Edlington
Consulting Group Limited

COOPER & WESTGATE CO. LTD

GROUND INVESTIGATION REPORT

Land at 87 The Village
Stockton-on-the-Forest
York
YO32 9UP

REPORT No. E240112

February 2024

DOCUMENT RECORD

Report Title	Ground Investigation Report
Project Address	Land at 87 The Village, Stockton-on-the-Forest, York, YO32 9UP
Project Number	E240112
Client	Cooper & Westgate Co. Ltd

	Signature	**Name and Qualifications**
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For and on behalf of Edlington Consulting Group Limited

Issue No	Date	Status
1	February 2024	Final Report

EXECUTIVE SUMMARY

Project Reference	E240112
Site Location	Land at 87 The Village, Stockton-on-the-Forest, York, YO32 9UP
OS Grid Reference	465594, 456101
Development Proposals	Re-development of the site through the erection of 3no. dwellings and 1no. domestic garage following demolition of workshop and stores. The redevelopment includes external vehicle hardstanding and limited localised areas of soft landscaping / gardens.
Current Site Usage	A residential property with workshop and existing soft-landscaped garden area to the rear, served by a central apron of vehicle hardstanding.
Topography	The topography of the redevelopment area is essentially level.
Vegetation	None within the proposed redevelopment areas.
Published Geology	The site is mapped to be underlain by superficial drift cover soils comprising Alne Glaciolacustrine Deposits underlain at depth by bedrock Sherwood Sandstone Group.
Ground Conditions Encountered	A superficial layer of Hardstanding and Reworked Ground (Topsoil) overlying, a veneer of Made Ground, further overlying typically fine-gained Alne Glaciolacustrine Deposits proved to 5.45m bgl. The underlying recorded Sherwood Sandstone Group bedrock was not encountered.
Groundwater Encountered	Groundwater was encountered as seepages / water strikes within the Alne Glaciolacustrine Deposits noted within the boreholes during drilling at depths of typically between 1.10m and 1.90m bgl, rising to depths of between 0.70m and 1.10m bgl after 20 minutes. Follow-on groundwater monitoring on two occasions at BH01 and BH04 indicate a standing water level of between 0.61m and 0.88m bgl.
Risks to Construction Workers	Generally low – see report for details.
Ground Contamination	None encountered. Watching Brief / Discovery Strategy approach should be adopted.
Chemical Attack on Buried Concrete	Design Sulphate Class DS-1 ACEC Class AC-1
Geotechnical Hazards	Low strength and potential compressibility of the Alne Glaciolacustrine Deposits (an under-consolidated stratum). Residual potential for volume change within the stratum due to desiccation however the notable silt/sand fraction is likely to result in a low to medium plasticity soil of typically low volume change potential. Further geotechnical classification testing may be necessary should the proposed building locations change and come within the zone of influence of established trees/vegetation.
Foundations	Traditional shallow pad foundations are considered technically feasible, taken down to a suitable depth into the fine-grained Alne Glaciolacustrine Deposits. Due regard should be given to the relatively lower strength and potential compressibility within the initial portion of the Alne Glaciolacustrine Deposits, together with the presence of a thin water-bearing band of coarse-grained soils at depths of typically between 1.90m and 2.35m bgl. Preliminary assessment indicates pad foundations constructed within the Alne Glaciolacustrine Deposits stratum could be designed to support an allowable bearing pressure of 60kPa whilst generally limiting settlements to 25mm taking into account a reduction in bearing capacity due to the effects of potential groundwater from approximately 1.90m bgl.

This executive summary should be read in conjunction with the main report.

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GROUND INVESTIGATION REPORT

Introduction

A combined geotechnical and geoenvironmental ground investigation has been undertaken for a proposed redevelopment of three residential dwellings on land at 87 The Village, Stockton-on-the-Forest, York, YO32 9UP. A Site Location Plan is provided in Appendix A. The Ordnance Survey National Grid reference for the approximate centre of the site is 465594, 456101.

Instructions to undertake the investigation were received from the Client, Cooper & Westgate Co. Ltd, by way of their email instruction dated 7th February 2024.

This report describes the desk study and intrusive site investigation activities carried out by Edlington Consulting Group Limited in order to provide an evaluation of the ground conditions and the extent of soil contamination on the site. On the basis of those findings, and subsequent laboratory testing and with regard to the proposed development, the report presents: initial human health and groundwater risk assessments (using the source-pathway-receptor risk assessment methodology); and geotechnical assessment and recommendations.

This report has been prepared for the sole use of the client and their professional advisors. This report shall not be relied upon by third parties without the express written authority of Edlington Consulting Group Limited. If an unauthorised third party comes into possession of this report, they must not rely on it and the authors owe them no duty of care and skill.

Scope of the Investigation

The scope of the investigation as defined and agreed with the Client, Cooper & Westgate Co. Ltd, was to undertake a combined geotechnical / geoenvironmental walkover survey, provide an assessment of the geotechnical engineering properties of the ground and the extent of soil contamination on the site.

Proposals

We understand that the proposed redevelopment comprises erection of 3no. dwellings and 1no. domestic garage following demolition of workshop and stores. The redevelopment includes external vehicle hardstanding and limited localised areas of soft landscaping / gardens.

A proposed redevelopment layout plan is presented in Appendix A for reference.

Detailed design drawings were not available at the time of writing, however anticipated structural loads for the proposed residential structures are anticipated to be in the order of around 85kPa.

Site Information and Walkover Survey

A walkover survey of the site and its immediate surrounds was undertaken on the 12th February 2024, in association with the fieldwork.

The site is situated within the village of Stockton-on-the-Forest, some 6km to the northeast of York. The site comprises a long rectangular parcel of land measuring approximately 18m by 50m and comprises a residential property with structures and hard landscaping in the central and southern portions, with the northern portion laid to soft landscaping.

Several structures were present across the site, which included a large single storey structure which was utilised as a work area for the assembly of air compressors as well as an area of this unit being utilised as a "spray booth" to coat the compressors. Part of the unit is utilised for storage.

A small shed is present to the north which the current land owner uses for the storage of motorbikes as well as work tools and associated products (i.e. paints, lubricants, spare parts). This shed had a small lean to similar to a small conservatory which overlooked a small area of grass.

Within the larger structure, an Above ground Storage Tank (AST) was present although this did not appear to be in use. Anecdotal evidence suggests that this was used to store heating oil for the unit.

