

Remediation Strategy

Sladen Mill, Littleborough



**SOIL AND
STRUCTURES**

Report Status

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Report Author

Russell Bowman (Director) BSc (Hons) MSc CEng CWEM MCIWEM

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Appendices Drawings > Generic Assessment Criteria (residential with home-grown produce)

Peer review: To support continuity throughout regulatory approval process, this Report has been reviewed by Tim Booth of T J Booth Associates.

Printing: This Report is intended to be read electronically on a >20 inch monitor or printed landscape, as double-sided A3. Font sizes have been selected that means it should remain legible printed landscape, as double-side A4.

Units: Throughout this Report chemical concentrations or target concentrations are reported in: parts per million (ppm) milligrams per kilogram (mg/kg) for solids; and, parts per billion (ppb) micrograms per litre (ug/l) for liquids.

Appointment

Soil and Structures Ltd were instructed by Mere Development Group (*the Client*) in June 2024 to prepare a Remediation Strategy (*the Report*) to support the re-development of a parcel of land formerly occupied by Sladen Mill, Littleborough (*the Site*).

Development proposals include for construction of 25 no. dwellings and associated hardstanding, including access roads, and soft landscaping areas under reserved matters planning application ref. 21/00950/REM pursuant to outline permission ref. 15/0125/OUT.

Reliance on the advice presented herein rests solely with the Client.

Scope and Context

The Remediation Strategy offers advice on risk mitigation measures or ‘remedial actions’ that are required to bring the site up to a condition that would be deemed ‘suitable for use’.

The legal context of this advice is rooted within national planning policy guidance (the National Planning Policy Framework) that is governed by planning law (various acts).

In this context, the Site would be deemed ‘suitable for use’ if residual risk is reduced to acceptably low levels for: two historical hazards; potentially harmful material and potentially polluting material; and, one geological hazard; radon gas.

Other ground-related hazards, e.g. shrink-swell clays, sub-structures, ground dissolution, are beyond the scope of this Report. It is noted that ground-related hazards are all inter-related and therefore commentary relating to other potential hazards, e.g. slope stability or sub-structures, is included within this Report.

Background to this Report

This Report is preceded by various, existing ground-related reports prepared by others and, most recently a Controlled Waters Risk Assessment prepared by Soil and Structures Ltd, ref. 20403-R-001-V04. All available background data, including these reports, are annexed to this Report as a separate document that is available on request.

Alongside this existing reporting, extended consultations with the Environment Agency have taken place that are discussed within the Controlled Waters Risk Assessment prepared by Soil and Structures Ltd.

References

The Remediation Strategy has been written with reference to various sources of information including; design drawings (appended); and, existing ground-related report referenced above (not appended; readers of this Report assumed have access to it).

Reference is also made to the ‘Engineer’ within this Report that relates to the appointed design engineer (structural and/or civil) who is most likely to be the main point of contact within the design team.

1.0 The Site and Proposed Development

1.1 The Site

Location and size: The Site (the planning boundary) comprises a parcel of land approximately 1.30 ha in area located 175 m north of Halifax Road, Littleborough, Lancashire (Figure 1).

Access: The main body of the Site is accessed on foot and by vehicle via a fenced entrance in the south-eastern corner and the upper level of the Site openly accessible on foot and by vehicle midway down the eastern boundary.

Topography: is characterised by two distinct areas with general westerly and north-westerly fall in levels (within the Castle Brook valley): i) the 'main body' of the Site that lies between 165 and 174 mAOD; and, ii) the 'upper level' that is present midway along the eastern boundary of the Site that lies between 176.5 and 177 mAOD.

Utilities: Below ground utilities are expected to be present beneath the Site with evidence of overhead lines on Site.

Existing structures: At the point of issue various structures were noted on Site including: a masonry structure and electrical sub-station on the western edge of the Site; sandstone retaining walls in varied conditions along the eastern edge of the Site and locally to the bridge in the southern portion of the Site; and, localised areas of residual concrete hardstanding.

1.2 The Proposed Development

Development proposals: Development proposals (Figure 2) include for construction of 25 no. dwellings and associated hardstanding, including access roads, and soft landscaping areas.

① **Development works and risk:** An appreciation of the construction processes is essential for development-related risk assessments given the groundworks stand to meaningfully alter the level of risk, e.g. unstable slopes being removed by earthworks, or unsuitable material being exposed as part of the works.

- To enable this development, the following groundworks are likely to be required, N.B. listing is outline only.
- > **Preparation:** at the point of inspection Site clearance and preparation appears to have been partially completed with remaining works including: demolition of the remaining structures (detailed above); and, removal of remaining hardstanding surfaces.
 - > **Earthworks (cut and fill):** Are expected to be required to suit development levels with the existing Made Ground deposits not anticipated to be suitable for re-use as a general fill in its current condition.
 - > **Utility Excavations:** Excavation of any drainage and other utility alignments.
 - > **Foundations:** Subject to the selected foundation solution, construction of sub-structures (foundations).
 - > **Surfacing:** Formation soft landscaping and hardstanding surfaces.

① **Risk profile of the proposed development for Human Health and 'Controlled Waters'**¹: The proposed development would see a former industrial site that has been subject to multiple uses (land associated with coal mining, woollen mill, cotton raising and finishing mill, and more recently the manufacture of LPDE products) developed for a residential use.

This change of use represents a shift from a land use with low sensitivity and high pollution potential (various industrial uses) to a high sensitivity and low pollution potential (residential). On this basis alone, the requirement for risk management (remedial works) would be anticipated. The existing ground-related reporting, including Soil and Structure's "Controlled Waters Risk Assessment", recommended that remedial works were required to reduce the risk presented to human health and Controlled Waters to acceptably low levels. This Report details the nature and extent of this work.

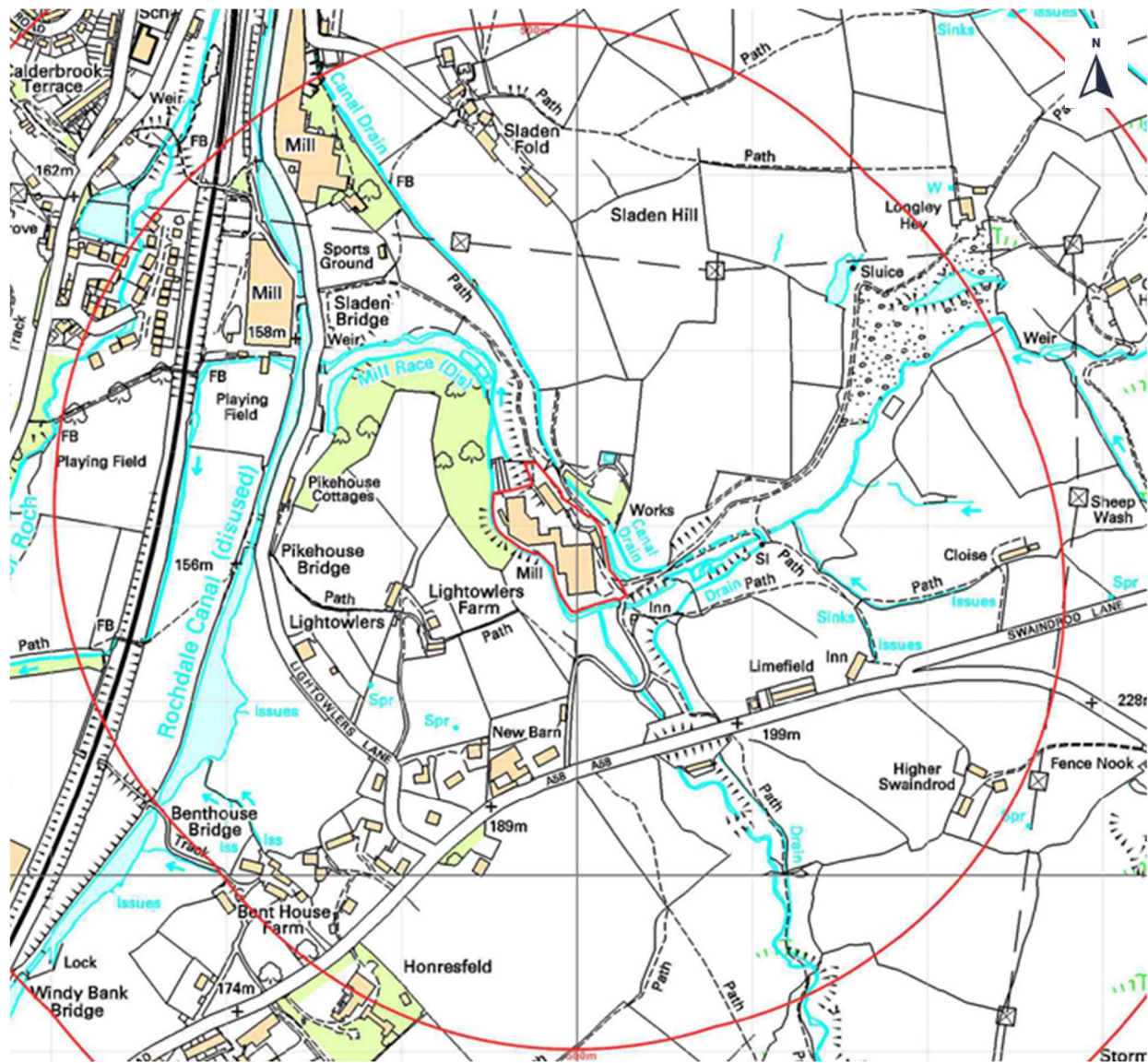


Figure 1: Location Plan
> Site approximately centred on 394983 417383
> Central red line = outline planning application boundary; outer red line = 500 m buffer

