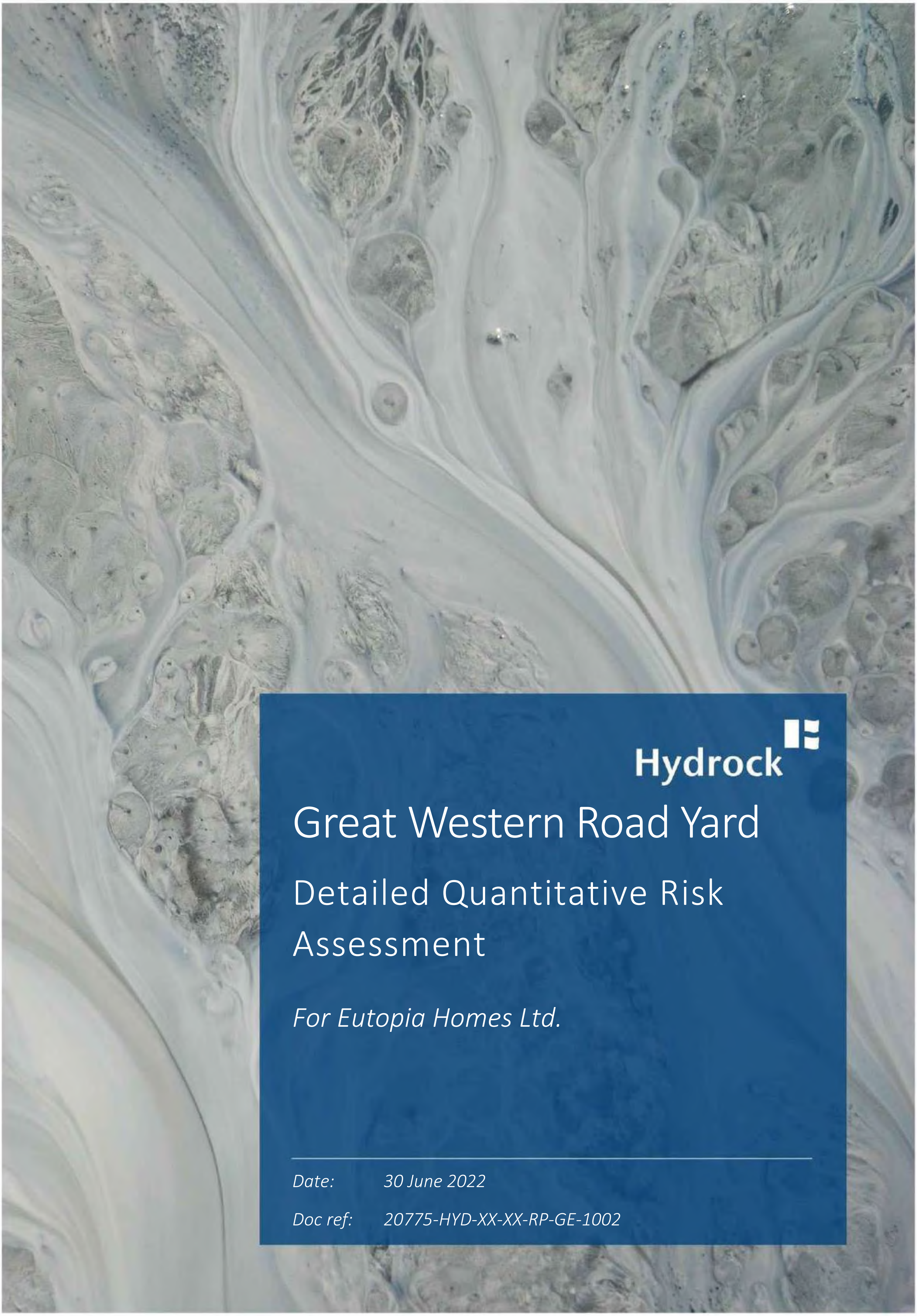
EUTOPIA
HOMES

Detailed Quantitative Risk Assessment

Great Western Yard

Hydrock



Hydrock

Great Western Road Yard

Detailed Quantitative Risk Assessment

For Eutopia Homes Ltd.

Date: *30 June 2022*

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1. INTRODUCTION

1.1 Background

Hydrock Consultants Ltd. (Hydrock) was commissioned by Eutopia Homes Ltd. (the Client) to prepare a Detailed Quantitative Risk Assessment (DQRA) for the Great Western Road Yard site in Gloucester (hereafter referred to as the 'site').

The site comprises a former large railway sidings known as the Great Western Road Yard (accessed via Horton Road to the east) and is situated immediately to the north of the main railway line into Gloucester railway station (orientated east to west along the southern site boundary). The site also includes a historical road transport depot that was formerly present in the north and is now occupied by four separate tenanted commercial units accessed off the Great Western Road to the north. The 'Tenanted Areas' are currently occupied by FLI Structures (a steel fabricator), Jays Timber Yard (a timber merchants), Auto Tune and Classic Leather (car repair/detailing), and Carlton Motors (a garage). A former car parking area in the far northwest of the site was formerly also a Tenanted Area (leased to the NHS for the nearby hospital), however, this is now accessible as part of the railway sidings area of the site. The entire site, including the Tenanted Areas, was formerly owned by Network Rail.

A Site Location Plan (Ref: 20775-HYD-XX-XX-DR-GE-1000, dated 3 March 2022) is presented in Appendix A. A general site layout plan, along with the Tenanted Areas, is shown on the Network Rail Sale Plan & Lease Overlays drawing (Ref: 6225807, dated 17 May 2018) presented in Appendix A.

Hydrock understands the site is to be redeveloped for residential end use, comprising a mixture of low-rise townhouses (1 to 2 storey) and high-rise apartment blocks (3 to 4 storey), public open space (POS), and associated infrastructure. The Proposed Masterplan Layout drawing by Darling Associates Ltd. (Ref: 03-0-01 [Preliminary], received 28 February 2022) is presented in Appendix A. Within the proposed layout drawing the site is spilt into the following two areas:

- Northern Area: containing apartment Blocks A, B and C.
- Southern Area: containing the townhouses and apartment Block D.

Several phases of ground investigation have been completed at the site, most recently by Hydrock in February-March 2022, and the findings are detailed in the Hydrock Supplementary Phase 2 Ground Investigation Report (Ref: 20775-HYD-XX-XX-RP-GE-1001, dated 26 April 2022) (hereafter referred to as the ‘Hydrock 2022 GIR’). Contaminants of potential concern (COPC), comprising petroleum hydrocarbons associated with the former fuel storage and refuelling infrastructure, were recorded in the Made Ground and natural soils of the Cheltenham Sand and Gravel, and light non-aqueous phases liquids (LNAPL) and dissolved phase concentrations in groundwater were also recorded.

A DQRA was recommended to quantify the potential risks posed by the identified petroleum hydrocarbon contamination to the Controlled Waters receptor. In addition, the potential risks posed from petroleum hydrocarbon vapours to future site occupants is also quantified as part of the higher tier of risk assessment presented within this report.

The works detailed herein have been undertaken in accordance with Hydrock’s fee proposal (Ref: email dated 14 April 2022) and the Client’s instructions to proceed (Ref: email dated 19 April 2022).

1.2 Objective

The objective of this commission is to quantify the potential risks posed from the recorded petroleum contamination at the site to both Controlled Waters and human health (via vapour migration) and to derive, where considered necessary, Remedial Target Values (RTV) for soil and/or groundwater that are protective of the critical receptor(s).

The key objective is to determine whether the site, under current conditions, poses a significant risk of significant pollution, and if so, what remedial targets apply by which this risk would be reduced to acceptable levels.

1.3 Scope of works

The scope of works for this commission is as follows:

- An additional round of groundwater monitoring and sampling across the site, including undertaking of aquifer permeability testing at selected monitoring wells;
- Carry out a DQRA for Controlled Waters using the Environment Agency's Remedial Targets Methodology (RTM) worksheet v3.2, including the derivation of RTVs that are protective of the critical receptor(s), where considered necessary;
- Carry out a natural attenuation assessment to provide further lines of evidence that degradation of the main risk driving COPCs is occurring on site.
- Carry out a DQRA for petroleum hydrocarbon vapour intrusion using the Contaminated Land Exposure Assessment (CLEA) tool, including the derivation of Site-Specific Assessment Criteria (SSAC), where considered necessary;
- Presentation of findings (i.e., preparation of this document).

1.4 Legislative framework and guidance

This report is written in broad accordance with the Environment Agency's (2021) Land Contamination Risk Management (LCRM). The modelling has been undertaken in accordance with the following:

- Environment Agency's (2006) RTM guidance for hydrogeological risk assessments; and
- Environment Agency's (2009a-c) CLEA guidance for human health risk.

Other relevant guidance that has been cross-referenced is indicated in the report text.

1.5 Available information

The principal source of information used to support this assessment is the Hydrock 2022 GIR, which should be read in conjunction within this report. Details of all historical phases of ground investigation and risk assessment (undertaken by others) are summarised in the Hydrock 2022 GIR, and the reported historical data that have been used in this report were considered suitable for this DQRA.

In addition, an additional round of groundwater monitoring and sampling, as well as permeability testing on selected monitoring wells, was undertaken across the site over the period 4 to 6 May 2022. The results and findings of the additional works are referenced in the relevant sections of this report.

2. SITE DESCRIPTION AND GROUND MODEL

2.1 Context

This section presents a brief summary of the Conceptual Site Model (CSM) pertaining to the site, which has been developed from multiple phases of ground investigation and risk assessment. The exploratory hole locations undertaken during all phases of ground investigation are presented on the Exploratory Hole Location Plan (Ref: 20755-HYD-XX-XX-DR-GE-1004, dated 03 February 2022) in Appendix A.

2.2 Site location

The site is located off Great Western Road, Gloucester approximately 200 m east of Gloucester railway station. The coordinates for the approximate centre of the site are 384107E, 218374N. A Site Location Plan (Ref: 20775-HYD-XX-XX-DR-GE-1000, dated 3 March 2022) is presented in Appendix A.

2.3 Site description

- The site is irregular in shape approximately 450 m by 100 m and comprises:
  - a former railway sidings with a collection of railway/engine sheds, hardstanding, relict building slabs, ballasted rail, inspection pits, and above ground storage tank (AST) bases.
  - Tenanted Areas in the north encompassing (from south to north):
    - FLI Structures (a steel fabricator);
    - Jays Timber Yard (a timber merchants);
    - Auto tune and Classic leather (car repair/detailing); and
    - Carlton Motors (a vehicle garage).

A general site layout plan, including the Tenanted Areas, is shown on the Network Rail Sale Plan & Lease Overlays drawing (Ref: 6225807, dated 17 May 2018) presented in Appendix A.

2.4 Site and surrounding area history

- The site has been utilised as a railway depot and sidings since at least the earliest mapping in 1883. Various railway sidings, tanks, buildings, and engine sheds have been located across the site over the past 130 years. The current layout has remained relatively similar to that of the 1970s, with the fuel storage and refuelling infrastructure in the central portion first marked on the 1954 mapping.
- Extensive railway sidings and depots were also present historically across the surrounding wider area including immediately to the west, south and east of the site.
- A sand pit is marked on the 1886 historical map in the east of the site.
- A road transport depot was marked in the north of the site from the 1954 mapping (at the location of the now Tenanted Areas).
- A gas works was historically present approximately 20 m to the northeast of the site (marked on the historical mapping between 1938 and 2014).
- A petrol filling station has been present approximately 100 m to the northeast since the early-1970s.

2.5 Potential sources of contamination

All of the potential sources of contamination that were identified from the historical information, as well as Hydrock's supplementary site walkover (as detailed in the Hydrock 2022 GIR), are presented on the Potential Sources of Contamination drawing (Ref: 20775-HYD-XX-XX-DR-GE-1002, dated 10 March 2022) presented in Appendix A.

2.6 Ground conditions

The ground conditions as proven by the ground investigations undertaken to date comprise:

- **Made Ground:** encountered from ground level to depths of between 0.1 m and 2.1 m below ground level (bgl), predominantly comprising either:
  - » Hardstanding associated with relic access roads and floor slabs of demolished structures; or
  - » ashy gravelly sand including, clinker, slag and brick; over
- **Cheltenham Sand and Gravel:** encountered to depths of between 1.7 m and 4.7 m bgl, where base proven, comprising orange/brown gravelly sands; over
- **Charmouth Mudstone Formation:** encountered to a maximum proven depth of 14.7m bgl (i.e., base not proven), comprising stiff clays becoming extremely weak mudstone at depth.

2.7 Hydrogeology and hydrology

- The Cheltenham Sand and Gravel deposits is classified as a Secondary A Aquifer.
- The Solid Geology of the Blue Lias Formation (not present) and Charmouth Mudstone Formation (undifferentiated) are classified as a Secondary (undifferentiated) Aquifer.
- The site is not in a groundwater Source Protection Zone. The nearest groundwater abstraction was recorded as 551 m south from the site (recorded as historical license in desk study information).
- The culverted River Twyver is approximately 250 m west/northwest of the site at its closest hydraulically downgradient point (the nearest un-culverted section is approximately 250 m southeast and hydraulically cross-gradient). The river flows northwest and joins the River Severn approximately 1.8 km northwest.
- Approximately 1.25 km west of the site the River Severn splits into the main river body (flowing south towards the Severn Estuary) and a tributary that flows south into Gloucester Docks and on to the Gloucester and Sharpness Canal.
- No active surface water abstraction licenses are recorded within 2 km of the site.

Hydrock has searched the freely available information on the online Environment Agency's Catchment Data Explorer for the River Twyver. The river is currently (2019 Cycle 2) classified under the Water Framework Directive as 'moderate' owing to its ecological status, partly due to heavy metals of copper and zinc, as well as ammonia being recorded as high. In addition, it is reported to be failing its chemical status due to priority hazardous substances, including mercury and its compounds, and polybrominated diphenyl ethers (PBDE). It is also recorded to have a high pH.

2.7.1 Groundwater elevations and flow direction

Shallow groundwater was encountered within the Cheltenham Sand and Gravel during ground investigation at depths between approximately 0.7 m bgl and 2.1 m bgl. A deeper groundwater body was encountered within the underlying cohesive Charmouth Mudstone Formation with head depths of between approximately of 1.1 m and 2.1 m bgl.

The groundwater monitoring undertaken across the site to date (both historically and more recent) has consistently shown the groundwater flow direction to be towards the west/northwest (i.e., towards the River Twyver and River Severn). The groundwater elevation contours for the shallow groundwater body recorded within the Cheltenham Sand and Gravel are presented on the contour plots (Ref: 20755-HYD-XX-XX-DR-GE-1006, dated 28 March 2022, -1007, dated 6 April 2022, -1021, dated 17 May 2022, -1025, dated 1 June 2022) in Appendix A. This includes the additional round of groundwater monitoring undertaken 4 to 6 May 2022 as well as the historical monitoring undertaken as far back as 1998.

2.8 Evidence of contamination

The Made Ground encountered across the site is characterised by frequent anthropogenic inclusions, including ash, clinker and slag. The corresponding analytical data recorded exceedances of heavy metals and polycyclic aromatic hydrocarbons (PAHs) significantly in excess of the Generic Assessment Criteria (GAC). In addition to the more common man-made constituents, three instances of visual asbestos containing materials (ACMs) were also encountered within the Made Ground, which were all suspected of being cement bound asbestos. Asbestos fibres (chrysotile or amosite) were also detected within three samples of Made Ground soils and concentrations were quantified at <0.001% and 0.0063 (the third sample was unquantified).

Made Ground soils in the vicinity of the former fuel storage and refuelling infrastructure in the central portion of the railway sidings area (i.e., ASTs, fuel pumps, fuel lines, oil-water interceptors, etc.) also exhibited significant visual and olfactory evidence of contamination, including visual staining and strong petroleum hydrocarbon odours. The underlying natural soils of the Cheltenham Sand and Gravel in these areas, and significantly hydraulically downgradient to the west/northwest, also recorded significant visual and olfactory evidence of contamination. LNAPL has also been observed within the soils and also as a measurable thickness on top of the shallow groundwater body. Suggesting that petroleum hydrocarbons had migrated vertically from point of release through the Made Ground soils to the shallow water body within the Cheltenham Sand and Gravel and then laterally with the prevalent groundwater flow direction to the west/northwest.

