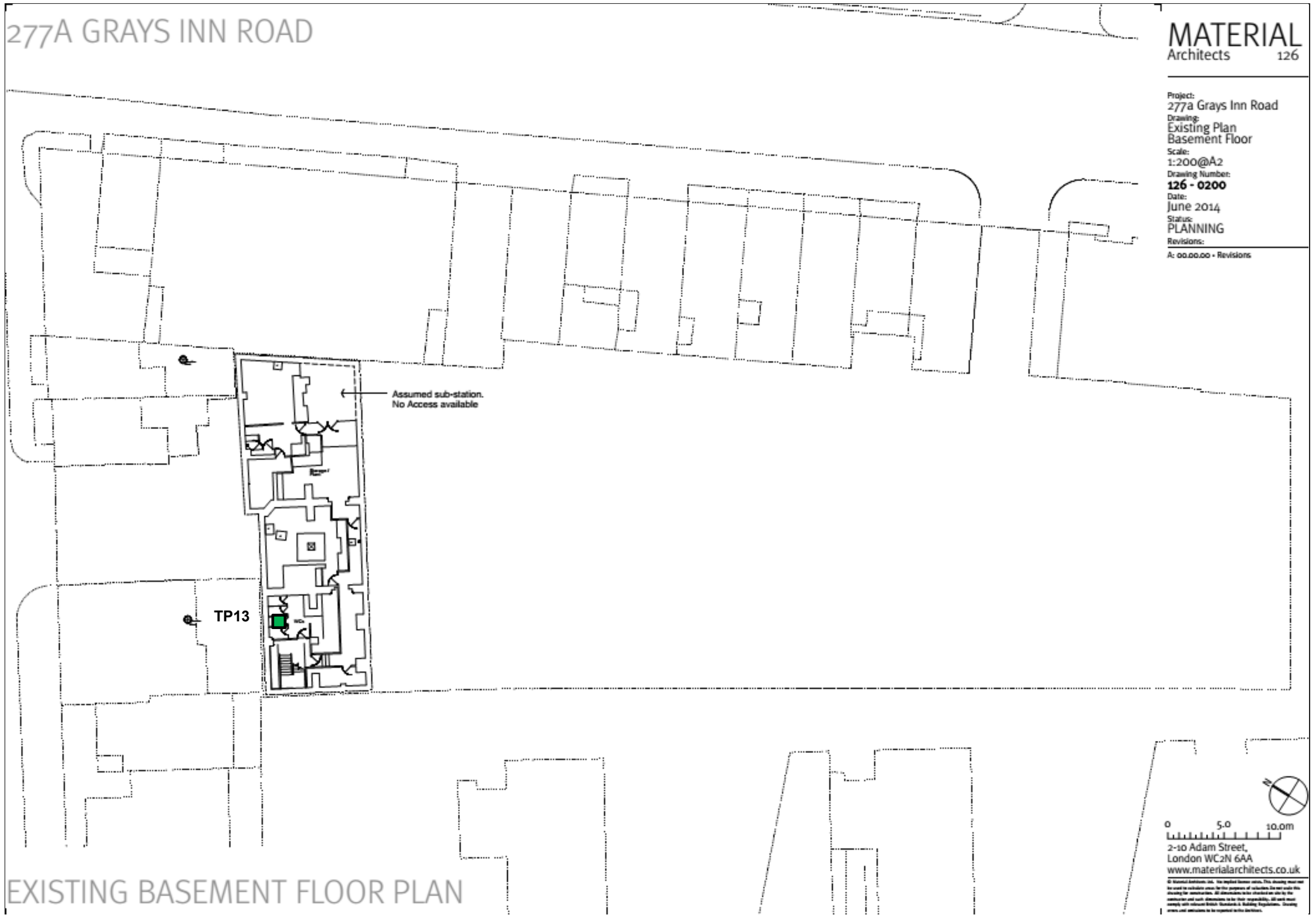


Appendix A Planning Permission.

Camden

Regeneration and Planning
Development Management
London Borough of Camden
Town Hall
Judd Street
London
WC1H 8ND

Tel 020 7974 4444
Textlink 020 7974 6866

planning@camden.gov.uk
www.camden.gov.uk/planning

Kieron Hodgson /
Rebecca Dewey
Iceni Projects
Flitcroft House
114-116 Charing Cross Road
London
WC2H 0JR

Application Ref: **2014/4267/P**
Please ask for: **Gavin Sexton**
Telephone: 020 7974 **3231**

10 October 2014

Dear Sir/Madam

DECISION

Town and Country Planning Act 1990 (as amended)

Full Planning Permission Granted Subject to a Section 106 Legal Agreement

Address:
277A Gray's Inn Road
London
WC1X 8QF

Proposal:
Demolition of existing building and comprehensive mixed-use redevelopment of the site to provide 60 residential units (including 14 affordable flats) comprising: 56 units arranged around the new open space (seven x 2 storey houses plus lower-ground floor, 49 x flats in 3, 7 and 8 storey blocks plus lower-ground floor) and 4 flats in a 4 storey plus lower-ground building on St Chads street, with ancillary basement gym; with offices at ground and lower-ground floor, café/gallery (Class A1/Class A3) at ground floor, together with cycle parking, access, landscaping, boundary treatments and associated works.
Drawing Nos: Supporting documents:
Daylight/Sunlight Assessment, by GVA Schatunowski Brooks June 2014; Letter from Ian Absolon (GVA Schatunowski Brooks) dated 18th August 2014 re Sunlight/Daylight with accompanying sheet 'Job 13 - Amenity results new wall height'; Design and Access Statement, prepared by Material Architects; Letter from Andy Robertson (Peter Brett Associates) 26th June 2014 re Flood risk assessment with associated appendices. Letter from J W S Mayes (Spencer Mayes) dated 27th August 2014 re SUDs proposal; Heritage Statement June 2014 by KM Heritage; Landscape Design Statement Revision A 15th August 2014 by Tyrens-Mesh Partnerships; Marketing Report by Gerald Eve LLP ref

Shay/AD/G6215; Transport Statement June 2014 by Iceni Projects; Energy Statement by Environ June 2014 refUK11-19893; Sustainability Statement by Environ June 2014 refUK11-19893; Code for Sustainable Homes and BREEAM Pre-assessment by Environ June 2014 refUK11-19893; Ecological Assessment by Environ June 2014 UK1119893; Air Quality Assessment by Environ June 2014 refUK11-19893; Noise Assessment by Sharps Redmore, No 1414511 (dated 26th June 2014); Basement Impact Assessment Rev 02 by Pringeur James; Phase 1 Desk stop study report (ref. 12138) by Herts & Essex Site investigations; Mechanical and Electrical Services Report Planning Issue Rev01 by Spencer Mayes.

Drawings:
Prefix 126- 0100, 0200, 0201, 0202, 0301, 0302, 0303, 0401, 0402, 0403, 0404, 0900, 0901, 0902, 0903, 0904, 1101, 1200A, 1201A, 1202B, 1203B, 1204B, 1205B, 1206A, 1207B, 1208B, 1209, 1301, 1302A, 1303A, 1304A, 1305A, 1306A, 1401B, 1402, 1403, 1404A, 1405A, 1406A, 1501, 1502, 1503, 1504, 1505, 1506A, 1507, 1508A, 1601, 1602, 1603, 1604, 1605, 1606, 1607, 1608, 1609, 1610, 1611, 1612, 1613, 1614, 1621, 1622. Landscape hardworks 055-055_300A, Landscape softworks 055-055_300A

The Council has considered your application and decided to grant permission subject to the following condition(s):

Condition(s) and Reason(s):

1 The development hereby permitted must be begun not later than the end of three years from the date of this permission.

Reason: In order to comply with the provisions of Section 91 of the Town and Country Planning Act 1990 (as amended).

2 The development hereby permitted shall be carried out in accordance with the following approved plans and drawings approved subsequently by the local planning authority pursuant to conditions on this decision notice:

Drawings:
Prefix 126- 0100, 0200, 0201, 0202, 0301, 0302, 0303, 0401, 0402, 0403, 0404, 0900, 0901, 0902, 0903, 0904, 1101, 1200A, 1201A, 1202B, 1203B, 1204B, 1205B, 1206A, 1207B, 1208B, 1209, 1301, 1302A, 1303A, 1304A, 1305A, 1306A, 1401B, 1402, 1403, 1404A, 1405A, 1406A, 1501, 1502, 1503, 1504, 1505, 1506A, 1507, 1508A, 1601, 1602, 1603, 1604, 1605, 1606, 1607, 1608, 1609, 1610, 1611, 1612, 1613, 1614, 1621, 1622. Landscape hardworks 055-055_300A, Landscape softworks 055-055_300A,

Supporting documents:
Daylight/Sunlight Assessment, by GVA Schatunowski Brooks June 2014; Letter from Ian Absolon (GVA Schatunowski Brooks) dated 18th August 2014 re Sunlight/Daylight with accompanying sheet 'Job 13 - Amenity results new wall height'; Design and Access Statement, prepared by Material Architects; Letter from Andy Robertson (Peter Brett Associates) 26th June 2014 re Flood risk assessment with associated appendices. Letter from J W S Mayes (Spencer Mayes) dated 27th

August 2014 re SUDs proposal; Heritage Statement June 2014 by KM Heritage; Landscape Design Statement Revision A 15th August 2014 by Tyrens-Mesh Partnerships; Marketing Report by Gerald Eve LLP ref Shay/AD/G6215; Transport Statement June 2014 by Iceni Projects; Energy Statement by Environ June 2014 refUK11-19893; Sustainability Statement by Environ June 2014 refUK11-19893; Code for Sustainable Homes and BREEAM Pre-assessment by Environ June 2014 refUK11-19893; Ecological Assessment by Environ June 2014 UK1119893; Air Quality Assessment by Environ June 2014 refUK11-19893; Noise Assessment by Sharps Redmore, No 1414511 (dated 26th June 2014); Basement Impact Assessment Rev 02 by Pringeur James; Phase 1 Desk stop study report (ref. 12138) by Herts & Essex Site investigations; Mechanical and Electrical Services Report Planning Issue Rev01 by Spencer Mayes.

Reason: For the avoidance of doubt and in the interest of proper planning.

3 Detailed drawings, or samples of materials as appropriate, in respect of the following, shall be submitted to and approved in writing by the local planning authority before the relevant part of the work is begun:

a) Details including sections at 1:10 of all windows (including jambs, head and cill), ventilation grills, external doors and gates;

b) Plan, elevation and section drawings, including fascia, pilasters and glazing panels of the new shop fronts at a scale of 1:10;

c) Typical plan, elevation and section drawings of balustrading to terraces and balconies;

d) Manufacturer's specification details of all facing materials (to be submitted to the Local Planning Authority) and samples of those materials (to be provided on site).

The relevant part of the works shall be carried out in accordance with the details thus approved and all approved samples shall be retained on site during the course of the works.

Reason: To safeguard the appearance of the premises and the character of the immediate area in accordance with the requirements of policy CS14 of the London Borough of Camden Local Development Framework Core Strategy and policies DP24 and DP25 of the London Borough of Camden Local Development Framework Development Policies.

4 No lights, meter boxes, flues, vents or pipes, and no telecommunications equipment, alarm boxes, television aerials or satellite dishes shall be fixed or installed on the external face of the buildings, without the prior approval in writing of the local planning authority.

Reason: To safeguard the appearance of the premises and the character of the immediate area in accordance with the requirements of policy CS14 of the London Borough of Camden Local Development Framework Core Strategy and policies DP24 and DP25 of the London Borough of Camden Local Development

Framework Development Policies.

5 Sample panels of the following shall be provided on site and shall be approved in writing by the local planning authority before the relevant parts of the works are commenced:

a. Typical courtyard flatted elevation (minimum 2m x 2m in size) including glazed opening showing reveal and header detail and elevation brickwork showing the colour, texture, face-bond and pointing of each of the two brick colours
b. Typical courtyard house elevation (minimum 2m x 2m in size) including fixed panel glazing and aluminium cladding showing junction and elevation brickwork showing the colour, texture, face-bond and pointing of each of the two brick colours

The approved panels shall be retained on location until the work has been completed.

Reason: To safeguard the appearance of the premises and the character of the immediate area in accordance with the requirements of policy CS14 of the London Borough of Camden Local Development Framework Core Strategy and policies DP24 and DP25 of the London Borough of Camden Local Development Framework Development Policies.

6 No development (other than site clearance & preparation, relocation of services, utilities and public infrastructure and demolition),shall take place until full details of hard and soft landscaping and means of enclosure of all un-built, open areas have been submitted to and approved by the local planning authority in writing. Such details shall include the following:

a. lighting to the open space and on-site public areas
b. external CCTV and security monitors/fixtures
c. measures to prevent vehicles from entering the site
d. the courtyard planters including sections, materials and finishes and planting schedules including a detailed scheme of maintenance and irrigation
e. design of integrated play equipment including details of materials and finishes
f. samples of all ground surface materials and finishes
g. a sample panel of the boundary wall to the Birkenhead Estate demonstrating the reclaimed brickwork, showing the face-bond (including hit and miss) and pointing

The relevant part of the works shall not be carried out otherwise than in accordance with the details thus approved.

Reason: To ensure that the development achieves a high quality of landscaping which contributes to the visual amenity and character of the area in accordance with the requirements of policy CS14 and policy CS15 of the London Borough of Camden Local Development Framework Core Strategy and policy DP24 of the London Borough of Camden Local Development Framework Development Policies.

7 All hard and soft landscaping works shall be carried out in accordance with the approved landscape details prior to the occupation for the permitted use of the development. Any trees or areas of planting which, within a period of 5 years from the completion of the development, die, are removed or become seriously damaged or diseased, shall be replaced as soon as is reasonably possible and, in any case, by not later than the end of the following planting season, with others of similar size and species, unless the local planning authority gives written consent to any variation.

Reason: To ensure that the landscaping is carried out within a reasonable period and to maintain a high quality of visual amenity in the scheme in accordance with the requirements of policies CS14 and CS15 of the London Borough of Camden Local Development Framework Core Strategy and policy DP24 of the London Borough of Camden Local Development Framework Development Policies.

8 Noise levels at a point 1 metre external to sensitive facades shall be at least 5dB(A) less than the existing background measurement (LA90), expressed in dB(A) when all plant/equipment (or any part of it) is in operation unless the plant/equipment hereby permitted will have a noise that has a distinguishable, discrete continuous note (whine, hiss, screech, hum) and/or if there are distinct impulses (bangs, clicks, clatters, thumps), then the noise levels from that piece of plant/equipment at any sensitive façade shall be at least 10dB(A) below the LA90, expressed in dB(A).

Reason: To safeguard the amenities of the adjoining premises and the area generally in accordance with the requirements of policy CS5 of the London Borough of Camden Local Development Framework Core Strategy and policies DP26 and DP28 of the London Borough of Camden Local Development Framework Development Policies.

9 At least 28 days before development commences (other than site clearance & preparation, relocation of services, utilities and public infrastructure, but prior to removal of any soil from the site),:

(a) a written programme of ground investigation for the presence of soil and groundwater contamination and landfill gas shall be submitted to and approved by the local planning authority in writing; and

(b) following the approval detailed in paragraph (a), an investigation shall be carried out in accordance with the approved programme and the results and a written scheme of remediation measures shall be submitted to and approved by the local planning authority in writing.

The remediation measures shall be implemented strictly in accordance with the approved scheme and a written report detailing the remediation shall be submitted to and approved by the local planning authority in writing prior to occupation.

Reason: To protect future occupiers of the development from the possible presence of ground contamination arising in connection with the previous

industrial/storage use of the site in accordance with policy CS5 of the London Borough of Camden Local Development Framework Core Strategy and policy DP26 of the London Borough of Camden Local Development Framework Development Policies.

10 Before the development (other than site clearance & preparation, relocation of services, utilities and public infrastructure and demolition),commences, details of secure and covered cycle storage area for 192 cycles shall be submitted to and approved by the local planning authority. The approved storage areas shall be provided in their entirety prior to the first occupation of any of the new units, and permanently retained thereafter.

Reason: To ensure the development provides adequate cycle parking facilities in accordance with the requirements of policy CS11of the London Borough of Camden Local Development Framework Core Strategy and policy DP17of the London Borough of Camden Local Development Framework Development Policies.

11 The lifetime homes features and facilities, as indicated on the drawings and documents hereby approved shall be provided in their entirety prior to the first occupation of any of the new residential units.

Reason: To ensure that the internal layout of the building provides flexibility for the accessibility of future occupiers and their changing needs over time, in accordance with the requirements of policy CS6 of the London Borough of Camden Local Development Framework Core Strategy and policy DP6 of the London Borough of Camden Local Development Framework Development Policies.

12 Prior to first occupation of the courtyard houses in block D, the boundary wall with the adjoining properties on Gray's Inn Road shall be completed to a height of no less than 1.7m above the level of the house roof terraces at 1st floor.

Reason: In order to prevent unreasonable overlooking of neighbouring properties in accordance with the requirements of policy CS5 of the London Borough of Camden Local Development Framework Core Strategy and policy DP26 of the London Borough of Camden Local Development Framework Development Policies.

13 Ductwork associated with Food & Drink uses

Prior to commencement of development, (other than site clearance & preparation, relocation of services, utilities and public infrastructure and demolition) principal details of the extract ventilating system associated with the ground floor food and drink uses hereby approved, shall be submitted to and approved in writing by the Local Planning Authority.

Such details to include routing of ducts and discharge points and associated acoustic isolation and sound and vibration attenuation measures and an Acoustic Impact report prepared by a suitably qualified and experienced acoustic engineer which sets out how the equipment would meet the council's published noise and

vibration standards.

The equipment shall be installed in accordance with the details thus approved and acoustic isolation shall thereafter be maintained in accordance with the manufacturers' recommendations.

In the event of no satisfactory ventilation being provided, no primary cooking shall take place on the premises.

Reason: To safeguard the amenities of the adjoining premises and the area generally in accordance with the requirements of policy CS5 of the London Borough of Camden Local Development Framework Core Strategy and policies DP26 and DP28 of the London Borough of Camden Local Development Framework Development Policies.

14 Prior to first occupation of any flats in blocks A or B, details of measures, such as privacy screens, to the roof terraces at third floor level and above, to protect the privacy of occupants of the development, shall be submitted to and approved in writing by the local planning authority.

All such measures shall be implemented prior to first occupation of the development and shall be permanently retained.

No part of the roofs to Blocks A and B, other than the areas identified on the approved drawings as terraces, shall be used as outdoor amenity space.

Reason: In order to prevent unreasonable overlooking of neighbouring premises in accordance with the requirements of policy CS5 of the London Borough of Camden Local Development Framework Core Strategy and policy DP26 of the London Borough of Camden Local Development Framework Development Policies.

15 Prior to first occupation of any flats in Block C, the details of measures, such as privacy screens shall be submitted to and approved in writing by the local planning authority. Such details to include:

a. Privacy measures to the roof terraces at first floor level to protect the privacy of occupants of the development and

b. The privacy screen to the 2nd floor terrace to protect the privacy of neighbours

All such measures shall be implemented in accordance with the approved details prior to first occupation of the development and shall be permanently retained.

No part of the roofs to Block C, other than the areas identified on the approved drawings as terraces, shall be used as outdoor amenity space.

Reason: In order to prevent unreasonable overlooking of neighbouring premises in accordance with the requirements of policy CS5 of the London Borough of Camden Local Development Framework Core Strategy and policy DP26 of the London Borough of Camden Local Development Framework Development

Policies.

16 Prior to occupation of the development the refuse and recycling storage facilities intended for its occupiers as shown on the drawings hereby approved shall be provided. All refuse and recycling storage facilities shall be permanently maintained and retained thereafter.

Reason: To safeguard the amenities of the adjoining premises and the area generally in accordance with the requirements of policy CS18 of the London Borough of Camden LDF Core Strategy and DP26 of the London Borough of Camden LDF Development Policies.

17 Piling method statement

Prior to commencement of any piling on site, a piling method statement, which has been prepared in consultation with Thames Water, shall be submitted to and approved in writing by the local planning authority. Such method statement to detail the type of piling to be undertaken and the methodology by which such piling will be carried out, including measures to prevent and minimise the potential for damage to subsurface water or sewerage infrastructure, and the programme for the works.

All piling works shall be undertaken only in strict accordance with the approved method statement.

Reason: To safeguard the existing public sewer infrastructure and to protect the structural stability of the neighbouring buildings and structures, in accordance with policies CS5 and CS14 of the London Borough of Camden Local Development Framework Core Strategy and policies DP24, DP26 and DP27 of the London Borough of Camden Local Development Framework Development Policies.

18 No music shall be played on the ground floor food and drink premises in such a way as to be audible within the residential premises above.

Reason: To safeguard the amenities of the adjoining premises and the area generally in accordance with the requirements of policies CS5 and CS7 of the London Borough of Camden Local Development Framework Core Strategy and policy DP26 and DP12 of the London Borough of Camden Local Development Framework Development Policies.

19 The food and drink use hereby permitted shall not be carried out outside the following times 07:00 to 22.00 hours Monday to Saturday, 09:00 to 21:00 on Sundays and Bank Holidays.

Outdoor seating areas associated with the retail/food & drink uses hereby permitted shall be cleared of customers between 20:00 and 08:00 hours, 7 days a week.

Reason: To safeguard the amenities of the adjoining premises and the area generally in accordance with the requirements of policies CS5 and CS7 of the

London Borough of Camden Local Development Framework Core Strategy and policy DP26 and DP12 of the London Borough of Camden Local Development Framework Development Policies.