¹ [Water Resources Act 1991 \(legislation.gov.uk\)](https://www.legislation.gov.uk/ukpga/1991/29)

Sladen Mill, Littleborough

SOIL AND STRUCTURES



Figure 2 – Development Plan
 > *Extract from appended drawing*

2.0 Risk Assessments – Summary Table

The following table presents a summary of the risk assessments for the three, ground-related hazards that are specific to the contaminated land regime. More in-depth analysis and assessment is presented within the *Controlled Waters Risk Assessment* prepared by Soil and Structures Ltd, ref. 20403-R-001-V04 and the *Phase 2 Site Investigation & Risk Assessment – Phase 3 Remediation Statement* report prepared by T J Booth & Associates dated February 2024 (Revision 5). The recommended remedial actions are also illustrated conceptually on the Ground Models presented within Section 3.0.

Hazard	If the hazard has been identified, what is the nature of the hazard?		If the risk presented by this hazard is not acceptably low, what remedial action (risk reduction) is recommended?	
Contamination (on-site)	→	Chemical testing of the Made Ground soils on Site (the <i>source</i>) revealed the presence of various chemical compounds at concentrations that, without remedial action, stand to present an unacceptable risk of harm to end users of the Site and any visitors (the <i>receptors</i>) through various <i>pathways</i>, e.g. direct contact with this material, tracking back dust into homes, as well as more specific <i>pathways</i> such as vapour intrusion in areas where material with the potential to generate vapour has been identified. No Per and Poly-Fluoroalkyl Substances (PFAS) were detected within the Made Ground soils on Site. Whilst concentrations of these chemical compounds vary across the Site, the Made Ground soils have been extensively disturbed through the action of the demolition works and are therefore considered to represent an ‘averaged area’. It is however noted that discrete areas of the Site do include evidence of free-phase hydrocarbons (Made Ground locally to TH2, TH7 and TH18) that could be treated as ‘<i>hot spots</i>’ of potentially harmful material for which targeted remedial action is recommended. The presence of asbestos fibres has been detected within the Made Ground soils across multiple locations. All Made Ground soils should be treated as potential Asbestos Containing Soils (ACSS) with suitable risk mitigation measures recommended for both the construction phase and the permanent, developed condition of the Site.	→	Made Ground (general): Recommended risk mitigation: Provision of a suitably thick, clean capping to all proposed areas of soft landscaping to serve as a physical barrier between the Made Ground soils and end users of the Site. It is noted that, in the absence of suitable soil forming material on the Site, the provision of clean capping is also required to serve as a physically suitable growing medium. Made Ground (locally to TH2, TH7 and TH18): Recommended risk mitigation: Excavation, delineation and in-situ stabilisation through solidification/stabilisation. In addition, as a precautionary measure, the provision of vapour resistant membrane (upgrade to ground gas protection recommended below) is recommended to all proposed dwellings within 10 m of the delineated zone.
Contamination (off-site; including transport of pollutants from off-site sources)	→	Spring points (the groundwater table) are present on the eastern boundary of the Site. Two of these springs have been confirmed to contain elevated concentrations of PFAS compounds, three times above the UK Drinking Water Standard) and therefore is serving as a <i>source</i> of both potentially harmful and polluting material (PFAS). Without remedial action this spring water stands to present an unacceptable risk to various <i>receptors</i> including: i) end users of the Site and any visitors through direct contact; ii) groundwater beneath the Site through infiltration; and, iii) surface water (Castle Brook) through direct discharge / surface run-off. Testing of surface water quality within Castle Brook upstream of the Site and within spring water discharging into Castle Brook 75 m downstream of the Site. At this stage, the spring water has only been tested for PFAS compounds and monohydric phenols noting that the recommended remedial action would not vary even if other chemicals were recorded at unacceptable concentrations within this water.	→	Spring water: Recommended risk mitigation: Provision of a dedicated, below ground toe-drain along the full length of the retaining wall planned along the full length of the eastern edge of the lower level of the Site to intercept all spring / seepage points and direct the spring water away from the Site’s soils, groundwater and proposed dwellings, directing the resultant water through granular activated carbon filters. It is noted that, management of the spring water will be required for both geotechnical and flood risk purposes, notwithstanding the risk presented to human health and controlled waters. In the source of this potentially polluting material lying off-Site, in addition to the risk mitigation works recommended herein, consideration may wish to be given to further investigation of plausible sources of the PFAS. The PFAS containing spring water has been adversely impacting soil and groundwater quality on the Site and, in developing the Site, may place some responsibility on the developer for management of water quality.
Pollution (waters)	→	Chemical testing of the groundwater across Site (one <i>source</i>) revealed chemical compounds at concentrations that, without risk mitigation, stand to present an unacceptable risk to Controlled Water (the <i>receptors</i>) through lateral and vertical mitigation (the <i>pathways</i>). With respect to PFAS, the original source of these chemical compounds is likely off Site (as discussed above). Whilst chemical concentrations vary across the Site, the groundwater quality could be generally described as ‘degraded’ and is therefore considered to represent an ‘averaged area’. It is however noted that discrete areas of the Site do include evidence of free-phase hydrocarbons (groundwater locally to TH2, TH7 and TH18) that are treated as ‘hot spots’ of potentially polluting material for which targeted risk mitigation is recommended. It is also noted that the chemical concentrations of fuel and oil range hydrocarbons in the soils and groundwater within these locations was found to be relatively ‘low’ despite evidence of free-product existing. The chemicals of concern are broad ranging with concentrations of toxic metals, inorganics, aromatic hydrocarbons and PFAS recorded above Environmental Quality Standards (annual average). The Controlled Water receptors identified include: Castle Brook (surface watercourse) west of the Site; and, groundwater below the Site.	→	Groundwater (general): Recommended risk mitigation: Provision of a dedicated, below ground toe-drain along the full length of the retaining wall planned along the full length of the eastern edge of the lower level of the Site to intercept all spring / seepage points and direct the spring water away from the Site’s soils, groundwater and proposed dwellings, directing the resultant water through granular activated carbon filters. Groundwater (locally to TH2, TH7 and TH18): Recommended risk mitigation: Excavation, delineation and either; i) two stage sump-pumping of hydrocarbon impacted groundwater to reduce the overall mass of free-phase hydrocarbons accounting for the anticipated ‘lag’ effects, i.e. following the first phase of pumping, hydrocarbons otherwise sorbed onto soil particles will have a tendency to mobilise/dissolve into groundwater; or, ii) in-situ stabilisation through solidification/stabilisation.
Ground gas (all types)	→	Plausible sources of ground gas were discussed within the “<i>Phase 2 Site Investigation & Risk Assessment – Phase 3 Remediation Statement</i>” report prepared by T J Booth & Associates dated February 2024 (Revision 5) and, apart from radon, assessed to have very low ground gas generation potential. The Site is located within an area where between 5 and 10 % of dwellings are predicted to be above the ‘Action Level’ for radon that, as currently set, represents half of a person’s annual average radiation dose.	→	Radon: Recommended risk mitigation: Precautionary provision of ‘full radon protection measures’ in line with BRE 211 is recommended to offer protection against the ingress of all ground gases (including radon). Note: vapour barriers are recommended within select properties as detailed above under ‘Contamination (on-Site)’.