The corresponding soil analytical data within both the Made Ground and underlying natural soils of Cheltenham Sand and Gravel recorded petroleum hydrocarbon concentrations in excess of the GAC, typically the heavier-end fractions between EC10-EC35. Dissolved phase groundwater concentrations of petroleum hydrocarbons were also recorded in excess of the WQTs within wells installed in the Cheltenham Sand and Gravel hydraulically downgradient of the former fuel infrastructure across the former railway sidings area.

The base of the Charmouth Mudstone Formation was not proven during the ground investigations (i.e., deepest proven depth 14.7 m bgl) and the cohesive material is considered to be a significant aquiclude that is preventing the downward migration of petroleum hydrocarbon contamination. The Charmouth Mudstone Formation was free of significant visual or olfactory evidence of contamination and also the corresponding soil and groundwater analytical data were all below GAC and WQTs, respectively.

A photo-ionisation detector (PID) was used to screen monitoring wells installed across the site (at the surface) for the presence of hydrocarbon vapours at the well head. Generally, readings were below 10 ppm, however, in areas of significant petroleum hydrocarbon impact, such as in the central portion of the railway sidings area, readings were generally above 50 ppm.

2.9 Conceptual Site Model

The preliminary CSM drawing (Ref: 20755-HYD-XX-XX-DR-GE-1003, dated 3 March 2022), which details all relevant sources, pathways and receptors for the site, is presented in Appendix A.

Based on the risk evaluation process detailed in the Hydrock 2022 GIR, which considered all available data for the site (i.e., historical and more recent), the active pollutant linkages that require mitigation and/or further assessment are summarised in Table 2.1.

Pollutant linkages PL7 (Controlled Waters) and PL8 (human health [vapour pathway]) are considered further within the DQRAs presented in Section 3 and Section 4, respectively.

Table 2.1: Residual risks following risk evaluation in Hydrock 2022 GIR

Contaminant Linkage				Comments	
Pollutant Linkage	Sources	Pathways	Receptors	General	Mitigation
PL 1.	PAHs in the Made Ground across the site.	Ingestion, inhalation or direct contact.	Human health.	Significant exceedances of the GAC.	Mitigation required in the form of an engineered clean cover system or hardstanding.
PL 2.		Root uptake.	Plant life.	Significant exceedances of the GAC.	Import of clean topsoil for use in clean cover system, including tree pits for new trees.
PL 3.		Water supply pipes.	Human health.	Organic chemicals present in soils in excess of Threshold Values.	Barrier pipe required.
PL 4.	Visible ACM and asbestos fibres in the Made Ground across the site.	Inhalation of fugitive dust.	Site users. Neighbours.	Three instances of visible ACM. Asbestos fibres recorded in soils between <0.001% and 0.0063%.	Mitigation required in the form of an engineered clean cover system or hardstanding. Control measures also required during construction phase to protect site workers and minimise risk to neighbouring properties from fugitive dust.
PL 5.	Petroleum hydrocarbons in Made Ground and natural soils.	Ingestion, inhalation or direct contact.	Human health.	Significant exceedances of the GAC associated with historical sources, including tank farm, refuelling area and interceptor.	Mitigation required in the form of an engineered clean cover system or hardstanding.
PL 6.		Water supply pipes.	Human health.	Organic chemicals present in soils in excess of Threshold Values.	Barrier pipe required.
PL 7.		Leachate migration. Base flow.	Controlled Waters.	LNAPL recorded on top of groundwater within excavations and monitoring wells. Significant exceedances of petroleum hydrocarbons WQT.	Higher tiers of risk assessment to determine if petroleum hydrocarbons are a risk to Controlled Waters, comprising a DQRA supported by additional targeted groundwater sampling. Removal of LNAPL and LNAPL impacted soils.
PL 8.	Hydrocarbon vapours.	Inhalation	Human health.	Elevated PID readings associated with petroleum hydrocarbon impacts.	Installation of hydrocarbon resistant membrane as part of all new structures. This requirement may be removed subject to findings of the higher tiers of risk assessment.

Contaminant Linkage				Comments	
Pollutant Linkage	Sources	Pathways	Receptors	General	Mitigation
PL 9.	Petroleum Hydrocarbons in impacted surface Made Ground adjacent to AST near TP219.	Ingestion, inhalation or direct contact.	Human health.	Black staining and hydrocarbon odours of localised surface soils. Significant exceedances of the GAC in surface soils. Leaching into the underlying natural soils not identified.	Delineation, removal/treatment of the surface Made Ground soils and verification.
PL 10	Asbestos in buildings.	Inhalation of fugitive dust.	Site users. Neighbours.	ACM recorded in existing/historical buildings in historical surveys.	Asbestos demolition survey. Careful removal in line with current guidelines required during demolition.

3. DETAILED QUANTITATIVE RISK ASSESSMENT – CONTROLLED WATERS

The Hydrock GIR recorded dissolved phase concentrations of petroleum hydrocarbons above their associated WQTs, notably within wells near the fuel storage and refuelling infrastructure of the former railway sidings. Consequently, higher tiers of risk assessment were recommended to quantify the risk to the Controlled Waters receptor from petroleum hydrocarbons.

The methodology and input parameters of the DQRA for Controlled Waters are presented in Section 3.1 and the results are presented Section 3.2. A sensitivity analysis for the modelling is presented in Section 3.3.

A natural attenuation assessment has also been undertaken to provide further lines of evidence. This is presented in Section 3.4.

3.1 Risk assessment methodology

3.1.1 Guidance

The DQRA for Controlled Waters that follows has been carried out in accordance with the following guidance documents:

- GOV.UK. March 2017. Collection: Groundwater protection. Groundwater protection guides covering: requirements, permissions, risk assessments and controls (previously covered in GP3).
- Environment Agency. 2006. Remedial Targets Methodology. Hydrogeological Risk Assessment for Land Contamination.

3.1.2 Model selection

The model chosen for this assessment is the Environment Agency's RTM Worksheet v3.2. This is a deterministic model that back-calculates acceptable contaminant concentrations at the source site based on defined acceptable environmental standards at a receptor.

3.1.3 Rationale

Ground investigation and generic risk quantitative assessment (GQRA) has shown there to be soil contamination that is having a recorded impact on groundwater beneath the former railway sidings area of the site. The active pollutant linkage with respect to Controlled Waters is based on the following scenario:

- **Source:** petroleum hydrocarbon impacts in the central portion of the former railway sidings, comprising the fuel storage, refuelling infrastructure and interceptors (i.e., in soil, as LNAPL, and in dissolved phase groundwater).
- **Pathway:** vertical leachate migration through the unsaturated zone and lateral transport through baseflow within the Secondary A aquifer of the Cheltenham Sand and Gravel.
- **Receptor:** the culverted River Twyver approximately 250 m west/northwest of the site at its closest hydraulically downgradient point (the nearest un-culverted section is approximately 250 m southeast and hydraulically cross-gradient). The river joins the River Severn approximately 1.8 km northwest.

The DQRA generates soil and groundwater target concentrations (RTVs) for the COPC at the site that are protective of Controlled Waters. The basis for these concentrations are the relevant WQTs presented in Section 3.1.5. Where site concentrations exceed the derived RTVs, there is considered to be a potential risk to Controlled Waters.

The RTM guidance suggests that when contaminants have a travel time of over 1,000 years, which can occur in low flowing groundwater systems and/or determinands with high partitioning coefficients, no action may need to be taken even if the RTV is exceeded. Whilst the travel time to the receptor is not explicitly provided in the RTM spreadsheets, the retarded contaminant velocity is included within the Level 3 Soil RTM worksheets. Using this retarded contaminant velocity and the distance to the compliance point for each COPC, the total travel time can be calculated, if required.

3.1.4 Compliance point

Current Environment Agency guidance on groundwater (see Section 3.1) states that the compliance point should be set at a distance of:

- 50 m hydraulically downgradient of the source area:
    - ‘for all hazardous substances in all aquifers’ (that is, those already in the groundwater or inputs from soils which cannot be prevented); and
    - ’for non-hazardous pollutants in groundwater with a strategic resource potential’ or
- 250 m hydraulically downgradient of the source area boundary:
    - ‘for non-hazardous pollutants in groundwater without a strategic resource potential’

Substances have been determined as either hazardous substances or non-hazardous pollutants by the Joint Agencies Groundwater Directive Advisory Group (JAGDAG) (JAGDAG, 2018). The list of substances is available by following this link (dated 31 January 2018).

The following compliance point for the Cheltenham Sand and Gravel has been selected:

- 50 m hydraulically downgradient of the source area due to the LNAPL determined by laboratory analysis to be ‘biodegraded diesel’ (petroleum oil is classified as hazardous).

3.1.5 Water Quality Targets

Future groundwater abstraction from beneath the site or the surrounding area is considered highly unlikely due to the heavily industrial past of the site and, significantly, the much wider surrounding area. The relevant Controlled Waters receptor is considered to be the River Twyver, therefore, as part of the GQRA in the Hydrock 2022 GIR the groundwater data were compared against WQT derived for the protection of inland aquatic ecosystems (i.e., Environmental Quality Standards [EQS]) only.

There are no published EQS for petroleum hydrocarbons represented as fractions based on equivalent carbon number. A common approach is to assess against the World Health Organisation (WHO) guide values for petroleum hydrocarbon fractions in drinking water (WHO, 2008), however, this is not considered relevant for EQS. Therefore, an initial target concentration of 10 µg/l at the receptor was used as part of the GQRA in the Hydrock 2022 GIR, and is continued to be used as the (receptor) target concentration in the DQRA presented in this report. The choice of this value is supported by the limited ecotoxicological evaluations submitted for diesel to the European Chemical Agency REACH database.

3.1.6 Analytical data

An additional round of groundwater sampling using low-flow techniques was undertaken over the period 4 to 6 May 2022 to support this DQRA. The groundwater samples were submitted for targeted laboratory analysis of:

- Speciated aliphatic and aromatic banding total petroleum hydrocarbons (24);
- Semi-volatile organic compounds (SVOC) (24); and
- Hydrock degradation water suite (9).

Laboratory certificates for the fourth round of sampling are presented in Appendix D.

Four rounds of groundwater sampling have now been completed across the site to date, comprising:

- **Round 1:** October 2020 (completed by others – data considered reliable);
- **Round 2:** November 2020 (completed by others – data considered reliable);
- **Round 3:** March 2022 (completed by Hydrock); and
- **Round 4:** May 2022 (completed by Hydrock).

The tabular presentation of these data comparing the four individual rounds of analytical data against the WQTs is provided in Appendix E.

Several SVOC were also detected in groundwater during the fourth round. However, there are no specific WQTs available for these particular compounds and they do not appear in the data tables referred to above, therefore, the detections have been summarised separately in the associated table in Appendix E.

LNAPL has also been recorded across the source area with the top of the LNAPL recorded at depths of between 0.8 m and 1.4 m bgl. LNAPL has historically been suspected at monitoring WS103, however, no measurable thickness of LNAPL has been recorded. During groundwater sampling, ‘black specs’ and ‘black globules’ were observed at this well in March and May 2022, respectively. The March and May 2022 groundwater samples were considered grab samples (a bailer was used in March and geochemical parameters did not stabilise in May 2022), therefore, the analytical data may not be reflective of true dissolved phase groundwater concentrations at this location. Recorded concentrations during March and May 2022 were also significantly above solubility limits, which also indicates that a source of LNAPL is present.

The spatial distribution of total petroleum hydrocarbons is presented on the drawings (Ref: 20775-HYD-XX-XX-DR-GE-1017, -1018, and -1019, all dated 7 April 2022 [Rounds 1 to 3, respectively], and -1024, dated 17 May 2022 [Round 4]) in Appendix A.

3.1.7 Contaminants of Potential Concern

COPC were screened against generic WQTs as part of the GQRA in the Hydrock 2022 GIR (and also again following the fourth sampling round in May 2022). Several COPC have exceeded their WQT, however, not all COPC are considered to pose a significant risk to Controlled Waters (see Section 7.5 of the Hydrock 2022 GIR for full details).

This DQRA is focused on assessing the main risk drivers with regards to Controlled Waters. The COPC that have not been taken forward for DQRA, along with their justification for removal from the process, are summarised in Table 3.1.

Table 3.1: Contaminants of potential concern not taken forward for Controlled Waters detailed quantitative risk assessment

Contaminant of Potential Concern (COPC)	Justification for removal
Heavy metals	Marginal exceedances of WQTs, including in the east of the site (i.e., hydraulically upgradient), and several metals also recorded as high within the surface water bodies across the surrounding area (as shown on the Environment Agency online Data Catchment Explorer). Therefore, considered to be reflective of background conditions of the surrounding area due to heavily industrial past.
Iron and manganese	Site-wide exceedances recorded within wells not near any apparent on site source areas, and also wells located on the site boundary/hydraulically downgradient of groundwater flow from off site. Therefore, considered plausible that concentrations are reflective of the prevailing chemical status of the underlying groundwater body. Concentrations will also likely be elevated due to reducing conditions causing the reduction of any naturally occurring iron (III) and manganese (IV) to the more soluble iron (II) and manganese (III) species, respectively. Therefore, not considered to be a risk driver in themselves, rather they indicate the presence of natural attenuation of other COPC.
Ammoniacal Nitrogen	Recorded in excess of the WQT within both shallow and deep groundwater. No on site sources have been identified (i.e., sewage leaks, historical landfilling, gas works). Ammonia is recorded as high within the surface water bodies across the surrounding area (as shown on the Environment Agency online Data Catchment Explorer). Therefore, considered to be reflective of background conditions of the surrounding area due to its heavily industrial past and/or wider agricultural use.
Sulphate	Sulphate only in excess of WQT in deep groundwater within Charmouth Mudstone Formation, which is known to be pyritic/sulphate bearing and it is considered likely that the elevated concentrations are representative of background conditions.
Xylenes	o-xylene recorded significantly in excess of WQT at WS103 during fourth sampling round in May 2022. Previously xylenes (and other BTEX compounds) had not been recorded in soil or groundwater samples at any exploratory location. Globules of LNAPL suspected at WS103 during sampling (see Section 3.1.6), therefore, elevated concentrations not considered to be reflective of dissolved phase groundwater conditions.

The COPC that are judged as the main risk drivers requiring DQRA are summarised in Table 3.2.

Table 3.2: Contaminants of potential concern considered main risk drivers for RTM modelling

Contaminant of Potential Concern (COPC)	Target Concentration at Receptor (µg/l)	Groundwater Concentration at Source (µg/l)*	Water Quality Target Source	Additional notes
Aliphatic >EC10-EC12	10	31	Withdrawn Private Water Supply Regulations 1991.	NA.
Aliphatic >EC12-EC16	10	1,300		NA.
Aliphatic >EC16-EC21	10	1,900		Assessed as Aliphatic EC16-EC35 as part of GQRA, however, analytical data are now separated into corresponding fractions as part of the DQRA.
Aliphatic >EC21-EC35		620		
Aromatic >EC10-EC12	10	280		Includes PAH indicator compounds, however, PAHs with associated target concentrations were not detected.
Aromatic >EC12-EC16	10	1,100		
Aromatic >EC16-EC21	10	570		
Aromatic >EC21-EC35	10	290		

Notes:

* = based on maximum concentration within source area from Rounds 1 to 4. Does not include analytical data from WS103 due to the presence of suspected globules of LNAPL within this monitoring well during sampling. See Section 3.1.6 for details.