20 The development (other than site clearance & preparation, relocation of services, utilities and public infrastructure and demolition),hereby approved shall not commence until such time as a suitably qualified chartered engineer with membership of the appropriate professional body has been appointed to inspect, approve and monitor the critical elements of both permanent and temporary basement construction works throughout their duration to ensure compliance with the design which has been checked and approved by a building control body. Details of the appointment and the appointee's responsibilities shall be submitted to and approved in writing by the local planning authority prior to the commencement of development. Any subsequent change or reappointment shall be confirmed forthwith for the duration of the construction works.

Reason: To safeguard the appearance and structural stability of neighbouring buildings and the character of the immediate area in accordance with the requirements of policy CS14 of the London Borough of Camden Local Development Framework Development Policies and policy DP27 (Basements and Lightwells) of the London Borough of Camden Local Development Framework Development Policies.

21 Prior to the commencement of development (other than site clearance & preparation, relocation of services, utilities and public infrastructure and demolition), full details of biodiverse, substrate-based extensive living roofs shall be submitted to and approved by the Local Planning Authority in writing. The details shall include

i. a detailed scheme of maintenance
ii. sections at a scale of 1:20 demonstrating the construction, materials used and a variation of substrate depth with peaks and troughs
iii. full details of planting species and density

The green roofs shall be fully provided in accordance with the approved details prior to first occupation and thereafter retained and maintained in accordance with the approved scheme.

Reason: To ensure that the green roof is suitably designed and maintained in accordance with the requirements of policies CS13, CS14, CS15 and CS16 of the London Borough of Camden Local Development Framework Core Strategy and policies DP22, DP23, DP24 and DP32 of the London Borough of Camden Local Development Framework Development Policies.

22 The development shall be implemented in accordance with the ecological enhancements recommended in the ecology appraisal hereby approved, including the implementation of a Habitat Management Plan prepared by a suitably qualified ecologist.

Prior to commencement on the development (other than site clearance & preparation, relocation of services, utilities and public infrastructure and demolition), details of bird and bat box locations and types and indication of species to be

accommodated shall be submitted to and approved in writing by the local planning authority. The boxes shall be installed in accordance with the approved plans prior to the occupation of the development and thereafter retained.

Reason: In order to secure appropriate features to conserve and enhance wildlife habitats and biodiversity measures within the development, in accordance with the requirements of the London Plan and policy CS15 of the London Borough of Camden Local Development Framework Core Strategy.

23 Prior to first occupation of the development, a system of sustainable urban drainage shall be installed in accordance with the recommendations of the letter from J W S Mayes (Spencer Mayes) dated 27th August 2014 re SUDs proposal hereby approved, in order to ensure a maximum site runoff rate of 22.2l/s in the event a 1:100 year storm with 30% provision for climate change. The system shall thereafter be retained and maintained.

Reason: To reduce the rate of surface water run-off from the buildings and limit the impact on the storm-water drainage system in accordance with policies CS13 and CS16 of the London Borough of Camden Local Development Framework Core Strategy and policies DP22, DP23 and DP32 of the London Borough of Camden Local Development Framework Development Policies.

24 Prior to commencement of development, (other than site clearance & preparation, relocation of services, utilities and public infrastructure and demolition), details of sound insulation measures for incorporation into the building envelope in order to achieve BS 8233 criteria of 30dB LAeq in all bedrooms and 35dB in all living rooms, shall be submitted to and approved in writing by the local planning authority. Such details to be prepared in accordance with the recommendations of the acoustic noise assessment by Sharps Redmore hereby approved.

The residential units shall not be occupied until the building has been constructed and fitted out in accordance with the approved measures, which shall thereafter be permanently retained and maintained in accordance with the manufacturers' recommendations.

Reason: To safeguard the amenities of future occupants in accordance with the requirements of policy CS5 of the London Borough of Camden Local Development Framework Core Strategy and policies DP26 and DP28 of the London Borough of Camden Local Development Framework Development Policies.

25 Prior to first operation of any plant equipment on the roof of the commercial units, a plant noise assessment, prepared by a suitably qualified expert, shall be submitted to the local planning authority and approved in writing. The assessment shall demonstrate how the equipment will meet the Council's noise standards as set out in condition 8 and shall identify all necessary noise and vibration mitigation measures which are required in order to achieve the standards. The plant shall not be operated other than in complete accordance with such mitigation measures, which shall be maintained in accordance with the manufacturers recommendations and shall be retained for as long as the equipment is operative.

Reason: To safeguard the amenities of the adjoining premises and the area generally in accordance with the requirements of policy CS5 of the London Borough of Camden Local Development Framework Core Strategy and policies DP26 and DP28 of the London Borough of Camden Local Development Framework Development Policies.

26 No works of construction of the basement shall commence until such time as a report, including a scheme for implementation, detailing the final design, methodologies and construction sequences required to ensure that the impact of the basement on neighbouring properties will not exceed 'slight' (level 2 of the Burland scale), have been submitted to and approved in writing by the local planning authority. The report shall be accompanied by a written certification by an suitably qualified chartered engineer who is independent of the report authors holding membership of the appropriate professional body, that appropriately conservative modelling relating to the local ground conditions and local water environment and structural condition of neighbouring properties have been incorporated into the final design in order to substantiate the report conclusions and recommendations.

The works of construction of the basement shall not be carried out other than in compliance with the approved methodologies and construction sequences.

Reason: To safeguard the appearance and structural stability of neighbouring buildings and the character of the immediate area in accordance with the requirements of policy CS14 of the London Borough of Camden Local Development Framework Development Policies and policy DP27 (Basements and Lightwells) of the London Borough of Camden Local Development Framework Development Policies.

27 Prior to the commencement of any works on site, details demonstrating how trees in the neighbouring estate shall be protected during construction work shall be submitted to and approved by the Council in writing. Such details shall follow guidelines and standards set out in BS5837:2012 "Trees in Relation to Construction". All trees on the site, or parts of trees growing from adjoining sites, unless shown on the permitted drawings as being removed, shall be retained and protected from damage in accordance with the approved protection details.

Reason: To ensure that the development will not have an adverse effect on existing trees and in order to maintain the character and amenity of the area in accordance with the requirements of policy CS15 of the London Borough of Camden Local Development Framework Core Strategy.

28 The basement gym shall not be used for any purposes other than as ancillary to residential uses within the site.

Reason: To safeguard the amenities of the adjoining premises and the area generally in accordance with the requirements of policy CS5 of the London Borough of Camden Local Development Framework Core Strategy and policy DP26 of the London Borough of Camden Local Development Framework Development Policies.

29 Notwithstanding the annotations on the drawings hereby approved, nothing in this permission grants consent for the entrance gates at the Grays Inn Road and St Chads Street access points to the development.

Reason: In order to ensure that ensure that the development allows free movement by all members of the community and contributes to the aims of community safety and mixed and balanced communities, in accordance with the requirements of policy CS17 of the London Borough of Camden Local Development Framework Core Strategy.

Informative(s):

1 Your proposals may be subject to control under the Building Regulations and/or the London Buildings Acts which cover aspects including fire and emergency escape, access and facilities for people with disabilities and sound insulation between dwellings. You are advised to consult the Council's Building Control Service, Camden Town Hall, Argyle Street WC1H 8EQ, (tel: 020-7974 6941).

2 Your proposals may be subject to control under the Party Wall etc Act 1996 which covers party wall matters, boundary walls and excavations near neighbouring buildings. You are advised to consult a suitably qualified and experienced Building Engineer.

3 Your attention is drawn to the need for compliance with the requirements of the Environmental Health regulations, Compliance and Enforcement team, [Regulatory Services] Camden Town Hall, Argyle Street, WC1H 8EQ, (tel: 020 7974 4444) particularly in respect of arrangements for ventilation and the extraction of cooking fumes and smells.

4 Noise from demolition and construction works is subject to control under the Control of Pollution Act 1974. You must carry out any building works that can be heard at the boundary of the site only between 08.00 and 18.00 hours Monday to Friday and 08.00 to 13.00 on Saturday and not at all on Sundays and Public Holidays. You are advised to consult the Council's Noise and Licensing Enforcement Team, Camden Town Hall, Argyle Street, WC1H 8EQ (Tel. No. 020 7974 4444 or on the website http://www.camden.gov.uk/ccm/content/contacts/council-contacts/environment/contact-the-environmental-health-team.en or seek prior approval under Section 61 of the Act if you anticipate any difficulty in carrying out construction other than within the hours stated above.

5 You are reminded that refuse sacks and receptacles shall not be deposited on the public footpath, or forecourt area until within half an hour of usual collection times. For further information please contact the Council's Environment Services (Rubbish Collection) on 020 7974 6914/5. or on the website http://www.camden.gov.uk/ccm/content/contacts/council-contacts/environment/contact-street-environment-services.en.

6 If a revision to the postal address becomes necessary as a result of this development, application under Part 2 of the London Building Acts (Amendment) Act 1939 should be made to the Camden Contact Centre on Tel: 020 7974 4444 or Environment Department (Street Naming & Numbering) Camden Town Hall, Argyle Street, WC1H 8EQ.

7 Your attention is drawn to the fact that there is a separate legal agreement with the Council which relates to the development for which this permission is granted. Information/drawings relating to the discharge of matters covered by the Heads of Terms of the legal agreement should be marked for the attention of the Planning Obligations Officer, Sites Team, Camden Town Hall, Argyle Street, WC1H 8EQ.

8 The correct street number or number and name must be displayed permanently on the premises in accordance with regulations made under Section 12 of the London Building (Amendments) Act 1939.

9 This permission is granted without prejudice to the necessity of obtaining consent under the Town and Country Planning (Control of Advertisements) (England) Regulations 2007. Application forms may be obtained from the Council's website, www.camden.gov.uk/planning or the Camden Contact Centre on Tel: 020 7974 4444 or email env.devcon@camden.gov.uk).

10 The Council supports schemes for the recycling of bottles and cans and encourages all hotels, restaurants, wine bars and public houses to do so as well. Further information can be obtained by telephoning the Council's Environment Services (Recycling) on 0207 974 6914/5 or on the website http://www.camden.gov.uk/ccm/content/environment/waste-and-recycling/twocolumn/new-recycling-rubbish-and-reuse-guide.en.

11 You are reminded of the need to provide adequate space for internal and external storage for waste and recyclables. For further information contact Council's Environment Services (Waste) on 020 7974 6914/5 or see the website http://www.camden.gov.uk/ccm/content/environment/waste-and-recycling/twocolumn/new-recycling-rubbish-and-reuse-guide.en.

12 With regard to condition 9 above the preliminary risk assessment is required in accordance with CLR11 model procedures for management of contaminated land and must include an appropriate scheme of investigation with a schedule of work detailing the proposed sampling and analysis strategy. You are advised that the London Borough of Camden offer an Enhanced Environmental Information Review available from the Contaminated Land Officer (who has access to the Council's historical land use data) on 020 7974 4444, or by email, http://www.camden.gov.uk/ccm/content/contacts/council-contacts/environment/contact-the-contaminated-land-officer.en, and that this information can form the basis of a preliminary risk assessment. Further information is also available on the Council's Contaminated Land web pages at http://www.camden.gov.uk/ccm/navigation/environment/pollution/contaminated-land/, or
from the Environment Agency at www.environment-agency.gov.uk.

13 You are reminded that this decision only grants permission for permanent residential accommodation (Class C3). Any alternative use of the residential units for temporary accommodation, i.e. for periods of less than 90 days for tourist or short term lets etc, would constitute a material change of use and would require a further grant of planning permission.

In dealing with the application, the Council has sought to work with the applicant in a positive and proactive way in accordance with paragraphs 186 and 187 of the National Planning Policy Framework.

You can find advice about your rights of appeal at:

http://www.planningportal.gov.uk/planning/appeals/guidance/guidancecontent

Yours faithfully

Ed Watson
Director of Culture & Environment

Appendix B TGEN Protocol.

TERRAGEN
Environmental Consultants

Practical, sustainable solutions to complex environmental problems

Terragen Environmental Consultants Ltd

Site Investigation, Environmental Risk Assessment and Waste Classification

E: info@tgen.co.uk

www.tgen.co.uk

1.0 REGULATORY FRAMEWORK

Throughout this document and in particular this section it is important to differentiate between contaminated land, which is used to mean land which meets the legal definition of contaminated land and other terms, such as land affected by contamination or land contamination etc., which are used to describe the much broader categories of land where contaminants are present or suspected, potentially requiring some form of mitigation, but usually not at a sufficient level of risk to meet the legal definition of contaminated land.

1.1 Part IIA Framework

Part IIA of the Environmental Protection Act (1990) (Part IIA) introduced a statutory legal definition for contaminated land, as follows:-

"…*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 of controlled waters is being, or is likely to be caused"

Under Part IIA, the default assumption should be that land is not contaminated land unless there is sufficient reason to consider otherwise. DEFRA (2012a) is the statutory guidance (the guidance) in support of the contaminated land regulations produced by DEFRA (2012b), which amended the 2006 regulations, which in turn revoked the 2000 regulations. The 2000 regulations enabled the Part IIA regime.

The guidance details how the Part IIA regime should be implemented. The guidance also details the decision process required to determine whether land is contaminated or not, along with remediation provisions, the goals of remediation, how regulators should ensure that the remediation requirements are reasonable and the process by which the enforcing authority may recover the costs of remediation from liable parties.

The government's objectives with respect to contaminated land are to:-

- Identify and remove unacceptable risks to human health and the environment.
- Seek to ensure that contaminated land is made suitable for its current use.
- Ensure that the burdens faced by individuals, companies and society as a whole are proportionate, manageable and compatible with the principles of sustainable development.

These three objectives underlie the fitness for purpose approach to remediation of contaminated land within the UK. The fitness for purpose approach consists of three elements:-

- Ensuring that land is suitable for its current use by identifying any land where contamination is causing unacceptable risks to human health and/or the environment, assessed on the basis of the current use and circumstances of the land, and returning such land to a condition where such risks no longer exist (i.e. through remediation of the land).
- Ensuring that land is made suitable for any new use as granted by planning permission by assessing the potential risks from contamination, on the basis of the proposed future use and circumstances, before final approval is given for the development and, where necessary to avoid unacceptable risks to human health and/or the environment, remediating the land before the new use commences. This is the role of the town and country planning and building control regimes.
- Limiting the requirements for remediation to the work necessary to prevent unacceptable risks to human health and/or the environment in relation to the current use or future use of the land for which planning permission is being sought by recognising that the risks from contaminated land can be satisfactorily assessed only in the context of specific uses of the land (whether current or proposed), and that any attempt to guess what might be needed at some time in the future for other uses is likely to result either in premature work (thereby risking distorting social, economic and environmental priorities) or in unnecessary work (thereby wasting resources).

In implementing the Part IIA regime, the local authority is required to strike a reasonable balance between:-

- Dealing with risks raised by contaminants in land and the benefits of remediating land to remove or reduce those risks.
- The potential impacts of regulatory intervention including the financial costs to whoever will pay for remediation, health and environmental impacts of taking action, property blight and burdens on affected people.

In most cases, Part IIA is regulated by the local authority and their role is to:-

- Inspect their area to identify contaminated land.
- Establish responsibilities for remediation of the land.
- See that appropriate remediation takes place through agreement with those responsible, or if not possible by serving a remediation notice or by the use of other powers, or in certain circumstances carrying out the work themselves.
- Keep a public register detailing the regulatory action which they have taken.

For special sites the Environment Agency (the agency) will take over from the local authority as regulator. Special sites typically include:-

- Contaminated land which affects controlled water and its quality.
- Oil refineries.
- Nuclear sites.
- Waste management sites.

Liability for remediation of contaminated land would be assigned to persons, organisations or businesses if they caused, or knowingly permitted contamination, or if they own or occupy contaminated land in a case where no polluter can be found.

The authority is required to take a precautionary approach to the risks raised by contamination, whilst avoiding disproportionality given the circumstances of each case. The aim being to consider the various benefits and costs of taking action with a view to ensuring that the regime produces net benefits, taking account of local circumstances.

Most remediation of land contamination in the UK takes place when a site is redeveloped for a new use. Conditions requiring remediation are normally attached to the planning consent. Where no redevelopment is proposed, a remediation notice can be served under the contaminated land regime introduced under Part IIA. Government policy is to encourage voluntary remediation of contamination through site redevelopment wherever possible rather than regulation under the contaminated land regime.

The Part IIA legislation is typically reserved for the most contaminated sites. The presence of harmful chemicals could provide a source in a pollutant linkage allowing the regulator to determine if there is a significant possibility of harm being caused to humans, buildings or the environment. Under such circumstances, the regulator would determine the land as contaminated under the provision of the legislation requiring the remediation process to be implemented.

Part IIA takes a risk-based approach to defining contaminated land. For the purposes of the guidance, risk means the combination of the likelihood that harm, or pollution of water, will occur as a result of contaminants in, on or under the land and the scale and seriousness of such harm or pollution if it did occur.

Under Part IIA, risks should be considered only in relation to the current use of the land. For the purposes of the guidance, the current use means:-

- The use which is being made of the land currently.
- Reasonably likely future uses of the land that would not require a new or amended grant of planning permission.
- Any temporary use to which the land is put, or is likely to be put, from time to time within the bounds of current planning permission.
- Likely informal use of the land, for example children playing on the land, whether authorised by the owners or occupiers, or not.
- In the case of agricultural land, the current agricultural use should not be taken to extend beyond the growing or rearing of the crops or animals which are habitually grown or reared on the land.

Under Part IIA, for a risk to exist there needs to be one or more contaminant-pathway-receptor linkages by which a relevant receptor might be affected by the contaminants in question. Therefore for a risk to exist there must be contaminants present in, on or under the land in a form and quantity that poses a hazard, and one or more pathways by which they might significantly harm people, the environment, or property, or significantly pollute controlled waters.

- A contaminant is a substance which is in, on or under the land and which has the potential to cause significant harm to a relevant receptor or to cause significant pollution of controlled waters.
- A receptor is something that could be adversely affected by a contaminant, i.e. a person, an organism, an ecosystem, property or controlled waters. The various types of receptors that are relevant under the Part IIA regime are explained in later sections.
- A pathway is a route by which a receptor is or might be affected by a contaminant.

All three elements of a contaminant linkage must exist in relation to land before it can be considered potentially to be contaminated land under Part IIA. The term significant contaminant linkage means a contaminant linkage, which gives rise to a level of risk sufficient to justify a piece of land being determined as contaminated land. The term significant contaminant means a contaminant that forms part of a significant contaminant linkage.

The Part IIA regime was introduced to help identify and deal with land that poses unacceptable levels of risk. It is not intended to apply to land with levels of contaminants in soil that are commonplace and widespread and for which, in the very large majority of cases, there is no reason to consider that there is an unacceptable risk.

Normal background concentrations (NBC) of contaminants in soil should not be considered to cause land to qualify as contaminated land, unless there is a particular reason to consider otherwise. Therefore, if it is established that land is at or close to NBC of particular contaminants, it should usually not be considered further in relation to the Part IIA regime.

In terms of the guidance, NBC of contaminants in soil may result from:-

- The natural presence of contaminants (e.g. caused by soil formation processes and underlying geology) at levels that might reasonably be considered typical in a given area and have not been shown to pose an unacceptable risk to health or the environment.
- The presence of contaminants caused by low level diffuse pollution and common human activity other than specific industrial processes. For example, this would include diffuse pollution caused by historic use of leaded petrol and the presence of benzo(a)pyrene from vehicle exhausts, and the spreading of domestic ash in gardens at levels that might reasonably be considered as typical.

NBC of contaminants in English soils have recently been established by DEFRA (2012c) following work undertaken by the British Geological Survey (BGS). The primary data sets used were the BGS geotechnical baseline survey of the environment and the English national soil inventory. NBC of arsenic, benzo(a)pyrene, cadmium, copper, lead, mercury and nickel have been determined for specific domains, such as the underlying parent rock/material, mineralisation/mining activity or an urban setting. That remaining is termed the principal domain.

Under Part IIA, there is a requirement to determine whether there is a possibility of significant harm. In terms of human health, this means the risk posed by one or more relevant contaminant linkage(s) relating to the land. It comprises:-

- The estimated likelihood that significant harm might occur to an identified receptor, taking account of the current use of the land in question.
- The estimated impact if the significant harm did occur i.e. the nature of the harm, the seriousness of the harm to any person who might suffer it and (where relevant) the extent of the harm in terms of how many people might suffer it.

In estimating the likelihood that a specific form of significant harm might occur the local authority should, among other things, consider:-

- The estimated probability that the significant harm might occur if the land continues to be used as it is currently being used and where relevant, if the land were to be used in a different way (or ways) in the future.
- The strength of evidence underlying the risk estimate. It should also consider the key assumptions on which the estimate of likelihood is based and the level of uncertainty underlying the estimate.

In the context of the Part IIA regime the following health effects would be considered to constitute significant harm to human health:-

- Death.
- Life threatening diseases (e.g. cancers).
- Other diseases likely to have serious impacts on health.
- Serious injury.
- Birth defects.
- Impairment of reproductive functions.

Other health effects may be considered to constitute significant harm. For example, a wide range of conditions may or may not constitute significant harm (alone or in combination) including physical injury, gastrointestinal disturbances, respiratory tract effects, cardiovascular effects, central nervous system effects, skin ailments, effects on organs such as the liver or kidneys or a wide range of other health impacts. In deciding whether or not a particular form of harm is significant harm, the local authority should consider the seriousness of the harm in question including the impact on the health, and quality of life, of any person suffering the harm; and the scale of the harm. The authority should only conclude that harm is significant if it considers that treating the land as contaminated land would be in accordance with the broad objectives of the regime.