2.1 Other commentary relate to ground-related risk assessments

Risk assessments are ‘live’ documents and the levels of risk may change if and where new information is presented, e.g. if and where unforeseen material is encountered in the ground.

The key contaminants of concern, or risk drivers, or are defined as:

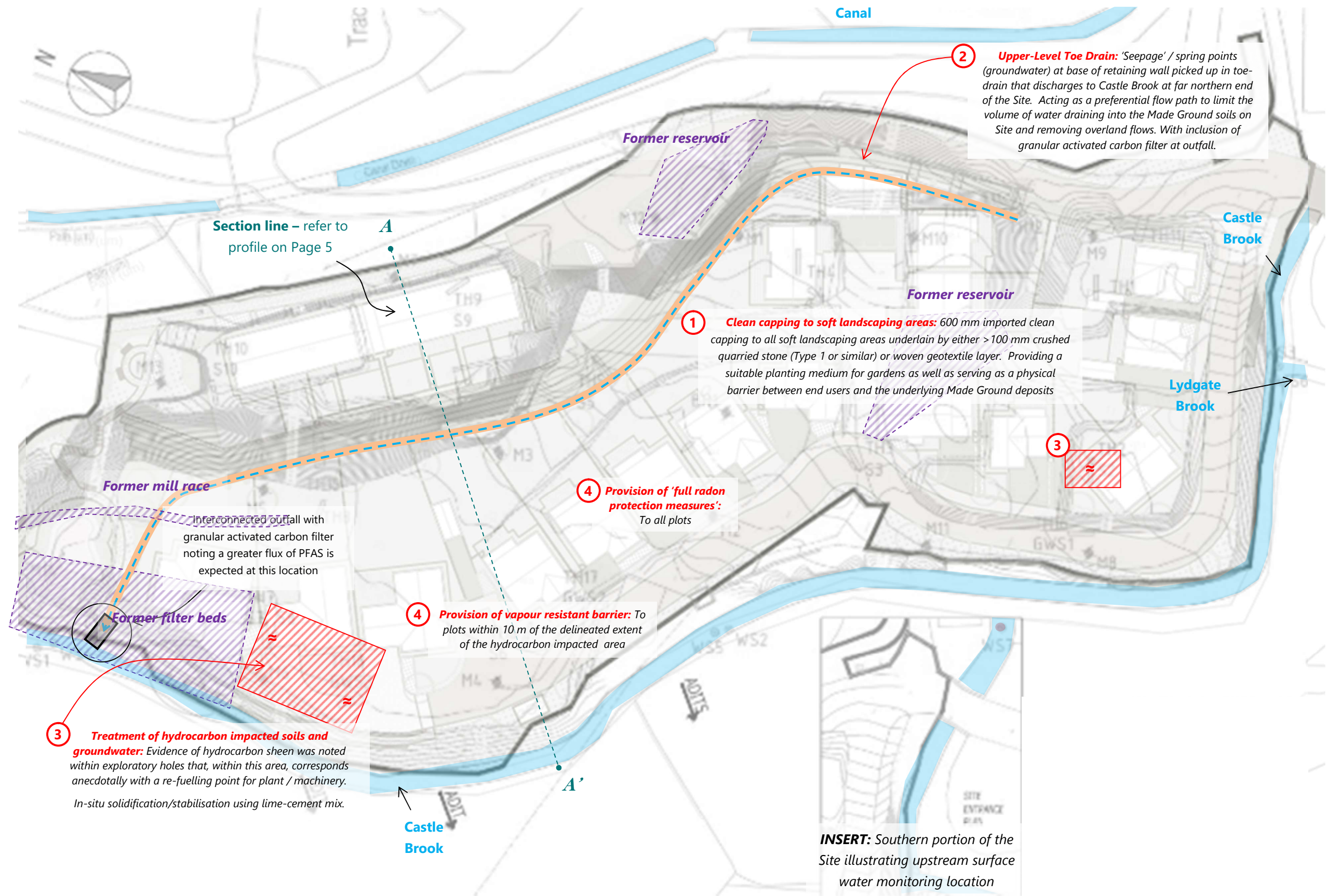
⚠ For soils: asbestos (asbestos containing soils; ACS)

⚠ For groundwater: PFAS, PAH, phenols and sulphate.

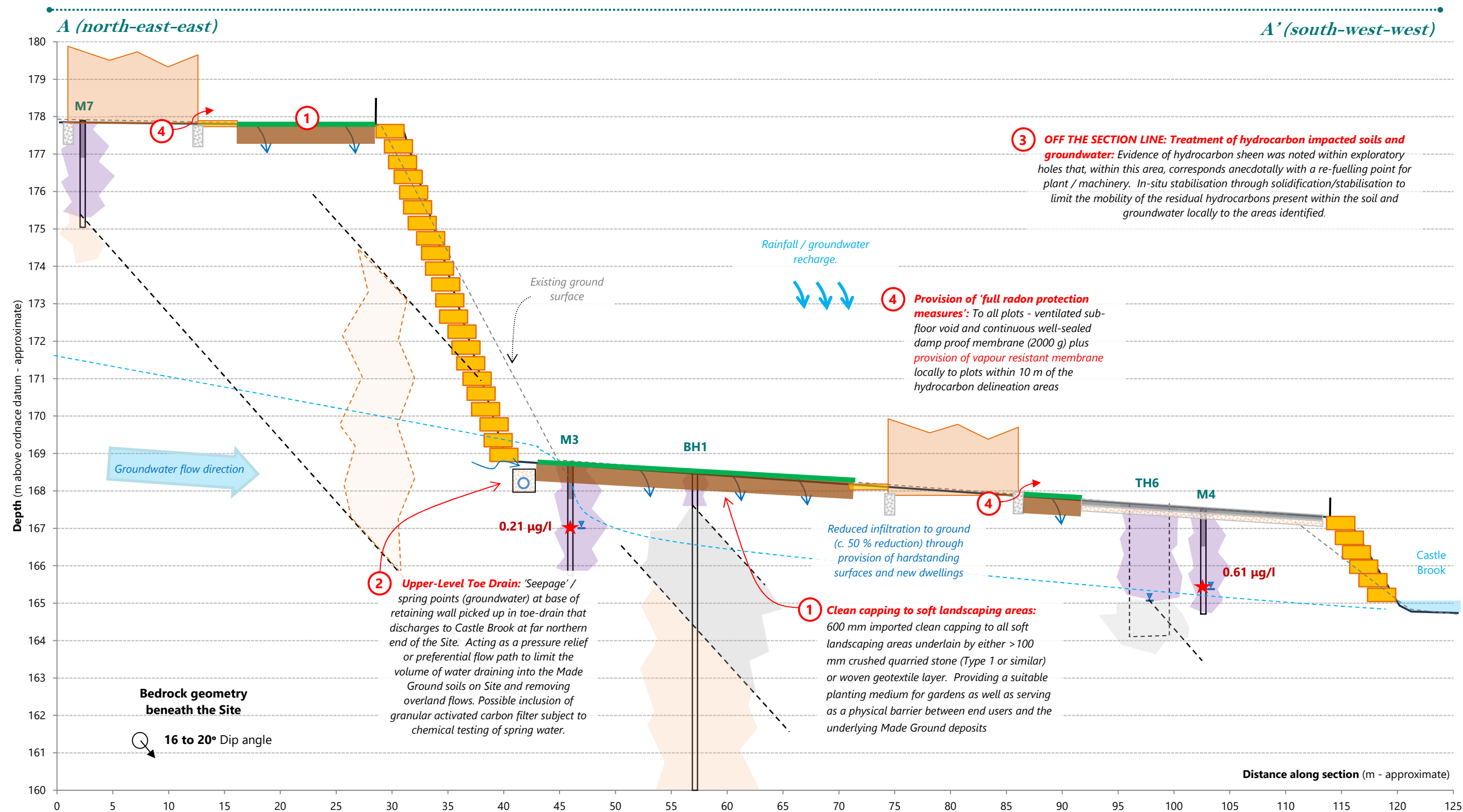
Is should be borne in mind that other chemicals are present within the soils and groundwater at concentrations that pose an unacceptable risk to human health and Controlled Waters however, these are deemed secondary to the risks posed by the contaminants of concern identified above.

Inherent risk reduction is incorporated as part of the development proposals, such as, a net increase in impermeable areas by around 50 % that will both serve as a physical barrier to the underlying Made Ground soils as well as reduce the rate of infiltration, a key factor in the fate and transport of groundwater-based chemicals.