Relevant guidance by CL:AIRE (2017) recommends that, where justifiable, the risks to groundwater from petroleum hydrocarbon fractions should be assessed using specific indicator compounds rather than the fraction as a whole. For this approach to be justified, the individual compound should comprise a large percentage of the petroleum hydrocarbon fraction. It is noted that the corresponding PAH indicator compounds for the fractions in Table 3.2 that have associated WQTs, including anthracene, benzo(a)pyrene, fluoranthene, and naphthalene, were not detected in groundwater samples. In addition, the remaining SVOC indicator compounds that were detected in groundwater do not have WQTs for their assessment (see associated table in Appendix E) and their recorded concentrations are not considered to comprise a significantly large enough percentage of the recorded petroleum hydrocarbon fraction. Therefore, the individual petroleum hydrocarbon fractions will be taken forward and assessed as part of the DQRA rather than their potential indicator compounds.

3.1.8 Limitations and uncertainty

The DQRA is subject to the following limitations and uncertainties:

- Attenuation may occur in the unsaturated zone but this is not included in the model, which may yield overly conservative predictions for soil sources.
- The model assumes instantaneous dilution of leaching contaminants in the groundwater body.
- Biodegradation is assumed to be occurring within the aquifer, although site-specific biodegradation rates have not been determined. Therefore, contaminant half-lives used in the model are based on values given in reliable literature sources and professional judgement. Monitoring to date (see Section 3.1.9) indicates generally anaerobic conditions suggesting that oxygen is being depleted by degradation, therefore, half-lives considered to be appropriate have been selected.
- The model assesses the risks from dissolved contaminants only – there is no assessment within the model of potential risks from the LNAPL, which has been recorded across the source area. Monitoring of LNAPL suggests the LNAPL is stable (i.e., not migrating).

3.1.9 Input parameters

Site-specific parameters used within the modelling are detailed in the below subsections. More general parameters, along with their justification, are summarised in Table 3.6. Contaminant-specific parameters are summarised in Table 3.7.

Dissolved phase groundwater concentration

The dissolved phase groundwater concentration trends for each of the risk driving COPC are presented on the trend graphs (and in the supporting tables) in Appendix E. The graphs are grouped into the location of the monitoring wells relative to the source area and the proven west/northwest groundwater flow direction (i.e., hydraulically upgradient, in source area, downgradient, etc.).

However, as previously discussed in Section 3.1.6, suspected LNAPL was recorded in WS103 during sampling in March and May 2022 (recorded as globules), and March's sample was a grab sample using a bailer, which may explain the significant increase in concentrations at this location rather than being representative of true dissolved phase concentrations.

Hydraulic gradient

The groundwater flow direction has been proven to be towards the west/northwest (i.e., towards the River Twyver and River Severn). The previously referenced shallow groundwater contour plots that are presented in Appendix A have been used to derive the hydraulic gradients summarised in Table 3.3.

Table 3.3: Summary of hydraulic gradient

Monitoring Date>>	June 1998	27 October 2020	8 March 2022	16 March 2022	21 March 2022	30 March 2022	4-6 May 2022
Average gradient	0.007	0.008	0.008	0.007	0.007	0.007	0.007

The hydraulic gradients are consistent both historically (as far back as 1998) and more recently. An average hydraulic gradient based on the seven contour plots of 0.007 is used as part of the DQRA presented within this report.

Permeability testing

Permeability testing was undertaken on monitoring wells BH101S, BH202, and BH204S on 5 May 2022. These wells all have their response zone installed within the shallow groundwater body in the Cheltenham Sand and Gravel. The testing comprised a series of both falling and rising head tests, and the results and findings of the testing are detailed within the accompanying Permeability Testing Analysis technical note (Ref: 20775-HYD-XX-XX-TN-GE-1000, dated 18 May 2022) in Appendix B.

The calculated hydraulic conductivities for each of the monitoring wells are summarised in Table 3.4.

Table 3.4: Hydraulic conductivity summary (m/d)

Monitoring well>>	BH101S		BH202		BH204S	
Test	Falling Head	Rising Head	Falling Head	Rising Head	Falling Head	Rising Head
Test 1 (m/d)	2.32	2.32	7.94	7.02	1.24	1.23
Test 2 (m/d)	1.22	2.02	7.02	7.81	0.85	1.92
Geomean	1.91		7.44		1.26	
Geomean (all)	2.61					

Calculated hydraulic conductivities across the three wells tested vary between 0.85 and 7.94 m/d. The wells are all installed in consistently characterised gravelly sands with consistent aquifer thicknesses within the wells. Therefore, the variation may be due to localised conditions within the aquifer and all data are considered representative. In addition, the range falls with the anticipated ranges for 'clean sand' reported by Freeze & Cherry (1979) (i.e., 8.64E-01 to 8.64E+02 m/d). The geomean of the site measured hydraulic conductivities of 2.61 m/d is used as part of the DQRA presented within this report.

Fractional organic carbon and moisture content

A total of seven soil samples from the unimpacted Cheltenham Sand and Gravel (i.e., without visual and olfactory evidence of contamination) have been analysed for fractional organic carbon (FOC) content. The results are summarised in Table 3.5. In addition, moisture content is also summarised in the below table, where relevant, which is a key parameter for calculating porosity.

Table 3.5: Fractional organic content and moisture content

Location	Depth (m bgl)	Strata	Visual or Olfactory Evidence	Zone	Fractional Organic Carbon	Moisture Content (%)
DP201	0.9	Cheltenham Sand and Gravel	No	Unsaturated	0.006	7.5
TP207	0.6		No		0.008	7.2
TP214	0.6		No		0.011	10.0
TP219	1.2		No		0.002	13.0
TP230	0.4		No		0.009	12.0
BH201	2.3		No	Saturated	0.002	--
BH202	1.2		No		0.004	--

The FOC content ranges from 0.002 to 0.011 within the unsaturated zone (i.e., the soil zone), and 0.002 to 0.004 within the saturated zone (i.e., the aquifer). Averages of 0.003 and 0.007, respectively, have been used as part of the DQRA presented within this report.

Geochemical parameters

The stabilised field measured geochemical parameters recorded during the low-flow groundwater sampling during Rounds 3 and 4 are summarised in the tables presented in Appendix B.

Due to the presence of LNAPL in monitoring wells WS104 and WS105, groundwater samples (and geochemical parameters) were not collected from these wells. Grab samples were collected from selected monitoring wells during Round 3, therefore, stabilised geochemical parameters were also not obtained from these wells.

In addition, during Round 4 the groundwater elevation within WS103 continued to fall whilst purging, therefore, the collection of a low-flow 'grab sample' was prioritised and the field measured geochemical parameters are not considered to have stabilised.

The distribution of the stabilised field measured dissolved oxygen and oxidation-reduction potential readings across the site are presented on the associated drawings (Ref: 20755-HYD-XX-XX-DR-GE-1008, and 1009, both dated 7 April 2022 [Round 3), and -1022, and -1023, both dated 17 May 2022 [Round 4]) presented in Appendix A. Their distribution can be summarised as:

- **Dissolved oxygen:** typically, values less than 0.5 mg/l were recorded in the field within monitoring wells in the source area and hydraulically downgradient.
- **Oxidation-reduction potential:** typically, negative values were recorded in the field within monitoring wells in the source area and hydraulically downgradient.

Petroleum hydrocarbons are generally oxidised at dissolved oxygen concentrations in excess of 1 mg/l, whereas concentrations less than 1 mg/L generally indicate anaerobic conditions. Therefore, within the source area and hydraulically downgradient, stabilised dissolved oxygen concentrations are generally indicative of anaerobic conditions and the on-going consumption of dissolved oxygen by aerobic degradation processes. In contrast, outside of this area concentrations are generally indicative of aerobic conditions.

The field measured oxidation-reduction potential readings were taken using an In-Situ AT500 multiparameter water quality meter that uses a silver/silver chloride electrode in potassium chloride solution, whereas the standard measurement for oxidation-reduction potential is based on a standard hydrogen electrode. The oxidation-reduction potential field measurements require correction to standardise them against the standard hydrogen electrode (In-Situ, 2022). This correction is shown in the geochemical summary table in Appendix E. The lowest corrected oxidation-reduction potential readings (i.e., less than 50 mV) are generally located in the source area or hydraulically downgradient, which indicates less oxidising (and potentially more reducing) conditions on site.

Analytical testing for evidence of nitrate, manganese, iron, and sulphate reduction was also undertaken to help determine whether degradation of the petroleum hydrocarbons is occurring on site. The concentrations of the key electron acceptors are generally favourable to support this and the results are presented in the geochemical summary table in Appendix E. This is also discussed separately in more detail as part of the natural attenuation assessment in Section 3.4.

It is considered that degradation of petroleum hydrocarbons is occurring on site and the DQRA models are set to 'apply degradation rate to pollutants in all phases'.

Summary of physical parameters

The physical input parameters, including literature values, where relevant, are summarised in Table 3.6.

Table 3.6: Summary of physical input parameters

Parameter	Value	Units	Justification
Water filled porosity of soil zone materials	0.157	-	Calculated using RTM porosity calculator using site-specific moisture content data (see Table 3.5) and density data for gravelly sand from Domenico & Schwartz (1990).
Air filled porosity of soil zone materials	0.271	-	
Bulk density of soil zone materials	1.59	g/cm^3	Mid-point for gravelly sand from Domenico & Schwartz (1990).
Bulk density of aquifer zone materials			
Infiltration rate	0.000475	m/d	20% of average annual rainfall at Cheltenham from Met Office (867 mm/yr). Considered suitable for a site to be covered by mixture of granular surfacing and hardstanding.
Saturated aquifer thickness	2.65	m	Average thickness of saturated Cheltenham Sand and Gravel from ground investigation data.
Groundwater plume width at source	60	m	Maximum thicknesses based on consistent data across impacted Cheltenham Sand and Gravel within the former tank farm and refuelling area (i.e., consistent exploratory log descriptions, visual/olfactory evidence, and analytical data).
Groundwater plume length at source	100	m	
Groundwater plume thickness at source	2.5	m	
Hydraulic gradient of water table	0.007	-	Mean hydraulic gradient for Cheltenham Sand and Gravel aquifer (see Table 3.3).
Hydraulic conductivity of aquifer	2.61	m/d	Geomean of hydraulic conductivity values from on site permeability testing of Cheltenham Sand and Gravel aquifer (see Table 3.4).
FOC in soil zone materials	0.003	-	Mean of unsaturated/saturated Cheltenham Sand and Gravel soil samples (see Table 3.5). Samples free of visual/olfactory evidence of contamination.
FOC in aquifer	0.007	-	
Effective porosity of aquifer	0.275	-	Mid-point for gravelly sand from Domenico & Schwartz (1990).
Path distance (i.e., compliance point)	50	m	Default compliance point for hazardous substances.
Time since pollutant entered groundwater	1 x 10^{99}	Years	Very large time chosen to achieve a steady-state solution.

Summary of contaminant parameters

The contaminant-specific input parameters are summarised in Table 3.7.

Table 3.7: Contaminant-specific input parameters

Contaminant of Potential Concern (COPC)	Koc (cm³/g)(1)	Henry's Law Constant(2)	Contaminant half-life (d)
Aliphatic >EC10-EC12	251,000	120	1,825(3)
Aliphatic >EC12-EC16	5,010,000	520	1,825(3)
Aliphatic >EC16-EC21	631,000,000	4,900	3,650(3)
Aliphatic >EC21-EC35	631,000,000	4,900	5,000(3)
Aromatic >EC10-EC12	2,512	0.14	130(4)
Aromatic >EC12-EC16	5,012	0.053	115(5)
Aromatic >EC16-EC21	15,819	0.013	476(6)
Aromatic >EC21-EC35	125,893	0.00067	1,953(7)

Notes:

1. TPH: Total Petroleum Hydrocarbon Criteria Working Group Series, Volume 3.
2. TPH: Total Petroleum Hydrocarbon Criteria Working Group Series, Volume 3.
3. Professional judgement taking 'Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand' (Ministry for the Environment, 2011) and also the relative ease of degradation of the various types of petroleum hydrocarbons using corresponding aromatic fractions as a general guide (i.e., also using notes [4] to [7] from Howard et al [1991]).
4. Midpoint naphthalene (Howard et al, 1991).
5. Midpoint of range for acenaphthylene, acenaphthene (Howard et al, 1991).
6. Midpoint of range for fluorene, anthracene, phenanthrene (Howard et al, 1991).
7. Midpoint of range for pyrene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(ghi)perylene, indeno(123cd)pyrene (Howard et al, 1991).

Although corresponding indicator compounds are not being assessed (see Section 3.1.7), information on their potential degradation rates from Howard et al (1991) are still considered relevant for the petroleum hydrocarbon fractions listed above (since information on these is not widely available elsewhere).

3.2 Risk assessment results

3.2.1 Modelled target concentrations

The full RTM worksheets for each of the COPC are presented in Appendix F and the results are summarised in Table 3.8.

Table 3.8: Summary of modelling results

Contaminant of Potential Concern (COPC)	Target Concentration at Receptor (µg/l)	50m Compliance Point			
		Level 3 Soil RTV (mg/kg)	Travel Time (soil) (years)	Level 3 Groundwater RTV (µg/l)	Travel Time (years) (groundwater)
Aliphatic >EC10-EC12	10	9.86E+33	4,532	2.92E+47	8,979
Aliphatic >EC12-EC16	10	3.94E+154	90,447	2.68E+215	179,184
Aliphatic >EC16-EC21	10	No impact	11,390,715	No impact	22,567,652
Aliphatic >EC21-EC35	10	No impact	11,390,715	No impact	22,567,652
Aromatic >EC10-EC12	10	5.34E+10	46	2.86E+17	92
Aromatic >EC12-EC16	10	2.54E+17	92	3.00E+26	181
Aromatic >EC16-EC21	10	2.43E+15	287	8.30E+22	568
Aromatic >EC21-EC35	10	7.35E+22	2,274	1.62E+32	4,505

Notes:

No impact = no significant breakthrough at compliance point (i.e., the source will likely be exhausted before significant breakthrough occurs).

All of the modelled RTVs are theoretical and are chemically impossible concentrations (i.e., 100% neat chemical would be in the order of 1E+9).

Travel times (both soil and groundwater) significantly exceed 1,000 years for all of the aliphatic petroleum hydrocarbon fractions modelled between >EC10-EC35, and also the aromatic fraction >EC21-EC35. These fractions have a high Koc (see Table 3.7) and a low to very low aqueous solubility (3.4×10^{-2} to 3.0×10^{-6} mg/l) indicating they have a low to very low relative mobility in groundwater, which is consistent with findings reported by CL:AIRE (2017). In addition, based on the input parameters used, the modelling for the aliphatic fractions >EC16-EC21 and >EC21-EC35 has determined that 'no significant breakthrough at compliance point' will occur, which indicates that the source of these fractions will likely be exhausted before significant breakthrough occurs (again consistent with the travel times in Table 3.8 and the findings by CL:AIRE [2017]). It is not considered that these petroleum hydrocarbon fractions will reach the surface water receptor and, therefore, do not pose a significant risk to Controlled Waters.

Notwithstanding their relative mobilities and travel times in excess of 1,000 years, for completeness, all fractions with a modelled RTV have been taken further for comparison against on site concentrations (both soil and groundwater).

3.2.2 Comparison against site conditions

The modelled RTVs are compared to on site soil and groundwater concentrations that were recorded during the ground investigation in Table 3.9 and Table 3.10, respectively.

Table 3.9: Comparison of derived soil target against on site concentrations

Contaminant of potential concern (COPC)	Level 3 Soil RTV (mg/kg)	Maximum Soil Concentration at Source (mg/kg)	Number of Exceedances
Aliphatic >EC10-EC12	9.86E+33	981	0
Aliphatic >EC12-EC16	3.94E+154	4,970	0
Aliphatic >EC16-EC21	No impact	6,560	NA
Aliphatic >EC21-EC35	No impact	2,560	NA
Aromatic >EC10-EC12	5.34E+10	360	0
Aromatic >EC12-EC16	2.54E+17	3,000	0
Aromatic >EC16-EC21	2.43E+15	3,800	0
Aromatic >EC21-EC35	7.35E+22	1,200	0

Notes:

All of the modelled RTVs are theoretical and are chemically impossible concentrations (i.e., 100% neat chemical would be in the order of 1E+9).