In deciding whether or not land is contaminated land on the grounds of significant possibility of significant harm to human health (SPOSH), the guidance introduces four categories. Categories 1 and 2 encompass land which is capable of being determined as contaminated land on the grounds of SPOSH to human health and Categories 3 and 4 would encompass land which is not capable of being determined on such grounds.

Category 1 (Human Health)
A SPOSH exists in any case where there is an unacceptably high probability, supported by robust science-based evidence that significant harm would occur if no action were taken to stop it. In such cases, the land should be deemed to be Category 1 where:-

- Similar land or situations are known, or are strongly suspected, on the basis of robust evidence, to have caused such harm before in the UK.
- Similar degrees of exposure (via any medium) to the contaminant(s) in question are known, or strongly suspected, on the basis of robust evidence, to have caused such harm before in the UK or elsewhere.
- Significant harm may already have been caused by contaminants in, on or under the land, and that there is an unacceptable risk that it might continue or occur again if no action is taken. Among other things, the authority may decide to determine the land on these grounds if it considers that it is likely that significant harm is being caused, but it considers either that there is insufficient evidence to be sure of meeting the balance of probability test for demonstrating that significant harm is being caused, or that the time needed to demonstrate such a level of probability would cause unreasonable delay, cost, or disruption and stress to affected people particularly in cases involving residential properties.

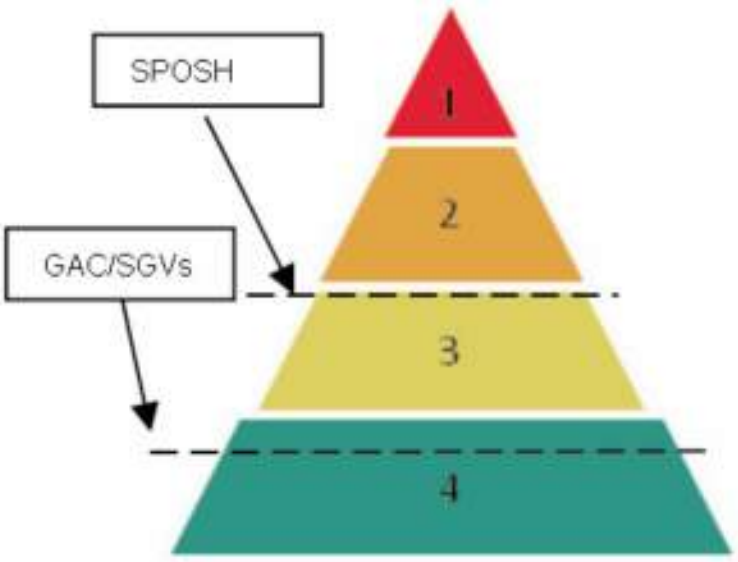
Category 4 (Human Health)
If the level of risk posed is low or there is no perceived risk then it should not be assumed that land poses a SPOSH. Such land is referred to as Category 4. The following types of land should be placed into Category 4:-

- Land where no relevant contaminant linkage has been established.
- Land where there are only NBC of contaminants in soil.
- Land that has been excluded from the need for further inspection and assessment because contaminant levels do not exceed relevant generic assessment.
- Land where estimated levels of exposure to contaminants in soil are likely to form only a small proportion of what a receptor might be exposed to anyway through other sources of environmental exposure (e.g. in relation to average estimated national levels of exposure to substances commonly found in the environment, to which receptors are likely to be exposed in the normal course of their lives).

Categories 2 and 3 (Human Health)
Land that cannot be placed into Categories 1 or 4 should be placed into either Category 2, in which case the land would be capable of being determined as contaminated land on the grounds of SPOSH or Category 3, in which case the land would not be capable of being determined on such grounds.

Land should be placed into Category 2 if there is a strong case for considering that the risks from the land are of sufficient concern that the land poses a SPOSH with all that this might involve. Category 2 may include land where there is little or no direct evidence that similar land, situations or levels of exposure have caused harm before, but nonetheless there is a strong case for taking action under Part IIA on a precautionary basis.

Land should be placed into Category 3 if the strong case (as described for Category 2) does not exist, and therefore the legal test for SPOSH is not met. Category 3 may include land where the risks are not low but nonetheless regulatory intervention under Part IIA is not warranted. This recognises that placing land in Category 3 would not stop others, such as the owner or occupier of the land, from taking action to reduce risks outside of the Part IIA regime if they choose.



Generic assessment criteria (GAC) and soil guideline values (SGV) relating to human health in representative end use scenarios are considered to represent cautious estimates of levels of contaminants in soil at which there is considered to be no risk to health or, at most, a minimal risk to health (i.e. Category 4). With regard to such criteria/values:-

- GAC/SGV may be used to indicate when land is very unlikely to pose a SPOSH to human health. This is on the basis that they are designed to estimate levels of contamination at which risks are likely to be negligible or minimal and far from posing a SPOSH to human health.
- GAC/SGV should not be used as direct indicators of whether a SPOSH to human health may exist. Also, the degree by which they are exceeded should not be viewed as being particularly relevant to this consideration, given that the degree of risk posed by land would normally depend on many factors other than simply the amount of contaminants in soil.
- GAC/SGV should not be seen as screening levels which describe the boundary between Categories 3 and 4 (i.e. the two categories in which land would not be contaminated land on the grounds of risks to human health). In the very large majority of cases, the GAC/SGV thresholds should describe levels of contamination from which risks should be considered to be comfortably within Category 4.
- GAC/SGV should not be viewed as indicators of levels of contamination above which detailed risk assessment would automatically be required under Part IIA.
- GAC/SGV should not be used as generic remediation targets under the Part IIA regime. Nor should they be used in this way under the planning system (e.g. in relation to ensuring that land affected by contamination does not meet the Part IIA definition of contaminated land after it has been developed).

In terms of the Part IIA regime, only the forms of harm to non-human receptors described in the table below should be considered as relevant in considering whether significant harm is being caused or there is a significant possibility of such harm.

Relevant Types of Receptor	Significant Harm	SPOSH
Any **ecological system**, or living organism forming part of such a system, within a location which is:- - A site of special scientific interest (under section 28 of the Wildlife and Countryside Act 1981). - A national nature reserve (under s.35 of the 1981 Act). - A marine nature reserve (under s.36 of the 1981 Act). - An area of special protection for birds (under s.3 of the 1981 Act). - A European site within the meaning of regulation 8 of the Conservation of Habitats and Species Regulations 2010. - Any habitat or site afforded policy protection under paragraph 6 of Planning Policy Statement (PPS 9) on nature conservation (i.e. candidate Special Areas of Conservation (SAC), potential Special Protection Areas (SPA) and listed Ramsar sites). - Any nature reserve (NNR) established under section 21 of the National Parks and Access to the Countryside Act 1949.	The following types of harm should be considered to be significant:- - Harm which results in an irreversible adverse change, or in some other substantial adverse change, in the functioning of the ecological system within any substantial part of that location. - Harm which significantly affects any species of special interest within that location and which endangers the long-term maintenance of the population of that species at that location. In the case of European sites, harm should also be considered to be significant harm if it endangers the favourable conservation status of natural habitats at such locations or species typically found there. In deciding what constitutes such harm, the local authority should have regard to the advice of Natural England and to the requirements of the Conservation of Habitats and Species Regulations 2010.	Conditions would exist for considering that a SPOSH exists to a relevant ecological receptor where the local authority considers that:- - Significant harm of that description is more likely than not to result from the contaminant linkage in question. - There is a reasonable possibility of significant harm of that description being caused, and if that harm were to occur, it would result in such a degree of damage to features of special interest at the location in question that they would be beyond any practicable possibility of restoration. Any assessment made for these purposes should take into account relevant information for that type of contaminant linkage, particularly in relation to the ecotoxicological effects of the contaminant.

Relevant Types of Receptor	Significant Harm	SPOSH
Property in the form of:- • Crops, including timber. • Produce grown domestically, or on allotments, for consumption. • Livestock. • Other owned or domesticated animals. • Wild animals which are the subject of shooting or fishing rights.	For crops, a substantial diminution in yield or other substantial loss in their value resulting from death, disease or other physical damage. For domestic pets, death, serious disease or serious physical damage. For other property in this category, a substantial loss in its value resulting from death, disease or other serious physical damage. The local authority should regard a substantial loss in value as occurring only when a substantial proportion of the animals or crops are dead or otherwise no longer fit for their intended purpose. Food should be regarded as being no longer fit for purpose when it fails to comply with the provisions of the Food Safety Act 1990. Where a diminution in yield or loss in value is caused by a contaminant linkage, a 20% diminution or loss should be regarded as a benchmark for what constitutes a substantial diminution or loss. This description of significant harm is referred to as an animal or crop effect.	Conditions would exist for considering that a SPOSH exists to the relevant types of receptor where the local authority considers that significant harm is more likely than not to result from the contaminant linkage in question, taking into account relevant information for that type of contaminant linkage, particularly in relation to the ecotoxicological effects of the contaminant.
Property in the form of buildings. For this purpose, building means any structure or erection, and any part of a building including any part below ground level, but does not include plant or machinery comprised in a building, or buried services such as sewers, water pipes or electricity cables.	Structural failure, substantial damage or substantial interference with any right of occupation. The local authority should regard substantial damage or substantial interference as occurring when any part of the building ceases to be capable of being used for the purpose for which it is or was intended. In the case of a scheduled ancient monument (SAM), substantial damage should also be regarded as occurring when the damage significantly impairs the historic, architectural, traditional, artistic or archaeological interest by reason of which the monument was scheduled. This description of significant harm is referred to as a building effect.	Conditions would exist for considering that a SPOSH exists to the relevant types of receptor where the local authority considers that significant harm is more likely than not to result from the contaminant linkage in question during the expected economic life of the building (or in the case of a SAM the foreseeable future), taking into account relevant information for that type of contaminant linkage.

1.2 Planning Framework

In accordance with DCLG (2012) development of land is required to be carried out in a sustainable manner. Contamination is a material planning consideration and where development is proposed conditions can be attached to any permission granted for development requiring assessment and subsequent management. Remediation schemes can also need planning permission in their own right.

Land owners and/or developers are required to ensure the proposed development is safe and suitable for use for the purpose for which it is intended.

The developer is thus responsible for determining whether land is suitable for a particular development or can be made so by remedial action. In particular, the developer should carry out an adequate investigation to inform a risk assessment to determine:-

- Whether the land in question is already affected by contamination through source-pathway-receptor pollutant linkages and how those linkages are represented in a conceptual model.
- Whether the development proposed will create new linkages (e.g. new pathways by which existing contaminants might reach existing or proposed receptors and whether it will introduce new vulnerable receptors).
- What action is needed to break those linkages and to avoid new ones, deal with any unacceptable risks and enable safe development and future occupancy of the site and of neighbouring land.

1.3 Building Control Framework

Building control authorities enforce compliance with DCLG (2010). Practical guidance is provided in approved documents, one of which is Part C: Site Preparation and Resistance to Contaminants and Moisture, which seeks to protect the health, safety and welfare of people in and around buildings, and includes requirements for protection against harm from chemical contaminants.

1.4 Controlled Water Framework

Part IIA defines pollution of controlled waters as the entry into controlled waters of any poisonous, noxious or polluting matter or any solid waste matter.

The term controlled waters in relation to England has the same meaning as in Part 3 of the Water Resources Act 1991, except that ground water does not include water contained in underground strata above the saturation zone (e.g. perched water).

Given that the Part IIA regime seeks to identify and deal with significant pollution (rather than lesser levels of pollution), the local authority should seek to focus on pollution which may be harmful to human health or the quality of aquatic ecosystems or terrestrial ecosystems directly depending on aquatic ecosystems, which may result in damage to material property or which may impair or interfere with amenities and other legitimate uses of the environment.

The following types of pollution should be considered to constitute significant pollution of controlled waters:-

- Pollution equivalent to environmental damage to surface water or groundwater as defined by DEFRA (2009c), but which cannot be dealt with under those regulations.
- Inputs resulting in deterioration of the quality of water abstracted, or intended to be used in the future, for human consumption such that additional treatment would be required to enable that use.
- A breach of a statutory surface water environment quality standard (EQS), either directly or via a groundwater pathway.
- Input of a substance into groundwater resulting in a significant and sustained upward trend in concentration of contaminants as defined in Article 2(3) of EU (2006).

Paragraphs A36 and A39 of DETR (2000) further define the basis on which land may be determined to be contaminated land on the basis of pollution of controlled waters, as before determining that pollution of controlled waters is being, or likely to be, caused, the local authority should be satisfied that a substance is continuing to enter controlled waters, or is likely to enter controlled waters. For this purpose, the local authority should regard something as being likely when they judge it more likely than not to occur.

Land should not be designated as contaminated land where:-

- A substance is already present in controlled waters.
- Entry into controlled waters of that substance from the land has ceased.
- It is not likely that further entry will take place.

Substances should be regarded as having entered controlled waters where:-

- They are dissolved or suspended in those waters.
- If they are immiscible with water, they have direct contact with those waters, or beneath the surface of the waters.

Controlled waters are defined in statute to be territorial waters which extend seawards for three miles, coastal waters, inland freshwaters, that is to say, the waters in any relevant lake or pond or of so much of any relevant river or watercourse as is above the freshwater limit, and groundwater, that is to say, any waters contained in underground strata.

Category 1 (Water)
This covers land where there is a strong and compelling case for considering that a significant possibility of significant pollution of controlled waters exists. In particular this would include cases where there is robust science-based evidence for considering that it is likely that high impact pollution would occur if nothing were done to stop it.

Category 2 (Water)
This covers land where the strength of evidence to put the land into Category 1 does not exist but, nonetheless, on the basis of the available scientific evidence and expert opinion, the risks posed by the land are of sufficient concern that the land should be considered to pose a significant possibility of significant pollution of controlled waters on a precautionary basis, with all that this might involve (e.g. likely remediation requirements and the benefits, costs and other impacts of regulatory intervention). Among other things, this category might include land where there is a relatively low likelihood that the most serious types of significant pollution might occur.

Category 3 (Water)
This covers land where the risks are such that the tests set out in Categories 1 and 2 above are not met, and therefore regulatory intervention under Part IIA is not warranted. This category should include land where it is very unlikely that serious pollution would occur or where there is a low likelihood that less serious types of significant pollution might occur.

Category 4 (Water)
This covers land where there is no risk or that the level of risk posed is low. In particular, where:-

- No contaminant linkage has been established in which controlled waters are the receptor in the linkage.
- The possibility only relates to types of pollution that should not be considered to be significant.
- The possibility of water pollution is similar to that which might be caused by background contamination.

1.5 Other Frameworks

There are a number of other regulatory and non-regulatory frameworks which can, or do, impact the assessment and/or the development of land affected by contamination. A detailed description of all of these frameworks is beyond the scope of this document. A summary of those frameworks most commonly impacting on the assessment of contamination at a site is however provided below.

1.5.1 Environmental Permitting Regulations

DEFRA (2010a) introduced the environmental permitting regulations (EPR) in E&W thereby replacing the former 2007 regulations. The EPR initially combined the pollution prevention and control (PPC) and waste management licensing (WML) regulations. Their scope has since been widened to include water discharge and groundwater activities, radioactive substances and provision for a number of directives.

Cornerstones of the EPR are contained in statutory guidance, such as Environment Agency (2013c). This guidance covers most of the standards and measures that apply to standard rules that are available for many activities, as well as the basic standards and measures that apply to all other activities subject to the EPR. The guidance was drafted to recognise the range of activities regulated through environmental permitting, both in terms of size and environmental risk. For some activities there are additional, sector-specific technical guidance notes.

Horizontal guidance was produced in support of Environment Agency (2013c). The purpose of horizontal guidance is to provide in depth information relevant to all sectors regulated under EPR, such as risk assessment, amenity, noise and vibration, odour, fugitive emissions (dust and pests), visible plumes, accidents, energy efficiency and the protection of controlled waters, and land. The horizontal guidance also helps to assess risks to the environment and human health when applying for a bespoke permit under the EPR.

Environment Agency (2008a) provides guidance and templates for producing a site condition report (SCR). In principle, a SCR is required for any facility regulated under the EPR, where there may be a significant risk to land or groundwater, or where one is necessary to satisfy requirements of the Integrated Pollution Prevention and Control Directive (2008/1/EC) (IPPC). A SCR describes and records the condition of the land and groundwater at a site. It will enable an operator to demonstrate that they

have protected land and groundwater during the lifetime of the site and it is in a satisfactory state when they come to surrender their permit.

IPPC is designed to prevent, reduce and eliminate pollution at source by using natural resources efficiently. It is intended to help industries operate in a more environmentally sustainable way. The activities covered include those arising from energy, metals, mineral, chemical, waste management industries, as well as others such as paper/board production, slaughterhouses, food and drink production, intensive pig and poultry farms. To comply with the regulations, operators need a permit and must use best available techniques to prevent emissions to air, land and water or, where that is not practicable, they must reduce them to an acceptable level. They must also minimise waste and recycle it where they can, conserve energy, prevent accidents and limit their environmental consequences, and return the site to a satisfactory state after operations cease.

The directive was implemented by DEFRA (2010a). Competent authorities for these regulations are:-

- The agency, which has responsibility for A(1) installations, the most polluting of the three industrial categories.
- Local authorities, which have responsibility for A(2) and Part B installations.

This legislation helps deliver the Water Framework Directive (EU 2000) objectives in a number of ways, including, for example, objectives for priority hazardous substances (cease or phase out discharges, emissions and losses) and by minimising other releases from major installations. The regulations are supported by Europe wide guidance notes on best available techniques.

The Revised Waste Framework Directive (EU 2008b) deals with the protection of human health and the environment against harmful effects caused by the collection, transport, treatment, storage and tipping of waste. Regulation under this legislation includes a system of permits and plans, which set out the essential factors to be taken into consideration in respect of the various waste disposal and recovery operations.

Waste operations that give rise to point and diffuse sources of pollution are controlled through DEFRA (2010a). Part II of the Environmental Protection Act (1990) includes a prohibition on the general deposit of waste or knowingly causing or permitting such waste to be deposited in or on any land except in accordance with an appropriate environmental permit. This is reinforced by the waste duty of care, which includes a duty on those producing waste to ensure that it is only passed to an authorised person and to take appropriate reasonable measures to prevent the escape of waste from their control or that of another person.

1.5.2 Environmental Impact Assessment (EIA)

Under the Environmental Impact Assessment Directive (2011/92/EU) before consent is given for certain development projects, such as large scale industrial or infrastructure projects, an assessment of the effects the development may have on the environment must be made, so that the competent authority that grants consent is aware of these possible consequences.

The developer makes the assessment and presents this in an environmental statement, which is consulted on widely. The environmental statement must identify, describe and assess impacts on people, plants and animals, soil, water, air, climate and the landscape, the built environment and cultural heritage, including how these factors link together. Consenting authorities can then assess whether a proposed development will have significant impacts on water bodies, and whether it may prevent environmental objectives being achieved.

The directive is implemented through a number of statutory instruments, covering the consenting procedures for various categories of development, including activities such as forestry and quarrying. Projects that require planning permission are governed by DCLG (2011).

1.5.3 Environmental Liability

The Environmental Liability Directive (2004/35/EC) seeks to achieve the prevention and remedying of environmental damage to habitats and species protected under EC law and to species or habitat on a site of special scientific interest for which the site has been notified, damage to water resources and land contamination which presents a threat to human health. It reinforces the polluter pays principle and makes operators financially liable for threats of or actual damage.

The directive is implemented in England through the Environmental Damage (Prevention and Remediation) Regulations (2009). The regulations apply only to the most serious types of damage. For water and biodiversity damage the regulations require much more extensive remediation than under existing legislation.

1.5.4 Habitats Directive

The Conservation of Natural Habitats and of Wild Fauna and Flora Directive (92/43/EEC), aims to contribute towards ensuring biodiversity through the conservation of natural habitats and wild plants and animals. Measures must be introduced to maintain or restore to favourable conservation status the natural habitats and populations of wild plants and animals identified as important within the EU. Representative areas with these habitats and species must be designated as SAC. SAC and SPA designated under the Birds Directive (2009/147/EC) form a network of protected areas known as Natura 2000.

The directive introduced for the first time for protected areas, the precautionary principle; that is that projects can only be permitted having ascertained no adverse effect on the integrity of the site. Projects may still be permitted if there are no alternatives, and there are imperative reasons of overriding public interest. In such cases compensation measures will be necessary to ensure the overall integrity of network of sites. As a consequence of amendments to the Birds Directive these measures are also applied to SPA. The directive is implemented by the Conservation of Habitats and Species Regulations (2010), which are administered by Natural England and the Countryside Council for Wales. SAC and SPA are also notified as Sites of Special Scientific Interest (SSSI).

1.5.5 Financial

The National House-Building Council (NHBC) is the standard setting body and the leading warranty and insurance provider for new and newly converted homes in the UK. Approximately 80% of new homes built in the UK each year are registered with NHBC and benefit from their ten year Buildmark warranty and insurance policy. In 1999, Buildmark was extended to provide the homeowner with contamination cover to provide protection against the issue of a statutory notice. This was done in the anticipation of Part IIA, which came into force a year later.

The NHBC identifies land affected by contamination in several possible ways:-

- By builder declaration through the NHBC registration process.
- By review of site investigation reports submitted with building control/Buildmark applications.
- By the NHBC through the screening of commercial, environmental databases for previous land use or through inspection.

NHBC seeks to ensure that any contamination hazards identified are managed in accordance with NHBC (2008) and NHBC (2011). The specific standard relating to contamination is provided in Chapter 4.1: Land Quality - Managing Ground Conditions. The NHBC will carry out a technical assessment on all sites, which have been identified as being potentially contaminated. Where remediation is undertaken, validation is usually sought from the builder/consultant to confirm that this has been carried out.