3.0 Ground Model – Endline (Post-Development Condition) – Plan (presenting an overview of the Remedial Actions)



3.0 Ground Model – Endline (Post-Development Condition) – Profile (aligned with dip direction of bedrock; presenting an overview of the Remedial Actions)



Illustrative / conceptual only – do not scale from drawing – note compressed horizontal axis

4.0 Remedial Works

Remedial action has been recommended to reduce the residual risk presented by ground-related hazards to acceptable low levels, as tabled in Section 2.0.

Five remedial actions are recommended with more in-depth commentary presented within this Section.

1 Remedial Action 1 – Clean capping to soft landscaping areas

The objective of this remedial action is to prevent end users of the Site being exposed to any residual Made Ground that is physically and chemically unsuitable for use as a soil forming material within soft landscaping areas on Site.

This remedial action can be achieved through: the provision of a suitable thickness of ‘clean capping’ to any areas where the Made Ground is present beneath soft-landscaping areas.

This remedial action has been selected given there is a requirement for importing soil-forming material to soft landscaping areas regardless of the requirement for remedial action.

- > **Function:** A clean capping or ‘cover system’ is designed to serve as a dedicated barrier between potentially harmful material (residual Made Ground) and end users (residents and visitors).
- > **Extent:** The clean capping is only required if and where residual Made Ground (non-natural soils) are present beneath planned soft landscaping areas. In this scenario, this is expected to apply to all soft landscaping areas.

If it can be demonstrated, through plot-by-plot inspection, that the sub-grade is free from Made Ground and comprised of natural soil, there would be no requirement for a dedicated clean capping to be provided and the soft landscaping design can be architect led.

- > **Thickness (Table 1):** The recommended thicknesses and composition are set out within Table 1 below.

This thickness aligns with the likely usage of the soft landscaping areas, current guidance² and the level of risk present on Site. If and where evidence of material that differs from that described herein, i.e. stained soils, that could present a greater risk of harm then deeper thicknesses of capping may be required.

It is noted that such an occurrence would be an ‘unexpected encounter’ for which a pre-agreed response plan would need to be agreed with the local planning authority (as detailed within Section 3.2)

The inclusion of a no-fines, crushed stone layer of at least 75 mm thickness is intended to serve as:

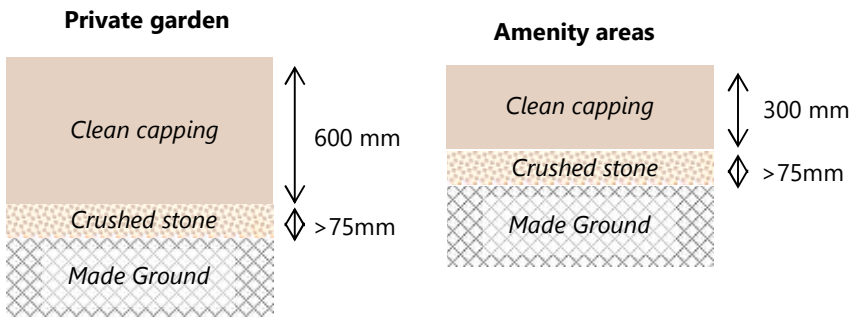
- i) A visual demarcation (that is not a plastic geotextile) acting as a ‘no-dig’ layer, limiting the potential for end uses of the Site to excavate through the capping into the underlying Made Ground soils; and,
- ii) A capillary break layer, limiting the potential for any upwards, vertical migration of soil or groundwater-based chemicals.

For tree and shrub planting areas, the advice of the landscape architect should be sought however, in general, at least 600 mm of soil is likely to be required.

Table 1: Clean capping design

Soft Landscaping Area	Clean Capping Component and Thickness			Total Depth Required
	Topsoil	Subsoil	Other	
Private garden areas	Min. 150 mm*	450 mm	>75mm ‘no fines’ crushed stone	700 mm
Amenity areas	Min. 150 mm*	150 mm	>75mm ‘no fines’ crushed stone	400 mm

* In general, the provision of topsoil thicknesses greater than 300 mm is liable to induce a collapse of the soil structure (compression or collapse)



- > **Material sourcing:** Topsoil and other imported soils should be sourced from a reputable supplier who can confirm the source of the material as well as its chemical and physical properties prior to being imported onto Site.
- > **Quality:** The soft landscaping soils’ quality should be verified for suitability against both; the relevant British Standards, e.g. BS3882:2015 for topsoil and BS8601:2013 for subsoil, and Local Planning Authority (LPA) guidance³.

The LPA guidance is hyperlinked below and reference should be made to Section 6.0 for the specific frequencies and suites of testing that are required for imported soils.

The frequency and suite of testing varies depending on the nature of the source, e.g. Greenfield or manufactured.

Imported soils shall therefore be defined as ‘suitable for use’ if the verification testing falls within the Generic Assessment Criteria that are appended.

² Cover Systems for Land Regeneration - Thickness of cover systems for Contaminated Land BRE/AGS/NHBC: 2004 (under review)

³ [Contaminated Land \ Manchester City Council](#)

2 Remedial Action 2 – Upper-level toe drain

The objective of this remedial action is to: i) limit pollution loading of the Site's soils and groundwater; and, ii) limit the flux of PFAS and other potential pollutants into Castle Brook.

This remedial action can be achieved through: the provision of an upper level toe-drain at the base of the upper embankment, to collect spring water and other seepages from the upper level embankment with in-line Granular Activated Carbon (GACarbon) filter at the outfall.

This remedial action has been selected given: i) it is the only viable means to reduce pollution loading to the Site soils and groundwater from the spring water source(s), ii) there is a requirement for a toe-drain to manage surface water flooding regardless of the requirement for remedial action; and, iii) the inclusion of the GACarbon filter demonstrates pollution control measures on water that requires management as part of the development works the quality of which cannot be controlled by the developer (off-Site source).

Based on the estimated flow rates, it is recommended that the toe drain comprises:

- > A perforated 150 mm diameter pipe with an invert level at least 150 mm below the base of the embankment's lowest level formed within a trench that is wrapped in geo-textile and filled with suitable granular, drainage medium with;
- > Falls of no less than 1 in 200 within the pipework to maintain flows;
- > A 150mm thick clay lining to the western edge of the trench to limit losses from the pipe; and,
- > A solid 150 mm diameter pipe connection over the last 1000 mm fall in levels to allow for sufficient head to develop with the Granular Activated Carbon filter at the outfall (Figure 3 and Figure 4).

① The final design of the pipework should be made in direct consultation with the project's drainage / civil engineer.

Once intercepted, the spring-water will be diverted away from the Site, that otherwise is considered likely to represent a significant flux of PFAS into the Site soils and groundwater. Notwithstanding this, there will remain a requirement to limit potential pollution of Castle Brook through the inclusion of some pre-treatment to the outfall water.

Pollution loading within the spring-water is expected to vary seasonally with the main control being rainfall rates and groundwater levels. It is therefore recommended that the GACarbon filter at the outfall is designed on a modular, 'in-principle' basis allowing for the performance to be optimised through the construction process.

In practice, this would entail a two-stage process.

- > Stage 1 of Granular Activated Carbon filter deployment: installation of a single filter module the performance of which is tested against reasonable predictions of the filter's short-term performance.

The filter module is conceptually illustrated within Figure 4 and is designed as a passive, gravity filter system (driven by the head of water within the solid 150 mm diameter pipe) with no mechanical parts for ease of maintenance / serviceability.

Inlet waters (spring water) will enter the filter and rise upwards under hydraulic pressure through the GACarbon filter medium at a rate that can be controlled by the density of the filter medium

① The final design of the filter should be made in direct consultation with the project's drainage / civil engineer as well as the GACarbon supplier

The performance of the filter which will again need to be validated through a programme of 'upstream' and 'downstream' monitoring.

At this stage, it is recommended that monitoring at 2 to 4 week and 12 to 16 week intervals (post-installation) is conducted with sampling and testing for key chemicals of concern.

Key chemicals of concern include: Perfluorootanoic Acid (PFOA) and PFOS (Perfluorooctane Sulfonate) the two key PFAS compounds within this setting.

These compounds have been selected based on their presence within groundwater beneath the Site (noting that soil-based concentrations of PAHs and phenols were 'low' suggesting the spring water is also transporting other chemicals onto Siet) and, with respect to PFAS, based on its confirmed presence within the spring-water.

At this stage, if and where PFAS, PAH and phenol concentrations can be reduced by a half of their 'upstream' concentration then single filter module is likely to be considered 'suitable for use'.