Table 3.10: Comparison of derived groundwater target against on site concentrations

Contaminant of potential concern (COPC)	Level 3 Groundwater RTV (µg/l)	Maximum Groundwater Concentration at Source (µg/l)	Number of Exceedances
Aliphatic >EC10-EC12	2.92E+47	31	0
Aliphatic >EC12-EC16	2.68E+215	1,300	0
Aliphatic >EC16-EC21	No impact	1,900	NA
Aliphatic >EC21-EC35	No impact	620	NA
Aromatic >EC10-EC12	2.86E+17	280	0
Aromatic >EC12-EC16	3.00E+26	1,100	0
Aromatic >EC16-EC21	8.30E+22	570	0
Aromatic >EC21-EC35	1.62E+32	290	0

Notes:

All of the modelled RTVs are theoretical and are chemically impossible concentrations (i.e., 100% neat chemical would be in the order of 1E+9).

The assessments in Table 3.9 and Table 3.10 record no exceedances of either the soil or groundwater modelled RTVs for any of the main risk driving COPCs.

3.3 Sensitivity analysis

The model input parameters listed in Table 3.6 (physical) and Table 3.7 (contaminant-specific) above are based on either site-specific values, where available, or have been taken from reliable literature sources. It is recognised that the input parameters are likely to fall within a range and that the chosen value can significantly impact the modelled RTVs.

The most sensitive input parameters for modelling are typically considered to be the following:

- Hydraulic gradient;
- Hydraulic conductivity; and
- Contaminant half-life.

Both hydraulic gradient and hydraulic conductivity are used to calculate groundwater velocity through the site and are based on site-specific values derived from the monitoring and testing undertaken during ground investigation. Significantly increasing the values would likely significantly decrease the modelled RTVs.

The hydraulic gradients calculated from site-specific data (historical and more recent) have been proven to only vary by 0.001 throughout the monitoring period as shown in Table 3.3 above. Therefore, the models are unlikely to be sensitive to the site-specific range of hydraulic gradients, and undertaking a sensitivity analysis on this parameter is unlikely to significantly change the modelled RTVs for both soil and groundwater.

Contaminant half-life is the time required to reduce the COPC concentration by half and has been taken from reliable literature sources. Significantly decreasing the values would likely significantly decrease the modelled RTVs.

The sensitivity of the models to hydraulic conductivity and contaminant half-life has been evaluated. The analysis has been undertaken on the petroleum hydrocarbon fraction aromatic >EC12-EC16 as the existing associated model already uses the lowest half-life in comparison to the other fractions (see Table 3.7 above).

The results of the sensitivity analysis for the soil and groundwater modelled RTVs are presented in Table 3.11 and

Table 3.12, respectively.

Table 3.11: Soil RTV sensitivity analysis

Parameter	Original Value used	Sensitivity Analysis		Soil Level 3 RTV (Minimum) (mg/kg)	Soil Level 3 RTV (Maximum) (mg/kg)	Comment
		Minimum Value	Maximum Value			
Hydraulic conductivity (m/d)	2.61	0.85	7.94	8.93E+11	5.12E+21	Range based on site-specific values from permeability testing during ground investigation. See Table 3.4 above.
Contaminant half-life (d)	115	58	230	5.58E+11	2.77E+25	Range based on 50% to 200% of value used. This range is supported by the maximum half-life reported for indicator compounds (acenaphthylene and acenaphthene) is 215 days (Howard et al, 1991).

Table 3.12: Groundwater RTV sensitivity analysis

Parameter	Original Value Used	Sensitivity Analysis		Ground-water Level 3 RTV (Minimum) (µg/l)	Ground-water Level 3 RTV (Maximum) (µg/l)	Comment
		Minimum Value	Maximum Value			
Hydraulic conductivity (m/d)	2.61	0.85	7.94	6.87E+11	1.19E+44	Range based on site-specific values from permeability testing during ground investigation. See Table 3.4 above.
Contaminant half-life (d)	115	58	230	3.01E+15	6.51E+34	Range based on 50% to 200% of value used. This range is supported by the maximum half-life reported for indicator compounds (acenaphthylene and acenaphthene) is 215 days (Howard et al, 1991).

Calculated hydraulic conductivities across the three wells tested during the ground investigation do vary between 0.85 and 7.94 m/d and the geomean was used as the original input parameter (see Section 3.1.9 for more information). The model is shown to be sensitive when this parameter is adjusted within the site-specific ranges.

Published degradation rates (i.e., half-lives) for petroleum hydrocarbon fractions are not widely available. A combination of literature sources on available petroleum hydrocarbon half-lives (Ministry for the Environment, 2011) and indicator compounds (Howard et al, 1991), and then refining these with professional judgement, has been used for the original input parameters in the modelling (see Section 3.1.9). The ranges then used within the sensitivity analysis are broadly based on the published ranges for the indicator compounds within Howard et al (1991). The model is shown to be sensitive when this parameter is adjusted within the specified ranges.

The sensitivity analysis has indicated that the model is sensitive to the ranges for both hydraulic conductivity and contaminant half-life. However, the original input parameter values used in the modelling are considered appropriate as they are based on (and constrained by) either site-specific data or reliable literature sources.

In addition, no exceedances of the derived soil and groundwater RTVs from the sensitivity analysis in Table 3.11 and

Table 3.12 (see above) are recorded when comparing these targets against the on site soil and groundwater concentrations. The risk to the Controlled Water receptor is still considered to be low even when using the most conservative modelled RTVs.

3.4 Natural attenuation assessment

To supplement the findings of the modelling that the risk to the Controlled Waters receptor is low, a natural attenuation assessment has been carried out to demonstrate that the plume is considered to be stable and that biodegradation of the petroleum hydrocarbons is occurring on site.

3.4.1 Approach

The approach of the natural attenuation assessment comprises:

1. Review of primary lines of evidence for natural attenuation, including the spatial extent of impact and temporal trends.
2. Review of secondary line of evidence for natural attenuation, including comparison of COPC and electron acceptor distribution.

3.4.2 Introduction to natural attenuation

Natural attenuation is the process under which contaminants within groundwater will degrade and decrease. Natural attenuation can progress effectively without biodegradation, however, attenuation through dilution does not result in mass reduction. For petroleum hydrocarbons, biodegradation is considered to be the primary mechanism by which the solute mass is removed.

The biodegradation of petroleum hydrocarbons occurs through their use by micro-organisms as primary substrates (sources of carbon and energy). During the metabolism process, electrons are transferred from the hydrocarbon to facilitate the release of energy. The hydrocarbon is termed an ‘electron donor’. The process also requires an ‘electron acceptor’ for the transferred electrons, and nutrients such as nitrate. Typical electron acceptors are oxygen, nitrate, ferric iron, sulphate, and carbon dioxide, which are utilised strictly in that order. The degradation of petroleum hydrocarbons occurs most effectively under aerobic (oxygen reducing) conditions, and reaction efficiency reduces significantly down the scale of electron acceptors. The degradation process is limited by the supply of electron acceptors, but since these are generally present in abundance in the natural environment, the biodegradation of petroleum hydrocarbons under aerobic conditions typically proceeds to complete degradation to non-toxic by-products.

The R&D Publication 95 by the Environment Agency (2000) suggests the use of three lines of evidence to determine if natural attenuation is occurring at the subject site:

- The primary line of evidence involves defining the plume as stable, shrinking or expanding. Emphasis is placed on demonstrating that concentrations of contaminants of concern are stable or decreasing hydraulically downgradient of the source area(s), along the groundwater flow path. For a dissolved phase plume, primary evidence is generally based on measured COPC concentrations over time. A shrinking or stable plume is indicative of natural attenuation.
- Secondary lines of evidence are used to support the primary evidence and involve measuring changes in chemical and geochemical data to demonstrate a loss of contaminant mass. This could include measuring groundwater parameters (e.g., dissolved oxygen and oxidation-reduction potential) and analytical testing of groundwater for geochemical indicators of natural biodegradation processes (i.e., manganese (III) and ferrous iron concentrations). The data are used to indicate that decreases in parent contaminant and/or electron acceptor/donor concentrations could be the result of an increase in metabolic by-products and/ or daughter compounds.
- Tertiary lines of evidence use data from laboratory microbiological testing to show that indigenous bacteria are capable of degrading site contaminants. This line of evidence is used when the first lines of evidence are inconclusive. Tertiary lines of evidence have not been considered at this stage.

To evaluate natural attenuation processes, it is considered that a minimum requirement for the groundwater monitoring well network is:

- Up hydraulic gradient monitoring well(s) to determine changes in background water quality;
- Cross-gradient monitoring well(s) to provide data on the plume geometry and seasonal changes in groundwater or plume flow direction;
- Monitoring well(s) in the contaminant source area to monitor changes in source strength with time;
- Monitoring well(s) located down hydraulic gradient of the source area, but within the contaminant plume to monitor plume behaviour and changing concentrations with time. These will normally be located along the centre line of the plume;
- Monitoring well(s) located immediately downgradient from the contaminant plume to provide data on the migration of the plume. Ideally these wells will also provide supporting evidence for natural. For example, evidence of an absence of contaminants but the depletion of electron acceptors, (for instance, decrease in nitrate and dissolved oxygen concentrations as advanced evidence of hydrocarbon pollution); and
- Sentinel monitoring well(s) located further downgradient between the plume and the identified receptor.

A significant monitoring well network is present at the site. The wells within the monitoring network that are used as part of the natural attenuation assessment, and based on the proven west/northwest, are listed in Table 3.13.

Table 3.13: Monitoring well network used as part of the natural attenuation assessment

Relative hydraulic location to source area	Monitoring Wells	Relative distance to source area (range)
Upgradient	WS104, BH101S, and WS116.	10 m
Cross-gradient	WS105.	20 m to 60 m
Within source area	WS203, WS101, WS204, WS102, WS205, WS103, WS206, and WS115.	NA
Downgradient	Row 1: WS204S, BH203, BH206	8 m to 18 m
	Row 2: BH205, and BH202	40 m to 70 m
Sentinel for the receptor	WS114, WS111, and WS110.	115 m to 150 m

The current monitoring well network is considered suitable to assess the efficacy of natural attenuation processes.

3.4.3 *Primary lines of evidence*

The principal primary line of evidence used to demonstrate that a groundwater plume is stable, shrinking or expanding, is the spatial extent and temporal trends of COPC concentrations, which are discussed in the subsections below.

Spatial extent and trends

Concentration trends over the period October 2020 to May 2022 for each of the petroleum hydrocarbon risk driving COPC are presented in Appendix E. The key findings grouped by monitoring well location are summarised below:

- Upgradient wells:
  - Only a single detection of aromatic fraction >EC12-EC16 has been recorded above laboratory method detection limit at WS116 at a maximum concentration of 17 µg/l (October 2020).
  - All other fractions have remained stable and have consistently been below laboratory method detection limit.
- Cross-gradient wells:
  - Concentrations of the two aliphatic fractions >EC12-EC16 and >EC21-EC35 have been recorded marginally above laboratory method, both at a maximum concentration of 11 µg/l (November 2020).
  - All other fractions have consistently been below laboratory method detection limit.
- Source area wells:
  - Concentrations of several aliphatic and aromatic fractions have fluctuated in several of the wells within the source area, notably between March and May 2022. The analytical data are often significantly above solubility limits, and the wells are all located near to observations of LNAPL recorded during the ground investigation. The fluctuations could indicate that LNAPL is also present at these locations and may have been entrained into the sample.
  - Concentrations of all fractions at WS103 significantly increased (by orders of magnitude) in March 2022, and then decreased again (by orders of magnitude) in May 2022. The potential reasons for this have previously been discussed, most notably that a grab sample using a bailer was collected at this location in March 2022 and globules of LNAPL were suspected. Analytical data are also significantly above solubility limits, which is also indicative of a LNAPL source at this location. Therefore, the analytical data may not be reflective of true dissolved phase groundwater concentrations at this location.
- Downgradient wells:
  - Concentrations of all aliphatic fractions >EC10-EC35 have remained stable and have consistently been below laboratory method detection limit at all wells downgradient of the source area (i.e., both ‘Row 1’ and ‘Row 2’).
  - Concentrations of aromatic fractions have been recorded at BH204S, BH203, and BH206, which are the closest wells to the source area (i.e., ‘Row 1’ ranging between 8 m and 18 m downgradient). Recorded concentrations at these wells are generally an order of magnitude lower than the maximum recorded concentration in the source area, and have remained relatively stable/show a small decrease between March and May 2022.

- Concentrations of all aromatic fractions have remained stable and have consistently been below laboratory method detection limit at BH205 and BH202, which are further from the source area (i.e., 'Row 2' ranging between 40 m and 70 m downgradient).

Sentinel wells:

- Only a single detection of aromatic >EC12-EC16 has been recorded above laboratory method detection limit at WS111 at maximum concentration of 31 µg/l (October 2020).
- All other fractions have remained stable and have consistently been below laboratory method detection limit.

Travel times

The modelled travel times for each of the petroleum hydrocarbon risk driving COPC are presented in Table 3.8 above.

The travel times in groundwater significantly exceed 1,000 years for all of the aliphatic petroleum hydrocarbon fractions modelled between >EC10-EC35, and also the aromatic fraction >EC21-EC35. These high travel times and low to very low relative mobilities in groundwater are corroborated by the groundwater analytical data for the downgradient wells. With the exception of low-level detections of aromatic >EC21-EC35 at BH204S, BH203, and BH206 in March 2022, which are the closest wells to the source area (maximum 170 µg/l at BH204S approximately 8 m downgradient), these specific fractions were not recorded above laboratory method detection limit. This suggests that breakthrough is not occurring beyond the closest downgradient wells.

The travel times in groundwater for the remaining aromatic fractions between >EC10-EC21 are orders of magnitude lower and range between 92 and 568 years. Low-level concentrations of these fractions have been recorded at the wells closest to the source area that range between 8 m and 18 m downgradient. The recorded concentrations are typically an order of magnitude lower than the maximum recorded concentration at WS203 in the source area, and breakthrough is not occurring beyond these wells (i.e., concentrations have always been below laboratory method detection limit at the further downgradient wells BH205, BH202, and also within the sentinel wells).

Various railway sidings, tanks, buildings, and engine sheds have been located across the site over the past 130 years with the fuel storage and refuelling infrastructure in the source area first marked on the 1954 mapping. The petroleum hydrocarbons could have been present in soil and groundwater for 70 years or more, which is of the same order of magnitude as the estimated travel times modelled for the more moderate mobility fractions reported by CL:AIRE (2017).

3.4.4 Secondary lines of evidence

The distribution of electron acceptors for the biodegradation of petroleum hydrocarbons is presented in the geochemical summary table in Appendix E. The key findings are summarised below:

- Dissolved oxygen:
  - Petroleum hydrocarbons may be oxidised aerobically at dissolved oxygen concentrations in excess of 1 mg/l, whereas concentrations less than 1 mg/l generally indicate an anaerobic environment. Oxygen is the first electron receptor to be used during the biodegradation process; therefore, a correlation between high impact and low dissolved oxygen may indicate natural attenuation is occurring.

