would therefore be unlikely to be investigated as contaminated land. A fuel spillage from a car is known to have taken place at the site in 2005 and was reported to the Petroleum Officer; however, the spillage was dealt with to the satisfaction of the Council. The Environment Agency have also been contacted; however, a response has not yet been received.

Conclusions
The site is currently a Petrol Filling Station and Made Ground is indicated to be present underlying the site, both of which may provide a potential source of contamination. Assuming the purchaser is satisfied that the site is in good condition and as the site is to remain in its current use, the above is not considered to present an increased risk to the perspective buyer.

Author: 
Checked by: 

Sarah Key, Senior Engineer 
Nick Langdon, Director
More detailed pre-acquisition surveys

- Full desk study and preliminary risk assessment
- Site investigation and risk assessment
- Allows risks to be priced and incorporated into purchase negotiation and agreeing land value
- Risk register for uncertainties
Planning application/Masterplanning Stage

- Typically a desk study is satisfactory to support a planning application
- Objective is to produce a Preliminary Conceptual Site Model based on available information
Desk study – site history

Gas holders
Site walkover
Desk study

Published geology
Desk study

Unpublished geology
Receptors

- Future residents/site users
- Off-site users
- Construction workers
- Groundwater/surface water
- Other environmental receptors
Preliminary Conceptual Site Model

**Sources**
1) Onsite sources
2) Offsite sources
3) Soil gas from Natural Soils
4) Soil gas from Made Ground

**Pathway**
1) Ingestion of soils or dust
2) Ingestion of particles or vapours
3) Dermal contact
4) Root uptake
5) Vapour / soil gas migration
6) Migration through permeable soils
7) Direct contact (Attack concrete)

**Receptors**

a) Construction workers
b) Future site occupiers
c) Users of neighbouring college building
d) Groundwater
e) Vegetation
f) Internal building spaces
g) Buildings and structures
Phase 2: Site investigation/risk assessment

Objectives:

• To evaluate potential risks identified within the desk study (geoenvironmental and geotechnical)
• Further refine the conceptual site model
• Establish whether mitigation is required

Occasionally required to support a planning application (e.g. high risk sites or to support and EIA)

More typically a pre-commencement planning condition
Why might you choose to undertake a site investigation pre-planning?

- To reduce requirements for discharge of pre-commencement planning conditions
- Understand remediation requirements and associated construction costs and programme implications
- Material re-use – cut and fill earthworks balance to establish final finish levels
Ground Investigation - Methods
Data interpretation and CSM
Geoenvironmental
Detailed Risk Assessment

**Level 1 - Soil**

- **Contaminant**
  - **Target concentration**
  - **Input Parameters**
    - **Variable**
    - **Value**
    - **Unit**
    - **Source of parameter value**

**Level 1 Remedial Target**

- **Remedial Target**
  - **mg/kg**
  - **mpg/l**

**Interactive CLEA software guide**

- **Generic assessment criteria (basic)**
  - **STEP 1**: Report Details
  - **STEP 2**: Basic Settings
  - **STEP 3**: Select Chemicals
  - **STEP 4**: Find Results

- **Site-specific assessment criteria (advanced)**
  - **STEP 1**: Report Details
  - **STEP 2**: Basic Settings
  - **STEP 3**: Select Chemicals
  - **STEP 4**: Advanced Settings
  - **STEP 5**: Find Results

**Database management**

- **Buildings** (Add / Edit)
- **Chemicals** (Add / Edit)
- **Land Uses** (Add / Edit)
- **Soils** (Add / Edit)

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Remediation strategy

- Typically pre-commencement condition
- Remediation objectives
- Details of remediation to be undertaken
- Verification plan
- Long term monitoring/maintenance requirements
Typical remediation requirements on a brownfield site

- Some limited contamination identified, principally in the Made Ground

- Potential risk to human health
  - Direct contact/ingestion
  - Ground gas
  - Permeation into water supply pipework

- Remediation strategy:
  - Capping layers
  - Gas/vapour protection measures
  - Upgraded water supply pipes/over-dug service corridors
  - Watching brief/discovery strategy for unforeseen contamination
Higher risk/more sensitive sites