Inside the buildings, the current floor slab comprised intact concrete in good condition with no visible or significant staining noted across the site. Where the AST was located, it was raised up off the ground on stilts with no visual and/or olfactory evidence noted.

The land use to the east and west comprises neighbouring residential properties whilst the land use to the north and south comprises a golf course and a main road respectively.

No topographical survey data was available at the time of writing.

No significant established vegetation was noted across the main area of the site during the site walkover however semi-mature trees and hedgerows are situated along to existing northern boundaries of the site adjacent to the existing garden / soft landscaped area.

No visual or obvious evidence of ground contamination was noted during the site walkover.

Summary of Previous Work

A previous phase of site investigation is understood to have been undertaken for the site, pertaining to planning for the current residential redevelopment. The following report is known to exist;

- *Phase 1 Desk Top Study Report,* prepared by Geo Environmental Engineering Ltd (report ref. 2018-3377, dated November 2019)

A copy of the above report was made available to ECG for review prior to undertaking the current ground investigation. The full report should be referred to, however the salient points are summarised below;

Context

The Phase 1 report comprised a desk study which used information obtained via a walkover survey and review of environmental database searches to develop a Conceptual Site Model and Preliminary Risk Assessment for the site in accordance with BS10175:2011+a2:2017, CLR11 “Model Procedures for the Management of Land Contamination and LCRM “Land Contamination Risk Management.

Phase 1 Desk Study Findings

A review of historical mapping indicated that the site comprised undeveloped land (possible orchard) from the earliest available mapping (c.1854) until at least c.1995. By c.2001, the historical plans indicate that a rectangular structure is present in the south of the site and is considered to relate to the present-day workshop structure (to be demolished).

The desk study identified that the local geology comprised superficial drift deposits of the Alne Glaciolacustrine Formation (laminated clays with bands of silt and fine sand) overlying the bedrock Sherwood Sandstone Group. Although not mapped beneath the site itself, the superficial geology is recorded to give way to the Sutton Sand Formation immediately to the southeast of the site.

The Alne Glaciolacustrine Deposits were classified as an Unproductive Stratum however the nearby Sutton Sand Formation (mapped on adjacent land to the southeast) is classified as a Secondary ‘A’ Aquifer.

The Sherwood Sandstone Group bedrock comprised a Principal Aquifer, however the site was not located within a Source Protection Zone (SPZ). The desk study concluded that there was unlikely to be a significant potential risk of mining beneath the site.

Records identified no historical or active landfill sites within 250m of the site, however historical mapping identified the presence of two infilled ponds; one located c.176m to the southeast and another c.184m to the south of the site. Given the scale of these features and distance from the site, neither was considered likely to pose a significant risk to the site.

Reference was made to the presence of a small pond feature located adjacent to the western boundary of the site which is inferred to have undergone infilling between c.1995 and c.2001.

Further potential sources of ground contamination were identified as general historical development and use of the site, potential Made Ground beneath the exterior yard area, machinery/equipment storage, the internal spray booth compartment and the inferred internal above-ground bunded heating oil tank.

The Phase 1 desk study recommended that a proportionate Phase 2 intrusive site investigation be undertaken utilising boreholes due to the access limitations across the site. The purpose of this further work was to target both areas of soft landscaping (where end users may come into contact with soils) and also to allow an assessment of ground gases / vapours and to further inform the geotechnical assessment.

Ground gas monitoring was recommended to assess the potential for hydrocarbon vapours at the site due to the legacy land use and heating fuel-oil storage at the site. The potential for methane and carbon dioxide (generated by the historical pond infill) to form a pathway to residential end users was considered very low.

Geology

Published Geology

Reference to the British Geological Survey (BGS) 1:50,000 scale map and other published geological information on the area indicates that the site is underlain by superficial drift cover soils comprising the Alne Glaciolacustrine Formation overlying the bedrock Sherwood Sandstone Group. Although not mapped beneath the site itself, the superficial geology is recorded to give way to the Sutton Sand Formation immediately to the southeast of the site.

The Alne Glaciolacustrine Formation is described in the local memoir as: '*grey-brown laminated clays, silts and sands'* and is considered to be between 4m and 7m in thickness beneath the site.

The bedrock Sherwood Sandston Group strata is described as: "*Red/yellow/brown, part pebbly sandstone with bands of mudstone and siltstone"* and is likely to be in excess of 20m in thickness beneath the site.

Hydrology

The nearest surface watercourse, an unnamed ditch connecting with North Drain is located 44m to the northeast of the site which represents the nearest surface water body feature to the site. A small pond feature is mapped some 104m to the northwest of the site.

Hydrogeology

EA records indicate the site is located on an Unproductive Stratum (the superficial Alne Glaciolacustrine Deposits) however the nearby Sutton Sand Formation (mapped on adjacent land to the southeast) is classified as a Secondary 'A' Aquifer. Then underlaying mapped Sherwood Sandstone Group bedrock is classified as a Principal Aquifer. The site is not recorded within a Source Protection Zone (SPZ).

The aquifer designation is based on geological mapping provided by the BGS, divided into two types:

- **Superficial** - the youngest geological deposits formed during the Quaternary period, resting on Bedrock geology.
- **Bedrock** – the main mass of rocks forming the Earth and present everywhere, either exposed at surface or concealed by Superficial Deposits or water.

For each type there are classifications of Principal, Secondary A and Secondary B Aquifers and Unproductive Strata, each with a decreasing rank of importance.

Updated Conceptual Site Model

A review of the Tier 1 Preliminary Risk Assessment presented in the previously completed Phase 1 desk study has been carried out in accordance with the current LRCM risk assessment evaluation criteria using the source-pathway-receptor principle to create a conceptual model for the site. This method is predicated on the principle that a pathway must exist between a potential source of contamination and a potential receptor for there to be a risk to that receptor. Potential sources of contamination and potential receptors relevant to the site have been assessed using the LRCM (2020) guidelines and are detailed below, together with the possible pathways that might allow contaminant linkages.

We understand the redevelopment proposal comprises demolition of the existing workshop structure and redevelopment with three residential dwellings with limited localised areas of soft / garden landscaping.