① Direct consultation with the Environment Agency should be maintained, particularly with respect to the performance of the filter.

Subject to the performance of a single filter module being confirmed, contingency allowance for 'upgrading' the system is recommended as detailed below.

- > Stage 2 of Granular Activated Carbon filter deployment: installation of up to two additional GACarbon filter modules in series (three in total) the performance of which will again need to be validated through a programme of 'upstream' and 'downstream' monitoring.

At this stage, it is recommended that monitoring at 2 to 4 week and 12 to 16 week intervals (post-installation) is conducted with sampling and testing for the same chemicals of concern: PFAS, PAHs and phenols.

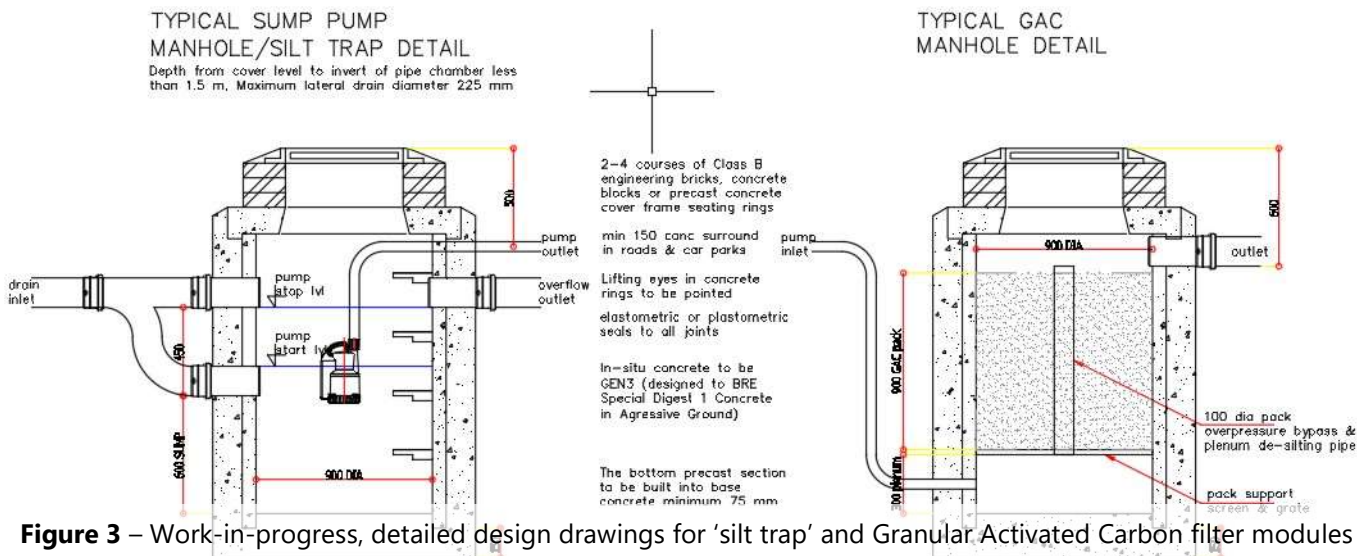


Figure 3 – Work-in-progress, detailed design drawings for 'silt trap' and Granular Activated Carbon filter modules
> Extract from appended drawing

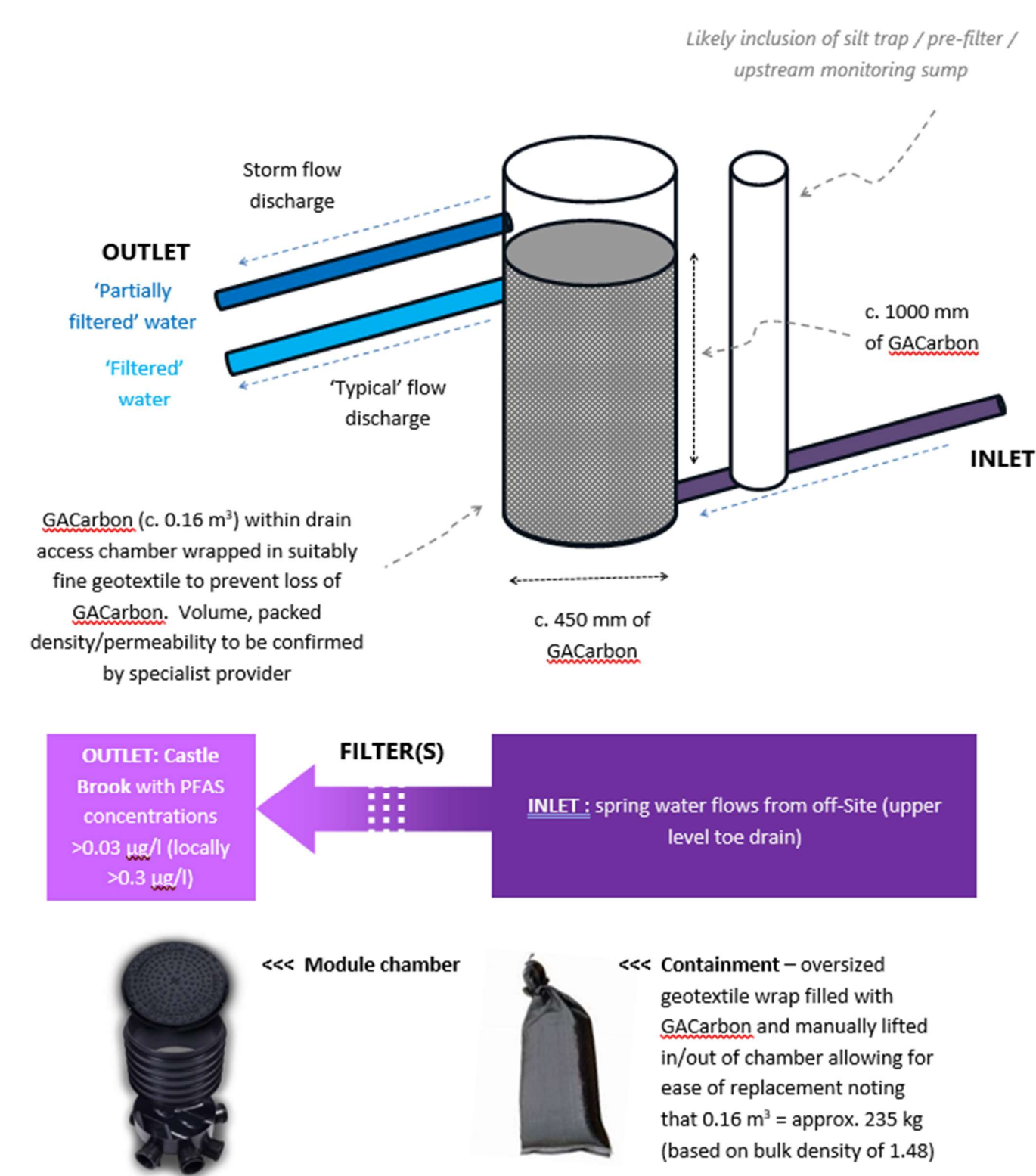


Figure 4 – Conceptual illustration of Granular Activated Carbon filter module
> Referencing PFAS as one chemical of concern noting others are present in the inlet water
> Examples of filter components illustrated bottom right

3 Remedial Action 3 – Treatment of hydrocarbon impacted soils and groundwater

The objective of this remedial action is to reduce the pollution potential of hydrocarbon impacted soils and groundwater present in localised 'hotspot' areas of the Site.

A secondary objective is to reduce the potential (and therefore the risk) for vapours to be generated beneath the proposed dwellings with some crossover with Remedial Action 4 detailed below.

This remedial action can be achieved through: in-situ solidification/stabilisation using a lime-cement mix.

This option has been selected based on the overall, low concentrations of hydrocarbons present within the soils and groundwater in these locations and the ability of solidification / stabilisation to effectively entrain both soil and water-based chemicals.

The action of mixing lime-cement with the soils will serve to have a three-fold affect of: i) initial exothermic effects resulting in a very short period of increased volatilisation of any volatile hydrocarbons within the soil and groundwater; ii) use of free water within the soil as part of the chemical reaction that in turn will result in; iii) podsolisation (chemical entrainment) of chemicals present with the soils and groundwater limiting their leachability.

Whilst not directly degrading the chemicals of concern (source removal) the action of stabilising the soils will limit the mobility of all chemical species resulting in either the near-permanent entrainment of the chemicals within the treated soil mass or else, 'slowing the flow' of potential pollutants, through limiting the leachability/mobility of the chemicals that, for hydrocarbon compounds will result in longer residency times in the ground and an increased likelihood of natural degradation.