- Free phase oils etc/gross contamination
- Potential risk to controlled waters
- More extensive remediation may be required
- Remediation options appraisal to develop cost effective remediation strategy
- Remediation requirements may include:
  - Soil removal/disposal
  - In-situ or ex-situ soil or groundwater remediation
Remediation Verification

- To demonstrate approved remediation strategy has been implemented
- Planning requirement – pre occupation
- Building warrantor requirement - CMLs
- Independent
- Critical that project team, including contractor is aware of requirements
Remediation Verification

- Site visits during earthworks
- Inspection of ground gas protection measures
- Inspection of capping layers
- Obtain details of water supply pipes
- Discovery Strategy

Verification report for submission to planning
Managing risks during construction - asbestos

- Asbestos in buildings to be demolished
- Asbestos in Made Ground
- Asbestos in demolition material (site derived and imported)
- Cross contamination through use of plant and equipment
- Risk based approach to asbestos
Case studies
Examples of brownfield in the south-west

Urban

Rural
Case Study 1 – Infilled Pond
Case Study 1 – Infilled Pond

- An unacceptable risk is considered to be present to the receptors identified, therefore remediation is required.

- Health and Safety
  - Appropriate PPE to be used by construction workers
  - Appropriate material management systems

- Waste Hierarchy and Classification
  - **Reduce**
  - **Reuse**
  - **Recycle**
  - **Recovery**
  - **Landfill**

- **Reuse**
  - On site treatment of material.

- **Recovery**
  - Offsite treatment of materials.
Case Study 1 – Infilled Pond

Gas monitoring data

- Tier 1 Risk Assessment undertaken in accordance with CIRIA C665.
- The ground gas regime was characterised as green in accordance with the NHBC traffic light classification.
- No special precautions required

<table>
<thead>
<tr>
<th>Location</th>
<th>Response Zone</th>
<th>Flow (max l/hr)</th>
<th>O2 (min %)</th>
<th>Peak CO₂ (max %)</th>
<th>CO₂ (Steady State %)</th>
<th>VOC (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WS1</td>
<td>Beacon Limestone</td>
<td>&lt;0.1</td>
<td>15.1</td>
<td>4.5</td>
<td>4.5</td>
<td>0.1</td>
</tr>
<tr>
<td>WS2</td>
<td>Beacon Limestone</td>
<td>&lt;0.1</td>
<td>17.8</td>
<td>2.3</td>
<td>2.3</td>
<td>0.3</td>
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<tr>
<td>WS3</td>
<td>Beacon Limestone</td>
<td>&lt;0.1</td>
<td>15.9</td>
<td>3.2</td>
<td>3.2</td>
<td>0.1</td>
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<tr>
<td>WS4</td>
<td>Beacon Limestone</td>
<td>&lt;0.1</td>
<td>16.5</td>
<td>3.8</td>
<td>3.8</td>
<td>0.5</td>
</tr>
<tr>
<td>WS5</td>
<td>Made Ground</td>
<td>&lt;0.1</td>
<td>9.3</td>
<td>5.8</td>
<td>2.5</td>
<td>0.3</td>
</tr>
</tbody>
</table>
Case Study 2 – Ground Gas Risk Assessment

Sources of ground gas
- Made Ground
- Alluvium

Gas monitoring results
- Carbon Dioxide = 7.4%
- Methane = <0.1%
- Flow Rate = 10.1 l/hr
Case Study 2 – Ground Gas Risk Assessment

Tier 1 Risk Assessment – Amber 1 require with a propriety gas membrane with a suspended underfloor void in accordance with CIRIA C665.