Potential Sources Contamination

Potential Solid-, Liquid- and Vapour-phase Contamination Sources

The results of the desk study and walkover survey has identified the following potential sources of soil or groundwater contamination may be present at, or in close proximity to, the site:

Potential Source	Potential Contaminants
Legacy use of the site as a workshop with spray booth, above-ground fuel oil tank and storage of consumables and machinery.	Variable: may include heavy metals, petroleum hydrocarbon, non-metals, metalloids and poly-cyclic aromatic hydrocarbon contamination, organic matter and asbestos with possible ground gases (carbon dioxide, methane and VOCs).
Potential Made Ground and contamination associated with past development, nearby pond infilling and possible spills / leaks.	

Potential Gaseous-phase Contamination Sources

The main groups of gaseous-phase contamination considered to be relevant at the site are gases (including methane and carbon-dioxide) that result from organic decomposition of constituents in the ground. As such, there is considered to be a potential risk of ground gases at the site.

In consideration of the source-pathway-receptor methodology for ground gas risk assessment set out in CIRIA C665, the sensitivity of the development is considered to be high (residential end use).

We have provisionally assessed the risk of ground gas impacting the site, by reference to the CL:AIRE research bulletin RB17, “A pragmatic approach to ground gas risk assessment”, 2012.

The following potential sources have been assessed:

There is no recorded landfill site within m of the site.

Historical mapping identified the presence of two infilled ponds; one located c.176m to the southeast and another c.184m to the south of the site. Given the scale of these features and distance from the site, neither was considered likely to pose a significant risk to the site.

A further small pond feature was located adjacent to the western boundary of the site which is inferred to have undergone infilling between c.1995 and c.2001. Although the small localised scale of this feature is not considered pose a significant risk of ground gases, precautionary hydrocarbon vapour monitoring is considered to be required. As this assessment will require structured gas sampling from standpipes, it is considered prudent and best practice to also undertake precautionary ground gas monitoring for carbon dioxide and methane to further assess this risk given the close proximity of the pond features to the proposed redevelopment.

Made Ground is unlikely to be in excess of 5m deep or in excess of an average of 3m in thickness.

Radon protection measures are not required.

As such, the site is not considered to be at significant risk from migrating methane or carbon dioxide ground gasses however as a precautionary measure and to further inform this assessment, a screening programme of ground gas monitoring is considered appropriate to assess and address the above referenced risk.

Receptors

The following most sensitive receptors have been identified at the site:

Human Health

Long-term risk group: end users of the site – future residents and visitors (children and adult)

Short-term risk group: construction workers (adult)

Environmental

Controlled Waters - the bedrock Sherwood Sandstone Group – classified as a Principal Aquifer.

Controlled Waters – the nearby superficial Sutton Sand Formation (mapped on adjacent land to the southeast) - classified as a Secondary 'A' Aquifer.

Controlled Waters - an unnamed watercourse (ditch) connecting with North Drain is located 44m to the northeast of the site.

Built Environment:

The proposed building foundations

Buried services, including water supply pipes

Pathways

It is considered that a number of potential pathways exist between these potential sources and the above-identified receptors.

For the human receptors these include:

Ingestion of soil attached to home-grown fruit and vegetables

Ingestion of fruit and vegetables with contamination uptake

Direct soil ingestion in areas of exposed soil

Inhalation of indoor and outdoor vapours and dust

Dermal contact with contaminated soil

For Controlled Waters, the pathways include:

Migration of contaminants through the unsaturated zone

Migration of contaminants through the groundwater

Movement of contaminants through drains or services runs

For the proposed substructures and buried services, the pathways include:

Leachable or corrosive contaminants within the soil

Leachable or corrosive contaminants within the groundwater

Potential Linkages

The relationship between a source, a pathway and a receptor is identified as the 'pollutant linkage' and if this is not complete then land does not present a risk to receptors. The potential linkages are summarised below, based on a proposed residential end use:

Potential Contaminants	Pathways	Receptors	Risk rating	Comment
Heavy metals, metalloids, non-metals, various hydrocarbons and asbestos in near-surface soils – from legacy use of the site, Made Ground associated with past development, storage and maintenance of machinery and potential ground gas (hydrocarbon) emissions from potential spillages of oils and heating fuel.	Contact, ingestion, inhalation	Construction & maintenance workers	Medium (Short-term)	Contaminants in soil may be disturbed during groundworks. Risks could be reduced with use of appropriate PPE.
		Site end users	Low (Long-term)	The linkage will only be complete through areas of soft landscaping. In the case of ground gases, should a linkage be established, the proposed redevelopment may require installation of gas protection measures or the source material (i.e. the historical pond infill) may require removal.
	Contact	Infrastructure	Low to Medium (Long-term)	Risk could be reduced by corrective selection of materials
	Migration	Controlled Waters	Low to Medium (Long-term)	Where the site has a cover of hardstanding, this may serve to inhibit migration
Various volatile hydrocarbons and poly-cyclic aromatic hydrocarbon contamination - from potential Made Ground /	Contact, ingestion, inhalation	Construction & maintenance workers	Medium (Short-term)	Contaminants in soil may be disturbed during groundworks. Risks could be reduced with use of appropriate personal protective equipment
		Site end users	Low (Long-term)	The linkage will only be complete through areas of soft landscaping

Potential Contaminants	Pathways	Receptors	Risk rating	Comment
operation and storage / maintenance of equipment.	Contact	Infrastructure	Low to Medium (Long-term)	Risk could be reduced by corrective selection of materials

Based on the desk study research alone, the sources, pathways and receptors listed in the CSM are considered to have the potential to be present as complete pollutant linkages. This model should be tested by means of an intrusive phase of fieldworks, inspection and chemical laboratory analyses of soils and (if necessary) groundwater and gas monitoring.

Geotechnical Conceptual Site Model

Due to the history of the site, a superficial veneer of Made Ground is anticipated beneath the site.

The desk study review of published records and mapping has indicated that the site is likely to be underlain by superficial glacial soils of the Alne Glaciolacustrine Formation with the mapped Sherwood Sandstone Group bedrock likely to be in excess of 5m depth.

The superficial mapped Alne Glaciolacustine Formation soils are likely to comprise normally or potentially under-consolidated laminated clays with bands of silt and fine sand which may be of low strength and prone to compression under applied loads. The stratum is also likely to be weak in tension and prone to side-wall collapse when exposed in open unsupported excavations, particularly in the presence of groundwater. Perched groundwater may be present at shallow depth beneath the site.