  - Low dissolved oxygen concentrations were identified in the wells within the source area and hydraulically downgradient, indicative of anaerobic conditions and the on-going consumption of dissolved oxygen by aerobic degradation processes. In contrast, dissolved oxygen within the upgradient and cross-gradient wells is typically above 1 mg/l, indicative of aerobic conditions.
- Nitrate → Nitrite:
  - As nitrate reduction occurs, concentrations of nitrate are expected to decrease.
  - Nitrate concentrations are relatively low in the upgradient and cross-gradient wells (i.e., less than 5 mg/l) indicating that nitrate is unlikely to be a significant electron acceptor at the site. Nitrate is depleted (<0.5 mg/l) in the wells within the source area and hydraulically downgradient relative to the upgradient and cross-gradient wells, indicative that nitrate reduction is occurring.
- Manganese IV → Manganese II:
  - As manganese IV reduction occurs, concentrations of manganese II are expected to increase. The presence of manganese II may indicate the anaerobic biodegradation of petroleum hydrocarbons where dissolved oxygen and nitrate are depleted.
  - Low-level manganese II concentrations were detected in the source area and hydraulically downgradient. Whilst there is some evidence for increasing manganese concentrations downgradient of the source area, the magnitude of the increases is relatively small, with concentrations typically <1 mg/l, indicating that manganese is unlikely to be a significant electron acceptor in this environment, or that it is being removed, potentially through precipitation of metal sulphides.
- Iron III → Iron II
  - Iron II ions are short lived in groundwater, as this species is readily oxidised as it migrates from anaerobic to aerobic environments. Therefore, the presence of iron II indicates both anaerobic conditions and the reduction of iron III, often by biotic processes (i.e., iron reducing bacteria). As iron III reduction occurs, concentrations of iron II are expected to increase.
  - Iron II concentrations were all below laboratory method detection limit (<0.2 mg/l) with the exception of WS101 in the source area. The low concentrations indicate iron may be of limited significance as an electron acceptor in this environment or that it is being removed, potentially through precipitation of metal sulphides.
- Sulphate → Sulphide:
  - Sulphate reduction is generally only observed when the environment is strongly reducing (i.e., lower than -220 mV), therefore, from the corrected oxidation-reduction potential readings (typically above 50 mV) it would not be expected to occur at this site. As sulphate reduction occurs, sulphate concentrations within the plume area are expected to decrease.
  - The highest sulphate concentrations (between 97 and 118 mg/l) were detected in the upgradient wells and also around the centre of the source area. There is some evidence for decreasing sulphate concentrations downgradient with the lower sulphate concentrations (≤20 mg/l) detected at BH204S and BH206 indicating that some sulphate reduction may be occurring.
- Methanogenesis:
  - Methanogenesis usually occurs under highly reducing conditions when the processes described above involving oxygen, nitrate, manganese, iron and sulphate reduction have been completed. During methanogenesis, carbon dioxide is used as an electron donor and methane is produced.

- Dissolved methane concentrations in groundwater have not been analysed for, however, methane concentrations (%) in the well head from the ground gas monitoring have been shown as an indication. Methane concentration in the well head is negligible with maximums of 0.8% and 1.8% recorded within the source area and downgradient, respectively.

3.4.5 Discussion

The spatial extent and trends indicate that the dissolved phase plume is likely to be stable. The stable temporal trends are most notable within the historical wells across the site that were sampled over the period 2020 to 2022. Concentrations of petroleum hydrocarbons in the more recent source area wells have fluctuated between March and May 2022, however, this may have been influenced by the presence of LNAPL and hence may not have been true dissolved-phase concentrations.

The petroleum hydrocarbon concentrations in the closest downgradient wells (‘Row 1’) show a rapid decreasing trend relative to the source area, before concentrations are not recorded above laboratory method detection limit beyond (‘Row 2’). The spatial extents are corroborated by the modelled travel times for each of the main risk driving COPC, which also demonstrate that the COPC are likely to be exhausted before significant breakthrough at the downgradient wells occurs (i.e., the COPC are unlikely to reach the surface water receptor).

Evidence for the biodegradation of petroleum hydrocarbons has also been established. The geochemical parameters indicate a generally anaerobic environment in the source area and also hydraulically downgradient. A strong correlation between relative high COPC concentration and low dissolved oxygen is shown, as well as the depletion of other parameters, including nitrate, manganese, iron, and sulphate.

Given the age of the former railway sidings area, and that the petroleum hydrocarbons could have been present in soil and groundwater for 70 years or more, the dissolved phase groundwater plume is considered to be stable and not expected to expand further. It is considered likely that natural attenuation processes are operating to mitigate risks to Controlled Waters from the residual impacts present at the site.

3.5 Consideration of plausible climate change effects

LCRM (Environment Agency, 2021) recommends that the potential environmental changes caused by predicted climate change are considered in risk assessments where climate change could have an impact on contaminant fate and transport and consequently receptor risk. Forthcoming Society of Brownfield Risk Assessment (SoBRA) guidance on Controlled Waters risk assessment and climate change, advocates that a number of climate change factors are considered. In the context of this site the most relevant consideration is impact of extreme rainfall events and the potential for increased hydraulic gradients and/or flooding.

The Environment Agency classifies the site to be in Flood Zone 1 and has a very low risk of Risk of Flooding from Rivers and the Sea (RoFRaS), which is equivalent to 1 in a 1,000-year chance of flooding.

The Phase 1 Desk Study prepared by Ove Arup & Partners Ltd for Network Rail to support the sale of the site (Ref: REP/006/16, dated 25 April 2016) recorded the potential for groundwater flooding at surface. This was due to the shallow nature of the superficial Cheltenham Sand and Gravel aquifer that overlies the low permeability Solid Geology of the Charmouth Mudstone Formation.

The site is located in an area with a very low risk of flooding from rivers and sea, however, if extreme rainfall events due to climate change were to increase groundwater levels, the LNAPL recorded across the source area would be pushed closer to the proposed sub-surface and surface infrastructure of the proposed development.

3.6 Summary and conclusions

- A DQRA to quantify the risk posed to the Controlled Waters receptor has been carried out for the petroleum hydrocarbon contamination recorded in the soil and groundwater across the former railway sidings area of the site (as reported in the Hydrock GIR).
- The site is characterised by groundwater within the superficial Cheltenham Sand and Gravel (Secondary A Aquifer), which provides baseflow towards the culverted River Twyver approximately 250 m west/northwest of the site at its closest hydraulically downgradient point (the nearest un-culverted section is approximately 250 m southeast and hydraulically cross-gradient).
- The main risk driving COPCs comprise petroleum hydrocarbon fractions (both aliphatic and aromatic) between >EC10-EC35. Indicator compounds have not been modelled as they have not been detected at a significantly large enough percentage of the associated fraction.
- To assess the risks to Controlled Waters, the following scenario has been modelled:
    - » vertical leachate migration through the unsaturated zone and lateral transport through baseflow within the Cheltenham Sand and Gravel; and
    - » a hypothetical compliance point of 50 m from the source area has been set, based on the maximum distance for hazardous substances.
- Input parameters for the model are either derived from site-specific testing or are appropriate and conservative values selected from reliable literature sources.
- The model is sensitive to the values of hydraulic conductivity and contaminant half-lives. The hydraulic conductivity values used in the model are constrained by site-specific conditions, whereas contaminant half-life values are literature-based and as such introduce significant conservatism.
- Travel times to the designated 50 m compliance point exceed 1,000 years for 5 out of the 8 petroleum hydrocarbon fractions, indicating that these fractions are unlikely to reach the surface water receptor.
- Notwithstanding the high travel times and relative low mobilities, all modelled soil and groundwater RTVs were compared against analytical data for the site, concluding:
    - » no exceedances of either the soil or groundwater modelled RTVs were recorded for any of the main risk driving COPCs.
- A natural attenuation assessment was also undertaken to supplement the findings of the DQRA, concluding:
    - » the spatial extent and trends indicate that the dissolved phase plume is likely to be stable;
    - » the geochemical parameters provide evidence for the biodegradation of petroleum hydrocarbons; and
    - » natural attenuation processes are likely operating to mitigate risks to Controlled Waters from the residual impacts present at the site.
- The findings of the DQRA and the natural attenuation assessment indicate that the risk to Controlled Waters is low and that remediation from a Controlled Waters perspective is not considered to be warranted.

- However, the modelling is applicable to the dissolved-phase groundwater contamination only. Given the shallow depths to LNAPL recorded across the source area, it is not considered practical to leave the LNAPL beneath the proposed development.
- The site has a very low risk of flooding from rivers and sea, however, if extreme rainfall events due to climate change were to increase groundwater levels (the site is located in an area with the potential for groundwater flooding), the LNAPL would be pushed closer to the proposed sub-surface and surface infrastructure/buildings of the proposed development.
- The LNAPL should be removed as far as reasonably practicable. In addition, LNAPL impacted /grossly impacted residual soils should also be removed to reduce the long-term source strength and enhance the potential for natural attenuation to mitigate the dissolved phase hydrocarbon plume longevity.
- The extent of the remediation required should be determined through the preparation of a ‘Remediation Options Appraisal’, followed by the preparation of a ‘Remediation Strategy and Verification Plan’.

4. DETAILED QUANTITATIVE RISK ASSESSMENT – HUMAN HEALTH (VAPOUR PATHWAY)

The Hydrock 2022 GIR reported hydrocarbon vapours in the monitoring wells at concentrations above 50 ppm, notably within wells near the fuel storage and refuelling infrastructure of the former railway sidings. Consequently, higher tiers of risk assessment were recommended to quantify the risk to human health from petroleum hydrocarbon vapours.

The rationale and approach of the DQRA for human health (vapour pathway) are presented in Section 4.1 and Section 4.2, respectively. The DQRA has been phased and the methodologies and results of each individual phase are presented in their own relevant subsection (Section 4.3 [screening] and Section 4.4 [modelling]).

4.1 Rationale

Ground investigation has shown there to be petroleum hydrocarbon LNAPL and dissolved phase groundwater contamination that may impact upon the future site occupants through the generation of petroleum hydrocarbon vapours. The potentially active pollutant linkage with respect to human health is based on the following scenario:

- **Source:** petroleum hydrocarbon impacts in the central portion of the former railway sidings, comprising the fuel storage, refuelling infrastructure and interceptors (i.e., in soil, as LNAPL, and in dissolved phase groundwater).
- **Pathway:** petroleum hydrocarbon vapour ingress via permeable soils and/or construction gaps.
- **Receptor:** future site occupants of the residential properties.

Other human health pathways are not addressed further as the Hydrock 2022 GIR recommendation for the implementation of a clean cover system as part of the proposed development still stands.

4.2 Approach

The approach for the DQRA for vapour intrusion of petroleum hydrocarbons is as follows:

- Screen proposed building distances to identified LNAPL and dissolved phase petroleum hydrocarbon impacts using screening distances based on appropriate literature sources.
- If proposed building locations fall within the applied screening distances, carry out vapour intrusion modelling using the CLEA tool. The modelling generates SSAC for the main risk driving COPC at the site, which are protective of human health.

4.3 Vapour intrusion screening distance

4.3.1 Introduction

The most recent guidance on the assessment for vapour intrusion (such as ASTM E2600 [2015] and US EPA OUST [2015]), advocate the use of screening distances to rule out the viability of vapour intrusion to buildings that are a safe distance away from the petroleum hydrocarbon source (note the guidance is limited to relatively small sources – for example those associated with underground storage tanks – and is not relevant to larger scale sources associated with bulk storage depots or refineries). Where vapour sources exist within the screening distances they are 'screened in' for further assessment and the guidance then advocates the use of quantitative assessment.

The Tier 1 search distance advocated in ASTM E2600 (2015) is 160 m for petroleum hydrocarbon sources and the Tier 2 screening distances designed to provide greater certainty are 9 m for dissolved phase plumes and 30 m for LNAPL. Once the absence of potential acute vapour risks has been confirmed, the guidance permits further modification of these distances based on site specific factors that affect vapour attenuation along the vapour migration pathway. Moreover, the US EPA OUST (2015) guidance provides vertical screening distances of 2 m for dissolved phase petroleum hydrocarbons and 4.6 m for LNAPL, and shorter distances still are advocated by Lahvis et al (2013) and Lahvis (2017) who emphasise the significance of vapour degradation in the unsaturated zone on actual vapour intrusion risk. This concept has been picked up by SoBRA (2017) in its recent development of GAC for vapour intrusion from groundwater and its summer workshop in 2017.

Precluding factors for the use of vapour intrusion screening distances include the presence of preferential pathways (e.g., underground services), large buildings (i.e., more than 20 m in length/width), fuel spills containing leaded fuels or bioethanol, biologically inactive soils (such as very dry coarse soils with very low organic content), soils with a very high organic content, soils with very low oxygen content (i.e., less than 1%v/v), and fractured/faulted rock. However, precluding factors are not considered relevant to the proposed development.

The screening distances from the different literature sources are summarised in Table 4.1.

Table 4.1: Summary of lateral and vertical screening (inclusion) distances

Source	US EPA OSWER (2015)	ITRC (2014)	Lahvis et al (2013)	Lahvis (2017)
LNAPL	4.6 m (benzene)	4.6 m (benzene)	4 m (benzene)	0-2.1 m (petroleum hydrocarbon fractions) 4.6m (n-hexane) 0.91m (naphthalene)
Dissolved phase	1.8 m (benzene)	1.5 m (benzene)	0 m (benzene)	-

For non-petroleum vapour sources, the Tier 1 search distance advocated in ASTM E2600 (2015) is 536 m, and the Tier 2 screening distance (to be used if supporting site investigation data is available on source size and behaviour) is 30 m. It is noted that EPA OSWER guidance (9200.2-154) does not specifically endorse this distance; stating that whilst theoretical analyses and anecdotal reports support it, a 30 m buffer would be inappropriate for certain higher risk scenarios. The US EPA recommends investigating soil vapour migration on a site-specific basis (i.e., larger or smaller distances may need to be considered when developing vapour intrusion investigation objectives and resultant data.

Lahvis (2017) provides a range of screening distances between 0 m and 2.1 m based on the different petroleum hydrocarbon fractions. The main risk driving petroleum hydrocarbon COPC at the site have been determined to be aliphatics and aromatics between >EC10-EC35, this is based on the ‘Product ID’ laboratory analysis undertaken on the LNAPL and also dissolved phase groundwater concentrations. Therefore, the most appropriate screening distance for the site from Lahvis (2017) is 1.2 m (based on aliphatics C9-C12). This distance will be used in the screening distance assessment detailed below.

4.3.2 Screening distance assessment

The locations and depth of LNAPL that has been confirmed on site is presented in Table 4.2.

Table 4.2: Summary of confirmed LNAPL on site

ID	Location Type	Depth to Top of LNAPL (shallowest recorded) (m bgl)	Comment
WS102	Monitoring well	0.99	Measured thickness in well.
WS115		1.34	Measured thickness in well.
TP210	Trial pit excavation	1.00	Seepage at 1.00 including LNAPL.
TP211		1.30	LNAPL and sheen and on groundwater.
TP222		1.40	LNAPL on groundwater.
TP226		1.30	LNAPL flooding excavation.
TP211		0.80	LNAPL seepage into excavation.

Notes:
Red denotes the depth of LNAPL is within the 1.2 m screening distance.

The recorded LNAPL locations and the current proposed development layout are presented on the Vapour Intrusion Screening Distance Assessment drawing (Ref: 20775-HYD-XX-XX-DR-GE-1026, dated 23 June 2022) in Appendix A.

The distance assessment shows that LNAPL is located beneath proposed building locations within the 1.2 m screening distance both vertically and laterally. The confirmed LNAPL locations are shown on the enclosed drawing, however, based on multiple lines of evidence (e.g., exploratory logs, soil concentrations, dissolved phase groundwater concentrations, saturations limits, etc.), it is considered likely that LNAPL is also present between these confirmed locations and also at other locations near the fuel storage and refuelling infrastructure to the east. The shallow groundwater within the Cheltenham Sand and Gravel has been recorded as shallow as 0.73 m bgl, therefore, any LNAPL at other locations is also likely to be within the 1.2 m screening distance.

Using the phased approach detailed in Section 4.2, vapour intrusion modelling using the CLEA tool is recommended.

4.4 Vapour intrusion modelling

4.4.1 Guidance

The vapour intrusion modelling that follows has been carried out in accordance with the following guidance documents:

- Environment Agency. 2009. Human health toxicological assessment of contaminants in soil. Science Report SC050021/SR2.
- Environment Agency. 2009. Updated technical background to the CLEA model. Science Report: SC050021/SR3.
- Environment Agency. 2009. CLEA Software (Version 1.05) Handbook. Science Report: SC050021/SR4.