Land contamination assessments may also be driven by other financial institutes, such as lenders, as part of pre-acquisition surveys and/or due diligence audits.

2.0 TGEN APPROACH

The Terragen Environmental Consultants Limited (TGEN) methodology for the assessment, investigation and subsequent management of land contamination within the UK is based upon a phased approach. Assessment may be required in the context of the Part IIA framework, the planning framework, the building control framework, the controlled water framework and the other frameworks, or a combination of all. The basis of an assessment involves:-

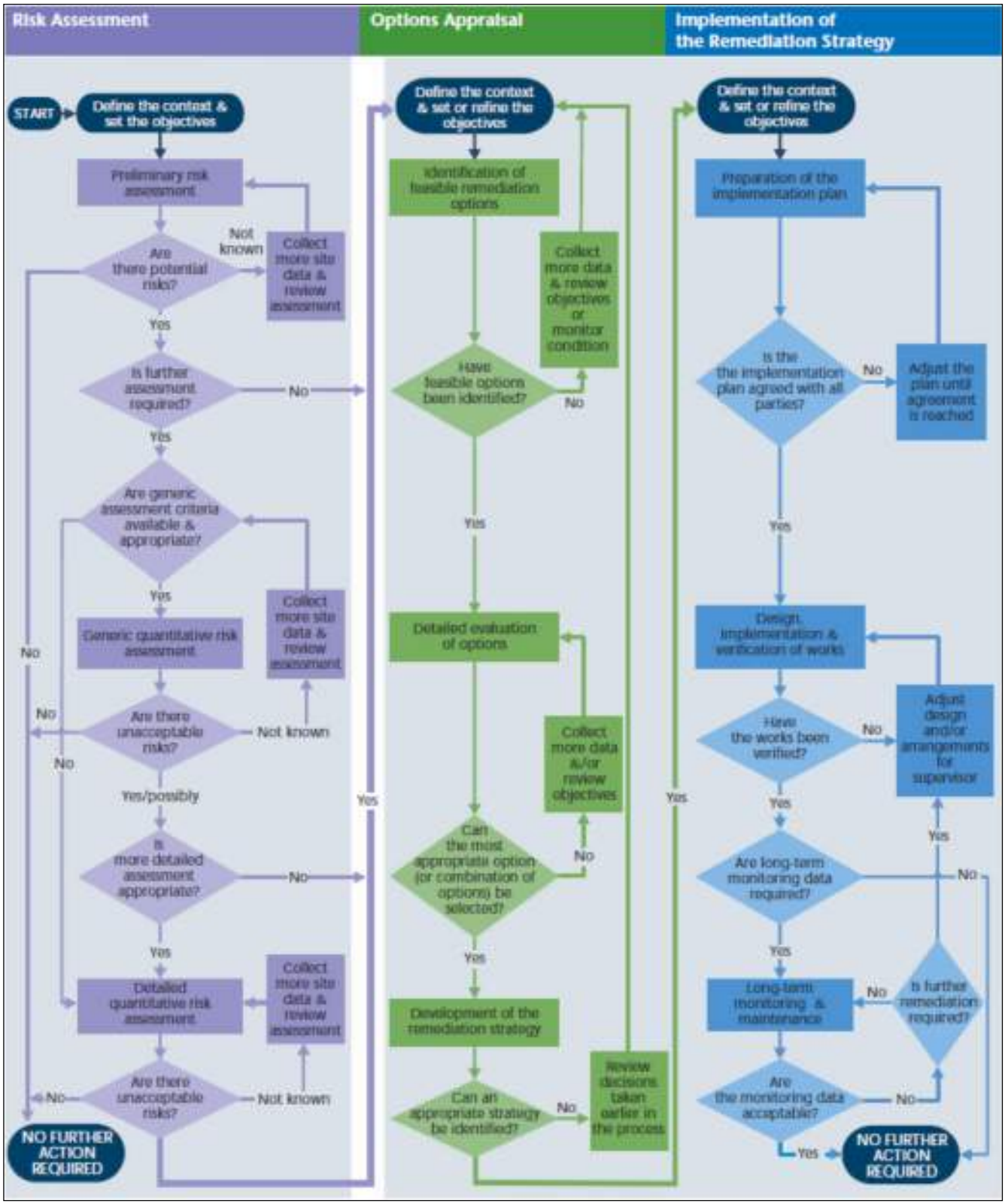
- Identifying a source of contamination.
- Identifying a pathway/media through which the contamination may migrate.
- Identifying a receptor or target at risk from the contamination.

If there is a significant pollutant linkage (SPL) i.e. a source of contamination, a sensitive receptor and a plausible pathway linking the two, then a risk is present. Through an appropriate investigation the significance of the SPL is estimated or quantified. Where the SPL and therefore the risk of harm is deemed significant then within the context of Part IIA the site may be designated as contaminated land. The source-pathway-receptor model used to assess sites is widely accepted in the industry however it does not take into account less scientific factors such as perceived risk.

The full list of statutory and non-statutory guidance documents, regulations, reports, models, tools and standards used to plan, undertake, risk assess and report site investigations for contaminated land are presented in Section 8. However, the main structure and format of our investigations is as specified in BSI (2010), BSI (2013b), Environment Agency (2010a,b,c) and Environment Agency (2004).

As detailed in Environment Agency (2004) the process of managing land contamination is through risk assessment (i.e. is the contamination a problem or could it become one in the future?), options appraisal (i.e. assessment of potential actions and how such actions could be implemented) and implementation of the remediation strategy (i.e. dealing with the contamination and proving that it has been carried out successfully).

As detailed in Environment Agency (2004) the process for each stage of the process of managing land contamination is as follows:-



2.1 Risk Assessment

Our risk assessment process is split into three stages, which comprises two phases of investigation as summarised below:-

Phase	Stage	Activities
Phase 1	Preliminary Risk Assessment (PRA)	Define the project objectives. Desk study and site reconnaissance. Develop a preliminary outline conceptual site model.
Phase 2	Generic Quantitative Risk Assessment (GQRA)	Design and undertake site investigations and analysis. Undertake risk assessment using generic assumptions. Refine the conceptual site model.
	Detailed Quantitative Risk Assessment (DQRA)	Design and undertake site investigations and analysis. Undertake risk assessments using site specific data and sometimes complex numerical models. Refine the conceptual site model.

2.1.1 Phase 1 PRA

A Phase 1 PRA defines the objectives of the overall assessment and provides an assessment of SPL, the culmination of which is the development of a preliminary conceptual site model (CSM) and the identification of any areas of potential concern (AoPC) within the site. Information relating to potential sources of contamination is obtained through a study of available documents and evidence, including current and historical land use, database survey, correspondence with regulatory authorities, site reconnaissance and an assessment of the results derived from previous intrusive investigations at the site. Investigations undertaken as part of a Phase 1 PRA are designed to:-

- Provide information on past and current uses of the site and surrounding area and the nature of any hazards and physical constraints.
- Identify current and likely future receptors, potential sources of contamination and likely pathways, and any features of immediate concern, including those that could be introduced in the future.
- Identify any aspect of the site requiring immediate attention (e.g. insecure fences, hazardous substances accessible to trespassers or likely to be dispersed by wind or water etc.).
- Provide information on the geology, geochemistry, soil, hydrogeology and hydrology of the site.
- Identify potentially different sub-areas (zones) of a site, based on differing ground conditions, potential contamination and past, present and future uses.
- Produce an initial conceptual model for the site as a whole and/or for any zones within the site.
- Identify areas where informed decisions are to be made using specialist assessment techniques or advisors (e.g. if there are ecological, unexploded ordnance (UXO) or archaeological considerations etc.).
- Provide data to assist in the design of potential subsequent exploratory and main investigations, and to give an early indication of possible remedial requirements.
- Provide information relevant to worker health and safety, and to the protection of the environment during field investigations.
- Identify the need to involve regulatory bodies prior to intrusive investigation.

The potentially active SPL identified in the CSM are then assessed in terms of the potential risk of harm to the identified receptors through a combination of the probability of occurrence and the potential severity of the consequence. The assigned risk takes into account the potential for regulatory or third party liability, the potential for affecting value and saleability, and the potential for extraordinary environment related development costs. The Phase 1 PRA risk matrix summarised below is based on guidance contained in CIRIA (2001). Definitions of the risk classifications presented in the guidance are as follows:-

Risk Matrix		Severity of Consequence			
		Severe	Medium	Mild	Minor
Probability of pollutant linkage	High Likelihood	Very High Risk [a]	High Risk [c]	Moderate Risk [f]	Low/Moderate Risk [j]
	Likely	High Risk [b]	Moderate Risk [e]	Low/Moderate Risk [i]	Low Risk [n]
	Low Likelihood	Moderate Risk [d]	Low/Moderate Risk [h]	Low Risk [m]	Very Low Risk [p]
	Unlikely	Low/Moderate Risk [g]	Low Risk [L]	Very Low Risk [o]	Very Low Risk [q]

- **Very High Risk** – there is a high probability that severe harm could arise to a designated receptor from an identified source; or there is evidence that severe harm to a designated receptor is currently happening.
- **High Risk** – harm is likely to arise to a designated receptor from an identified source.
- **Moderate Risk** – it is possible that harm could arise to a designated receptor from an identified source. It is relatively unlikely that any such harm would be severe or if any harm were to occur it is more likely that the harm would be relatively mild.
- **Low Risk** – it is possible that harm could arise to a designated receptor from an identified source, but it is likely that this harm, if realised, would at worst normally be mild.
- **Very Low Risk** – there is a low possibility that harm could arise to a receptor. In the event of such harm being realised it is not likely to be severe.

In instances where SPL are not present or a very low to low risk is identified then the assessment will conclude with the completion of the Phase 1 PRA. Where active (or potentially active) SPL are identified or more elevated risk rankings assigned, then additional assessment will be required to quantify those risks.

The findings of the Phase 1 PRA form the basis upon which the requirement for, scopes of and phasing of subsequent investigations are decided and designed.

The Phase 1 PRA and the objectives of the investigation are reviewed and the need for further investigation considered, based upon the quantity and quality of previous site investigation information available, the level of confidence required from the actual characterisation of ground conditions and hazards, and the results of the risk assessment. Where applicable a summary/scope of future works is normally included.

2.1.2 Phase 2 GQRA and DQRA

Where the outcome of the Phase 1 PRA identifies potential SPL and therefore potential risk, a Phase 2 GQRA and/or DQRA would be undertaken in order to provide quantification of the SPL and therefore greater certainty of the significance of risk. If necessary, an intrusive site investigation together with suitable chemical analysis of soil, leachate and/or water samples, ground gases etc. is designed and implemented in order to gather sufficient information to provide quantification of the risks identified within the Phase 1 PRA.

The information gathered as part of the intrusive investigation is initially compared against generic assessment criteria (GAC) to assess the significance of links within the source-pathway-receptor model and as part of the Phase 2 GQRA a refined CSM can then be produced to assess the identified risks. Remedial measures and/or further works are then designed to either mitigate or further assess the identified risks.

Where necessary, the information gathered as part of the site investigation (and supplemented with additional information) can be compared against site specific assessment criteria (SSAC) in order to more fully rationalise any identified risks.

The scope of the Phase 2 works would be dependent upon the outcome of the Phase 1 PRA but would potentially involve the following:-

- Intrusive investigation (see Section 3.0).
- Assessment of risks to human health (see Section 4.0).
- Assessment of risks to controlled water (see Section 5.0).
- Assessment of risks to other sensitive receptors (see Section 6.0).
- Assessment of risks from ground gas (see Section 7.0).

The outcome of the Phase 2 GQRA or DQRA may be that the risk is not significant and therefore further works or mitigation is not required. If the risk is identified as being significant, or is such that the site is not deemed suitable for the proposed use, then remedial measures may be required in order to break the identified SPL and in so doing reduce the risk to an acceptable level.

2.2 Remediation

2.2.1 Phase 3 Options Appraisal

Where the Phase 1 PRA, Phase 2 GQRA and/or DQRA identify unacceptable risks in the context of the current or proposed use of a site, then remedial measures would be required. There are a wide range of remedial methods available with the method chosen being dependent upon the contaminant(s) identified, the site conditions, the proposed development, timescales and budget available. The first stage of Phase 3 involves a detailed assessment of potential options for remediation. Our approach is detailed in the table below.

Stage	Activities
Identify Feasible Remediation Options	Review and refine the conceptual model. Identify management and technical objectives. Define remediation objectives and criteria. Identify a shortlist of feasible remediation options.
Detailed Evaluation of Options	Evaluate and analyse options individually and in combination. Decide which of the options is/are most appropriate.
Develop a Remediation Strategy	Consider the zoning and timing of remediation. Decide how the strategy will be verified. Review costs and benefits. Develop a practical strategy for the remediation.

In some cases the simplest remediation method that is generally accepted for contamination that has been identified as posing a potential risk to humans, but not to other receptors, is to provide a barrier between occupiers/users of a site and the identified contamination. This barrier normally comprises a clean covering of soil. This remediation method is only suitable for contaminants that are of low volatility and/or mobility.

In accordance with UK policy and where feasible the removal of soil from site is minimised and disposal offsite as waste to landfill is considered as a last resort.

2.2.2 Phase 3 Implementation of Remediation

Once a method of remediation has been selected a plan would be prepared detailing how the measures would be implemented, monitored (where necessary) and verified as detailed in the table below.

Stage	Activities
Prepare an Implementation Plan	Identify management responsibilities. Consult with relevant parties (e.g. regulators, land owners etc.). Confirm if regulatory permits are required. Develop phasing and timetable.
Design, Implement and Verify the Remediation	Complete pilot trials (may need a permit). Procure contractors. Obtain permits. Produce a verification plan. Carry out remediation. Verify (in reports) what has been done.
Long Term Monitoring and Maintenance	Monitor how well the remediation has worked. Review and adjust the monitoring programme as necessary. Analyse results and report them. Take action if results indicate a need.

2.3 Verification and Closure

During the implementation of the approved remediation strategy we would attend site to carry out the necessary verification works (e.g. sampling, records and documentation of site works etc.). Upon the successful completion of the remediation all of the verification records would be compiled in a closure report detailing all of the works undertaken.

3.0 INTRUSIVE INVESTIGATION

If necessary an intrusive site investigation together with suitable chemical analysis of soil, leachate and/or water samples, ground gases etc. is designed and implemented by TGEN in order to gather sufficient information to provide quantification of the risks identified within the Phase 1 PRA and to inform a Phase 2 GQRA or DQRA. The site investigation itself may be split into several sub-phases, dependent upon the size and scale of the site as detailed in the following sections.

3.1 Exploratory Investigation

An exploratory investigation is often used on sites identified as a low risk as part of the Phase 1 PRA in order to confirm that assessment. For more complex sites or those allocated a higher risk, an exploratory investigation may be implemented as a precursor to, and to inform the design of, a main investigation. If implemented, an exploratory investigation would be designed to:-

- Test the contamination and site characteristics identified within the preliminary CSM.
- Obtain further information in relation to potential sources of contamination, likely pathways and features of immediate concern.
- Obtain further information on the geology, geochemistry, soil, hydrogeology and hydrology of the site.
- Provide further information to aid the design of a main investigation, including health and safety aspects.
- Provide data for a review of the CSM and to update the risk assessment.

3.2 Main Investigation

The main investigation would be designed to:-

- Obtain data on the nature and extent of contamination, the geology, geochemistry, soil, hydrogeology and hydrology of a site.
- Provide data to review the preliminary CSM and to update the risk assessment.
- Provide data for the selection and design of remedial works.

3.3 Supplementary Investigation(s)

In cases where an exploratory and/or main investigation highlight specific issues at a site then a supplementary investigation(s) would be designed in order to:-

- Provide clearer delineation of a particular area (zone) of contamination or a contamination plume.
- Address or clarify specific technical matters (e.g. to confirm the applicability and feasibility of potential remedial options or obtain information for their design etc.).

3.4 In Situ Testing

Where necessary, during the intrusive investigation(s), an assessment of soils for the presence of volatile organic compounds by visual and olfactory means is supplemented with the use of a PhoCheck Plus 2000 photo ionisation detector (PID) calibrated with isobutylene gas and fitted with a 10.6eV UV lamp. Subsamples are placed into a polythene bag, which is then sealed to exclude as much atmospheric air as possible. The soil samples are gently broken up within the bags and left for circa thirty minutes in order to facilitate volatilisation from the pore spaces. Following this the PID is inserted into the polythene bag to test for the presence ionisable volatile compounds.

3.5 Laboratory Testing

During the intrusive investigation(s) samples of soil, water, gas etc. are recovered from representative locations and submitted to an approved UKAS/MCERTS accredited laboratory.

Collection
Dedicated amber jars, bottles, epa vials, plastic tubs, gas bags/tubes etc. provided by the laboratory, are used for the collection of samples. To minimise the potential for cross contamination, disposable gloves are changed for each sample collected and equipment used is cleaned between each sampling event.

Preservation
Loss of volatile compounds through desorption and volatilisation from the samples is limited by filling and tightly enclosing the samples in dedicated amber jars, thus ensuring minimal headspace, and

storing at a low temperature (i.e. a refrigerated cool box), which further minimises biodegradation of organic compounds.

Transport
Samples are transported to the laboratory in dedicated containers maintained at a low temperature. All samples and analytical requests are recorded on the laboratory chain of custody form prior to dispatching for analysis.

3.6 Assessment of Potential Contaminants

Two criteria are used for the selection of potential contaminants to test for during ground investigations:-

- Contaminants must be likely to be present on many sites affected by current or former industrial use in the UK in sufficient concentrations to cause harm. The purpose of this criterion is to exclude substances that are rarely found or are unlikely to be present in harmful concentrations.
- Contaminants must pose a potential risk to human beings and/or other sensitive receptors (e.g. the water environment, ecology, plants, construction or building materials and property etc.).

Only substances meeting both of the above criteria are selected for analysis. Therefore, the selected substances are:-

- Likely to occur on many industrial sites in sufficient concentrations to cause harm or pollution.
- Known or suspected to pose significant risk to humans (death, serious injury, cancer or other disease, genetic mutation, birth defects or the impairment of reproductive functions).
- Known or suspected to pose a significant risk to the water environment, or likely to cause other adverse impacts in the water environment as a result of their presence on land.
- Known or suspected to pose a significant risk to ecology as a result of their presence on land.
- Known or suspected to have a significant effect on buildings or building materials.
- Known or suspected to be persistent and mobile in soils or have tendency to bio-accumulate through exposure of sensitive organisms.

The following documents are the primary sources for identifying those contaminants likely to be present:-

- Environment Agency (2002) identified priority contaminants, selected on the basis that they are likely to be present on many current or former sites affected by industrial or waste management activity in the UK in sufficient concentrations to cause harm.
- DoE (1995a) describe specific industrial processes and the chemicals that are commonly found on industrial land.

The information gathered during the investigation(s) is then compared against generic assessment criteria (GAC) to assess links within the source-pathway-receptor model (see Sections 4 to 7).

4.0 RISKS TO HUMAN HEALTH

In order to undertake a Phase 2 GQRA, contaminant concentrations from samples generated from a Phase 2 site investigation need to be compared to appropriate GAC. Current industry practice is to use, as first preference, SGV published by the agency and derived using the CLEA model.

The CLEA model provides an approach for the assessment of chronic risks to human health from concentrations of a substance within soil, where appropriate.

The current version of the model (v1.06) was published in 2009 and, following its publication, a number of SGV have also been produced. However, the SGV published to date are only for a limited number of contaminants. Where published SGV do not exist, other published GAC values derived from a risk-based assessment of human toxicological and/or ecotoxicological data have been utilised in accordance with the following hierarchy:-

- GAC prepared in accordance with the CLEA v1.06 model by authoritative bodies (e.g. CL:AIRE, CIEH, EIC etc.).
- GAC prepared in accordance with the CLEA v1.06 model and associated documents by TGEN.

4.1 TGEN Approach

The approach adopted has been to generate GAC for chronic risks to human health using CLEA v1.06. In generating GAC, input parameters consistent with the most recent agency publications have been adopted (see Section 8).

4.1.1 Substance Specific Information (Health Criteria Values)

Toxicological data for respective contaminants have been chosen for use based on the guidance in Environment Agency (2009a). Where UK guidance is available (i.e. existing published TOX reports) the appropriate health criteria values (HCV) have been adopted. Where no TOX report is available the following approaches has been used (given in order of preference):-

- Published toxicity reviews to derive HCV within CIEH (2009).
- Other appropriate UK sources.
- Authoritative European sources.
- International organisations (e.g. WHO).
- Appropriate, authoritative US sources (e.g. USEPA).

4.1.2 Substance Specific Information (Physico Chemical Characteristics)

Fate and transport characteristics for the contaminants for which GAC have been derived were chosen using the following hierarchy of data sources:-

- Environment Agency (2008b).
- Environment Agency (2003).
- Other UK government documents.
- European data sources (e.g. NIPHE 2001).
- International data sources (e.g. WHO and USEPA).

4.1.3 Model Settings

In the generation of GAC, default settings have been used for the following exposure scenarios:-

- Residential with Plant Uptake.
- Residential without Plant Uptake.
- Allotments.
- Commercial/Industrial.

The default soil type is set as a sandy loam with a pH of 7. Soil organic matter (SOM) contents of 1%, 3% and 6% have been considered, where appropriate.

4.1.4 Soil Saturation

With the exception of petroleum hydrocarbon fractions, GAC have been limited to the calculated soil saturation limit for organic species, which is in accordance with the approach taken by the agency in the production of SGV. Petroleum hydrocarbon fractions are assessed, where appropriate, based on hazard index and so have not been limited to soil saturation.