The ultimate competence of the stratum to support traditional spread foundations may exhibit a degree of lateral variability and the controlling factors are likely to be the soil grading (particularly silt content) and the presence of any groundwater strikes. In addition, glacial derived soils often contain a significant component of clay and, as such, may exhibit a notable volume change potential.

Given the localised presence of trees and established vegetation, together with a potential for possible historically removed trees within the development footprint, there is the potential for desiccation within the Alne Glaciolacustine Formation soils. As such, there is a potential for the requirement to deepen foundations and suspend floor slabs to accommodate the effects of tree influence and seasonal ground movement. As such, detailed logging of the soils in conjunction with laboratory plasticity and moisture content profiling may be required to assess the stratum for foundation design.

The above issues may significantly affect foundation design and geotechnical profiling of the stratum will require representative investigation and laboratory testing to derive a reliable design. Depending upon the nature of the ground, aggressive chemical conditions may be present which could pose a long-term integrity risk to embedded concrete.

Groundwater, if present at a shallow depth, may pose a risk of excavation instability and running sand, especially within soils of high silt.

The intrusive investigation has been implemented to address these main issues and establish any potential problems for foundations and the general development of the site.

Exploration and Testing

Four intrusive exploratory holes were formed at the site on the 12th February 2024. These comprised four Continuous Tube Sampler boreholes using a Competitor Dart rig and one trial pit using hand tools.

Exploratory Hole Type	Reference
Continuous Tube Sampler Boreholes	BH01 to BH04
Hand-dug Trial Pit	HP01

The positions of all exploratory holes undertaken at the site as part of this investigation can be seen on the Exploratory Hole Location Plans in Appendix A. The logs are provided in Appendix B and the results of the geotechnical laboratory testing are provided in Appendix C.

Engineering conclusions given in this report are based on data obtained from these sources, but it should be noted that variations, which affect these conclusions, may inevitably occur between and beyond the test locations. Also, water levels may vary seasonally and with other factors.

Methodology

Sampling Strategy

The investigation was undertaken in accordance with the scope of works agreed with our client. The positions of the exploratory holes were selected by Edlington Consulting Group Limited to provide a wide coverage of information on the site area.

The exploratory locations were targeted on the following basis;

Test Location	Rationale
BH01 to BH04 and HP01	To determine the ground conditions within the proposed redevelopment footprint, targeting proposed garden / soft landscaping areas and potential sources of contamination where possible.

Health and Safety

Prior to commencement of boring/testing, and in order to minimise the dangers from/to buried services, the proposed locations were scanned using a Cable Avoidance Tool. At the borehole locations, a service avoidance pit was dug, using hand tools, to a depth of around 1.2m below ground level (bgl).

Exploratory Holes

Continuous tube sample boreholes BH01 to BH04 were put down using an Archway Competitor Dart rig to a depth of 5.45m bgl. Boreholes were advanced using a plastic lined steel tube system, driven into the ground by a top drive percussive hammer. A near continuous 87mm to 57mm diameter core sample was recovered for examination and laboratory testing. Standard Penetration Tests (SPTs) were taken at 1.0m intervals.

Hand dug trial pit, HP01, was excavated by hand to a maximum depth of 0.74m below ground level to examine the near-surface soils. On completion, the trial pit was carefully backfilled with arisings in thin layers, ensuring that excavated material was replaced in the same order as it had been removed.

Small-disturbed samples were taken at regular intervals down to the base of the holes for subsequent laboratory testing and inspection. On completion, all boreholes and trial pits were carefully backfilled with arisings in thin layers, ensuring that excavated material was replaced in the same order as it had been removed.

In-situ Testing

Correction to the field 'N' values (to 'N_{60}' values) for the effects of energy delivery have been applied to the SPT (Standard Penetration Test) results from this investigation, in line with the recommendations given in BS EN ISO 22476-3, 2005, National Annex A.

Installations

On completion of the boring, boreholes BH01 and BH04 were installed with a 33mm diameter slotted uPVC standpipe from 3.0m depth to 0.5m bgl. From 0.5m depth up to ground level a plain pipe was added. The slotted section of the standpipe was surrounded with pea gravel, while expansive bentonite clay was added around the plain pipe and below the slotted section to seal the borehole. The standpipe was finished with a rubber bung and gas tap and protected with a stopcock cover, which was then concreted flush with ground level.

Gas / groundwater monitoring was undertaken on two occasions, as a precaution, to the methodology set out in CIRIA C665.

Ground Conditions

The intrusive investigation revealed that the general succession of strata was represented by an initial superficial layer of either Made Ground (Topsoil) or Hardstanding / Sub-base overlying a veneer of Made Ground, further underlain by Alne Glaciolacustrine Deposits, proved to the full depth of the boreholes.

Topsoil (Made Ground)

Encountered at BH01, BH02 and HP01 from ground level down to depths of between 0.22m and 0.35m bgl. Represented by grass overlying dark brown silty clay with abundant roots and pockets of organic matter.

Hardstanding / Sub-base

Encountered at BH03 and BH03 at ground level and represented by either broken crushed concrete or intact concrete to depths of 0.10m and 0.40m bgl.

Made Ground

Encountered at all exploratory locations from below the overlying Hardstanding / Topsoil (Made Ground) down to depths of typically between 0.80m and 1.10m bgl (locally 0.40m bgl). Represented in general by dark greyish brown silty sandy slightly gravelly clay with organic matter and cobbles of decayed wood and brick and fragments of rare ceramic and occasional glass.

Alne Glaciolacustrine Deposits

Encountered at all exploratory locations from beneath the Made Ground and proved down to 5.45m bgl. Represented by initially soft to firm grey/brown silty sandy clay to typically between 1.40m and 1.60m bgl, thereafter becoming firm to stiff silty sandy clay with depth. A layer of water bearing silty clayey sand / gravel was encountered within the stratum at depths of between 1.90m and 2.35m bgl in BH01, BH02 and BH04.