4.4.2 Model selection

The model chosen for this assessment is the Environment Agency's CLEA tool v1.071. This is a deterministic model that back-calculates acceptable contaminant soil concentrations at the source based on defined acceptable environmental standards at a receptor. There are more advanced vapour intrusion models that can be used, however, at this stage in the assessment process the CLEA model is considered to be an appropriate starting point.

4.4.3 Contaminants of Potential Concern

The main risk driving petroleum hydrocarbon COPC at the site have been determined to be aliphatic and aromatic fractions between >EC10-EC35. This has been determined based on consistent soil concentrations across the source area, the 'Product ID' laboratory analysis undertaken on the LNAPL, and also dissolved phase groundwater concentrations across the source area and hydraulically downgradient. It is noted that the EC16-35 fractions have a low volatility and vapour emissions from these fractions is likely to be very low.

The COPC that are judged as the main risk drivers requiring modelling are summarised in Table 4.3.

Table 4.3: Contaminants of potential concern considered main risk drivers for CLEA modelling

Contaminant of Potential Concern (COPC)	Consistent soil concentrations across source	Fraction within identified LNAPL	Consistent dissolved phase groundwater concentrations across source and downgradient
Aliphatic >EC10-EC12	Yes	Yes	Yes
Aliphatic >EC12-EC16	Yes	Yes	Yes
Aliphatic >EC16-EC35	Yes	Yes	Yes
Aromatic >EC10-EC12	Yes	Yes	Yes
Aromatic >EC12-EC16	Yes	Yes	Yes
Aromatic >EC16-EC21	Yes	Yes	Yes
Aromatic >EC21-EC35	Yes	Yes	Yes

4.4.4 Limitations and uncertainty

The modelling is subject to the following limitations and uncertainties:

- Degradation in the vapour phase may occur in the unsaturated zone but this is not included in the model, which may yield overly conservative predictions.
- Where the derived SSAC exceed the lower saturation limit of the COPC (shown by red highlight in the CLEA model), exposure from the vapour pathway will be over-predicted (i.e., exposure is unlikely to reach the relevant health criteria value [HCV] and the risk is likely to be negligible [Environment Agency, 2009c]).
- The CLEA tool does not model the potential risks associated with non-aqueous phase liquid (NAPL), and its presence should be considered when the derived SSAC exceed the lower saturation limit of the COPC. LNAPL has been confirmed on site and the CLEA handbook (Environment Agency, 2009c) recommends that a NAPL-specific model should be used in this scenario, however, the models referenced within the handbook have now been withdrawn and not directly replaced.
- NAPL can create greater vapour by direct volatilisation from the NAPL phase but with 4-phase partitioning Raoult's law applies and the partial vapour pressures of each constituent is limited by that constituent's molar fraction within the NAPL.
- Soil vapour monitoring or sampling is not available to calibrate the model. This would improve the confidence in the phase partitioning calculations the model performs, and permit an assessment of vapour intrusion directly from the measured soil vapour concentrations. This is of particular benefit if source remediation is not being considered.

4.4.5 Input parameters

The site-specific parameters that have been changed from the default CLEA model settings are summarised in Table 4.4. The remaining default settings for the CLEA model for a residential setting are presented in the CLEA settings worksheet in Appendix G.

Table 4.4: Summary of site-specific input parameters

Parameter	Value	Units	Justification
Building type	Medium/large terraced house	-	Corresponds with typical footprint of terraced townhouses in Southern Area of proposed development (approximately 40 m^2).
Soil type	Sand	-	Based on ground investigation data and exploratory log descriptions for the Cheltenham Sand and Gravel.
Soil organic matter (SOM) %	1	%	Average of SOM values for unimpacted Cheltenham Sand and Gravel across the site.
Depth to top of source	110	cm	Average depth to top of identified impacts from ground investigation data.
Thickness of contaminant layer	250	cm	Maximum thicknesses based on consistent data across impacted Cheltenham Sand and Gravel within the former tank farm and refuelling area (i.e., consistent exploratory log descriptions, visual/olfactory evidence, and analytical data).

4.4.6 Modelling results

Site-Specific Assessment Criteria

The CLEA model results worksheet is presented in Appendix G and the derived SSAC are summarised in Table 4.5.

Table 4.5: Summary of CLEA vapour intrusion SSAC

Contaminant of Potential Concern (COPC)	Site-Specific Assessment Criteria			SSAC Flag	Lower Soil Saturation Limit (mg/kg)
	Oral HCV (mg/kg)	Inhale HCV (mg/kg)	Combined (mg/kg)		
Aliphatic >EC10-EC12	NR	1.30E+02	1.30E+02	Combined	4.77E+01
Aliphatic >EC12-EC16	NR	7.52E+02	7.52E+02	Combined	2.37E+01
Aliphatic >EC16-EC35	8.11E+04	NR	NR	Oral	8.48E+00
Aromatic >EC10-EC12	NR	1.73E+02	1.73E+02	Combined	3.62E+02
Aromatic >EC12-EC16	NR	1.81E+03	1.81E+03	Combined	1.68E+02
Aromatic >EC16-EC21	4.40E+04	NR	NR	Oral	5.36E+01
Aromatic >EC21-EC35	6.87E+06	NR	NR	Oral	4.83E+00

Notes:

Red shading denotes the derived SSAC is above the lower soil saturation limit of the COPC.

Green shading denotes the derived SSAC is below the lower soil saturation limit of the COPC.

The red shading within the above table demonstrates that the derived SSAC exceed the associated lower soil saturation limit for six out of the seven main risk driving COPC. The relationship between vapour concentration and soil concentration is summarised in Figure 4.1. As the lower soil saturation limit for the COPC is reached, increasing the soil concentration will not result in the generation of more vapour as the vapour concentration is capped at the vapour saturation limit (as shown by the plateauing of the graph below). Therefore, comparison of these SSAC against on site soil concentrations will be overly conservative. Exposure is unlikely to reach the relevant HCV and the risk based on the conceptual model is likely to be negligible (Environment Agency, 2009c).

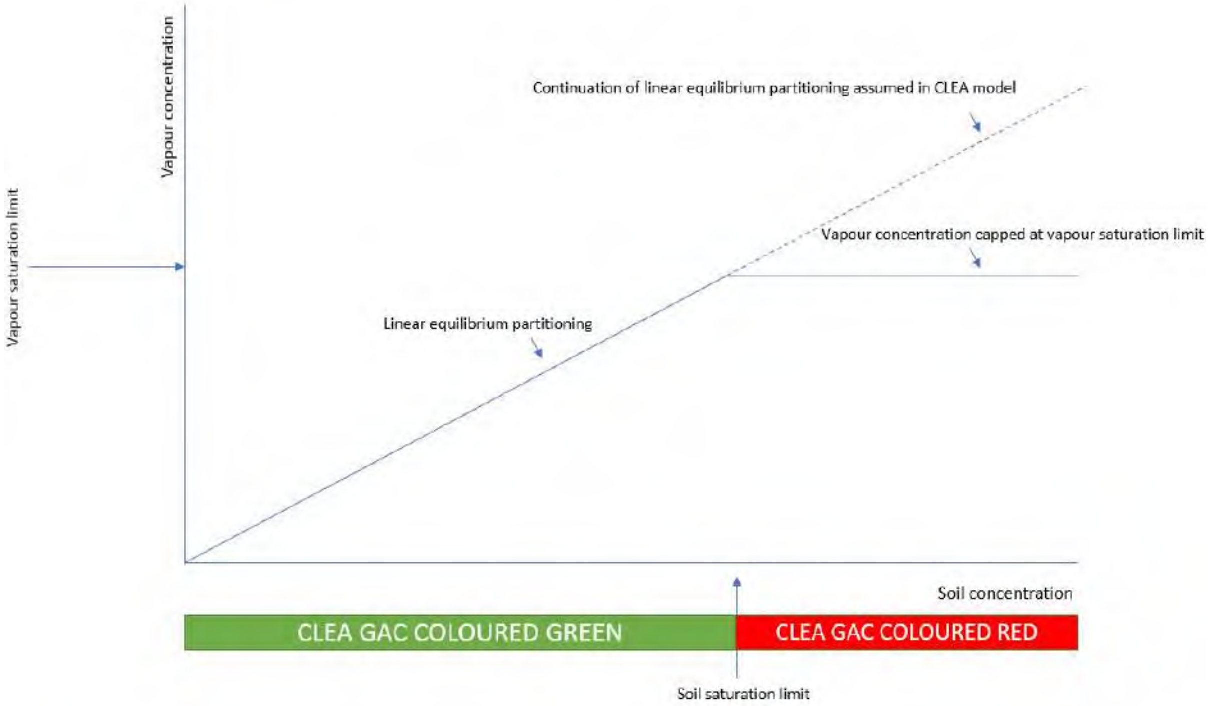

Figure 4.1: Relationship between vapour concentration and soil concentration

The CLEA handbook (Environment Agency, 2009c) considers that in this scenario the lower soil saturation should be used as the assessment criterion, however, this is not practical in many cases due to the very low saturation limits of some of the COPC and is also highly conservative and, therefore, will also over-predict exposure.

Only the petroleum hydrocarbon fraction aromatic >EC10-EC12 has an assessment criterion below its lower soil saturation limit, as shown by the green shading in Table 4.5.

In accordance with the Environment Agency's (2005) guidance on evaluating risk from petroleum hydrocarbons, additivity has been considered as part of this assessment. The soil saturation limits have been entered into the CLEA model as source concentrations and the model run in forwards "ratio" mode to calculate the risk at vapour saturation. The settings and results of the additional modelling are presented in Appendix G.

This indicates that at soil saturation the hazard quotient for aliphatic >EC10-EC12 is 0.37. The remainder of hazard quotients are considered insignificant. Even at a hazard quotient of 0.37 for aliphatic >EC10-EC12, adding this to the 1.0 hazard quotient for >EC10-EC12 would give a maximum hazard index at aromatic >EC10-EC12 of 1.37, which given the conservatisms in the modelling is considered to be acceptable. However, as the aliphatic and aromatic fractions have different toxicities they would not be added together. The highest other aliphatic hazard quotient is 0.03 for aliphatic >EC12-EC16 and highest other aromatic hazard quotient is 0.09 for aromatic >EC12-EC16.

Only aromatic >EC10-EC12 has been taken forward for comparison against on site soil concentrations.

Comparison against site conditions

The relevant modelled SSAC taken forward for comparison against on site soil concentrations recorded during the ground investigation are assessed in Table 4.6.

Table 4.6: Comparison of derived SSAC against on site concentrations

Contaminant of potential concern (COPC)	SSAC (mg/kg)	Number of Soil Samples*	On site Soil Concentrations* (range) (mg/kg)	Number of Exceedances
Aromatic >EC10-EC12	173	45	<1 (MDL) - 360	8

Notes

* = soil samples and associated concentrations for impacted Cheltenham Sand and Gravel only (i.e., observed visual/olfactory evidence of contamination).

MDL = laboratory method detection limit.

Eight exceedances of the SSAC for petroleum hydrocarbon fraction aromatic >EC10-EC12 have been recorded with a maximum concentration of 360 mg/kg. The exceedances are generally concentrated around the source area near the fuel storage and refuelling infrastructure of the former railway sidings area.

Discussion

Exceedances of the derived assessment criterion for a single petroleum hydrocarbon fraction have been recorded, which may indicate a risk to future site occupants based on the current site condition. However, the CLEA model does not take into account degradation of the vapour in the unsaturated zone, nor does it aggregate the risk from the other fractions modelled (which is likely to be negligible), nor the effect of LNAPL in reducing the partial vapour pressures of the individual petroleum substances present in the mixture, therefore, the potential risk is likely to be overestimated.

The CLEA model also does not assess the risk from LNAPL, which has been confirmed across the source area. Six of the COPC modelled have derived assessment criterion that are above their associated soil saturation limits, therefore, the use of a NAPL-specific model is recommended (Environment Agency, 2009c), however, the referenced models have now been withdrawn and not directly replaced. The SoBRA (2018) advises that direct soil vapour measurements should be undertake from above the LNAPL to remove the uncertainty.

Notwithstanding the above, given the shallow depths to LNAPL that have been recorded across the source area, it is not considered practical to leave the LNAPL beneath the proposed development and the LNAPL should be removed as far as reasonably practicable. The LNAPL could well be at a depth within which foundations and sub-surface infrastructure are required. LNAPL in direct contact with concrete can create a preferential vapour intrusion pathway caused by the absorption of the LNAPL into the concrete. In addition, LNAPL impacted/grossly impacted soils should also be removed, which will help to prevent the generation of nuisance odours. This is also a recommendation of the DQRA undertaken for the Controlled Waters receptor (Section 3).

Following the removal of LNAPL and LNAPL impacted/grossly impacted soils, the risk to future site occupants from petroleum hydrocarbon vapours is considered to be low. Therefore, vapour protection measures as part of the proposed development are not considered to be warranted so long as the LNAPL and residual soil concentrations are reduced to concentrations below yet to be established remedial target criteria.

4.5 Summary and conclusions

- A DQRA to quantify the risk posed to future site occupants (i.e., human health) via vapour intrusion into proposed buildings has been carried out for the petroleum hydrocarbon contamination recorded across the former railway sidings area of the site (as reported in the Hydrock GIR).

- The main risk driving COPCs comprise petroleum hydrocarbon fractions (both aliphatic and aromatic) between >EC10-EC35.
- To assess the risks to future site occupants, the following scenario has been modelled:
  - vapour ingress into proposed buildings via permeable soils and/or construction gaps.
- Input parameters for the model are either derived from exploratory log descriptions from the ground investigation, site-specific testing, or are appropriate default settings of the CLEA model.
- Six out of the seven COPC modelled have derived SSAC that are above their associated soil saturation limits, therefore, exposure from the vapour pathway is over-predicted (i.e., exposure is unlikely to reach the relevant HCV and the risk is likely to be negligible).
- The assessment criterion for the remaining petroleum hydrocarbon fraction (aromatic >EC10-EC12) recorded eight exceedances when compared against on site soil concentrations for the impacted Cheltenham Sand and Gravel (out of a possible 45 samples). A maximum soil concentration of 360 mg/g against a SSAC of 173 mg/kg.
- The exceedances may indicate a risk to future site occupants based on the current site condition, however, the CLEA model does not take into account degradation, therefore, the potential risk is likely to be overestimated.
- Due to the derivation of SSAC above soil saturation limits, and the confirmed presence of LNAPL across the source area, relevant guidance recommends the use of NAPL-specific modelling tools. However, the referenced models have now been withdrawn.
- Notwithstanding the above, given the shallow depths to LNAPL that have been recorded across the source area, it is not considered practical to leave the LNAPL beneath the proposed development and the LNAPL should be removed as far as reasonably practicable. In addition, LNAPL impacted/grossly impacted soils should also be removed (this is also a recommendation of the DQRA for the Controlled Waters receptor).
- Following the removal of LNAPL and LNAPL impacted/grossly impacted soils, the risk to future site occupants from petroleum hydrocarbon vapours is considered to be low. Therefore, vapour protection measures as part of the proposed development are not considered to be warranted.
- The extents of the remediation required should be determined through the preparation of a ‘Remediation Options Appraisal’, followed by the preparation of a ‘Remediation Strategy and Verification Plan’.

5. RECOMMENDATION FOR FURTHER WORK

The extent of the remediation required to remove LNAPL and LNAPL impacted/grossly impacted soils should be determined through the preparation of a 'Remediation Options Appraisal', followed by the preparation of a 'Remediation Strategy and Verification Plan'.

This should include a detailed review of all available lines of evidence to determine appropriate remediation criteria that are suitable for both construction and post-completion of the proposed development (i.e., review of exploratory log descriptions, visual and olfactory evidence of contamination such as staining and odours, PID readings, recorded soil concentrations, etc.).

Other forms of remediation are also required across the site to mitigate the risks to the other active pollutant linkages, including the installation of a clean cover system in all soft landscaping areas.