The use of lime-cement is recommended given the variably graded nature of the Made Ground deposits that lend themselves to the use of a broader based or mixed soil additive.

- It is recommended that the areas where evidence of 'free-phase' hydrocarbons are encountered that:
- > A conservative estimate of the extent of hydrocarbon impacted soils is marked out;
 - > The soils are excavated vertically in a sequential manner, under the same controls in place for general earthworks, to a depth at which evidence of hydrocarbon staining is present;
 - > When evidence of stained soils/groundwater are encountered, the excavation is progressed to a natural soil formation using a riddling bucket with lime-cement dosing to achieve between 1 to 2 % vol/vol of the total soil mass).
- The lime : cement ratios should be between 90 : 10 to 80 : 20 dry-weight.

The use of continuous Photoionisation Detection during the works is recommended to support validation of the extent of the delineation (how far the hydrocarbon impacted soils and groundwater extends).

It is recommended that this work is supervised by a suitably qualified and experienced environmental engineer / engineering geologist.

4 Remedial Action 4 – Provision of ‘full radon protection measures’ to all new dwellings

The objective of this remedial action is to reduce the potential (and therefore the risk) for radon gas to enter the proposed dwellings.

As noted above under Remedial Action 4, secondary objective is to reduce the potential (and therefore the risk) for vapours to enter select dwellings.

This remedial action can be achieved through: the provision of ‘full radon protection measures’ to all dwellings with incorporation of a vapour barrier to select properties.

This option has been selected based a precautionary approach towards ground gases (all types) and vapours allowing for two forms of protection to the properties (sub-floor ventilation and gas/vapour resistant barriers).

This approach offers conservative, low-cost risk management of gases and vapours for which accurate assessment of risk is both costly and unreliable.

The action of providing “full radon protection” (in accordance with BRE 211 {2015}) to be provided to the new dwellings will offer inherent, effective protection against all ground gases.

The action of providing vapour barriers (hydrocarbon resistant) to the properties within 10 m of the delineated extent of hydrocarbon impacted soils will offer additional protection to these properties from any residual volatile hydrocarbons present within the ground.

This option has been selected based on the overall, low concentrations of hydrocarbons present within the soils and groundwater in these locations and the ability of solidification / stabilisation to effectively entrain both soil and water-based chemicals.

The ventilation should be:

- > 150 mm clear void installed front-to-back or side-to-side but NOT on all elevations. Installing on all elevations will create ‘dead-zones’ under the slab otherwise with the ventilation working off pressure differentials and not direct wind flows.
- > The installation of a minimum three (3) air bricks at no greater than 1500 mm centres along the front and back elevations of the properties is recommended.
- > The internal sleeper walls need to be ventilated too (missing blocks) to allow free flow of air across full length of the plot.

The membrane should be:

- > A minimum 1200 gauge is required with the recommended upgrade to 2000 gauge membrane to limit the potential of the barrier being damaged/punctured by follow-on trades; and,
- > Well-sealed, e.g. double-jointed and service penetrations sealed, such that it can act as an effectively ‘air tight’ barrier to the movement of any radon gas up into the habitable spaces.

The membrane within properties 10 m away from the confirmed extent of the hydrocarbon delineation zone should be:

- > A hydrocarbon and Volatile Organic Compound resistant membrane (as defined by CIRIA C748:2014)

- > Well-sealed, e.g. double-jointed and service penetrations sealed, such that it can act as an effectively ‘air tight’ barrier to the movement of any radon gas up into the habitable spaces.

The ventilation is the first and main line of defence, but the barrier needs to be well installed as modern houses have high levels of air tightness that can result in an increased likely of gases being ‘sucked’ into habitable spaces across the pressure gradient difference.

4.1 Response plan for ‘Unforeseen Contamination’

If and where any material is revealed on Site that differ physically or in colour from those detailed and illustrated herein or are suspected as being potentially harmful or polluting, then the advice of the Engineer or the author of this Report should be sought.

Examples of ‘unforeseen contamination’ could include visibly stained or odorous soils.

The Engineer should in turn notify Rochdale Borough Council’s Contaminated Land Team of the encounter and, given the groundwater regime and proximity of the Site to Castle Brook, the Environment Agency.

If and where the unforeseen contamination requires remedial action that differs from the actions detailed herein, then a revised Remediation Strategy should be submitted to Rochdale Borough Council’s Contaminated Land Team and the Environment Agency.

Agreement on any revisions to the Remediation Strategy should be agreed in advance of any work on or around the potentially contaminated material recommencing.

4.2 Other Actions

New water supply pipes are expected to be formed into Made Ground sub-soils that include chemicals that may pose a risk of fouling to the water supply pipes.

As a minimum, it is recommended that water supply pipes are constructed using ‘barrier pipe’ (PE/AL/PE) and that all trenches are confirmed to be free from any potentially polluting material, e.g. stained or odorous soils.

5.0 Validation Plan

On completion of the development works (and the recommended remedial works) a Validation Report should be prepared and submitted to the Local Planning Authority for approval.

The Validation Report should set out the lines of evidence that demonstrate, or validate, how the recommended remedial works have been completed satisfactorily and have achieved their stated aim.

1 Remedial Action 1 – Clean capping to soft landscaping areas

The following lines of evidence should be sought to demonstrate Made Ground deposits are covered by a suitable thickness of 'clean capping':

> For the clean capping thickness:

- Hand excavated trial pits on a plot-by-plot basis or one per every 50 m² of soft landscaping illustrating (through photographic evidence) how, the required thickness of clean capping has been provided over the Made Ground.

Guidance on the requirement for photographic evidence can be found in Local Planning Authority guidance⁴.

Hand pits should be taken down onto the 'no-dig' stone layer but no deeper to maintain the integrity of this layer and limit mixing with the underlying Made Ground deposits.

- Relative comparisons of reduced and final level surveys are not considered suitable however photographic evidence of the reduced level surface, prior to clean capping placement can be used to supplement the validation works.

> For the clean capping quality:

- As detailed within Section 4.0 - Remedial Action 1, the chemical suitability of soil forming materials should be confirmed in line with local planning authority guidance.

2 Remedial Action 2 – Upper-level toe drain

The following lines of evidence should be sought to demonstrate the upper-level toe-drain and associated infrastructure have been installed correctly and are functioning at an acceptable level:

> For the toe-drain construction:

- Photographic evidence of the drain being installed to the agreed specification as outlined within Section 4.0 - Remedial Action 2.

> For the Granular Activated Carbon filter:

- Photographic evidence of the filter being installed to the agreed specification as outlined within Section 4.0 - Remedial Action 2.
- At the point of installation: Upstream sampling of water quality within the drain for Perfluorootanoic Acid (PFOA) and PFOS (Perfluorooctane Sulfonate) the two key PFAS compounds within this setting.
- After 2 to 4 weeks: Upstream and downstream, sampling of water quality within the drain for; PFOA and PFOS.
- After 12 to 16 weeks: Upstream and downstream, sampling of water quality within the drain for; PFOA and PFOS.

The performance of the filter shall be assessed on a trial-and-error basis with the overall objective of achieving a 'betterment' in water quality at the downstream outfall. In practice, the filter is seeking to achieve a short to mid term reduction in all chemicals of concern by around 50 %, i.e. if and where PFOA is measured at 0.3 ug/l upstream of the filter, the objective is to achieve a reduction to 0.15 ug/l at the downstream outfall.

If and where less than 25 % reduction in concentrations occurs at either sampling event, then allowance for a secondary filter should be made.

This requirement should be determined in direct consultation with the Environment Agency.

For the upper-level toe drain, given the source of PFAS has been determined to lie off Site, ultimate responsibility for the management of these potential pollutants lies with third parties, yet to be identified. Notwithstanding this, in managing these waters, the Client will take on some responsibility towards their quality and potential risk these pollutants pose to Controlled Waters.

Confirming the extent of this responsibility is recommended and beyond the scope of this Report.

The installation of the filter to the upper-level toe drain is recommended on an in-principle basis to demonstrate duty of care towards this water that, at present, is freely draining across and into the Site soils and directly discharging into Castle Brook with the only controls on PFAS concentrations being dilution and natural retention/retardation.

3 Remedial Action 3 – Treatment of hydrocarbon impacted soils and groundwater

The following lines of evidence should be sought to demonstrate that the hydrocarbon impacted soils and groundwater have been treated as recommended:

> For the extent of the works:

Photographic diary of the works prepared by the suitably qualified supervisor of the works illustrating through visual inspection and PID 'sniff-tests' the extent of hydrocarbon impacted soils has been chased out entirely.