The results of the field strength tests, and other relevant data, are summarised below:

Parameter	Range	Comments
SPT Field 'N' Value	Typically, 7 to 10 (1.0m to 1.50m bgl) Typically, 12 to 23 (3.00m to 5.50m bgl)	Low to medium strength soils Medium strength soils

Laboratory testing revealed the following results:

Parameter	Range	Comments
Water Content (%)	13 - 16	-
Liquid Limit (%)	26 - 28	Fine-grained portion (dominant matrix) CLAY of Low plasticity (BS5930 Casagrande)
Plastic Limit (%)	14 - 16	
Plasticity Index (%)	12	
Modified Plasticity Index (%)	9 - 11	Typically, non-shrinkable to low Volume Change Soil - (NHBC)
Passing on 63µm sieve (%)	43 - 50	BS1377 'fine soil' fraction

Potential Desiccation

Roots were observed in the Topsoil and Made Ground at BH01 and BH02 to depths of between 0.50m and 0.65m bgl. Soil samples of the variably coarse and fine-grained Alne Glaciolacustrine Deposits tested under laboratory conditions classified the stratum as a soil of locally up to low volume change potential. However, analysis of soil water contents indicates that the soils are not currently desiccated and this is likely to be due in part to rehydration of the soil from a high groundwater table.

Observed Soil Contamination

None observed.

Groundwater

Groundwater was encountered as follows;

Exploratory Location	Strike Depth (m bgl)	Depth on Completion (m bgl)
BH01	Seepage at 1.10m	0.85m
BH02	1.90m	1.10m
BH03	3.00m	1.00m
BH04	1.90m	0.70m
HP01	None encountered	None encountered

Groundwater Monitoring

Groundwater monitoring has been carried out on two occasions to date in the instrumented boreholes as a part of this investigation. The monitoring results are as follows;

Exploratory Location	Depth (m bgl) – 16th Feb	Depth (m bgl) – 21st Feb
BH01	0.63	0.61
BH04	0.88	0.82

Sulphate and pH Tests

Water-soluble sulphate and pH tests were carried out on four soil samples recovered from the exploratory holes across the site. The values recorded are summarised in the table below:

Stratum	Water-soluble Sulphate SO4 (mg/l)	pH (pH units)	Number tested
Made Ground	10 to 91	8.6 to 8.8	2
Alne Glaciolacustrine Deposits	40 to 60	7.7 to 8.0	2

Ground Gas

Ground gas monitoring has been carried out on two occasions to date, as a precaution, in the instrumented boreholes as a part of this investigation using a calibrated Geotech GA 5000 gas analyser. The monitoring rounds were undertaken on the 16th February 2024 and the 21st February 2024 during periods of both falling and rising atmospheric pressure conditions.

The results of the monitoring are summarised in the table below:

Parameter	Range	Comments
Oxygen (%v/v)	19.1 – 19.6	-
Carbon Dioxide (%v/v)	0.2 – 0.3	-
Methane (%v/v)	<0.1	-
Flow rate (l/h)	<0.1	-

VOC monitoring was undertaken during the monitoring event within the standpipes installed in BH01 and BH04 using a MiniRae 3000 PID/VOC Monitor. Mobile concentrations of VOCs within the standpipes were found to be below the limit of detection (< 0 ppm).

Ground Contamination Assessment

Soil Testing

Five samples of the shallow soils at the site were tested for a range of contaminants.

The test suite was decided upon following consultation of the Environment Agency's publication Land Contamination Risk Management (LCRM) and was performed on a representative range of targeted soil samples by specialist analytical soil laboratory i2 Analytical Ltd which holds both UKAS and MCERTS accreditation.

The test suite included a range of:

- Inorganic substances, including metals and metalloids
- Speciated Poly-cyclic Aromatic Hydrocarbons (PAH)
- Total Petroleum Hydrocarbons (TPH), with eight-band splits
- Asbestos screening

Unless explicitly stated on the laboratory report, the soil samples were tested to obtain 'Total' values within the soil.

The results of the tests from this investigation are included in Appendix C.

Selected soil samples were screened on site using a hand-held photo-ionisation detector (PID) to measure any volatile organic hydrocarbons in the sample headspace.

The results from the PID monitor indicated negligible levels of volatile compounds are present with values of less than the limit of detection (<0 ppm) recorded in the soil samples down to the full depth of the exploratory holes.

Risk Assessment Guidelines – Human Health

The human health risk assessment has been approached using the guidance and evaluation criteria provided in the Environment Agency's publication Land Contamination Risk Management (LCRM), published in October 2020 to undertake an indicative Tier 2 Generic Quantitative Risk Assessment (GQRA) for the site in order to manage the likely risks posed to groundworkers and end-users.

Human health assessment criteria used are based upon the proposed final land use of the site. As the site is to be redeveloped to accommodate a new temporary teaching facility within a school setting, the Generic Assessment Criteria (GAC) for the standard land-use, *'residential with home-grown produce'* has been used for initial conservative screening for the risks to the identified end-users.

The results of the soil samples tested have been compared to the following published GACs:

Category 4 Screening Levels (C4SLs)

Published in March 2014 by DEFRA, a limited number of Category 4 Screening Levels (C4SLs) were produced to support the revised Statutory Guidance to support Part 2A of the Environmental Protection Act 1990, which was published in April 2012. This Guidance introduced a new four-category system for classifying land under Part 2A for cases of a Significant Possibility of Significant Harm to human health, where Category 1 includes land where the level of risk is clearly unacceptable, and Category 4 includes land where the level of risk posed is acceptably low.

Although not the primary purposes, the DEFRA letter dated 3rd September 2014 from Lord de Mauley established that the C4SLs also suitable for use in planning situations, as did the Department for Communities and Local Government (DCLG)'s 'Planning Portal' document from June 2014.

Suitable 4 Use Levels (S4ULs)

To supplement the limited number of C4SLs, a set of Suitable for Use Levels (S4ULs) were produced by Land Quality Management (LQM) and the Chartered Institute of Environmental Health (CIEH) in 2015 using the Environment Agency's Contaminated Land Exposure Assessment (CLEA) software, version 1.06 released in 2009, and the revised assumptions used in deriving the C4SLs.

The S4ULs are more conservative than the C4SLs and are derived to represent the minimal levels of risk to human health as described in the Environment Agency's SR2 guidance, with the intention of being 'suitable for use' under planning.

Risk Assessment Guidelines – Groundwater

The procedures set out in Environment Agency's Remedial Targets Methodology (RTM) Hydrogeological risk assessment for contaminated land (2006), have been followed.

Results of Total Soil Tests

Asbestos

Screening for the presence of asbestos did not reveal any asbestos containing material (ACM) or fibres in the two representative soil samples of the superficial soils examined.