Following the DQRA process detailed within this report, the updated pollutant linkages are summarised in Table 5.1.

Table 5.1: Residual risks following detailed quantitative risk assessment

Contaminant Linkage				Comments	
Pollutant Linkage	Sources	Pathways	Receptors	General	Mitigation
PL	PAHs in the Made Ground across the site.	Ingestion, inhalation or direct contact.	Human health.	Significant exceedances of the GAC.	Mitigation required in the form of an engineered clean cover system or hardstanding.
PL 2.		Root uptake.	Plant life.	Significant exceedances of the GAC.	Import of clean topsoil for use in clean cover system, including tree pits for new trees.
PL 3.		Water supply pipes.	Human health.	Organic chemicals present in soils in excess of Threshold Values.	Barrier pipe required.
PL 4.	Visible ACM and asbestos fibres in the Made Ground across the site.	Inhalation of fugitive dust.	Site users. Neighbours.	Three instances of visible ACM. Asbestos fibres recorded in soils between <0.001% and 0.0063%.	Mitigation required in the form of an engineered clean cover system or hardstanding. Control measures also required during construction phase to protect site workers and minimise risk to neighbouring properties from fugitive dust.
PL 5.	Petroleum hydrocarbons in Made Ground and natural soils.	Ingestion, inhalation or direct contact.	Human health.	Significant exceedances of the GAC associated with historical sources, including tank farm, refuelling area and interceptor.	Mitigation required in the form of an engineered clean cover system or hardstanding.
PL 6.		Water supply pipes.	Human health.	Organic chemicals present in soils in excess of Threshold Values.	Barrier pipe required.
PL 7.		Leachate migration. Base flow.	Controlled Waters.	LNAPL recorded across source area. DQRA undertaken that recorded no exceedances of derived RTVs. Risks to Controlled Waters receptor are low, however, not practical to leave LNAPL beneath proposed development.	Removal of LNAPL and LNAPL/grossly impacted soils, as far as reasonably practicable. Preparation of a Remedial Options Appraisal to determine remediation extents and remediation criteria.

Contaminant Linkage				Comments	
Pollutant Linkage	Sources	Pathways	Receptors	General	Mitigation
PL 8.	Hydrocarbon vapours.	Inhalation	Human health.	DQRA undertaken that recorded eight exceedances of SSAC for a single petroleum hydrocarbon fraction. However, modelling does not take into account degradation and likely to overestimate exposure. Notwithstanding the likely low risk, not practical to leave LNAPL beneath proposed development.	Removal of LNAPL and LNAPL/grossly impacted soils, as far as reasonably practicable. Preparation of a Remedial Options Appraisal to determine remediation extents and remediation criteria. Following removal, no vapour protection measures are required.
PL 9.	Petroleum Hydrocarbons in impacted surface Made Ground adjacent to AST near TP219.	Ingestion, inhalation or direct contact.	Human health.	Black staining and hydrocarbon odours of localised surface soils. Significant exceedances of the GAC in surface soils. Leaching into the underlying natural soils not identified.	Delineation, removal/treatment of the surface Made Ground soils and verification.
PL 10	Asbestos in buildings.	Inhalation of fugitive dust.	Site users. Neighbours.	ACM recorded in existing/historical buildings in historical surveys.	Asbestos demolition survey. Careful removal in line with current guidelines required during demolition.

6. REFERENCES

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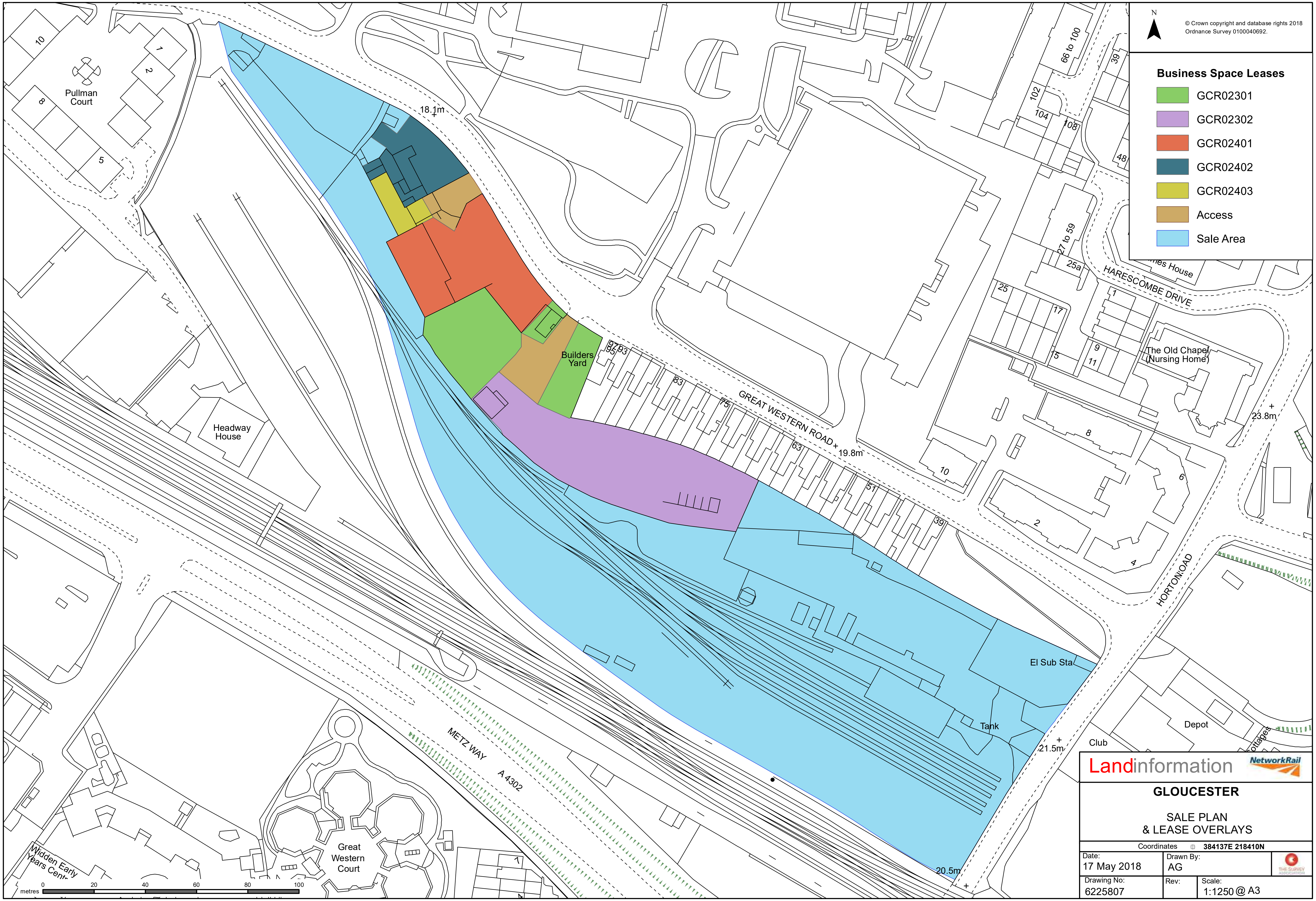
Appendix A Drawings



Business Space Leases

- 🟩 GCR02301
- 🟪 GCR02302
- 🟥 GCR02401
- 🟦 GCR02402
- 🟨 GCR02403
- 🟫 Access
- 🟦 Sale Area

Landinformation

NetworkRail

GLOUCESTER

SALE PLAN
& LEASE OVERLAYS

Coordinates 384137E 218410N

Date: 17 May 2018

Drawn By: AG

Drawing No: 6225807

Rev:

Scale: 1:1250 @ A3

General Notes

This drawing is copyright of Darling Associates. This drawing shall not be scaled. All dimensions are in mm unless otherwise stated. All dimensions shall be checked on site prior to commencing the works and any discrepancies to be reported to Darling Associates. All works shall conform to the current edition of the building regulations and other statutory requirements. All materials and workmanship shall conform with the relevant British Standard specifications and codes of practice. This drawing forms part of an application for planning permission. It shall not be used for any other purpose without the express permission of Darling Associates. This drawing may incorporate information from other professionals. Darling Associates cannot accept responsibility for the integrity and accuracy of such information. Any clarification and/or additions that are required appertaining to such information should be sought from the relevant profession or their appointed representative.

Drawings, specifications and schedules are to be read in conjunction with the following where applicable: Employer's Requirements documents, Agreements to Lease, Structural Engineer's drawings and specifications, Civil Engineer's drawings and specifications, Survey Drawings, Party Wall/ Boundary Awards. Other specialist design consultant's requirements as appointed by the Main Contractor. Other specialist design sub-contractor's requirements as appointed by the Main Contractor.

0 5m 25m 50m 50m

Key Plan

Notes

REV	NOTES	DATE	BY	AUTH

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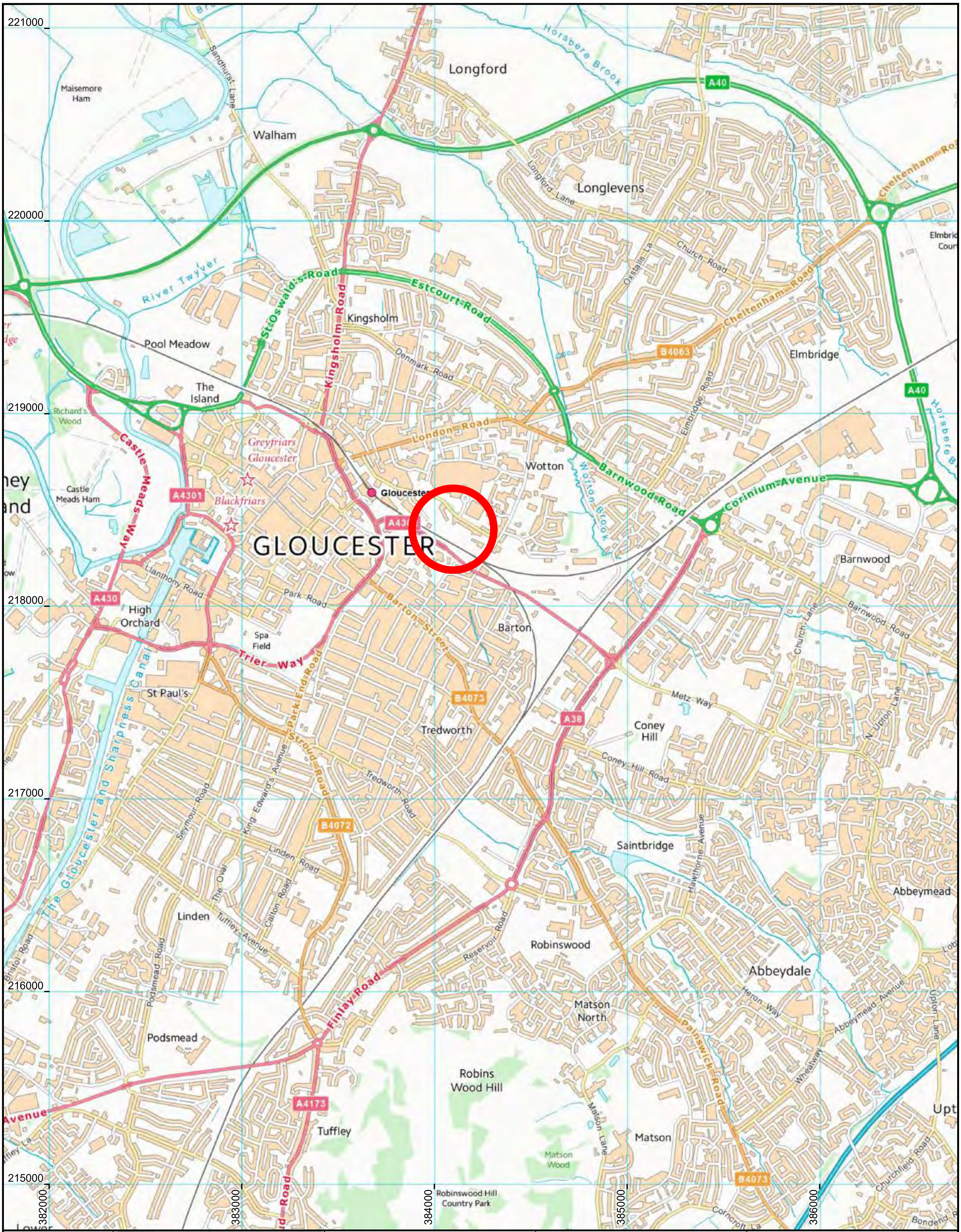
DRAWING STATUS
Preliminary

TITLE
Proposed
Masterplan Layout

PROJECT
Great Western Yard

SCALE AT A1	SCALE AT A3	
1:500	N.T.S.	
JOB NO	DRAWING	REV
19050	03-0-01	-



OS NORTH

Site Ref: SO81

0 500
Metres

P1	FIRST ISSUE					
	EP	03/03/22	SW	03/03/22	SW	03/03/22
REV.	REVISION NOTES/COMMENTS					
	DRAWN BY	DATE	CHECKED BY	DATE	APPROVED BY	DATE

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CLIENT
EUTOPIA HOMES LTD

PROJECT
GREAT WESTERN ROAD YARD

TITLE
SITE LOCATION PLAN

HYDROCK PROJECT NO.
C-20775-C

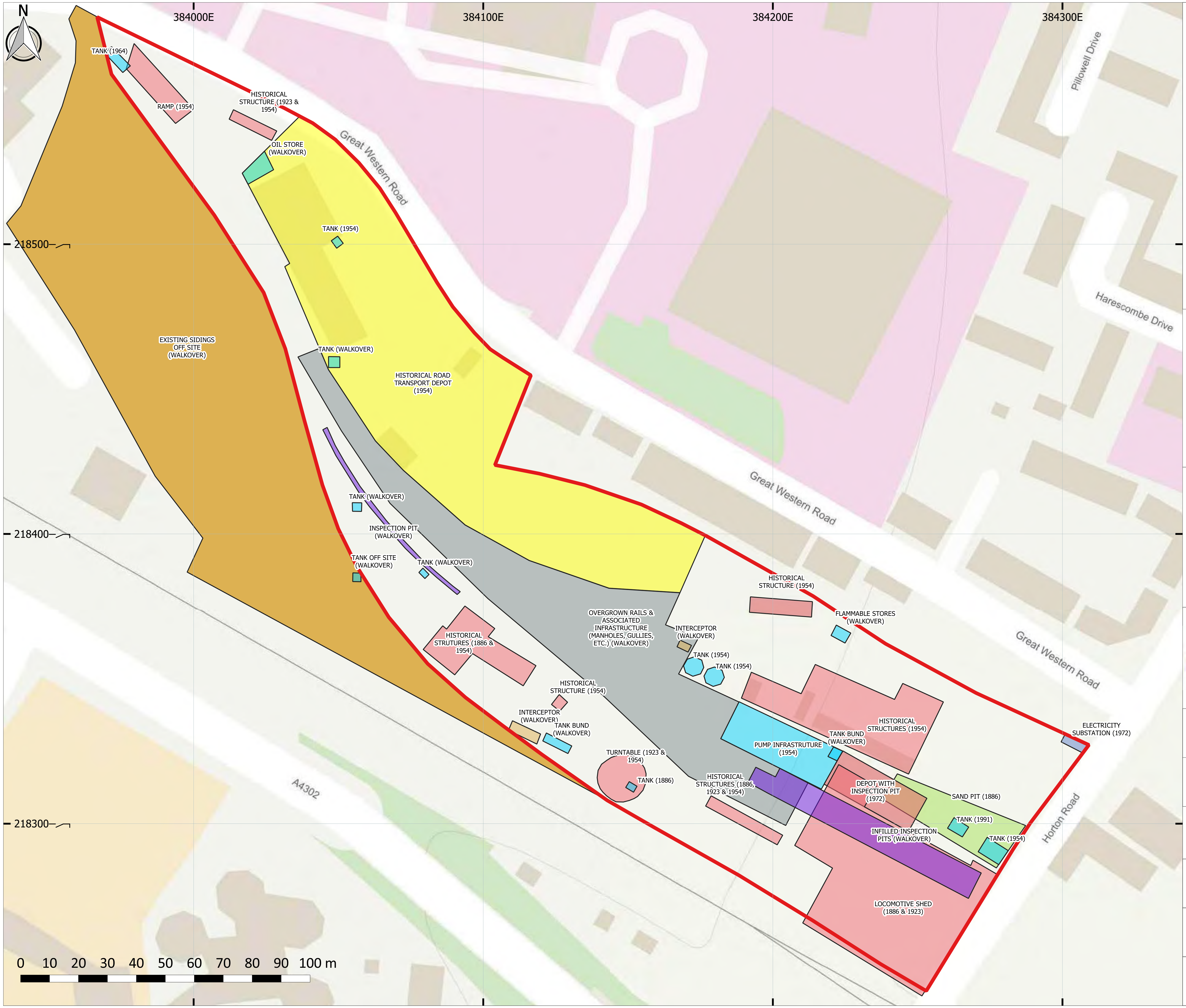
SCALE @ A4
1:25,000

PURPOSE OF ISSUE
SUITABLE FOR INFORMATION

STATUS
S2

DRAWING NO. (PROJECT CODE-ORGINATOR-ZONE-LEVEL-TYPE-ROLE-NUMBER)
20755-HYD-XX-XX-DR-GE-1000

REVISION
P1



KEY PLAN

🟥 Site Boundary

POTENTIAL SOURCES OF CONTAMINATION

🟦 FUEL INFRASTRUCTURE

🟪 INSPECTION PIT

🟫 INTERCEPTOR

🟦 ELECTRICITY SUBSTATION

🟩 SAND PIT

🟨 ROAD TRANSPORT DEPOT

⬜ OVERGROWN RAILS & ASSOCIATED INFRASTRUCTURE

🟥 HISTORICAL STRUCTURES

🟧 EXISTING SIDINGS (OFF SITE)

NOTES

1. Contains OS data © Crown copyright and database right (2022). Licence number: 100023353.
2. Potential signficant sources of contamination based on desk-based review of historical reports and site walkover survey.