Basic Radon Protection measures required

Tier 2 Risk Assessment – Fault Tree Analysis in accordance with CIRIA C152

<table>
<thead>
<tr>
<th>Input Parameter</th>
<th>Residential Scenario</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon dioxide concentration</td>
<td>7.4%</td>
<td>Worst case peak carbon dioxide concentration recorded as part of the monitoring period.</td>
</tr>
<tr>
<td>Flow rate</td>
<td>10.1l/hr</td>
<td>Peak flow rate</td>
</tr>
<tr>
<td>Room size</td>
<td>1.5m x 1.5m x 2.5m</td>
<td>Smallest room in the house, based on a downstairs toilet, with a soil pipe passing through the sub-floor void.</td>
</tr>
<tr>
<td>Occupation Rate (O)</td>
<td>80%</td>
<td>Residential properties are assumed to be occupied approximately 80% of the time.</td>
</tr>
<tr>
<td>Detection (D)</td>
<td>1.0</td>
<td>The buildings are not expected to have carbon dioxide detection equipment.</td>
</tr>
<tr>
<td>Ventilation (V)</td>
<td>Calculated by model</td>
<td>No mechanical ventilation assumed. One air change per day is assumed (i.e. cupboard opened once a day).</td>
</tr>
<tr>
<td>Entry (E)</td>
<td>0.0000255</td>
<td>Probability of a crack being present in the concrete slab beneath the cupboard is assumed to be 0.001. Probability of a defect being present in the membrane is calculated to be 0.0255. This is conservative.</td>
</tr>
<tr>
<td>Migration (M)</td>
<td>1.0</td>
<td>Source of land gas is assumed to be in the soils beneath the foundations and therefore no migration is assumed.</td>
</tr>
<tr>
<td>Barrier (B)</td>
<td>1.0</td>
<td>No barrier that could impact gas migration is assumed to be present.</td>
</tr>
<tr>
<td>Potential (P)</td>
<td>1.0</td>
<td>Based on monitoring data, gas generation potential is assumed.</td>
</tr>
<tr>
<td>Conditions (C)</td>
<td>1.0</td>
<td>Conditions that support carbon dioxide generation are assumed to be present on the site.</td>
</tr>
</tbody>
</table>
### Results of Tier 2 Risk Assessment

<table>
<thead>
<tr>
<th>Gas concentration in air (Consequence)</th>
<th>Calculated annual frequency to exceed maximum concentration</th>
<th>Pass or Fail the $1 \times 10^6$ frequency</th>
<th>Time to reach critical concentration (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5 (8 hour exposure limit)</td>
<td>$7.84 \times 10^{-7}$</td>
<td>Pass</td>
<td>7</td>
</tr>
<tr>
<td>3.0 (Breathing difficulties)</td>
<td>$1.31 \times 10^{-7}$</td>
<td>Pass</td>
<td>41</td>
</tr>
<tr>
<td>5.0 (Asphyxiation)</td>
<td>$7.84 \times 10^{-8}$</td>
<td>Pass</td>
<td>69</td>
</tr>
</tbody>
</table>

On the basis of the fault tree assessment gas protection measures above basic radon protection measures are not required at the site.
Case Study 3 - Arsenic

Naturally occurring metals in south-west

Arsenic

Nickel
## Case Study 3 - Arsenic

<table>
<thead>
<tr>
<th>Sample</th>
<th>Arsenic (mg/kg)</th>
<th>Bioavailability (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TP1</td>
<td>64</td>
<td>7.9</td>
</tr>
<tr>
<td>TP2</td>
<td>79</td>
<td>7.8</td>
</tr>
<tr>
<td>TP3</td>
<td>82</td>
<td>8.1</td>
</tr>
<tr>
<td>TP4</td>
<td>80</td>
<td>3.8</td>
</tr>
<tr>
<td>TP5</td>
<td>58</td>
<td>11.5</td>
</tr>
<tr>
<td>TP6</td>
<td>43</td>
<td>9.2</td>
</tr>
<tr>
<td>TP7</td>
<td>36</td>
<td>11.2</td>
</tr>
<tr>
<td>TP8</td>
<td>46</td>
<td>9.9</td>
</tr>
<tr>
<td>TP9</td>
<td>79</td>
<td>9.6</td>
</tr>
<tr>
<td>TP10</td>
<td>81</td>
<td>3.7</td>
</tr>
</tbody>
</table>

**Generic Assessment Criteria** – 32mg/kg

**Site Specific Assessment Criteria** – 112mg/kg