All other determinands

Results of the soil testing have been compared to relevant published GACs, as discussed above. For S4ULs, a range of values have been published for the organic contaminants based on the SOM (soil organic matter) content. As site-specific soil organic content was not determined, where S4ULs have been adopted for the organic contaminants, analytical results have been compared to the most conservative value, which is that for soils of 1% SOM as a preliminary screening tool.

None of the determinant concentration were higher than the relevant conservative GAC for human health (residential with home-grown produce) setting.

These findings and examination of trial pits and borehole arisings indicate that there is a low risk of a soil-contaminant-linkage developing for the aforementioned human health receptors and so we consider that no further assessment is necessary.

Human Health Risk Assessment

The following qualitative risk assessment has been carried out using the S-P-R (source-pathway-receptor) concept, which is predicated on the principle that a pathway must exist between a potential source and potential receptor for there to be a risk.

Potential sources of contamination have been assessed using the LRCM Guidelines.

From the initial CSM, the potential human receptors at risk are:

Long-term risk group: end users of the site – future residents and visitors (children and adult)

Short-term risk group: construction workers (adult)

The risks to these two groups of receptors and any necessary protective remedial measures resulting from development of the site are discussed below.

If the proposed site use or layout should alter significantly, then the human health risk assessment will require re-evaluation.

Long-Term Risk Group (Children and adult future residents / visitors)

The investigation revealed no visual or olfactory evidence of significant contamination on site (including risks from Asbestos). Furthermore, although the CSM identified possible heavy metals, metalloids, non-metals, asbestos as potential sources of contamination, there was no evidence of such in the soils on the site.

No significant sources of contamination have been identified. Testing of soil samples for a wide range of potential contaminants returned determinant concentrations below GAC for the proposed site use. No plausible sources or pathways for ground gas migration onto the site have been identified for the site based on the findings of the investigation.

On this basis, it is considered that there is no further need for investigation or remedial measures at this site prior to the proposed redevelopment, as the soils at the site pose a low risk to this group of human receptors.

Given that the nature of ground investigations are not exhaustive in terms of site coverage, it is recommended that the developer adopts a Discovery Strategy during the groundworks phase of the development and that any areas of concern are referred back to Edlington Consulting Group at an early stage for further assessment.

Short-Term Risk Group (Construction and Maintenance Workers)

For construction workers and maintenance workers that are exposed to the ground, there is a short-term exposure risk (at each site they attend, which contributes to an overall lifetime exposure risk) and the pathway of primary concern is ‘direct soil ingestion’. Protective measures that are different to those taken to protect the long-term exposure group (such as end-users of the site) are, therefore, required.

Remedial Measures

To reduce the risks to as low as reasonably practicable for this group of workers, it is recommended that appropriate health and safety measures be implemented along with the use of Personal Protective Equipment (PPE). All personnel coming into contact with the soil, groundworkers in particular, should be instructed to use gloves when on site to avoid dermal contact and to restrict inadvertent hand-to-mouth ingestion. Washing facilities should be provided, and should be used prior to activities such as eating, smoking or toilet visits.

Discovery Strategy

Should any suspicious soils be encountered that differ from our ground model, work should cease in that area and further assessment will be necessary by a suitably qualified geo-environmental engineer. This may require further intrusive investigation or soil sampling, along with supplementary contamination risk assessment and, potentially, remediation. Any further recommendations will require regulatory approval.

Controlled Waters Risk Assessment

Following the field observations and assessment of laboratory results from this investigation, the initial conceptual site model can now be revised.

The following qualitative risk assessment has been carried out in accordance with the procedures set out in the Environment Agency's Remedial Targets Methodology Hydrogeological risk assessment for contaminated land (2006) and uses the S-P-R (source-pathway-receptor) concept: which is predicated on the principle that a pathway must exist between a potential source and potential receptor for there to be a risk.

The potential environmental receptors, from the initial CSM, are:

Controlled Waters - the bedrock Sherwood Sandstone Group – classified as a Principal Aquifer.

Controlled Waters – the nearby superficial Sutton Sand Formation (mapped on adjacent land to the southeast) - classified as a Secondary 'A' Aquifer.

Controlled Waters - an unnamed watercourse (ditch) connecting with North Drain is located 44m to the northeast of the site.

The potential linkages, from the initial CSM, are:

Migration of heavy metals, metalloids, non-metals and various hydrocarbons into the aquifer beneath the site, depending on the degree of fracturing and permeability of the strata.

The CSM is revised, below, with consideration of the relevant field observations and laboratory test results.

Groundwater contamination

No obvious contamination or significant thicknesses of Made Ground was identified in any part of the site.

Within the soil samples tested, none of the determinant concentrations were elevated above normal background levels.

It is, therefore, considered that the above-recognised environmental receptors will not be at risk from potential groundwater pollution at the site, subject to the findings of the Discovery Strategy and regulatory approval.

Ground Gas Risk Assessment

The preliminary ground gas risk assessment dis not identify any significant potential sources of carbon dioxide or methane ground gases on or near the site. Hydrocarbon vapour monitoring was required due to the legacy land use at the site and due to the presence of an above ground heating oil storage tank.

Historical mapping identified the presence of two infilled ponds; one located c.176m to the southeast and another c.184m to the south of the site, with a further small pond feature located adjacent to the western boundary of the site (inferred to have undergone infilling between c.1995 and c.2001. However, given the scale and nature of these features neither was considered likely to pose a significant risk to the site.

The intrusive investigation encountered a site wide veneer of Made Ground but only down to depths of between 0.80m and 1.10m bgl. This stratum was underlain by a significant thickness of fine-grained Alne Glaciolacustrine Formation; proved to the full depth of the boreholes at 5.45m bgl. As such, it is be concluded that no significant on-site sources and pathways of ground gases have been identified for the site.

Given the low-permeability of the local superficial geology and the nature and scale of the nearby recorded infilled ground features, the ground gas generation potential of the recorded backfilled ponds within the local area was considered to be *low*. Consequently, the overall risk posed by ground gases to the site and the proposed redevelopment was considered *Low*.

In line with the guidance set out in CIRIA C665, a precautionary programme of two ground gas visits spaced over periods of both rising and falling atmospheric pressure was undertaken to provisionally define the ground gas regime beneath the site.

The monitoring revealed that low levels of carbon dioxide, up to 2.1% v/v, are being produced in the ground. No Methane was recorded above the limit of detection at 0.1% v/v. Low flow rates of between <0.1l/h and 0.3l/h were recorded that shows that significant volumes of gas are not being produced in the ground.