4.1.5 Cyanides

The primary risk to human receptors from free cyanide in soils is an acute risk (i.e. a single dose could have a lethal affect as opposed to adverse effects from cumulative intake (chronic affect)).

There is no current UK guidance available for calculating acute risks from free cyanide. As such, the (officially withdrawn) SNIFFER (2003) methodology has been used to derive an acute GAC of 60 mg/kg for all exposure scenarios. The value is given for free or easily released cyanide but can be used to assess total cyanide in the absence of cyanide speciation. In cases where the total cyanide exceeds the GAC then analysis of free or easily released cyanide is completed.

4.1.6 Limitations of the CLEA Model

In the application of GAC (and SGV) to a site, the limitations of the CLEA model have been recognised. Specifically these relate to the absence of certain pollutant considerations such as risks to services, of fire and explosion, aesthetics, institutional perception, groundwater, surface waters, eco-toxicological risk and risks to buildings (amongst others).

In addition, the GAC specifically do not meet the requirements of the legal definition of significant possibility of significant harm but provide a benchmark below which concentrations of contaminants are not considered to warrant further consideration in the context of the land use scenario.

The CLEA model also does not explicitly consider the potential for chronic impact to human health from indoor inhalation of concentrations of volatile vapours from dissolved phase contamination. The potential exists for this to be an important exposure route for a limited number of highly volatile contaminants. As such, GAC have been calculated for volatile contaminants for volatilisation from groundwater using RISC 4. It should be noted that the RISC 4 approach does not include advection into buildings and we consider alternative approaches where this is likely to be a significant issue.

Exposure factors required for the model have been derived using the information contained within Environment Agency (2009a,b,c,d). Where ranges of values are provided for input parameters, an appropriate conservative single value has been chosen for input into the RISC 4 model.

The following table details the receptor exposure factors used to generate the GAC.

Receptor Parameters	Unit	Residential	Source	Commercial	Source
Lifetime	yr	6	Environment Agency (2009b) - Section 3.2.3.	49	Environment Agency (2009b) - Section 3.4.1.
Body Weight	kg	14.2	Environment Agency (2009b) - Table 3.2 (average over age 0-6 considering child age 0-1 has 0.5yr exposure).	70	Environment Agency (2009b) - Section 4.1.
Indoor Air Exposure (Frequency)	days/yr	365	Environment Agency (2009b) - Table 3.1.	230	Environment Agency (2009a) - Table 3.9.
Indoor Air Exposure (Duration)	yr	6	Environment Agency (2009b) - Section 3.2.3.	49	Environment Agency (2009a) - Section 3.4.1.
Lung Retention Factor	fraction	1	Conservative assumption.	1	Conservative assumption.
Inhalation Rate Indoors	m^3/hr	0.5	Environment Agency (2009b) - Table 4.14 (calculated average).	0.56	Environment Agency (2009b) - Table 4.14 (calculated average).
Time Indoors	hr/day	21.7	Environment Agency (2009b) - Table 3.2.	8.3	Environment Agency (2009b) - Box 3.6.
Bioavailability for All Contaminants	%	100	Default conservative assumption.	100	Default conservative assumption.

Default building parameters that have been utilised in the generation of the groundwater GAC values as presented in the following table:-

Building Parameters	Unit	House	Source	Office	Source
Footprint Area	m^2	28	Environment Agency (2009b) - Table 3.3.	424	Environment Agency (2009b) - Table 3.10.
Volume	m^3	134.4	Environment Agency (2009b) - Table 3.3.	4070.4	Environment Agency (2009b) - Table 3.10.
Air Exchanges Per Day	no.	12	Environment Agency (2009b) - Table 3.3.	24	Environment Agency (2009b) - Table 3.10.
Foundation Thickness	m	0.15	Environment Agency (2009b) - Table 3.3.	0.15	Environment Agency (2009b) - Table 3.10.
Foundation Cracks	fraction	0.001429	Environment Agency (2009b) - Table 3.3.	0.000389	Environment Agency (2009b) - Table 3.10.
Porosity of Foundation Cracks	factor	1	Assumes crack fraction is entirely available for vapour ingress.	1	Assumes crack fraction is entirely available for vapour ingress.
Water Content in Foundation Cracks	cm^3/cm^3	0	Conservative assumption.	0	Conservative assumption.

House (small two storey terrace). Office (pre-1970 three storey).

In the absence of UK guidelines, the exposure scenario adopted has considered a groundwater source 0.5m below the base of the building as a conservative approach representing an example of a very shallow aquifer and corresponding with the depth of a soil source as adopted in the generic scenario in the CLEA model. The appropriateness of this assumption is assessed on a site by site basis considering the conceptual model for the site. The groundwater model parameters are presented in the following table:-

Groundwater Parameters	Units	Value	Source
Distance Between Building Foundation and Groundwater	m	0.50	Environment Agency (2009b) - Page 51.
Total Porosity in Source Zone	cm^3/cm^3	0.53	Environment Agency (2009b) - Table 4.4 (i.e. sandy loam).
Water Content in Source Zone	cm^3/cm^3	0.33	Environment Agency (2009b) - Table 4.4 (i.e. sandy loam).
Thickness of Capillary Fringe	cm	10	Estimate.
Air Content in the Capillary Fringe	cm^3/cm	0.01	Estimate.

For many contaminants, no risk is calculated at concentrations below the pure phase solubility of the contaminant. Caution is applied when non-aqueous phase liquids (NAPL) are likely to be present, either where these have been detected during monitoring or where the concentration of a component in a mixture exceeds 10% of its calculated effective solubility. In such cases, a separate assessment of the generation of volatile vapours from NAPL via modelling or a soil vapour survey may be undertaken.

It is important to note that the values are only applicable to human health and cannot be used to determine the potential risks to controlled waters.

4.2 Use of Statistical Tests in Data Interpretation

4.2.1 Averaging Zones

CLEA methodology requires the definition of averaging zones based on previous/current/future spatial land use, soil type, proposed site end uses or other distinguishing features. Where there is similar historic and/or contemporary land use across a site and the redevelopment plans indicate that the site is to be under a single end use then horizontally the whole site is taken as one averaging area.

4.2.2 Sample Depths

It is intended that the CLEA statistical analysis is applied to soils from <1.0mbgl. This is due to the greatest likelihood that site end users would be exposed to these soils. Samples tested from below this depth during an assessment would be subjected to a similar analysis to assess the chemical characteristics of natural soils and deeper areas of fill. Where samples are included within the dataset(s) that are >1mbgl, it is assumed, with regards to human health, that excavation associated with the development may result in soils from these greater depths being within 1m of final levels in areas of sensitive end use at the site. This could be considered as an additional layer of conservatism within the approach adopted.

In addition, it should be noted that the methodology makes depth based assumptions regarding risks to human health from soils, which can be summarised as follows:-

- For direct ingestion of soil and dust, dermal contact with soil outdoors and soil derived dust indoors, and inhalation of soil derived dust outdoors and indoors contamination is assumed to be present in the top 0.1m of the soil profile.
- For consumption of vegetables and ingestion of soil attached to them it is assumed that the contamination is present in the top 0.5m of the soil profile.
- For inhalation of soil vapours outdoors, the contamination is assumed to be at a depth of 1.0m.
- For inhalation of soil vapours indoors, the contamination is assumed to be directly below the building.

Where necessary (and feasible), the different depths of the potential risks to human health are taken into account in designing and/or assessing site investigations.

4.2.3 Statistical Approach

A statistical basis for the assessment of the analytical results obtained during the site investigation is detailed within CL:AIRE (2008). The premise is to review an entire data set in an appropriate way in comparison to selected GAC. The assumption made is that the results from the site investigation are to some degree representative of the contaminant concentration throughout that area or volume of soil represented by the sample or samples. The most appropriate method for assessing a given dataset is dependent upon a range of site specific factors together with the quantity and quality of the data

generated and the chosen approach differentiated for datasets where random or targeted sampling has been undertaken and where a site is being considered in a planning or Part IIA context.

Where it is required to draw conclusions about the condition of the land under scrutiny as part of a planning scenario comparison is made between a value larger than the sample mean, in this case the upper confidence limit (UCL) and the critical concentration (GAC) as opposed to the Part IIA scenario (whereby comparison is made between the lower confidence limit (LCL) and the critical concentration). The UCL provides an estimate of the population mean, based on test data, with a 95% confidence that the actual mean does not exceed this value.

In the first instance, the approach to statistical assessment involves a qualitative assessment of the dataset. This involves a summary of the number of tests, maximum concentration, mean concentration, standard deviation and number of non-detects. In instances where both the maximum and mean concentrations are below the prescribed GAC then further assessment is not considered necessary.

For compounds where the maximum or mean concentration exceeds the respective GAC, a statistical assessment is undertaken in accordance with CL:AIRE (2008). The USEPA ProUCL Version 5.0 (2013) is used to determine the presence of statistical outliers within the dataset, the normality of the distribution and the upper confidence limit at a 95% confidence interval (UCL_{95}) concentration using an appropriate statistical tool.

Where statistical outliers (not representative of the dataset) are identified, the respective samples/locations are considered to be hotspots and are removed from the dataset for consideration in isolation from the remaining samples.

Following the removal of any outliers, the dataset is re-evaluated. The distribution of the dataset is determined in accordance with the Shapiro-Wilk normality test. For datasets with a normal distribution, the UCL_{95} concentration is determined using the Students t-test at a 95% confidence interval. For lognormal distributions, the UCL_{95} concentration is determined using the Chebyshev Theorem at a 95% confidence interval.

4.3 Human Health GAC

4.3.1 Heavy Metals

Source	Determinand	Generic Assessment Criteria		
		Residential	Allotment	Commercial
CL:AIRE	Antimony[b]	550	-	7500
SGV	Arsenic[abh]	32	43	640
CL:AIRE	Barium[b]	1300	-	22000
CIEH	Beryllium[abc]	51[d]	55[e]	420[d]
CIEH	Boron[abc]	290	45	190000
CIEH	Cadmium[abc]	3.0[i]	0.53[i]	350[d]
SGV	Cadmium[abcj]	10	1.8	230
CIEH	Chromium (III)[abc]	3000	35000	30000
CIEH	Chromium (VI)[abc]	4.3[d]	2.1[e]	35[d]
CIEH	Copper[abc]	2300	520	72000
TGEN GAC	Lead[n]	290	250	5690
SGV	Elemental Mercury[abg]	1.0	26[f]	26[f]
SGV	Inorganic Mercury[ab]	170	80	3600
SGV	Methyl Mercury[abg]	11	8	410
CL:AIRE	Molybdenum[b]	670	-	17000
SGV	Nickel[abc]	130[k]	230	1800[k]
SGV	Selenium[abm]	350	120	13000
CIEH	Vanadium[abc]	75	18	3200
CIEH	Zinc[abcd]	3800	620	670000

[a] Based on a sandy loam soil as defined in Environment Agency (2009b) and 6% SOM.
[b] Values are rounded to two significant figures.
[c] In applying the rules for non-soil background to the GAC, the background average daily exposure (ADE) is limited to being no larger than the contribution from the relevant soil ADE.
[d] Based on a comparison of inhalation exposure with inhalation index dose (ID).
[e] Based on a comparison of oral and dermal exposure with oral tolerable daily soil intake (TDSI).
[f] The GAC is based on the vapour saturation limit.
[g] For the purposes of modelling the vapour inhalation pathway, elemental and methyl mercury are treated as organic.
[h] Based on a comparison of oral and dermal soil exposure with oral ID.
[i] Based on a comparison of oral and dermal exposure with oral tolerable daily intake (TDI).
[j] Based on a lifetime exposure via oral, dermal and inhalation pathways.
[k] Based on a comparison of inhalation exposure with inhalation TDI.
[l] Based on a comparison of oral, dermal and inhalation exposure with oral TDI.
[m] Based on oral, dermal and inhalation pathways.
[n] Based on in-house GAC determined using CLEA V1.06.

4.3.2 BTEX

Source	Determinand	Residential	Allotment	Commercial
SGV	Benzene[abcde]	0.33	0.07	95
SGV	Toluene[abcde]	610	120	4400[f]
SGV	Ethylbenzene[abcde]	350	90[g]	2800[h]
SGV	o-Xylene[abcdei]	250	160[g]	2600[h]
SGV	m-Xylene[abcdei]	240	180[g]	3500[h]
SGV	p-Xylene[abcdei]	230	160[g]	3200[h]

a	Based on a sandy loam soil as defined in Environment Agency (2009b) and 6% SOM. At a lower SOM, GAC may not be sufficiently protective.
b	Values are rounded to two significant figures.
c	GAC for BTEX will vary according to SOM for all land uses.
d	GAC for BTEX assume that free phase contamination is not present.
e	GAC for BTEX are based on a subsurface soil to indoor air correction factor of 10.
f	GAC presented are based on the vapour saturation limit.
g	In applying the rules for non-soil background to the allotment GAC, the inhalation background ADE is limited to being no larger than the contribution of the inhalation soil ADE.
h	GAC for commercial land use are capped at the lower of the vapour and aqueous saturation limits.
i	Exposure to all isomers of xylene should be considered together, because the HCV applied is based on the intake of total xylene and not an individual isomer in isolation.

4.3.3 Petroleum Hydrocarbons

Source	Determinand	Residential[abcde]			Allotments[abcde]			Commercial[abcde]		
		1%	2.5%	6%	1%	2.5%	6%	1%	2.5%	6%
CIEH	Aliphatic C_5-C_6	30	55	110	740	1700	3900	3400 (304)[sol]	6200 (558)[sol]	13000 (1150)[sol]
CIEH	Aliphatic C_6-C_8	73	160	370	2300	5600	13000	8300 (144)[sol]	18000 (322)[sol]	42000 (736)[sol]
CIEH	Aliphatic C_8-C_{10}	19	46	110	320	770	1700	2100 (78)[sol]	5100 (190)[vap]	12000 (451)[vap]
CIEH	Aliphatic C_{10}-C_{12}	93 (48)[vap]	230 (118)[vap]	540 (283)[vap]	2200	4400	7300	10000 (48)[sol]	24000 (118)[vap]	49000 (283)[vap]
CIEH	Aliphatic C_{12}-C_{16}	740 (24)[sol]	1700 (59)[sol]	3000 (142)[sol]	11000	13000	13000	61000 (24)[sol]	83000 (59)[sol]	91000 (142)[sol]
CIEH	Aliphatic C_{16}-C_{35}[f]	45000[f] (8.5)[sol]	64000[f] (21)[sol]	76000[f]	260000[f]	270000[f]	270000[f]	1600000[f]	1800000[f]	1800000[f]
CIEH	Aliphatic C_{35}-C_{44}	45000[f] (8.5)[sol]	64000[f] (21)[sol]	76000[f]	260000[f]	270000[f]	270000[f]	1600000[f]	1800000[f]	1800000[f]
CIEH	Aromatic C_5-C_7	65	130	280	13	27	57	28000 (1220)[sol]	49000 (2260)[sol]	90000 (4710)[sol]
CIEH	Aromatic C_7-C_8	120	270	611	22	51	120	59000 (869)[vap]	110000 (1920)[sol]	190000 (4360)[vap]
CIEH	Aromatic C_8-C_{10}	27	65	151	8.6	21	51	3700 (613)[vap]	8600 (1500)[vap]	18000 (3580)[vap]
CIEH	Aromatic C_{10}-C_{12}	69	160	346	13	31	74	17000 (364)[sol]	29000 (899)[sol]	34500 (2150)[sol]
CIEH	Aromatic C_{12}-C_{16}	140	310	593	23	57	130	36000 (169)[sol]	37000	37800
CIEH	Aromatic C_{16}-C_{21}	250[f]	480[f]	770[f]	46[f]	110[f]	260[f]	28000[f]	28000[f]	28000[f]
CIEH	Aromatic C_{21}-C35	890[f]	1100[f]	1230[f]	370[f]	820[f]	1600[f]	28000[f]	28000[f]	28000[f]
CIEH	Aromatic C_{35}-C_{44}	890[f]	1100[f]	1230[f]	370[f]	820[f]	1600[f]	28000[f]	28000[f]	28000[f]
CIEH	Aliphatic+Aromatic C_{44}-C_{70}	1200[f]	1300[f]	1300[f]	1200[f]	2100[f]	3000[f]	28000[f]	28000[f]	28000[f]

[a] Based on a sandy loam soil as defined in Environment Agency (2009b) and 1%, 2.5% and 6% SOM.
[b] GAC for petroleum hydrocarbons will vary according to SOM for all land uses.
[c] Values are rounded to two significant figures.
[d] GAC assume that free phase contamination is not present.
[e] GAC are based on a subsurface soil to indoor air correction factor of 10.
[f] Oral, dermal and inhalation exposure is compared with oral HCV.
[sol] GAC presented exceed the solubility saturation limit, which is shown in brackets.
[vap] GAC presented exceed the vapour saturation limit, which is shown in brackets.

4.3.4 Polyaromatic Hydrocarbons

Source	Determinand	Residential[abcde]			Allotment[abcde]			Commercial[abcde]		
		1%	2.5%	6%	1%	2.5%	6%	1%	2.5%	6%
CIEH	Acenaphthene	210	480	1000	34	85	200	85000 (57)[sol]	98000 (141)[sol]	100000
CIEH	Acenaphthylene	170	400	850	28	69	160	84000 (86)[sol]	97000 (212)[sol]	100000
CIEH	Anthracene	2300	4900	9200	380	950	2200	530000	540000	540000
CIEH	Benzo(a)anthracene	3.1	4.7	5.9	2.5	5.5	10	90	95	97
CIEH	Benzo(a)pyrene	0.83	0.94	1.0	0.60	1.2	2.1	14	14	14
CIEH	Benzo(b)fluoranthene	5.6	6.5	7.0	3.5	7.4	13	100	100	100
CIEH	Benzo(g,h,i)perylene	44	46	47	70	120	160	650	660	660
CIEH	Benzo(k)fluoranthene	8.5	9.6	10	6.8	14	23	140	140	140
CIEH	Chrysene	6.0	8.0	9.3	2.6	5.8	12	140	140	140
CIEH	Dibenzo(a,h)anthracene	0.76	0.86	0.90	0.76	1.5	2.3	13	13	13
CIEH	Fluoranthene	260	460	670	52	130	290	23000	23000	23000
CIEH	Fluorene	160	380	780	27	67	160	64000 (31)[sol]	69000	71000
CIEH	Indeno(1,2,3-cd)pyrene	3.2	3.9	4.2	1.8	3.8	7.1	60	61	62
CIEH	Naphthalene	1.5	3.7	8.7	4.1	9.9	23	200 (76)[sol]	480 (183)[sol]	1100 (432)[sol]
CIEH	Phenanthrene	92	200	380	16	38	90	22000	22000	23000
CIEH	Pyrene	560	1000	1600	110	270	620	54000	54000	54000

[a] Based on a sandy loam soil as defined in Environment Agency (2009b) and 1%, 2.5% and 6% SOM.
[b] GAC for polyaromatic hydrocarbons will vary according to SOM for all land uses.
[c] Values are rounded to two significant figures.
[d] GAC assume that free phase contamination is not present.
[e] GAC are based on a subsurface soil to indoor air correction factor of 1.
[sol] GAC presented exceed the solubility saturation limit, which is shown in brackets.
[vap] GAC presented exceeds the vapour saturation limit, which is shown in brackets.

4.3.5 Source of Polyaromatic Hydrocarbons

PAH compounds are formed as the result of the incomplete combustion of carbon, either as a result of natural or anthropogenic processes, and are endemic in the environment as well as being present as the result of fuel based combustion (e.g. used engine oil, exhaust emissions etc.).

There are a number of methods which can be used to assess the ratio of certain PAH compounds in order to determine the likely source of contamination (e.g. petroleum products, combustion products, coal derived or plant derived).

We have used three methods, as detailed in the following publications:-

- NAVFAC (2003).
- EFSA (2008).
- Yunker et al. (2002).

In this section the following abbreviations are used for the various PAH compounds:-

- Fluoranthene FL
- Pyrene PY
- Phenanthrene PH
- Anthracene AN
- Benzo(a)anthracene BaA
- Benzo(b)fluoranthene BbF
- Benzo(k)fluoranthene BkF
- Benzo(a)pyrene BaP
- Indeno(123-cd)pyrene IcdP
- Benzo(ghi)perylene BghiP

NAVFAC (2003) defines three main source types of PAH:-

- Petrogenic generated from organic matter in ancient sediments by geologic conditions.
- Pyrogenic generated by the combustion of organic matter (wood, coal, petroleum, wastes etc.).
- Biogenic generated by modern biological processes of diagenetic processes (e.g. oxidation of organic matter).

The following broad trends in the data analysed were recognised:-

- A ratio of FL to PY of <1 is indicative of petrogenic sources.
- A ratio of FL to PY of >1 is indicative of pyrogenic sources.
- A ratio of PH to AN of >5 is indicative of petrogenic sources.
- A ratio of PH to AN of <5 is indicative of pyrogenic sources.

EFSA (2008) provides indicative ratios of BbF, BkF and IcdP to BaP as detailed below:-

	Coal Combustion (industrial and domestic)	Wood Combustion (industrial and domestic)	Natural Fires	Cars (Petrol)	Cars (Diesel)	Heavy Duty Vehicles
BbF/BaP	0.05	1.2	0.6	1.2-0.9	0.9	5.6
BkF/BaP	0.01	0.4	0.3	0.9-1.2	1.0-0.8	8.2
IcdP/BaP	0.8	0.1	0.4	1.0-1.4	1.1-0.9	1.4

Yunker et al (2002), produced a double ratio plot of BaA:CH against FL:PY. The results of the plot would indicate that:-

- Where the FL:PY ratio is <0.65 the PAH is a result of the combustion of petroleum products.
- Where the FL:PY ratio is >1.0 the PAH is a result of coal combustion.
- Where the FL:PY ratio is between 0.65 and 1.0 the PAH is a result of other combustion products.
- Where the BaA:CH ratio is <0.1 it is likely that the PAH is a result of plant derived materials.