> For the solidification/stabilisation works:

Photographic diary of the works prepared by the suitably qualified supervisor of the works confirming mix ratios for the lime : cement.

4 Remedial Action 4 – Provision of 'full radon protection measures' and vapour barriers to select properties

The following lines of evidence should be sought to demonstrate this ground gas protection measures have been installed as recommended:

> For the gas protection design:

Detailed design drawings are appended.

> For the ground gas / vapour protection installation:

The installation of ground gas protection shall be completed by the Client, an experienced house-building contractor.

⁴ [Contaminated Land | Manchester City Council](#)

This approach is considered appropriate for this development type (low-rise residential developments with ventilated void) under current good practice guidance⁵.

For radon gas, the inspection and verification of protection measures is commonly not a regulated activity despite the higher background threat this gas presents compared to other gases.

It is therefore recommended that:

- *For properties where radon gas protection is installed:* that the provision of suitable radon protection measures is verified by an independent consultant or qualified and experienced installer for at least 3 plots.
- *For properties where vapour protection is required:* that the provision of suitable vapour protection measures is verified by an independent consultant or qualified and experienced installer for all affected plots (to be confirmed following completion of Remedial Action 3).

The appointed 'verifier' shall be the Author of this Report who is a *competent, experienced and suitably trained* individual with specific experience of detailed quantitative risk assessment (for ground gas) and inspection and sign-off of ground gas protection (various designs) for over 1000 properties.

Signed inspection report shall be prepared by the 'verifier', confirming that the agreed gas protection has been installed correctly in line with the design and current guidance^{5,6}.

Any non-conformances, e.g. inadequate sealing of service penetrations or multiple punctures, shall be immediately identified by the 'verifier' and, where not able to be rectified adequately on the inspection visit, an additional visit scheduled to demonstrate that appropriate steps have been taken to address the non-conformance.

① **Follow-on trades** should be made aware that any damage to the membrane is unacceptable and stands to compromise the gas protection.

5.1 Unforeseen material

If and where potentially harmful or polluting material is unexpectedly encountered in the ground, then a pre-agree response plan should be developed in consultation with the relevant regulatory authorities as discussed in Section 4.1.

As part of the Validation Report, confirmation of any pre-agreed response plan(s) having been completed satisfactorily should be included within the Validation Report.

5.2 Other Actions

Provision of suitable pipe material should be confirmed through either photographic evidence or order sheets.

⁵ NHBC publication 'NHBC Foundation – Hazardous ground gas – an essential guide for housebuilders' April 2013

Remediation Strategy

Sladen Mill, Littleborough

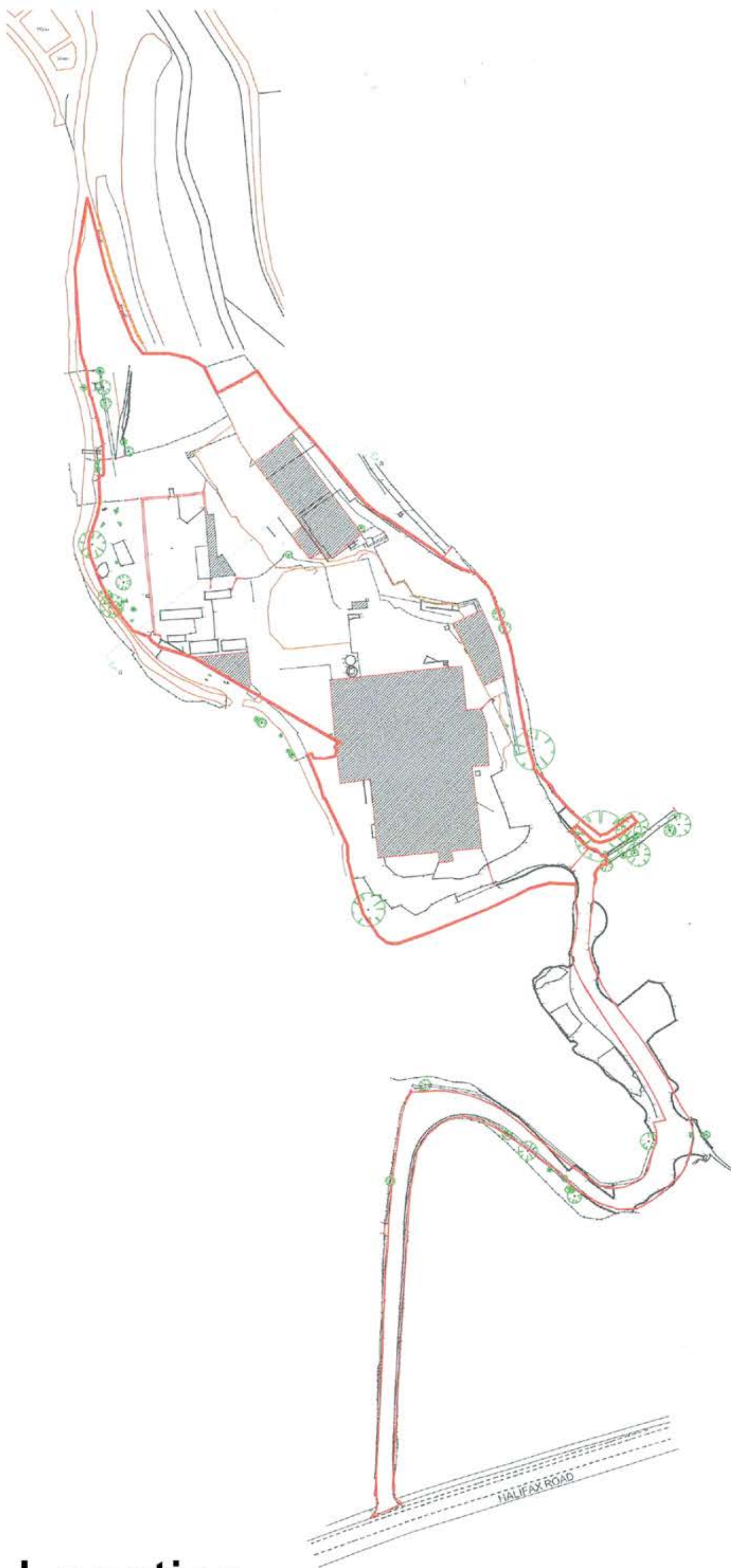
6.0 Recommendations

Recommended follow-on work:

1. [Review of this Remediation Strategy](#) and the advice herein.
2. [Submission of this Remediation Strategy](#) to the Local Planning Authority in support of the discharge of Condition 5 of the outline planning application.
3. [Partial planning condition discharge](#) of Parts iii) of Condition 5 of Decision Notice ref. 15/01235/OUT.
4. [Submission of the recommended Validation Report](#); and,

Subject to the satisfactory completion of the recommended remedial works and approval of the Validation Report by the relevant regulatory authorities;

5. [Full planning condition discharge](#) of Parts iii) of Condition 5 of Decision Notice ref. 15/01235/OUT.



Site Location

scale 1:1250



nicol thomas
t 01706290088 f 01706290099 e oldham@nicolthomas.com

Sladen Mill, Littleborough
Site Location Plan

Drawing No M4856 Date 25.06.21 Scale 1:1250@A3 Drawn KS

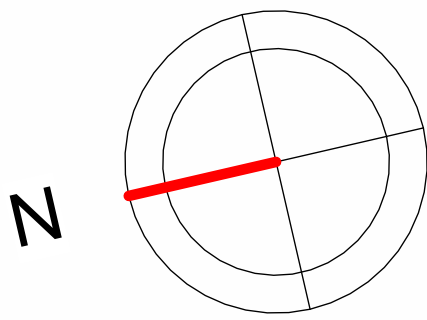
Schedule of Accommodation:

Plot	Accommodation	sqm	sqft
1	3 Bedroom House	96	1032
2	3 Bedroom House	96	1032
3	3 Bedroom House	96	1032
4	3 Bedroom House	96	1032
5	3 Bedroom House	96	1032
6	3 Bedroom House	96	1032
7	3 Bedroom House	96	1032
8	3 Bedroom House	96	1032
9	4 Bedroom House	138	1484
10	4 Bedroom House	138	1484
11	4 Bedroom House	218	2346
12	4 Bedroom House	162	1744
13	4 Bedroom House	130	1398
14	4 Bedroom House	130	1398
15	4 Bedroom House	130	1398
16	4 Bedroom House	160	1722
17	4 Bedroom House	180	1937
18	5 Bedroom House	182	1959
19	5 Bedroom House	182	1959
20	5 Bedroom House	182	1959
21	3 Bedroom House	103	1108
22	3 Bedroom House	103	1108
23	5 Bedroom House	260	2800
24	5 Bedroom House	260	2800
25	5 Bedroom House	278	3000