Ground Gas Screening Values

These results have been evaluated with reference to Code of practice for the characterization and remediation from ground gas in affected developments, BS8485, to confirm the conceptual site model.

Using the maximum carbon dioxide reading of 2.1% with the highest recorded absolute flow rate of 0.3l/hr, the maximum gas screening value is 0.0063l/hr. There were no carbon dioxide levels above 5% and no methane levels above 1%. PID monitoring on two occasions recorded VOC concentrations of <0 ppm.

This classifies the site as Characteristic Situation CS1 (very low hazard potential) and NHBC green. The NHBC guidance is derived for an 8m x 8m house and relies on the building having a 150mm under slab void.

Ground Gas Protection Measures

Therefore, for this residential development it is considered that no gas protection measures are necessary with regard to methane or carbon dioxide gas. The BGS advises that no radon gas protection measures are necessary for buildings without underground rooms at this site.

The conclusions of this report should be agreed in writing with the Local Planning Authority prior to commencement of the proposed development.

Infrastructure Risk Assessment

Subsurface Concrete

The concrete design mix recommendations for subsurface concrete have been assessed in terms of BRE Special Digest 1.

In view of the known site history, the proposed development area can be considered as a brownfield location.

The groundwater beneath the site should be considered as mobile.

Chemical tests have recorded the following characteristic values for the given site situation:

Type of Site	Groundwater	Characteristic Soil Soluble Sulphate (mg/l)	Characteristic pH (pH units)
Brownfield	Static	50	8.3

These results provide a Design Sulphate Class of DS-1.

The above assessment provides an Aggressive Chemical Environment for Concrete (ACEC) Class of AC-1.

Underground Services

Organic contaminants, such as petroleum or polycyclic aromatic hydrocarbons, may attack plastic pipes and remedial measures may be required.

Should any suspected contamination be encountered, it is recommended that the advice of a specialist geoenvironmental consultancy such as Edlington Consulting Group should be obtained. The likely remedies for protecting services within any contaminated ground would likely comprise the removal of the pathway with the contaminated soils (such as by sleeving the pipe with another material) or by removing the contamination source itself.

It should be noted that the utility companies often have their own local guidelines and standards on levels of shallow soil contamination in the ground that may or may not be acceptable for the installation of below ground services. These standards may be different to those specified for assessing risks to human health and groundwater.

The local requirements should be obtained from the particular service supply company as soon as possible to avoid unexpected delays or additional development costs.

Guidance can be sought from the UK Water Industry Research (UKWIR), ‘Guidance for the selection of water supply pipes to be used in brownfield sites’, reference 10/WM/03/21, 2010. This document proposes that the assessment of the hazard to potable water supply pipes should be based on the following pathways: contact with migrating groundwater, permeation of vapour, and direct contact with soil.

Approval should be sought for the type of pipes proposed before they are installed.

Geotechnical Engineering Conclusions

We understand that the proposed redevelopment comprises erection of 3no. dwellings and 1no. domestic garage following demolition of workshop and stores. The redevelopment includes external vehicle hardstanding and limited localised areas of soft landscaping / gardens.

A proposed redevelopment layout plan is presented in Appendix A for reference.

Soils

The exploratory work from this investigation has proven the expected general strata sequence comprising an initial superficial layer of either Made Ground (Topsoil) or Hardstanding / Sub-base overlying a veneer of Made Ground, further underlain by Alne Glaciolacustrine Deposits, proved to the full depth of the boreholes.

The Topsoil (Made Ground) was encountered at BH01, BH02 and HP01 from ground level down to depths of between 0.22m and 0.35m bgl and typically comprised grass overlying dark brown silty clay with abundant roots and pockets of organic matter.

The Hardstanding / Sub-base was encountered at BH03 and BH03 at ground level and represented by either broken crushed concrete or intact concrete to depths of 0.10m and 0.40m bgl.

The Made Ground was encountered at all exploratory locations from below the overlying Hardstanding / Topsoil (Made Ground) down to depths of typically between 0.80m and 1.10m bgl (locally 0.40m bgl). The stratum typically comprised dark greyish brown silty sandy slightly gravelly clay with organic matter and cobbles of decayed wood and brick and fragments of rare ceramic and occasional glass.

Alne Glaciolacustrine Deposits were encountered at all exploratory locations from beneath the Made Ground and proved down to 5.45m bgl. The stratum typically comprised initially soft to firm grey/brown silty sandy clay to typically between 1.40m and 1.60m bgl, thereafter becoming firm to stiff silty sandy clay with depth. A layer of water bearing silty clayey sand / gravel was encountered within the stratum at depths of between 1.90m and 2.35m bgl in BH01, BH02 and BH04.

Groundwater

Groundwater was encountered within the exploratory locations during the fieldworks at depths of between 1.10m and 3.00m bgl, typically within the coarse-grained band within the Alne Glaciolacustrine Deposits, rising to depths of between 0.70m and 1.10m bgl after 20 minutes.

Follow-on groundwater monitoring on two occasions within standpipe installations at BH01 and BH04 indicate a standing water level of between 0.61m and 0.88m bgl.

Site Excavation

Conventional hydraulic plant should be satisfactory for undertaking excavations (i.e., service trenches) within the soil; however, the location an extent of any permissible excavations will be determined by the nature and extent of the relevant root protection areas (RPAs) and the advice of a specialist should be sought to ensure that the relevant provisions of the RPAs in operation at the site as observed.

In line with HSE guidelines, all excavations requiring personnel access should be adequately supported to avoid the risk of collapse. Consideration should also be given to the stability of open trenches where personnel are working in close proximity.

Side wall instability is expected to occur within trench excavations through soft / water-bearing silt-dominated soils and discrete coarse-grained soils, even in the absence of groundwater and careful consideration of excavation stability will be required. The Alne Glaciolacustrine Deposits were found to comprise a generally fine-grained soil however a notable band of water-bearing coarse-grained material was consistently encountered within the stratum across BH01, BH02 and BH04 at depths of between around 1.90m and 2.35m bgl.

Instability was noted within the boreholes as drilling progressed through the initial portion of the Alne Glaciolacustrine Deposits and casing was required to a depth of up to 2.5m to support the bore. The boreholes were observed to collapse back in to depths of between 3.50and 4.00m bgl when the casing was withdrawn on completion of the boreholes. As such, open excavations within the Alne Glaciolacustrine Deposits are likely to require close wall support.