Yunker et al (2002) also carried out a literature review of published PAH ratios for a number of sources and identified the following broad trends in the data:-

- FL to FL plus PY
  - <0.4 Petroleum hydrocarbon sources.
  - 0.4-0.5 Liquid fossil fuel combustion products.
  - >0.5 Grass, wood and coal combustion products.
- BaA to BaA plus CH
  - <0.2 Petroleum hydrocarbon sources.
  - 0.2-0.35 Petroleum hydrocarbon sources or combustion.
  - >0.35 Combustion products.
- AN to AN plus PH
  - <0.1 Petroleum hydrocarbon sources.
  - >0.1 Combustion sources.
- IcdP to IcdP plus BghiP
  - <0.2 Petroleum hydrocarbon sources.
  - 0.2-0.5 Petroleum hydrocarbon combustion.
  - >0.5 Grass, wood and coal combustion products.

4.3.6 Chloroalkanes & Alkenes

Source	Determinand	Residential[abcde]			Allotment[abcde]			Commercial[abcde]		
		1%	2.5%	6%	1%	2.5%	6%	1%	2.5%	6%
CIEH	1,2-Dichloroethane	0.0054	0.0080	0.014	0.0046	0.0083	0.016	0.71	1.0	1.8
CIEH	1,1,1-Trichloroethane	6.2	13	28	48	110	240	700	1400	3100
CIEH	1,1,2,2-Tetrachloroethane	1.4	2.9	6.3	0.41	0.89	2.0	290	580	1200
CIEH	1,1,1,2-Tetrachloroethane	0.90	2.1	4.8	0.79	1.9	4.4	120	260	590
CIEH	Tetrachloroethene	0.94	2.1	4.8	1.6	3.7	8.7	130	290	660
CIEH	Tetrachloromethane (Carbon Tetrachloride)	0.018	0.039	0.089	0.16	0.37	0.85	3.0	6.6	15
CIEH	Trichloroethene	0.11	0.22	0.49	0.43	0.95	2.2	12	25	55
CIEH	Trichloromethane (Chloroform)	0.75	1.3	2.7	0.36	0.70	1.5	110	190	370
CIEH	Chloroethene (Vinyl Chloride)	0.00047	0.00064	0.00099	0.00055	0.0010	0.0018	0.063	0.081	0.12

[a] Based on a sandy loam soil as defined in Environment Agency (2009b) and 1%, 2.5% and 6% SOM.
[b] GAC for chloroalkanes and alkenes will vary according to SOM for all land uses.
[c] Values are rounded to two significant figures.
[d] GAC for chloroalkanes and alkenes assume that free phase contamination is not present.
[e] GAC for chloroalkanes and alkenes are based on a subsurface soil to indoor air correction factor of 1.

4.3.7 Explosives

Source	Determinand	Residential[abcde]			Allotment[abcde]			Commercial[abcde]		
		1%	2.5%	6%	1%	2.5%	6%	1%	2.5%	6%
CIEH	2,4,6-Trinitrotoluene (TNT)	1.6	3.7	8.0	0.24	0.58	1.4	1000	1000	1100
CIEH	RDX	3.5	7.4	16	0.52	1.1	2.5	6400	6400	6400
CIEH	HMX	5.7	13	26	0.86	1.9	3.9	110000	110000	110000

[a] Based on a sandy loam soil as defined in Environment Agency (2009b) and 1%, 2.5% and 6% SOM.
[b] GAC for explosives will vary according to SOM for all land uses.
[c] Values are rounded to two significant figures.
[d] GAC for explosives assume that free phase contamination is not present.
[e] GAC for explosives are based on a subsurface soil to indoor air correction factor of 1.

4.3.8 Pesticides

Source	Determinand	Residential[abcde]			Allotment[abcde]			Commercial[abcde]		
		1%	2.5%	6%	1%	2.5%	6%	1%	2.5%	6%
CIEH	Aldrin	1.7	2.0	2.1	1.3	2.6	4.0	54	54	54
CIEH	Dieldrin	0.69	1.4	2.2	0.13	0.32	0.73	90	91	92
CIEH	Atrazine	0.24	0.56	1.3	0.037	0.085	0.20	870	880	880
CIEH	Dichlorvos	0.29	0.6	1.3	0.044	0.091	0.2	842	872	893
CIEH	Alpha-Endosulfan	2.9	7.0	16	0.47	1.2	2.7	2310 (0.003)[vap]	2990 (0.007)[vap]	3390
CIEH	Beta-Endosulfan	2.8	6.6	15	0.44	1.1	2.6	2580 (0.00007)[vap]	3160 (0.0002)[vap]	3480
CIEH	Alpha-Hexachlorocyclohexane	19	46	100	3.0	7.4	18	14000	14600	14900
CIEH	Beta-Hexachlorocyclohexane	1.7	3.9	8.5	0.26	0.64	1.5	1120	1130	1130
CIEH	Gamma-Hexachlorocyclohexane	0.58	1.4	3.0	0.089	0.22	0.52	532	546	552

[a] Based on a sandy loam soil as defined in Environment Agency (2009b) and 1%, 2.5% and 6% SOM.
[b] GAC for pesticides will vary according to SOM for all land uses.
[c] Values are rounded to two significant figures.
[d] GAC assume that free phase contamination is not present.
[e] GAC are based on a subsurface soil to indoor air correction factor of 1.
[vap] GAC presented exceed the vapour saturation limit, which is given in brackets.

4.3.9 Chlorobenzenes

Source	Determinand	Residential[abcde]			Allotment[abcde]			Commercial[abcde]		
		1%	2.5%	6%	1%	2.5%	6%	1%	2.5%	6%
CIEH	Chlorobenzene	0.33	0.73	1.7	5.9	14	32	59	130	310
CIEH	1,2-Dichlorobenzene	16	39	91	94	230	540	2100 (571)[sol]	5100 (1370)[sol]	12000 (3240)[sol]
CIEH	1,3-Dichlorobenzene	0.29	0.70	1.7	0.25	0.61	1.5	32	77	180
CIEH	1,4-Dichlorobenzene	30	72	170	15	37	88	4500 (224)[vap]	10000 (540)[vap]	22000 (1280)[vap]
CIEH	1,2,3-Trichlorobenzene	1.0	2.6	6.1	4.7	12	28	110	270	620
CIEH	1,2,4-Trichlorobenzene	1.8	4.5	11	31	75	180	230	560	1300
CIEH	1,3,5-Trichlorobenzene	0.23	0.57	1.3	4.7	12	28	24	57.8	140
CIEH	1,2,3,4-Tetrachlorobenzene	12	29	62	4.4	11	26	1800 (122)[vap]	3200 (304)[vap]	4500 (728)[vap]
CIEH	1,2,3,5-Tetrachlorobenzene	0.49	1.2	2.8	0.38	0.94	2.2	52 (39.4)[vap]	120 (98.1)[vap]	250 (235)[vap]
CIEH	1,2,4,5-Tetrachlorobenzene	0.30	0.68	1.4	0.064	0.16	0.37	44 (19.7)[sol]	73 (49.1)[sol]	97
CIEH	Pentachlorobenzene	5.2	10	17	1.2	3.1	7.1	650 (43.0)[sol]	770 (107)[sol]	830
CIEH	Hexachlorobenzene	0.59 (0.20)[vap]	1.0 (0.50)[vap]	1.4	0.18	0.42	0.92	48 (0.20)[vap]	53	55

[a] Based on a sandy loam soil as defined in Environment Agency (2009b) and 1%, 2.5% and 6% SOM.
[b] GAC for chlorobenzenes will vary according to SOM for all land uses.
[c] Values are rounded to two significant figures.
[d] GAC for Chlorobenzenes assume that free phase contamination is not present.
[e] GAC for Chlorobenzenes are based on a subsurface soil to indoor air correction factor of 1.
[sol] GAC presented exceed the solubility saturation limit, which is given in brackets.
[vap] GAC presented exceeds the vapour saturation limit, which is given in brackets.

4.3.10 Phenol & Chlorophenol

Source	Determinand	Residential			Allotment			Commercial		
		1%	2.5%	6%	1%	2.5%	6%	1%	2.5%	6%
SGV	Phenol	-	-	420	-	-	280	-	-	3200 (38000)[f]
CIEH	Phenol[abcde]	210	390	780	32	60	120	1100000 (24200)[vap]	1100000 (38100)[vap]	1200000
CIEH	2-chlorophenol[abcde]									
CIEH	2,4-dichlorophenol[abcde]	0.87[g]	2.0[g]	4.4[g]	0.13[g]	0.30[g]	0.70[g]	3500[h]	4000[h]	4200[h]
CIEH	2,4,6-trichlorophenol[abcde]									
CIEH	2,3,4,6-tetrachlorophenol[abcde]									
CIEH	Pentachlorophenol[abcde]	0.55	1.3	3.0	0.084	0.21	0.49	1200	1300	1400

[a] Based on a sandy loam soil as defined in Environment Agency (2009b) and 1%, 2.5% and 6% SOM.
[b] GAC for phenols will vary according to SOM for all land uses.
[c] Values are rounded to two significant figures.
[d] GAC for phenols assume that free phase contamination is not present.
[e] GAC for phenols are based on a subsurface soil to indoor air correction factor of 1.
[f] Based on a threshold protective of direct skin contact with phenol. The guideline in brackets is based on health effects following long term exposure and is provided for illustration purposes only.
[g] Derived for 2,4,6-dichlorophenol or 2,3,4,6-tetrachlorophenol.
[h] Derived for 2-chlorophenol or 2,4-dichlorophenol.
[sol] GAC presented exceed the solubility saturation limit, which is given in brackets.
[vap] GAC presented exceed the vapour saturation limit, which is given in brackets.

4.3.11 Others

Source	Determinand	Residential			Allotment			Commercial		
		1%	2.5%	6%	1%	2.5%	6%	1%	2.5%	6%
CIEH	Carbon Disulphide[abcde]	0.10	0.20	0.44	4.8	10	23	12	23	50
CIEH	Hexachlorobutadiene	0.21	0.51	1.2	0.25	0.61	1.4	32	69	120

[a] Based on a sandy loam soil as defined in Environment Agency (2009b) and 1%, 2.5% and 6% SOM.
[b] GAC will vary according to SOM for all land uses.
[c] Values are rounded to two significant figures.
[d] GAC assume that free phase contamination is not present.
[e] GAC are based on a subsurface soil to indoor air correction factor of 1.

5.0 RISKS TO CONTROLLED WATERS

5.1 Control of Residual Contamination

Part IIA introduced the regime for the identification and remediation of contaminated land. Land may be classified as contaminated under the regime by virtue of actual or likely pollution of controlled waters caused by substances in, on or under the land. The agency is a statutory consultee in relation to controlled waters issues. In situations where there is no existing pollutant linkage, Section 161 of the Water Resources Act (1991) (as amended 2003) and the Anti-Pollution Works Regulations (1999) can be used to address contamination, which could represent a potential risk.

5.2 Control of Contamination from Ongoing Activities

The existing Groundwater Directive (80/68/EEC) aims to protect groundwater from pollution by controlling discharges and disposals of certain dangerous substances to groundwater. In the UK, the directive is implemented through the Groundwater Regulations (DETR 1998b). Groundwater pollution is prevented under these regulations by preventing or limiting the inputs of listed substances into groundwater. Substances controlled under the regulations fall into two lists:-

List 1	List 2
• Organohalogen compounds and substances, which may form such compounds in the aquatic environment. • Organophosphorus compounds. • Organotin compounds. • Substances which possess carcinogenic, mutagenic or teratogenic properties in or via the aquatic environment (including substances which have those properties which would otherwise be in List 2). • Mercury and its compounds. • Cadmium and its compounds. • Mineral oil and hydrocarbons. • Cyanides.	• Metals, metalloids and compounds of antimony, arsenic, barium, beryllium, boron, chromium, cobalt, copper, lead, molybdenum, nickel, selenium, silver, tellurium, thallium, tin, titanium, uranium and zinc. • Biocides and their derivatives not appearing in List 1. • Substances which have a deleterious effect on the taste or odour of groundwater and compounds liable to cause the formation of such substances in such water and to render it unfit for human consumption. • Toxic or persistent compounds of silicon and substances which may cause the formation of such compounds in water, excluding those which are biologically harmless or are rapidly converted in water into harmless substances. • Inorganic compounds of phosphorus and elemental phosphorus. • Fluorides. • Ammonia and nitrites.

List 1 substances are the most toxic and must be prevented from entering groundwater. Substances in this list may be disposed of to the ground, under a permit, but must not reach groundwater.
List 2 substances are less dangerous and can be discharged to groundwater under a permit, but must not cause pollution.

Listed dangerous substances have assessment criteria in the form of EQS. The dangerous substance is not believed to be detrimental to aquatic life at a concentration below its EQS limit (see EU 2008a).

The old Groundwater Directive was repealed by the Water Framework Directive (WFD) in 2013. DEFRA (2010b) has been used to enact both the WFD and its daughter directive on the protection of groundwater in E&W. This new Groundwater Directive (2006/118/EC) is commonly referred to as the Groundwater Daughter Directive (EU 2006).

The existing principle of preventing or limiting the inputs of List 1 or List 2 substances respectively into groundwater under the original Groundwater Regulations (DETR 1998b) remains, but have been expanded and will continue to expand to encompass any substance liable to cause pollution. In addition, the WFD provides a risk based framework for regulation.

5.3 Water Framework Directive

The WFD (EU 2000) came into force in England & Wales (E&W) on 02/01/2004 through the Water Environment (Water Framework Directive) (England and Wales) Regulations 2003 (SI 2003:3242 dated 10/12/2003). The WFD establishes the legal framework to protect and restore clean water across the EU and ensure its long term, sustainable use. It sets specific deadlines for member states to protect aquatic ecosystems and sets the goal of achieving a good (chemical and ecological) status for all surface water (rivers, estuaries and coastal water) and groundwater (aquifers) in the EU by 2015.

Good status is considered to be a function of concentrations of pollutants which:-

- Do not exceed the quality standards under relevant EU legislation.
- Would not result in a failure of associated surface water bodies to achieve environmental objectives.
- Would not result in a significant diminution of the ecological or chemical quality of associated surface water bodies.
- Would not result in any significant damage to groundwater dependent terrestrial ecosystems.

The WFD is designed to:-

- Enhance the status and prevent further deterioration of aquatic ecosystems and associated wetlands, which depend on the aquatic ecosystems.
- Promote the sustainable use of water.
- Reduce pollution of water, especially by priority and priority hazardous substances.
- Ensure the progressive reduction of groundwater pollution.

The measures to achieve the objectives are set out in River Basin Management Plans (RBMP), of which there are eleven in E&W. The RBMP were required to be operational by 22/12/2012. In E&W, the RBMP were submitted to DEFRA by the agency on 22/09/09 for approval and publication by the deadline. They were enacted by DEFRA (2009a).

The WFD requires, as a matter of priority, the causes of pollution to be identified and emissions to be dealt with at source in the most economically and environmentally effective manner. In accordance with Article 4, all member states should implement necessary measures with the aim of progressively reducing pollution from priority substances and ceasing or phasing out emissions, discharges and losses of priority hazardous substances.

The Environmental Quality Standards Directive (2008/105/EC dated 16/12/2008) (EQSD) has replaced the List of Priority Substances (2455/2001/EC) since its implementation on 13/01/2009. Similarly, the EQSD (EU 2008a) has repealed the limit values contained in a number of specific daughter directives to the old Dangerous Substances Directive (see below) such as those for mercury (82/176/EEC and 84/156/EEC), cadmium (83/513/EEC), HCCH (84/491/EEC) and the List 1 Daughter Directive (86/280/EEC), as amended by 88/347/EEC and 90/415/EEC, although the directives themselves remained in force until fully repealed on 22/12/2012. The EQSD is a daughter directive to the WFD and was enacted in E&W by DEFRA (2010b).

The WFD repealed the Drinking Water Abstraction Directive (75/440/EEC dated 16/06/75) (DWAD) on 22/12/2007 and repealed on 22/12/2013 the following directives:-

- The Groundwater Directive (2006/118/EC dated 12/12/2006) (GWD) repealed 80/68/EEC dated 17/12/1979, which was implemented in E&W by The Groundwater Regulations 1998 (SI 1998:2746 dated 02/12/1998). The GWD is a daughter directive of the WFD and came into force in the EU on 16/01/2009 but will itself be repealed by the WFD. The main aim of the GWD is to protect groundwater against pollution and deterioration. The new GWD has been implemented in E&W by DEFRA (2010a).
- The Shellfish Waters Directive (2006/113/EEC dated 12/12/2006) (SWD) is a codified version, which repealed 79/923/EEC dated 30/11/1979 and came into force on 16/01/2007. The values set by the SWD came into force on 16/01/2013, when the WFD repealed the SWD.
- The Fresh Waters Fish Directive (2006/44/EC dated 06/09/06) (FWFD) is a codified version, which repealed 78/659/EEC dated 18/07/78. It was brought into force in E&W by the Surface Waters (Fishlife) (Classification) Regulations 1997 (SI 1997:1331 dated 12/06/1997), as amended by SI 2003:1053 on 12/05/2003.
- The Dangerous Substances Directive (2006/11/EC dated 15/02/06) (DSD) is a codified version, which repealed 76/464/EEC dated 04/05/76. The DSD has been integrated into the WFD and will be used to implement the EU wide good status of all water bodies by 2015. The current regulations used to implement the DSD into E&W legislation, such as the Surface Waters (Dangerous Substances) (Classification) Regulations 1997 (SI

1997:2560 dated 24/10/1997) as amended by SI 1998:389 on 25/03/1998, are still in force until repealed by the WFD.

Although the WFD has/will repeal the Directives listed above, and of course all relevant regulations used to introduce the directives into E&W law, the EQS values selected for the WFD must be at least as stringent as those that they replace. The RBMP must contain measures to implement a number of directives (as listed below), which will remain in force and are not superseded by the WFD:-

- The IPPC Directive (2008/1/EC dated 15/01/2008) (IPPCD) is a codified version, which repealed 96/61/EC dated 24/09/1996.
- The Bathing Water Directive (2006/7/EEC dated 15/02/2006) (BWD), which repealed 76/160/EEC dated 08/12/1975 on 31/12/2014.
- The Drinking Water Directive (98/83/EC dated 03/11/1998) (DWD) is a codified version, which repealed 80/778/EEC dated 15/07/1980. It was brought into force in E&W on 25/12/03 by the Water Supply (Water Quality) Regulations 2000 (SI 2000:3184 made on 04/12/2000) and amended by SI 2007:2734 dated 13/09/2007, which came into force on 22/12/2007.
- The Urban Waste Water Treatment Directive (98/15/EC dated 27/02/98) (UWWTD) amended 91/271/EEC dated 21/05/1991 on 27/03/1998.
- The Nitrates Directive (91/676/EEC dated 12/12/1991) (ND).
- The Sewage Sludge Directive (86/278/EEC dated 12/06/1986) (SSD).

Similarly, other directives to be taken into account include:-

- The Marine Strategy Framework Directive (2008/56/EC dated 17/06/2008) (MSFD) is the equivalent of the WFD for marine waters. The MSFD had to be transposed by member states by July 2010 with the aim of achieving good status across the EU by 2020.
- The Biocidal Products Directive (98/8/EC dated 16/02/1998) (BPD).
- The Plant Protection Products Directive (91/414/EEC dated 26/07/1993) (PPPD).

5.4 TGEN Approach

At the GQRA level, assessment typically comprises the following:-

- Consideration of soil concentrations of organic substances in the context of soil saturation to determine the potential for migration under gravity.
- Comparison of soil leachate concentrations against appropriate GAC.
- Comparison of groundwater concentrations against appropriate GAC.

This approach is equivalent to Tier 1/Level 1 assessment as undertaken using ConSim v2.5 (2009) and/or Environment Agency (2006a).

The ideal remediation standard from the regulatory perspective is natural background quality, namely, there should be no significant deterioration in the water quality at the receptor (that is, it should not be detectable against natural background variations). This data may be obtained from up hydraulic gradient locations or regional datasets. The agency has published information on the baseline condition of several aquifers. It is recognised, however, that such data is rarely available and remediation to such a standard is often not technically achievable or cost effective. For this reason target concentrations utilised as GAC may be based on water quality standards that are appropriate for the intended use or to ensure that objectives for a groundwater or associated water body are met. The standards selected (as appropriate) are listed below in Section 5.5 and the sources of information listed in Section 8. In E&W, priority is given to UK standards, then EU standards with those that are statutory taking precedence over those that are non-statutory. Where data is not available for a specific substance, additional standards such as those published by WHO or USEPA are used if appropriate.

5.5 Controlled Water GAC

Within the tables, values in bold are from current and/or proposed EQS values from directly relevant EU Directives or UK Regulations or DEFRA/agency statutory guidance values. Values separated by a hyphen give the range of EQS values for different alkalinity and/or upland vs lowland waters etc. Values in brackets are MAC. Where necessary the map of areas of hard and soft water (produced by the UK Drinking Water Inspectorate or agency records, or results of analyses) is/are used to determine the hardness of controlled waters in the vicinity of a site.

The table below accompanies the following controlled water GAC tables and provides an explanation of the abbreviations used and the sources of information used to derive the GAC.