See landscaping plan for full detail for green space



Visual Scale - 1:300



materials palette

rainwater goods to be black gutters, downpipes and waste pipes fascias where applicable to be s/w painted black doors: composite high security front and rear entrance doors. Garage doors to be aluminium in finish to match main entrance doors

- Hedge with 1000mm metal wired fence separating rear gardens

Low level hedge to front garden

Grass

Green space

Tegula Paviours/sets Vehicle Use
- Tegula Paviours/sets (Pedestrian use Contrasting)

Tarmac Driveways/parking

Tarmac Road

Stone Wall - varies

Tegula Paviours/sets public footpath
- Timber fence

600mmx600mm Pavers

Pond
- 900mm to front gardens
-1000mm high to rear of retaining wall
-1800mm when creating a privacy garden wall

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Rev	Date	Description
N	02.12.22	pond changed to engineers drawing
O	06.12.22	Revised to EA comments
P	05.01.23	structural detail information included
Q	17.01.23	wall length increased
R	19.01.23	Wall decreased
S	24.01.23	Tim Booth revisions
T	13.02.23	Patio area updated

nicol thomas

architects project managers construction cost consultants CDM co-ordinators

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Heyside House, Blackshaw Lane, Heyside, Royton, Oldham OL2 6NS
t: 01707 290088 f: 01707 290099 e: oldham@nicolthomas.com
also at Edinham (registered office)

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Client	Mainly Mere		
Job	Sladen Mill, Littleborough		
Drawing title Site Layout			
Project number	M4856	(PL)02	Rev T
Scale	As indicated @ A1		
Date	01/30/23		
Drawn by	KS	Checked by	GRF

13.02.23

Material Suitability
Chemical Screening

SOIL AND STRUCTURES

Notes on Generic Assessment Criteria
1. Assumes sandy loam soil (default soil type)
2. Assumes 6% SOM
3. Assumes small terraced house
4. S4UL = Suitable 4 Use Levels (LQM/CIEH) - <i>minimal risk</i>
5. C4SL = Category 4 Screening Levels (DEFRA) - <i>acceptably low risk</i>
6. Bold GACs derived from SGV report input parameters in CLEA v1.071

Material Description
Lab Sample Number
Sample Reference
Sample Number
Depth (m)
Date Sampled
Time Taken

Topsoil (imported)	Topsoil (imported)	Topsoil (imported)	Topsoil (imported)	Topsoil (imported)

Generic Assessment Criteria

Exceeds by more than x2	Exceeds by less than x2
-------------------------	-------------------------

Analytical Parameter (Soil Analysis)	Units	Detection	Accred?
Stone Content	%	0.1	NONE
Moisture Content	%	N/A	NONE
Total mass of sample received	kg	0.001	NONE

Not applicable
Not applicable
Not applicable

Asbestos in Soil	Type	N/A	ISO 17025

Type
Detected or not?
Analyst

General Inorganics			
pH - Automated	pH Units	N/A	MCERTS
Water Soluble Sulphate as SO ₄ 16hr extraction (2:1)	mg/kg	2.5	MCERTS
Water Soluble SO ₄ 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS
Water Soluble SO ₄ 16hr extraction (2:1 Leachate Equivalent)	mg/l	1.25	MCERTS
Organic Matter	%	0.1	MCERTS

Review when <5 or >9
Not applicable
Not applicable
Not applicable
GSV variable

Speciated PAHs			
Naphthalene	mg/kg	0.05	MCEBTS
Acenaphthylene	mg/kg	0.05	MCEBTS
Acenaphthene	mg/kg	0.05	MCEBTS
Fluorene	mg/kg	0.05	MCEBTS
Anthracene	mg/kg	0.05	MCEBTS
Anthracene	mg/kg	0.05	MCEBTS
Fluoranthene	mg/kg	0.05	MCEBTS
Pyrene	mg/kg	0.05	MCEBTS
Benzo(a)anthracene	mg/kg	0.05	MCEBTS
Chrysene	mg/kg	0.05	MCEBTS
Benzo(b)fluoranthene	mg/kg	0.05	MCEBTS
Benzo(k)fluoranthene	mg/kg	0.05	MCEBTS
Benzo(a)pyrene	mg/kg	0.05	MCEBTS
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCEBTS
Dibenz(a,h)anthracene	mg/kg	0.05	MCEBTS
Benzo(g,h,i)perylene	mg/kg	0.05	MCEBTS
Coronene	mg/kg	0.05	NOH

SAUL	CASL
>	Surrogate Marker
>	Surrogate Marker
>	Surrogate Marker
>	Surrogate Marker
>	Surrogate Marker
>	Surrogate Marker
>	Surrogate Marker
>	Surrogate Marker
>	Surrogate Marker
>	5
>	Surrogate Marker
>	Surrogate Marker
	-

[illegible]

Total PAH			
Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS

Not available

--	--	--	--	--

Phenols			
Total - Monohydric	mg/kg	1	MCERTS

S4UL	C45L
420	4

--	--	--	--	--

Heavy Metals / Metalloids			
Arsenic (aquia regia extractable)	mg/kg	1	MCERTS
Boron (water soluble)	mg/kg	0.2	MCERTS
Cadmium (aquia regia extractable)	mg/kg	0.2	MCERTS
Chromium (hexavalent)	mg/kg	1.2	MCERTS
Chromium (aquia regia extractable)	mg/kg	1	MCERTS
Copper (aquia regia extractable)	mg/kg	1	MCERTS
Lead (aquia regia extractable)	mg/kg	1	MCERTS
Mercury (aquia regia extractable)	mg/kg	0.3	MCERTS
Nickel (aquia regia extractable)	mg/kg	1	MCERTS
Selenium (aquia regia extractable)	mg/kg	1	MCERTS
Zinc (aquia regia extractable)	mg/kg	1	MCERTS

S40L	C45L
>	37
290	<
>	22
21	<
910	<
2400	<
>	200
1	<
130	<
350	<
3700	<

[illegible]

Monoaromatics & Oxygenates			
Benzene	µg/kg	1	MCERTS
Toluene	µg/kg	1	MCERTS
Ethylbenzene	µg/kg	1	MCERTS
p & m-xylene	µg/kg	1	MCERTS
o-xylene	µg/kg	1	MCERTS
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	1	MCERTS

S4UL	C4SL
»	0.87
610	«
350	«
230	«
230	«

Petroleum Hydrocarbons			
TPH-CWG >Aliphatic >EC5 - EC6	mg/kg	0.001	MCERTS
TPH-CWG >Aliphatic >EC6 - EC8	mg/kg	0.001	MCERTS
TPH-CWG >Aliphatic >EC8 - EC10	mg/kg	0.001	MCERTS
TPH-CWG >Aliphatic >EC10 - EC12	mg/kg	1	MCERTS
TPH-CWG >Aliphatic >EC12 - EC16	mg/kg	2	MCERTS
TPH-CWG >Aliphatic >EC16 - EC21	mg/kg	8	MCERTS
TPH-CWG >Aliphatic >EC21 - EC35	mg/kg	8	MCERTS
TPH-CWG >Aliphatic (EC5 - EC35)	mg/kg	10	MCERTS

160	←
530	←
150	←
760	←
4300	←
11000	←
	←

[illegible]

TPH-CWG - Aromatic >EC5 - EC7	mg/kg	0.001	MCERTS
TPH-CWG - Aromatic >EC7 - EC8	mg/kg	0.001	MCERTS
TPH-CWG - Aromatic >EC8 - EC10	mg/kg	0.001	MCERTS
TPH-CWG - Aromatic >EC10 - EC12	mg/kg	1	MCERTS
TPH-CWG - Aromatic >EC12 - EC16	mg/kg	2	MCERTS
TPH-CWG - Aromatic >EC16 - EC21	mg/kg	10	MCERTS
TPH-CWG - Aromatic >EC21 - EC35	mg/kg	10	MCERTS
TPH-CWG - Aromatic (EC5 - EC35)	mg/kg	10	MCERTS

300	←
660	←
190	←
380	←
660	←
930	←
1700	←