The presence of groundwater was encountered during the fieldworks at depths of between 1.10m and 3.00m bgl, typically within the coarse-grained band within the Alne Glaciolacustrine Deposits, rising to depths of between 0.70m and 1.10m bgl after 20 minutes. Long-term monitoring has indicated a standing hydrostatic groundwater level at BH01 and BH04 of between 0.61m and 0.88m bgl.

Seasonal variation in groundwater levels beneath the site should be anticipated and further long-term monitoring would be required to determine the full seasonal regime.

Conventional pumping from sumps may be sufficient to control any groundwater inflows down to depths of approximately 1.00m bgl, however it is recommended that excavations down into the water-bearing coarse grained band within the Alne Glaciolacustrine Deposits be avoided where possible. Consideration should be given to timing groundworks to coincide with the Summer to minimise the potential effects of groundwater entries.

Consideration should be given to the effects of future trees and shrubs on service runs that cross the site. Soil movements brought on by the influence of vegetation (particularly in sensitive and expansive soils) can severely disrupt the drain runs and mains services, and measures should be incorporated into the excavations to allow for future ground movements.

Foundation Options Appraisal

Shallow Pad / Strip Foundations

From a geotechnical perspective, lightly-loaded shallow pad foundations could be technically feasible in the Alne Glaciolacustrine Deposits encountered beneath the proposed development footprint.

All Topsoil and Reworked / Made Ground soils should be removed from beneath the proposed pad foundations, where present.

The formation level Alne Glaciolacustrine Deposits soils should be carefully inspected prior to the construction of the pad / strip foundations and any localised zones of significant root infestation or any weak/soft areas of natural soils or localised deeper areas of Made / Reworked Ground should be carefully removed and replaced with coarse-grained and well compacted fill.

It is considered that suitably reinforced strip / pad footings could be used to support the proposed light-loads within this area of the site. For initial design purposes, pad foundations not exceeding 1.0m in width may be adopted at a minimum depth of 1.00m or 0.2m into the Alne Glaciolacustrine Deposits (whichever is deeper), where an allowable bearing pressure of 60kPa may be adopted. The above allows for settlements generally not to exceed 25mm taking place over a number of years.

Raft foundations

A raft foundation solution is considered geotechnically feasible for supporting the anticipated structural loadings within the ground conditions encountered.

It is recommended that any organic or notably soft/loose Made Ground soils are removed from beneath the proposed raft foundation. The formation level should be carefully inspected and proof-rolled prior to the construction of the raft and any localised zones of significant root infestation should be carefully removed and replaced with coarse-grained and well compacted fill. It should be noted that a detailed numerical assessment of raft settlement behaviour at the site has not been undertaken at this stage.

For preliminary guidance, based on the ground conditions encountered beneath the site, it is considered that a suitably designed raft could be constructed on a well compacted layer of coarse-grained fill within the initial fine-grained Alne Glaciolacustrine Deposits, at a nominal depth of 0.75m bgl, limiting settlements to around 30-40mm provided a net increase in loading intensity at formation level beneath the raft of 25kPa was not exceeded – subject to further detailed settlement analysis and confirmatory plate load testing.

The ultimate settlement performance of a raft foundation will be partially determined by the stiffness of such a raft, any imbalance or eccentricity in loading in conjunction with the quality of workmanship during construction and these factors should be further considered as part of the design process.

The formation level should be carefully inspected and proof-rolled prior to the construction and any weak/soft areas of natural soils or areas of Made Ground should be carefully removed and replaced with coarse-grained and well compacted fill to a suitable depth.

Disposal of Arisings

Site excavations, such as for foundations and services trenches are likely to produce arisings, some of which may be able to be re-used on-site and some of which will be surplus to requirements. The options for disposal of these arisings are discussed below:

Re-Use of Material on Site

If surplus arisings are 'fit for re-use' on the site and have not been treated, its re-use is allowed within the planning law. If it needs treating prior to re-use, exemptions can be sought from the EA to allow this activity.

A recent voluntary code of practice published by CL:AIRE, in conjunction with the EA, (the Definition of Waste: Development Industry Code of Practice, Version 2) endorses the re-use of arisings on and off the site of origin without the need for exemptions from the EA, dependent on whether it is "fit for purpose".

It also supports the use of "Hub and Cluster" sites (to enable surplus soil to be used on agreed sites in the local vicinity, dependent on the soil being 'fit for purpose').

The use of a Materials Management Plan (MMP) during the earthworks phase will help to avoid paying tax on soil movements that might otherwise attract tax, if they are construed by the HMRC as being waste without the relevant documentation to prove otherwise.

Based upon the preliminary chemical screening testing undertaken as part of this investigation, the soils on this site are considered to be suitable to be re-used on site for landscaping purposes, dependent on the agreement of the Local Authority. Depending upon the volume of soil being considered for re-sue, additional supplementary chemical testing may be required.

Waste Classification

Arisings that are surplus to requirements will, under current waste management legislation, be classified as Waste and need disposing off-site. Records must be kept of where the Waste is taken upon leaving site, and of its destination.

The classification of Waste soils is a two-fold process using the soil chemical test results and the European Waste Catalogue for off-site disposal; followed by testing under the Waste Acceptance Criteria (WAC) specifically for landfill disposal.

Waste Acceptance Criteria (WAC) – Landfill Disposal

If the surplus arisings are to be disposed to a landfill facility, then the implementation of the Landfill Directive requires additional classification of the soils under the Waste Acceptance Criteria (WAC). This will determine whether it should be destined for an Inert, Non-hazardous, Stable Non-Reactive Hazardous, or Hazardous landfill, or whether is classed as 'Problematic Waste', for which an alternative disposal method must be sought.

Uncontaminated, natural soil will remain Inert by default and eligible for the lower rate of landfill tax. Similarly, 'reworked soils' and demolition 'stone' comprising ONLY materials listed in the Schedule of the Landfill Tax (Qualifying Material) Order 2011 (SI 2011/1017) will also be eligible for the lower rate of landfill tax.

Waste Acceptance Criteria (WAC) was not undertaken as part of this phase of investigation and would be required should disposal of soils to landfill be required.

Any pieces of ACM encountered should be segregated and disposed of as hazardous waste unless gravimetric testing indicates that the concentration of asbestos fibres in the pieces is less than 0.1%.

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