A	FW	The River Basin Districts Typology Standards and Groundwater Threshold Values (Water Framework Directive) (England and Wales) Directions 2010.
	MW	The River Basin Districts Typology Standards and Groundwater Threshold Values (Water Framework Directive) (England and Wales) Directions 2010.
	GW	The River Basin Districts Typology Standards and Groundwater Threshold Values (Water Framework Directive) (England and Wales) Directions 2010.
B	FWS	Freshwater Fish Directive (2006/44/EC) & Surface Waters (Fishlife) Directions 2010 (salmonid water).
	FWC	Freshwater Fish Directive (2006/44/EC) & Surface Waters (Fishlife) Directions 2010 (cyprinid water).
C	GW	Groundwater Directive (2006/118/EC) and Groundwater (England and Wales) Regulations 2009 (SI 2009:2902).
D	DW	Drinking Water Directive (98/83/EEC) and/or the Water Supply (Water Quality) Regulations 2000 (SI 2000:3184) (as amended).
	PW	The Private Water Supplies Regulations 2009 (SI 2009:3101).
E	FW	Various UK, EU & international statutory and non-statutory fresh water EQS values.
	MW	Various UK, EU & international statutory and non-statutory marine water EQS values.
	DW	Various UK, EU & international statutory and non-statutory drinking water EQS values.
F	WAC	The Landfill (England & Wales) Regulations 2002 (as amended) (using inert WAC limits).
	NRA	NRA leachate guidance values.
G	SW	RIVM 2005 (surface water).
	MW	RIVM 2005 (marine water).
	GW	RIVM 2005 and/or RIVM 711701 023 (groundwater SRCeco GW).
	DW	RIVM 711701 023 (drinking water using lowest of max. concentration for GW as DW or SRC human GW).
H	FW	Environment & effluent general quality parameters (fresh water/rivers).
	GW	Environment & effluent general quality parameters (groundwater).
	SW	Environment & effluent general quality parameters (treated sewage effluent).
	TE	Environment & effluent general quality parameters (trade effluent).
I	MRV	Based on current E&W national and/or UKAS accredited laboratory minimum reporting values/LoD.
J	FW	Environment Agency (2010). Hazard Matrix.
	GW	Environment Agency (2010). Hazard Matrix.

A	&/or Environment Agency (2011). H1 Environmental Risk Assessment – Annex D (Version 2.2) for FW & MW.
E	Includes WHO (2011). Guidelines for Drinking Water Quality (4th Edition).
FW	Freshwater.
MW	Marine water.
GW	Groundwater.
DW	Drinking water.
PW	Private.
TE	Trade effluent.

5.5.1 Surface Water GAC

Contaminant	Units	Fresh Water	Ref	Marine Water	Ref
Aluminium	ug/l	**5-100**	**J**	5-100	J
Antimony	ug/l	**113**	**J**	113	J
Arsenic	ug/l	**50**	**A**	**25**	**A**
Barium	ug/l	**130**	**J**	130	J
Beryllium	ug/l	0.5	I	0.5	I
Boron	ug/l	2000	E	7000	E
Cadmium	ug/l	**0.1-0.25 (0.45-1.5)**	**A**	**0.2 (0.45-1.5)**	**A**
Chromium III	ug/l	**4.7 (32)**	**A**	15	E
Chromium VI	ug/l	**3.4**	**A**	**0.6 (32)**	**A**
Copper	ug/l	**1-28**	**A**	**5**	**A**
Iron	ug/l	**1000**	**A**	**1000**	**A**
Lead	ug/l	**7.2**	**A**	**7.2**	**A**
Manganese	ug/l	**60.5**	**J**	60.5	J
Mercury	ug/l	**0.05 (0.07)**	**A**	0.05 (0.07)	A
Molybdenum	ug/l	**73**	**J**	73	J
Nickel	ug/l	**20**	**A**	**20**	**A**
Selenium	ug/l	**2.1**	**J**	2.1	J
Silver	ug/l	0.1	I	**0.5 (1.0)**	**A**
Tin (inorganic)	ug/l	**25**	**A**	**10**	**A**
Vanadium	ug/l	**20-60**	**J**	20-60	J
Zinc	ug/l	**8-125**	**A**	**40**	**A**
pH	units	**5.2-9.0**	**A**	5.2-9.0	A
Bromate	ug/l	10	D	10	D
Chloride	mg/l	**250**	**A**		
Conductivity	uS/cm	2500	A		
Fluoride	mg/l	**1-15**	**A**	**5 (15)**	**A**
Nitrate (as NO_3)	mg/l	50	E		
Nitrite (as NO_2)	mg/l	**0.01-0.03**	**B**		
Phosphorus	mg/l	**0.04-0.12**	**A**		
Sodium	mg/l	170	E		
Sulphate	mg/l	**400**	**A**	250	E
Sulphide (as H_2S)	ug/l	**0.25 (1.0)**	**A**	**10**	**A**
Suspended Solids	mg/l	**25**	**B**	**10 to 100**	**A**
Total Dissolved Solids	mg/l	400	F		
Ammonia (Unionised)	mg/l	**0.005 (0.025)**	**B**	**0.021**	**A**
Ammonium	mg/l	**0.3-0.6**	**A**		
BOD_5	mg/l	**4-5**	**A**		
COD (Filtered)	mg/l	30	E		
DOC	mg/l	50	F		
Cyanide (free)	ug/l	**1 (5)**	**A**	**1 (5)**	**A**
Cyanide	ug/l	50	E		
Phenol	ug/l	**7.7 (46)**	**A**	**7.7 (46)**	**A**
Acenaphthene	ug/l	**5.8**	**J**	5.8	J
Acenaphthylene	ug/l	12	E	12	E
Anthracene	ug/l	**0.1 (0.4)**	**A**	**0.1 (0.4)**	**A**
Benzo (a) anthracene	ug/l	**0.18**	**E J**	0.18	E J
Benzo (b) fluoranthene	ug/l	**0.03**	**A**	**0.03**	**A**
Benzo (k) fluoranthene	ug/l	**0.03**	**A**	**0.03**	**A**
Benzo (ghi) perylene	ug/l	**0.02**	**J**	0.02	J
Benzo (a) pyrene	ug/l	**0.05 (0.1)**	**A**	**0.05 (0.1)**	**A**
Chrysene	ug/l	**0.28**	**J**	0.28	J
Dibenzo (a) anthracene	ug/l	0.04	E	0.04	E
Fluoranthene	ug/l	**0.1 (1.0)**	**A**	**0.1 (1.0)**	**A**
Fluorene	ug/l	**3**	**J**	3	J
Indeno (123-cd) pyrene	ug/l	**0.02**	**J**	0.02	J
Naphthalene	ug/l	**2.4**	**A**	**1.2**	**A**
Phenanthrene	ug/l	**0.4**	**J**	0.4	J
Pyrene	ug/l	0.08	E	0.08	E
TPH (Hydrocarbons)	ug/l	50 to 200	E	50 to 200	**B** E
Benzene	ug/l	**10 (50)**	**A**	**8 (50)**	**A**
Ethylbenzene	ug/l	**90**	**J**	20	E
Toluene	ug/l	**50 (380)**	**A**	**40 (370)**	**A**
Xylene	ug/l	**30**	**A**	**30**	**A**
Individual Pesticides	ug/l	0.1	C	0.1	C
Total Pesticides	ug/l	0.5	C	0.5	C

Contaminant	Units	Fresh Water	Ref	Marine Water	Ref
Acrylamide	ug/l	0.5	E	0.5	E
Arachlor	ug/l	**0.3 (0.7)**	**A**	**0.3 (0.7)**	**A**
Atrazine	ug/l	**0.6 (2.0)**	**A**	**0.6 (2.0)**	**A**
Bentazone	ug/l	**500**	**A**	**500**	**A**
Biphenyl	ug/l	**25**	**A**	**25**	**A**
Carbendazim	ug/l	**0.1 (1.0)**	**A**	**0.1 (1.0)**	**A**
Carbon tetrachloride	ug/l	**12**	**A**	**12**	**A**
Chlorfenvinphos	ug/l	**0.1 (0.3)**	**A**	**0.1 (0.3)**	**A**
Chloroform	ug/l	12	E	12	E
4-chloro-3-methyl-phenol	ug/l	**40**	**A**	**40**	**A**
Chloronitrotoluenes	ug/l	**10**	**A**	**10**	**A**
2-chlorophenol	ug/l	**50 (250)**	**A**	**50 (250)**	**A**
Chlorpyrifos	ug/l	**0.03 (0.1)**	**A**	**0.03 (0.1)**	**A**
Chlortoluron	ug/l	**2 (20)**	**A**	**2**	**A**
Clopyralid	ug/l	0.1	A	0.1	A
Cyanazine	ug/l	0.1	A	0.1	A
Cyclodiene pesticides (sum)	ug/l	**0.01**	**A**	**0.005**	**A**
Cypermethrin	ug/l	**0.1 (0.4)**	**A**	**0.1 (0.4)**	**A**
2,4-D	ug/l	**0.3 (1.3)**	**A**	**0.3 (1.3)**	**A**
DDT (total)	ug/l	**0.025**	**A**	**0.025**	**A**
Dalapon	ug/l	0.1	A	0.1	A
Diazinon	ug/l	**0.01 (0.02)**	**A**	**0.01 (0.1)**	**A**
Dichlorobenzene	ug/l	**20 (200)**	**A**	**20 (200)**	**A**
1,2-Dichloroethane	ug/l	**10**	**A**	**10**	**A**
Dichloromethane	ug/l	**20**	**A**	**20**	**A**
2,4-Dichlorophenol	ug/l	**20**	**A**	**20**	**A**
Dichlorprop	ug/l	100	A	100	A
Dichlorvos	ug/l	**0.01**	**A**	**0.04 (0.6)**	**A**
Di(2-ethylhexyl)-phthalate	ug/l	**1.3**	**A**	**1.3**	**A**
Dimethoate	ug/l	**0.48 (4.0)**	**A**	**0.48 (4.0)**	**A**
Diuron	ug/l	**0.2 (1.8)**	**A**	**0.2 (1.8)**	**A**
Endosulfan	ug/l	**0.005 (0.01)**	**A**	**0.0005 (0.004)**	**A**
Fenitrothion	ug/l	**0.01**	**A**	**0.01**	**A**
Glyphosphate	ug/l	0.1	A	0.1	A
Hexachlorobenzene	ug/l	**0.01 (0.05)**	**A**	**0.01 (0.05)**	**A**
Hexachlorobutadiene	ug/l	**0.1 (0.6)**	**A**	**0.1 (0.6)**	**A**
Hexachlorocyclohexane	ug/l	**0.02 (0.04)**	**A**	**0.002 (0.02)**	**A**
Isoproturon	ug/l	**0.3 (1.0)**	**A**	**0.3 (1.0)**	**A**
Linuron	ug/l	**0.5 (0.9)**	**A**	**0.5 (0.9)**	**A**
Malathion	ug/l	**0.01**	**A**	**0.02**	**A**
MCPA	ug/l	**2 (20)**	**A**	**2 (20)**	**A**
Mecoprop	ug/l	**18 (187)**	**A**	**18 (187)**	**A**
Metazachlor	ug/l	0.1	A	0.1	A
Nonylphenol	ug/l	**0.3 (2.0)**	**A**	**0.3 (2.0)**	**A**
Octylphenol	ug/l	**0.1**	**A**	**0.01**	**A**
Pentachlorobenzene	ug/l	**0.007**	**A**	**0.0007**	**A**
Pentachlorophenol	ug/l	**0.4 (1.0)**	**A**	**0.4 (1.0)**	**A**
Permethrin	ug/l	**(0.01)**	**A**	**(0.01)**	**A**
Propazine	ug/l	0.1	A	0.1	A
Propetamphos	ug/l	0.1	A	0.1	A
Simazine	ug/l	**1.0 (4.0)**	**A**	**1.0 (4.0)**	**A**
Terbutryn	ug/l	0.1	A	0.1	A
Tetrachloroethylene	ug/l	**10**	**A**	**10**	**A**
TCE	ug/l	**10**	**J**	10	J
Tetrachloroethane	ug/l	10.1 (57.8)	A	10.1 (57.8)	A
Tetrachloromethane	ug/l	12	E	12	E
1,1,1-Trichloroethane	ug/l	**100**	**A**	**100**	**A**
1,1,2-Trichloroethane	ug/l	**400**	**A**	**300**	**A**
Trichloroethene	ug/l	10 (55.2)	A	10 (55.2)	A
Trichloroethylene	ug/l	**10**	**A**	**10**	**A**
Tributyltin	ug/l	**0.001 (0.0015)**	**A I**	**0.001 (0.0015)**	**A I**
Trichlorobenzenes	ug/l	**0.4**	**A**	**0.4**	**A**
Trichloromethane	ug/l	**2.5**	**A**	**2.5**	**A**
Trietazine	ug/l	0.1	A	0.1	A
Trifluralin	ug/l	**0.03**	**A**	**0.03**	**A**
Trihalomethanes	ug/l	100	E	100	E
Vinyl Chloride	ug/l	**840**	**J**	840	J

5.5.2 Groundwater GAC

Contaminant	Units	Secondary	Ref	Principal	Ref
Aluminium	ug/l	5-100	J	200	D
Antimony	ug/l	113	J	5	D
Arsenic	ug/l	**51.6 (199)**	**A**	**10**	**J**
Barium	ug/l	**700**	**J**	**700**	**J**
Beryllium	ug/l	0.5	I	12	E
Boron	ug/l	2000	E	1000	D
Cadmium	ug/l	**0.2 (1.1)**	**A**	**5**	**J**
Chromium III	ug/l	**5 (27.6)**	**A**	**50**	**J**
Chromium VI	ug/l	3.4	A	50	J
Copper	ug/l	**10.1 (57.8)**	**A**	**2000**	**J**
Iron	ug/l	1000	A	200	D
Lead	ug/l	**7.3 (39.8)**	**A**	**25**	**J**
Manganese	ug/l	**50**	**J**	**50**	**J**
Mercury	ug/l	**1**	**J**	**1**	**J**
Molybdenum	ug/l	**70**	**J**	**70**	**J**
Nickel	ug/l	**20.2 (116)**	**A**	**20**	**J**
Selenium	ug/l	**10**	**J**	**10**	**J**
Silver	ug/l	0.1	I	100	E
Tin (inorganic)	ug/l	25	A	25	E
Vanadium	ug/l	20-60	J	50	E
Zinc	ug/l	**75.8 (414)**	**A**	**5000**	**J**
pH	units	5.2-9.0	A	6.5-9.5	D
Bromate	ug/l	10	A	10	D
Chloride	mg/l	250	A	250	D
Conductivity	uS/cm	2500	A	2500	D
Fluoride	mg/l	1-15	A	1.5	D
Nitrate (as NO_3)	mg/l	**50**	**C**	**50**	**C**
Nitrite (as NO_2)	mg/l	0.5	D	0.5	D
Phosphorus	mg/l	**41.4 (536)**	**A**	2.2	E
Sodium	mg/l	200	D	200	D
Sulphate	mg/l	400	A	250	D
Sulphide (as H_2S)	ug/l	0.25 (1.0)	A	0.25 (1.0)	A
Ammonia (Unionised)	mg/l	0.005 (0.025)	B	1.5	E
Ammonium	mg/l	**0.3 (1.73)**	**A**	0.5	D
BOD_5	mg/l	4-5	A	5	D
COD (Filtered)	mg/l	30	E	5	D
DOC	mg/l	50	F	50	F
Cyanide (free)	ug/l	1 (5)	A	70	E
Cyanide	ug/l	50	E	50	D
Phenol	ug/l	**15.2 (82.8)**	**A**	**10**	**A**
Acenaphthene	ug/l	21	E	21	E
Acenaphthylene	ug/l	12	E	12	E
Anthracene	ug/l	**0.1 (0.55)**	**A**	0.1 (0.4)	A
Benzo (a) anthracene	ug/l	0.18	E J	0.18	E J
Benzo (b) fluoranthene	ug/l	0.03	E J	0.03	E J
Benzo (k) fluoranthene	ug/l	0.03	E J	0.03	E J
Benzo (ghi) perylene	ug/l	0.02	J	0.02	J
Benzo (a) pyrene	ug/l	0.05 (0.1)	A	**0.01**	**J**
Chrysene	ug/l	0.28	J	0.28	J
Dibenzo (a) anthracene	ug/l	0.04	E	0.04	E
Fluoranthene	ug/l	**0.1 (0.6)**	**A**	0.1 (0.6)	A
Fluorene	ug/l	3	J	3	J
Indeno (123-cd) pyrene	ug/l	0.02	J	0.02	J
Naphthalene	ug/l	**2.4 (13.2)**	**A**	**2.4**	**J**
Phenanthrene	ug/l	0.4	J	0.4	J
Pyrene	ug/l	0.08	E	0.08	E
TPH (Hydrocarbons)	ug/l	50 to 200	**B** E	10	E
Benzene	ug/l	**10.1 (55.2)**	**A**	**1**	**J**
Ethylbenzene	ug/l	90	J	300	E
Toluene	ug/l	**50.5 (276)**	**A**	700	J
Xylene	ug/l	**30.3 (166)**	**A**	500	E
Individual Pesticides	ug/l	0.1	C	**0.1**	**C**
Total Pesticides	ug/l	0.5	C	**0.5**	**C**

Contaminant	Units	Secondary	Ref	Principal	Ref
Acrylamide	ug/l	0.5	E	0.1	D
Arachlor	ug/l	0.3 (0.7)	A	0.1	D
Atrazine	ug/l	**0.62 (3.47)**	**A**	**0.1**	**A**
Bentazone	ug/l	**514 (2890)**	**A**	**0.1**	**A**
Biphenyl	ug/l	25	A	25	A
Carbendazim	ug/l	0.1 (1.0)	A	0.1	A
Carbon tetrachloride	ug/l	**12.1 (66.2)**	**A**	**3**	**A**
Chlorfenvinphos	ug/l	**0.1 (0.58)**	**A**	**0.1**	**A**
Chloroform	ug/l	**2.53 (13.8)**	**A**	**100**	**A**
4-chloro-3-methyl-phenol	ug/l	40	A	40	A
Chloronitrotoluenes	ug/l	10	A	10	A
2-chlorophenol	ug/l	50 (250)	A	50	A
Chlorpyrifos	ug/l	0.03 (0.1)	A	0.03	A
Chlortoluron	ug/l	2 (20)	A	0.1	A
Clopyralid	ug/l	0.1	A	0.1	A
Cyanazine	ug/l	0.1	A	0.1	A
Cyclodiene pesticides (sum)	ug/l	0.01	A	0.1	E
Cypermethrin	ug/l	**0.0001 (0.0005)**	**A**	**0.1**	**A**
2,4-D	ug/l	1	E	30	E
DDT (total)	ug/l	0.025	A	0.1	E
Dalapon	ug/l	0.1	A	**0.1**	**A**
Diazinon	ug/l	**0.01 (0.06)**	**A**	**0.1**	**A**
Dichlorobenzene	ug/l	20 (200)	A	300	E
1,2-Dichloroethane	ug/l	10	A	**3**	**A**
Dichloromethane	ug/l	**20.7 (62.2)**	**A**	**10**	**A**
2,4-Dichlorophenol	ug/l	20	A	20	A
Dichlorprop	ug/l	100	A	100	A
Dichlorvos	ug/l	0.01	A	0.1	D
Di(2-ethylhexyl)-phthalate	ug/l	1.3	A	1.3	A
Dimethoate	ug/l	0.48 (4.0)	A	6	E
Diuron	ug/l	**0.2 (1.2)**	**A**	**0.1**	**A**
Endosulfan	ug/l	0.005 (0.01)	A	0.1	D
Fenitrothion	ug/l	0.01	A	0.1	D
Glyphosphate	ug/l	0.1	A	0.1	A
Hexachlorobenzene	ug/l	0.01 (0.05)	A	0.1	D
Hexachlorobutadiene	ug/l	0.1 (0.6)	A	0.6	E
Hexachlorocyclohexane	ug/l	0.02 (0.04)	A	0.1	D
Isoproturon	ug/l	**0.3 (1.7)**	**A**	**0.1**	**A**
Linuron	ug/l	0.5 (0.9)	A	0.1	D
Malathion	ug/l	0.01	A	0.1	D
MCPA	ug/l	2 (20)	A	0.1	A
Mecoprop	ug/l	**5.1 (28.9)**	**A**	**0.1**	**A**
Metazachlor	ug/l	0.1	A	0.1	A
Nonylphenol	ug/l	0.3 (2.0)	A	0.3	A
Octylphenol	ug/l	0.1	A	0.1	A
Pentachlorobenzene	ug/l	0.007	A	0.007	A
Pentachlorophenol	ug/l	**0.4 (2.2)**	**A**	**0.1**	**A**
Permethrin	ug/l	**0.01 (0.06)**	**A**	**0.1**	**A**
Propazine	ug/l	0.1	A	0.1	A
Propetamphos	ug/l	0.1	A	**0.1**	**A**
Simazine	ug/l	**1.0 (5.8)**	**A**	**0.1**	**A**
Terbutryn	ug/l	0.1	A	0.1	A
Tetrachloroethylene	ug/l	10	A	10	A
TCE	ug/l	10	J	10	D
Tetrachloroethane	ug/l	**10.1 (57.8)**	**A**	**10**	**A**
Tetrachloromethane	ug/l	12	E	3	D
1,1,1-Trichloroethane	ug/l	**101 (552)**	**A**	**10**	**A**
1,1,2-Trichloroethane	ug/l	**404 (2210)**	**A**	**10**	**A**
Trichloroethene	ug/l	**10 (55.2)**	**A**	**10**	**A**
Trichloroethylene	ug/l	10	A	10	A
Tributyltin	ug/l	0.001 (0.0015)	A I	0.02	E
Trichlorobenzenes	ug/l	0.4	A	20	E
Trichloromethane	ug/l	2.5	A	2.5	A
Trietazine	ug/l	0.1	A	0.1	A
Trifluralin	ug/l	0.03	A	0.1	A
Trihalomethanes	ug/l	100	E	100	D
Vinyl Chloride	ug/l	840	J	0.5	D

5.5.3 Drinking Water GAC

Contaminant	Units	DW	Ref
Aluminium	ug/l	**200**	**D**
Antimony	ug/l	**5**	**D**
Arsenic	ug/l	**10**	**D**
Barium	ug/l	700	E
Beryllium	ug/l	12	E
Boron	ug/l	**1000**	**D**
Cadmium	ug/l	**5**	**D**
Chromium III	ug/l	**50**	**D**
Chromium VI	ug/l	50	D
Copper	ug/l	**2000**	**D**
Iron	ug/l	**200**	**D**
Lead	ug/l	**25**	**D**
Manganese	ug/l	**50**	**D**
Mercury	ug/l	**1**	**D**
Molybdenum	ug/l	70	E
Nickel	ug/l	**20**	**D**
Selenium	ug/l	**10**	**D**
Silver	ug/l	100	E
Tin (inorganic)	ug/l	25	E
Vanadium	ug/l	50	E
Zinc	ug/l	**5000**	**J**
pH	units	**6.5-9.5**	**D**
Bromate	ug/l	**10**	**D**
Chloride	mg/l	**250**	**D**
Conductivity	uS/cm	**2500**	**D**
Fluoride	mg/l	**1.5**	**D**
Nitrate (as NO_3)	mg/l	**50**	**D**
Nitrite (as NO_2)	mg/l	**0.5**	**D**
Phosphorus	mg/l	2.2	E
Sodium	mg/l	**200**	**D**
Sulphate	mg/l	**250**	**D**
Sulphide (as H_2S)	ug/l	0.25 (1.0)	A
Total Dissolved Solids	mg/l	600	E
Ammonia (Unionised)	mg/l	1.5	E
Ammonium	mg/l	**0.5**	**D**
BOD_5	mg/l	**5**	**D**
COD (Filtered)	mg/l	**5**	**D**
DOC	mg/l	50	F
Cyanide (free)	ug/l	70	E
Cyanide	ug/l	**50**	**D**
Phenol	ug/l	10	A
PAH (UK4)	ug/l	**0.1**	**D**
Benzo (a) pyrene	ug/l	**0.01**	**D**
TPH (Hydrocarbons)	ug/l	10	E
Benzene	ug/l	**1**	**D**
Ethylbenzene	ug/l	300	E
Toluene	ug/l	700	E
Xylene	ug/l	500	E
Individual Pesticides	ug/l	**0.1**	**D**
Total Pesticides	ug/l	**0.5**	**D**
Acrylamide	ug/l	**0.1**	**D**
Arachlor	ug/l	**0.1**	**D**
Atrazine	ug/l	**0.1**	**A D**
Bentazone	ug/l	**0.1**	**A D**
Biphenyl	ug/l	25	A
Carbendazim	ug/l	**0.1**	**A D**
Carbon tetrachloride	ug/l	**3**	**A D**
Chlorfenvinphos	ug/l	**0.1**	**A D**
Chloroform	ug/l	**100**	**A**
4-chloro-3-methyl-phenol	ug/l	40	A
Chloronitrotoluenes	ug/l	10	A
2-chlorophenol	ug/l	50	A

Contaminant	Units	DW	Ref
Chlorpyrifos	ug/l	0.03	A
Chlortoluron	ug/l	**0.1**	**A D**
Clopyralid	ug/l	**0.1**	**A D**
Cyanazine	ug/l	**0.1**	**A D**
Cyclodiene pesticides (sum)	ug/l	**0.1**	**D**
Cypermethrin	ug/l	**0.1**	**A D**
2,4-D	ug/l	30	E
DDT (total)	ug/l	0.1	E
Dalapon	ug/l	**0.1**	**A D**
Diazinon	ug/l	**0.1**	**A D**
Dichlorobenzene	ug/l	300	E
1,2-Dichloroethane	ug/l	**3**	**A D**
Dichloromethane	ug/l	**20**	**E**
2,4-Dichlorophenol	ug/l	20	A
Dichlorprop	ug/l	**100**	**A**
Dichlorvos	ug/l	**0.1**	**D**
Di(2-ethylhexyl)-phthalate	ug/l	8	E
Dimethoate	ug/l	6	E
Diuron	ug/l	**0.1**	**A D**
Endosulfan	ug/l	**0.1**	**D**
Fenitrothion	ug/l	**0.1**	**D**
Glyphosphate	ug/l	**0.1**	**A D**
Hexachlorobenzene	ug/l	**0.1**	**D**
Hexachlorobutadiene	ug/l	0.6	E
Hexachlorocyclohexane	ug/l	**0.1**	**D**
Isoproturon	ug/l	**0.1**	**A D**
Linuron	ug/l	**0.1**	**D**
Malathion	ug/l	**0.1**	**D**
MCPA	ug/l	**0.1**	**A D**
Mecoprop	ug/l	**0.1**	**A D**
Metazachlor	ug/l	**0.1**	**A D**
Nonylphenol	ug/l	0.3	A
Octylphenol	ug/l	0.1	A
Pentachlorobenzene	ug/l	0.007	A
Pentachlorophenol	ug/l	**0.1**	**A**
Permethrin	ug/l	**0.1**	**A D**
Propazine	ug/l	**0.1**	**A D**
Propetamphos	ug/l	**0.1**	**A D**
Simazine	ug/l	**0.1**	**A D**
Terbutryn	ug/l	**0.1**	**A D**
Tetrachloroethylene	ug/l	10	A
TCE	ug/l	**10**	**D**
Tetrachloroethane	ug/l	**10**	**A**
Tetrachloromethane	ug/l	**3**	**D**
1,1,1-Trichloroethane	ug/l	10	A
1,1,2-Trichloroethane	ug/l	10	A
Trichloroethene	ug/l	**10**	**A**
Trichloroethylene	ug/l	10	A
Tributyltin	ug/l	0.02	E
Trichlorobenzenes	ug/l	20	E
Trichloromethane	ug/l	2.5	A
Trietazine	ug/l	**0.1**	**A D**
Trifluralin	ug/l	**0.1**	**A D**
Trihalomethanes	ug/l	**100**	**D**
Vinyl Chloride	ug/l	**0.5**	**D**

PAH $_{(UK4)}$ (benzo (b) fluoranthene, benzo (k) fluoranthene, benzo (ghi) perylene and indeno (123-cd) pyrene).

6.0 RISKS TO OTHER RECEPTORS

6.1 Ecological

Environment Agency (2008c) has developed an ecological risk assessment (ERA) framework for contaminated soils in collaboration with relevant statutory authorities and industry. The ERA framework aims to provide a structured approach for assessing the risks to ecology from chemical contamination in soils, a requirement under Part IIA (contaminated land) of the Environmental Protection Act 1990. Where a statutory ecological receptor is identified on, or in close proximity to a site, an assessment in accordance with the current agency ERA framework is undertaken.

The ERA framework has been designed to:-

- Establish whether pollutant linkages are likely to exist between contamination on a site and the identified designated ecological receptors by undertaking a desk study and compilation of a preliminary conceptual site model.
- Gather sufficient information for making decisions regarding whether harm to these receptors is occurring or could occur in the future by undertaking a screening step based on a comparison of chemical analyses of site soils with a soil screening value (SSV) for the contaminants of potential concern or by use of ecological surveys and/or biological testing to gather evidence for any harm to ecological receptors present at the designated site and then seeking to attribute the harm to the chemical contamination.

The document describing the ERA framework (SR1) is supported by six guidance documents:-

- Desk studies and conceptual site models (SR2a).
- Use of soil screening values (SR2b).
- Use of bioassays (SR2c).
- Use of ecological surveys (SR2d).
- Attribution of cause and effect (SR2e).
- Standard operating procedures for bioassays (SR3).

The ERA framework for contaminants in soils is based on best practice in risk assessment and consequently can also be used in contexts other than Part IIA, such as within conservation regulations, and planning, and pollution control.

6.1.1 Part IIA

Ecological harm within Part IIA is confined to specified receptors, which are any ecological systems or living organisms forming part of such systems within a location which is:-

- A SSSI notified under section 28 of the Wildlife and Countryside Act 1981.
- A NNR declared under section 35 of the above act.
- A marine nature reserve designated under section 36 of the above act.
- An area of special protection for birds under section 3 of the above act.
- Any habitat or site afforded policy protection under paragraph 6 of PPS 9 on nature conservation.
- Any nature reserve established under section 21 of the National Parks and Access to the Countryside Act 1949.
- Any European site within the meaning of regulation 10 of the Conservation (Natural Habitats etc) Regulations 1994.
- Any candidate SAC or potential SAC given equivalent protection.

6.1.2 Habitats Directive

Regulation 3 of the Conservation Regulations 1994 (commonly known as the Habitats Regulations) implements the requirements of the European Habitats Directive 92/43/EEC in the UK. It also secures the protection of areas classified under the Wild Birds Directive 79/409/EEC.

The agency applies the regulations when considering all applications for authorisations, permissions, permits, consents and environmental licenses and for all relevant agency policy and operational activities. A risk assessment process is initiated in situations where an application under the UK system of land use planning or a review of permits, licenses, etc. is likely to impact on sites protected under the regulations. The ERA framework is used in this process.

6.1.3 Planning and Pollution Control

ODPM (2004) states that land contamination, or the possibility of it, is a material planning consideration in the preparation of development plan documents and in taking decisions on individual planning applications. Development plans and decisions on individual planning applications should take into account the potential sensitivity of the area to adverse effects from pollution, including nature conservation interests such as:-

- SSSI.
- National Parks.
- Areas of Outstanding Natural Beauty (AONB).
- SAC and SPA.
- Wetlands of international importance (RAMSAR sites).

Where appropriate, SSV and the wider ERA framework is used to assess the possible risks to nature conservation interests when potentially polluting activities are proposed. Where necessary, they are also applied to the assessment and remediation of historic contamination.

6.2 Soil and Landscape Planting

Where soils are to be used (reused or imported) for landscape planting, an assessment is made in accordance with BSI (2007a) unless composted materials are used, in which case BSI (2011) is referred to. Dependent upon the risk scenarios identified, reference to other publications such as Dickinson et al (2000), NIPHE (2001) and specific scientific/research papers published by ourselves or contained in our extensive library may be made.

6.3 Buildings and Construction Materials

Building materials are often subjected to aggressive environments which cause them to undergo chemical or physical changes. These changes may result in loss of strength or other properties that may put at risk their structure integrity or ability to perform to design requirements. Aggressive conditions include:-

- Severe climates.
- Coastal conditions.
- Polluted atmospheres.
- Contaminated soil.

In aggressive ground conditions, the potential for contaminant attack depends on the following:-

- The presence of water as a carrier of chemical contaminants.
- The availability of the contaminant in terms of solubility, concentration and rates of replenishment.
- Contact between the contaminant and the building material.
- The nature of the building materials and its capability of being attacked by contaminants.

In general the thicker the building material the less likelihood there is for contaminant attack to cause damage to the integrity of the structure.

6.3.1 Hazard Identification and Assessment

The identification of hazards is based on the findings of the investigation primarily relating to former land uses (i.e. the potential for chemical contamination and the likely forms present) and laboratory determination of the concentration of chemical contaminants. Clearly, the scope of laboratory testing is determined with respect to former land uses and contaminants which may cause harm to human health, and water resources.

The identification of hazards from contamination and subsequent assessment of risks is based on the following:-

- The contaminants present on a site.
- The nature of the contaminant (e.g. calcium sulphate is much less soluble than sodium or magnesium sulphate and is, therefore, less of a concern with regards to sulphate attack).
- The concentration of contaminants. In general, the higher the concentration the greater the hazard.
- The solubility of the contaminants. Those that are not soluble will not generally react with materials.
- The permeability of the soils (i.e. the pathway through which fluids can transport contaminants to the building).

The process of risk assessment for building materials is concerned with identification of the hazard (contaminants at the site a source) and subsequently how the contaminants can reach the building (pathway) and how they can react with the building (receptor). Thus the risk assessment produced is based on the source-pathway-receptor model.

In this context, buildings include construction materials, underground structures and services. An assessment of potential risks to buildings and construction materials is undertaken in accordance with statutory guidance such as DCLG (2010) and other guidance such as DoE (1987 and 1992), BRE (1994), Highways Agency (1998), Environment Agency (2000a and 2001a) and other references as summarised in Section 8. Where required, concentrations of contaminants are compared against the threshold values given in DoE (1987) and DoE (1992) for organic contaminants, BRE (2005) for protection of concrete, Highways Agency (1998) for protection of earthworks, UKWIR (2010) for the selection of potable water supply pipe materials and other references as summarised in Section 8.

6.4 Property

In this context, property is defined as crops, home grown/allotment produce, pets, livestock and wild animals, subject to shooting/fishing rights etc. It excludes buildings, underground structures, services, plant and machinery. A summary of the documents referred to in undertaking property risk assessments is contained in Section 8 and includes Alloway (2004) BSI (2011), DEFRA (2012c), Dickinson et al (2000), DoH (2010), Environment Agency (2007b), (EU (2002), ICRCL (1990) and MAFF (1998) as superseded by DEFRA (2009b).

7.0 RISK FROM GROUND GAS

7.1 Legislative Framework

The presence of harmful ground gasses could provide a potential source within in a pollutant linkage allowing the regulator (local authority or the agency) to determine if there is a significant possibility of harm being caused to humans, buildings or the environment.

With regards to planned future use, ODPM (2004) requires developers to undertake appropriate risk assessments to demonstrate to the local authority that proposals adequately mitigate any potential hazards associated with contamination including ground gas. The Town and Country Planning (General Development Procedure) Order 1995, requires the local authority to consult with the agency before granting planning permission for development within 250m of land which is being used for the deposit of waste or has been at any time in the last 30 years, or it has been notified for the purposes of that provision.

Building control bodies enforce compliance with DCLG (2010). Practical guidance is provided in approved documents, one of which is Part C (site preparation and resistance to contaminants and moisture), which seeks to protect the health, safety and welfare of people in and around buildings, and includes requirements for protection against harm from ground gas.

In complying with DCLG (2010), a risk assessment approach is required in relation to gaseous contamination based on the source-pathway-receptor conceptual model procedure. We have adopted procedures described in the relevant documents along with BSI (2013a) for investigation and assessments of risk of a development being affected by ground gases and if appropriate the identification of mitigation measures.

An assessment of the risk of the site being affected by ground gases is based on the following aspects:-

- Source of the gas.
- Investigation information.
- Migration feasibility.
- Sensitivity of the development and its location relative to the source.

7.2 General

The following assessment relates to the potential for, and the effects of, gasses generated by biodegradable matter. A separate but related class of problem involves the migration of hydrocarbon vapour phase resulting for example from spillages of petroleum products and/or solvents. The principal ground gasses are carbon dioxide (CO_2) and methane (CH_4). The potential for the development to be affected by radon gas is also considered within the Phase 1 PRA.

Where risks from ground gases are identified as a potential SPL, then an appropriate programme of gas monitoring and/or risk assessment is undertaken.

During the site investigation, the design of any gas monitoring is based upon the CSM derived as part of the Phase 1 PRA. An appropriate number of boreholes excavated during the site investigation and sited to target the SPL would be installed with standpipes (e.g. a 19mm to 50mm diameter HDPE monitoring standpipe, protected by an end cap and gravel pack, completed with a bung, valve and metal cover etc.). The response zone (the slotted section of the pipe) would be confined to the strata identified as the potential pathway for the migration of ground gases. Typically, the first one metre from ground level comprises plain standpipe with a bentonite seal to prevent the ingress of atmospheric gases.

In accordance with CIRIA (2007) and based on the gas hazard and site sensitivity, an appropriate density/spacing for the boreholes would be chosen. Subsequently, in accordance with CIRIA (2007) and based on the generation potential, and site sensitivity for the development, an appropriate programme of monitoring over an appropriate period of time would be designed and implemented, ideally during which at least one set of monitoring would be undertaken during low/falling atmospheric pressure.

The results of the gas monitoring assessment are then used to generate a gas screening value (GSV) for the worst case concentration of the gas at the worst case steady state flow, which would then be compared with relevant guidance such as NHBC (2007), BSI (2007b) and CIRIA (2007) etc.

It should be noted that the NHBC traffic light system is specifically for low rise housing developments with a clear, ventilated subfloor void, whereas CIRIA is for residential (not low rise) developments and/or office/commercial/industrial developments.

Where appropriate, the local environmental health department and/or building control are consulted on the scope of any proposed measures to be adopted at the earliest opportunity.

7.3 Ground Gas GAC

7.3.1 NHBC Traffic Light System

The table below contains typical maximum concentrations and Gas Screening Values (GSV) for the traffic light system detailed in NHBC (2007).

Traffic Light Classification	Methane		Carbon Dioxide	
	Typical Maximum Concentration (%v/v)	Gas Screening Value (l/hr)	Typical Maximum Concentration (%v/v)	Gas Screening Value (l/hr)
Green	1	0.13	5	0.78
Amber 1	5	0.63	10	1.60
Amber 2	20	1.60	30	3.10
Red				

Based on the traffic light classification, the following recommendations for gas protection measures are provided by NHBC (2007):-

Traffic Light Classification	Ground Protection Measures Required
Green	Ground gas protection measures are not required.
Amber 1	Low level ground gas protection measures are required, using a membrane and ventilated subfloor void that creates a permeability contrast to limit the ingress of gas into buildings. Gas protection measures are to be installed as prescribed in BRE (2001). Ventilation of the subfloor void should be designed to provide a minimum of one complete volume change per 24hrs.
Amber 2	High level ground gas protection measures are required, creating a permeability contrast to prevent ingress of gas into buildings. Gas protection measures are to be installed as prescribed in BRE (2001). Membranes used should always be fitted by a specialist contractor and should be fully certified. As with Amber 1, ventilation of the subfloor void should be designed to provide a minimum of one complete volume change per 24hrs.
Red	Standard residential housing is not normally acceptable without further ground gas risk assessment and/or possible remedial mitigation measures to reduce/remove the source of the ground gases. In certain circumstances, active protection methods could be applied, but only when there is a legal agreement assuring the management and maintenance of the system for the life of the property.

7.3.2 CIRIA System

GAC for ground gas based on the modified Wilson and Card and the CIRIA recommendations for gas protection measures (CIRIA 2007) are summarised in the tables below:-

Characteristic Situation	Risk Classification	GSV (l/hr) (CH_4 or CO_2)	Additional Factors	Typical Sources
1	Very low risk	<0.07	Typically CH_4 <1%v/v and/or CO_2 <5%v/v. Otherwise consider increase to Situation 2.	Natural soil with a low organic content and typical made ground.
2	Low risk	<0.7	Borehole flow rate not to exceed 70l/hr. Otherwise consider increase to Situation 3.	Natural soil with a high peat/organic content and typical made ground.
3	Moderate risk	<3.5	None.	Old landfill, inert waste and flooded mine working.
4	Moderate to high risk	<15	Quantitative risk assessment required to evaluate scope of protective measures.	Mine working susceptible to flooding and completed landfill (DoE 1991 & 1995b).
5	High risk	<70	None.	Un-flooded and inactive mine with near surface workings.
6	Very high risk	>70	None.	Recent landfill sites.

Characteristic Situation	Residential Building (Not Low Rise)		Commercial/Industrial Development	
	Levels of Protection	Typical Scope of Protective Measures	Levels of Protection	Typical Scope of Protective Measures
1	None	No special precautions.	None	No special precautions.
2	2	a) Reinforced concrete cast in situ floor slab (suspended, non-suspended or raft) with at least 1200g DPM9 and underfloor venting. b) Beam and block or precast concrete and 2000g DPM/reinforced gas membrane and underfloor venting. All joints and penetrations sealed.	1 to 2	a) Reinforced concrete cast in situ floor slab (suspended, non-suspended or raft) with at least 1200g DPM9. b) Beam and block or precast concrete slab and minimum 2000g DPM/reinforced gas membrane. c) Possibly underfloor venting or pressurisation in combination with a) and b) depending on use. All joints and penetrations sealed.
3	2	All types of floor slab as above. All joints and penetrations sealed. Proprietary gas resistant membrane and passively ventilated or positively pressurised underfloor subspace.	1 to 2	All types of floor slab as above. All joints and penetrations sealed. Minimum 2000g DPM/reinforced gas proof membrane and passively ventilated underfloor subspace or positively pressurised underfloor subspace.
4	3	All types of floor slab as above. All joints and penetrations sealed. Proprietary gas resistant membrane and passively ventilated underfloor subspace or positively pressurised underfloor subspace, oversite capping or blinding and in ground venting layer.	2 to 3	All types of floor slab as above. All joints and penetrations sealed. Proprietary gas resistant membrane and passively ventilated or positively pressurised underfloor subspace with monitoring facility.
5	4	Reinforced concrete cast in situ floor slab (suspended, non-suspended or raft). All joints and penetrations sealed. Proprietary gas resistant membrane and ventilated or positively pressurised underfloor subspace, oversite capping and in ground venting layer, and in ground venting wells or barriers.	3 to 4	Reinforced concrete cast in situ floor slab (suspended, non-suspended or raft). All joints and penetrations sealed. Proprietary gas resistant membrane and passively ventilated or positively pressurised underfloor subspace with monitoring facility. In ground venting wells or barriers.

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