REVISIONS

P01 | MK | 10 MARCH 2022 | FIRST ISSUE

Hydrock

CLIENT
EUTOPIA HOMES LTD.

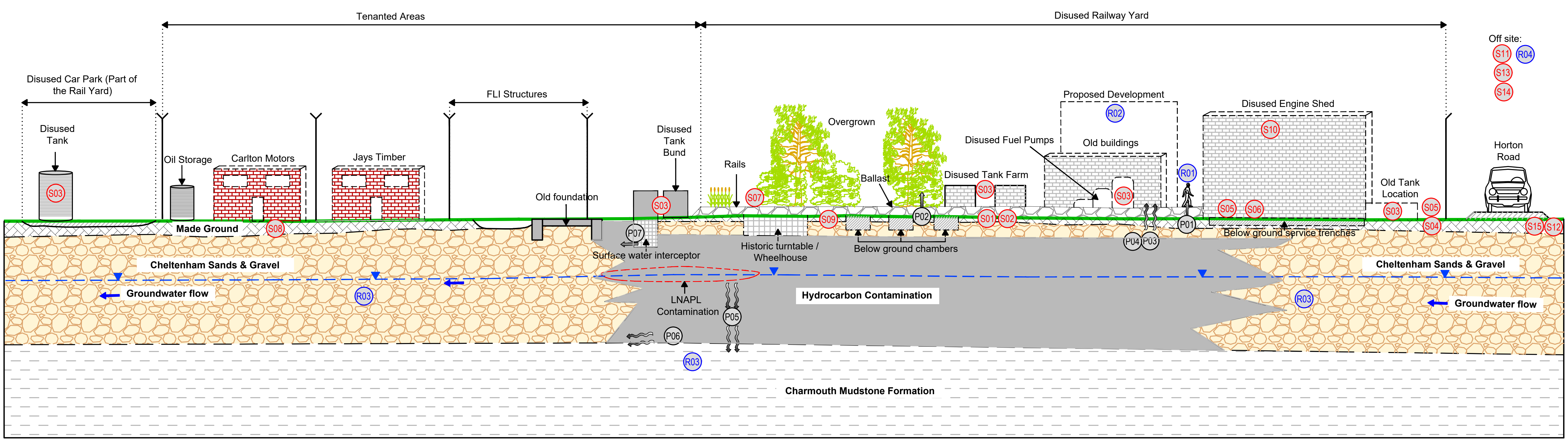
PROJECT
GREAT WESTERN ROAD YARD

TITLE
POTENTIAL SOURCES OF CONTAMINATION

HYDROCK PROJECT NO.	SCALE @ A3
20775	1:1250

PURPOSE OF ISSUE	STATUS
SUITABLE FOR INFORMATION	S2

DRAWING NO.	REVISION
20775-HYD-XX-XX-DR-GE-1002	P01



Potential on-site sources of contamination

S01. Made Ground associated with the historical use of the site, including as a railway siding and road transport depot, possibly including elevated concentrations of metals, metalloids, PAHs and petroleum hydrocarbons.

S02. Made Ground potentially containing asbestos fibres and ACMs from demolition of historical structures.

S03. Petroleum hydrocarbon fuels, lubricants, and solvents from the operation of the numerous former train refuelling and servicing areas, including leakage from ASTs and associated infrastructure.

S04. Made ground associated with the historical infilling of the former sand pit in the east of the site, possibly including elevated concentrations of metals, metalloids, PAHs and petroleum hydrocarbons.

S05. Coal tar potentially present in the bituminous bound pavements present on site.

S06. PCBs associated with the historical use of railway related equipment and components.

S07. Pesticides associated with the historical control of weeds and vegetation across the site.

S08. Ground gases (carbon dioxide and methane) from organic materials in the Made Ground.

S09. Hydrocarbon vapours from spillages and/or leaks of petroleum hydrocarbons, lubricants and solvents.

S10. Asbestos within existing buildings.

Potential off-site sources of contamination

S11. Hydrocarbon fuels, lubricants, and solvents from the operation of the refuelling station approximately 100m northeast of the site, including leakage from USTs, ASTs and associated infrastructure.

S12. Made Ground associated with the historical use of the surrounding industrial area, including extensive use as railway sidings to the east, south and west, possibly including asbestos and elevated concentrations of metals, metalloids, PAHs and petroleum hydrocarbons.

S13. Petroleum hydrocarbon fuels, lubricants, and solvents from the historical operation of the numerous former train refuelling areas and tanks across the surrounding area, including leakage from USTs, ASTs and associated infrastructure.

S14. Made Ground, associated with the historical gas works approximately 20m north east, possibly including asbestos and elevated concentrations of metals, metalloids, PAHs, petroleum hydrocarbons, ammoniacal liquor, foul lime and tar contamination.

S15. Ground gases (carbon dioxide and methane) from organic materials in the Made Ground associated with the industrial use of the surrounding area.

Potential receptors

The following potential receptors in relation to the proposed land use have been identified.

R01. People (site end users, neighbours).

R02. Development end use (buildings, utilities and landscaping).

R03. Groundwater: Secondary A aquifer status of the Cheltenham Sand and Gravels and the Secondary (undifferentiated) status of the Charmouth Mudstone Formation.

R04. Surface water: the River Twyver (culverted and un-culverted) approximately 200 m southwest (at its closest point), which is a tributary of the River Severn approximately 1.8 km to the west (R04).

Potential pathways

The following potential pathways have been identified.

P01. Ingestion, skin contact, inhalation of dust and outdoor air by people.

P02. Root uptake by plant life.

P03. Ground gas (methane and carbon dioxide) ingress via permeable soils and/or construction gaps.

P04. Hydrocarbon vapour ingress via permeable soils and/or construction gaps.

P05. Migration of contaminants via leachate migration into the aquifers of the Cheltenham Sand and Gravels and Charmouth Mudstone Formation.

P06. Migration of contaminants via base flow through the Cheltenham Sand and Gravels and Charmnouth Mudstone Formation.

P07. Surface water via drainage discharge.

KEY

—	Existing ground profile
— —	Conjectural geological boundary
- ▼ -	Groundwater elevation
▨	Made Ground
▨	Cheltenham Sands & Gravel
▭	Hydrocarbon Contamination
▭	Charmouth Mudstone Formation

NOTES

1. All dimensions are to be checked on site before the commencement of works. Any discrepancies are to be reported to the Architect & Engineer for verification. Figured dimensions only are to be taken from this drawing.

2. This drawing is to be read in conjunction with all relevant Engineers' and Service Engineers' drawings and specifications.

P1	FIRST ISSUE					
	EP	03/03/22	SW	03/03/22	SW	03/03/22
REV.	REVISION NOTES/COMMENTS					
	DRAWN BY	DATE	CHECKED BY	DATE	APPROVED BY	DATE

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CLIENT
EUTOPIA HOMES LTD

PROJECT
GREAT WESTERN ROAD YARD

TITLE
PRELIMINARY CONCEPTUAL SITE MODEL

HYDROCK PROJECT NO.
C-20775-C

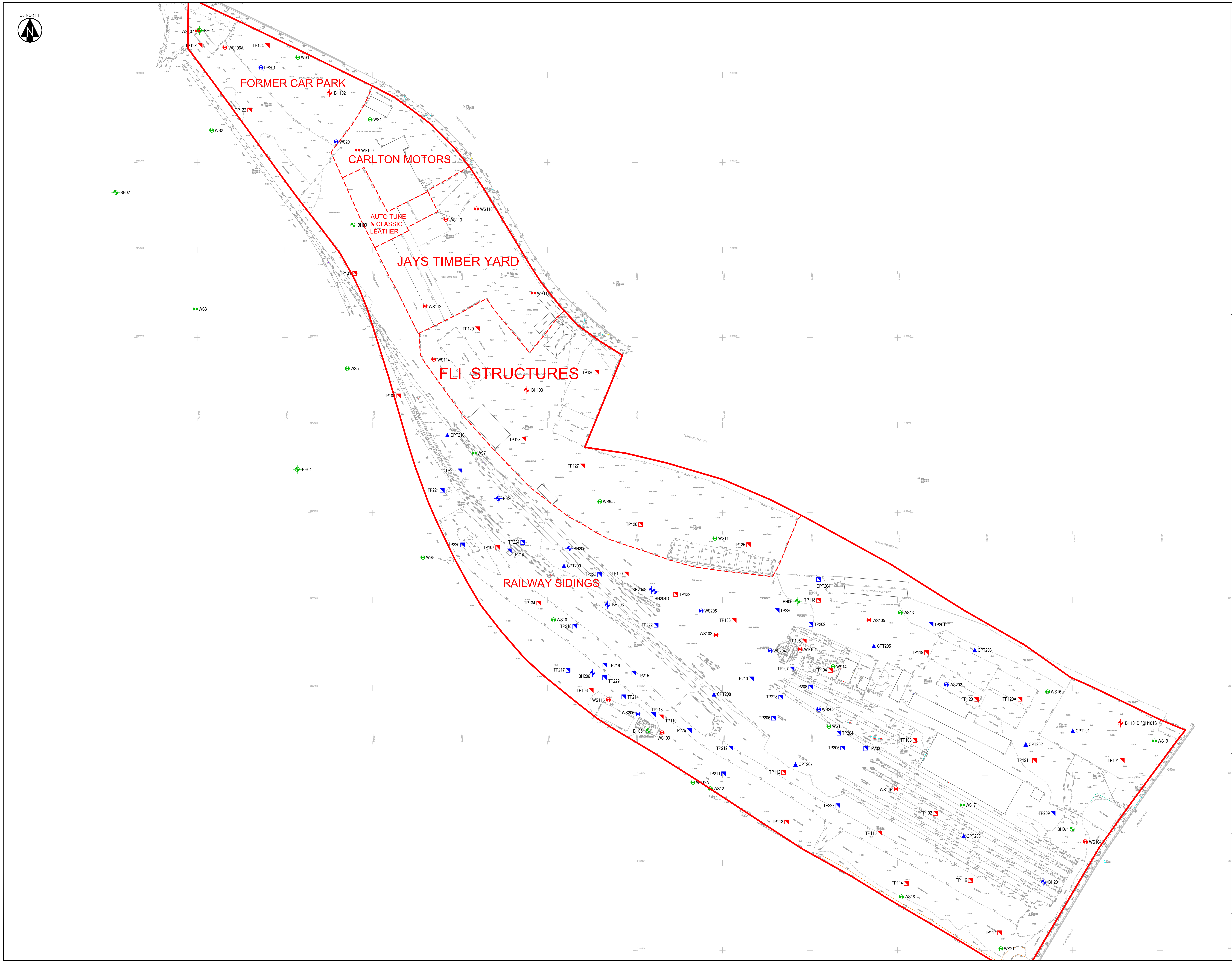
SCALE @ A3
NTS

PURPOSE OF ISSUE
SUITABLE FOR INFORMATION

STATUS
S2

DRAWING NO. (PROJECT CODE-ORGINATOR-ZONE-LEVEL-TYPE-ROLE-NUMBER)
20755-HYD-XX-XX-DR-GE-1003

REVISION
P1



KEY

Site investigation boundary	
Tenanted area boundaries	

Hydrock 2022 Locations

WSi	●	Window sample hole
BHi	⊕	Borehole
TPi	◪	Trial pit
CPTi	▲	CPT Tests
DPi	●	Dynamic Probes

JFHR & GES 2020 Locations

WSi	●	Window sample hole
BHi	⊕	Borehole
TPi	◪	Trial pit

Weeks 1998 Locations

WSi	●	Window sample hole
BHi	⊕	Borehole

NOTES

1. All dimensions are to be checked on site before the commencement of works. Any discrepancies are to be reported to the Architect & Engineer for verification. Figured dimensions only are to be taken from this drawing.

2. This drawing is to be read in conjunction with all relevant Engineers' and Service Engineers' drawings and specifications.

3. This drawing has been based on the following drawings and information: TOPOGRAPHICAL SURVEY_53083/TOPO-1, 53083/TOPO-2, 53083/TOPO-3_ JANUARY 2019.

4. Historical exploratory locations from JFHR and Weeks investigations are based on either coordinates, if provided, or georeferencing of their EHLP. TP111 from the JFHR 2020 investigation is not shown on their plan, therefore, the location is unknown.

P1	FIRST ISSUE					
	EP	03/02/22	SW	03/02/22	SW	03/02/22
REV.	REVISION NOTES/COMMENTS					
	DRAWN BY	DATE	CHECKED BY	DATE	APPROVED BY	DATE

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PROJECT
GREAT WESTERN ROAD YARD

TITLE
EXPLORATORY HOLE LOCATION PLAN

HYDROCK PROJECT NO.	SCALE @ A0
C-20775-C	1:400

PURPOSE OF ISSUE	STATUS
SUITABLE FOR INFORMATION	S2

DRAWING NO. (PROJECT CODE-ORGINATOR-ZONE-LEVEL-TYPE-ROLE-NUMBER)	REVISION
20755-HYD-XX-XX-DR-GE-1004	P1

KEY PLAN

Site Boundary

VISUAL & OLFACTORY EVIDENCE OF PETROLEUM HYDROCARBONS

- ● LNAPL MEASURED IN WELL
- ● LNAPL OBSERVED DURING EXCAVATION
- ● GREY OR BLACK STAINING, SHEEN, ODOUR, ETC.
- ● NO EVIDENCE (ORANGE SAND & GRAVEL)
- ○ N/A - REFUSAL (OBSTRUCTION, ETC.)

NOTES

1. Contains OS data © Crown copyright and database right (2022). Licence number: 100023353.
2. Visual and olfactory evidence of petroleum hydrocarbons only shown (from all ground investigations). Other evidence of contamination may have been observed - see Hydrock report (2022) and exploratory logs for full details.

REVISIONS

P01 | MK | 11 MARCH 2022 | FIRST ISSUE

Hydrock

CLIENT
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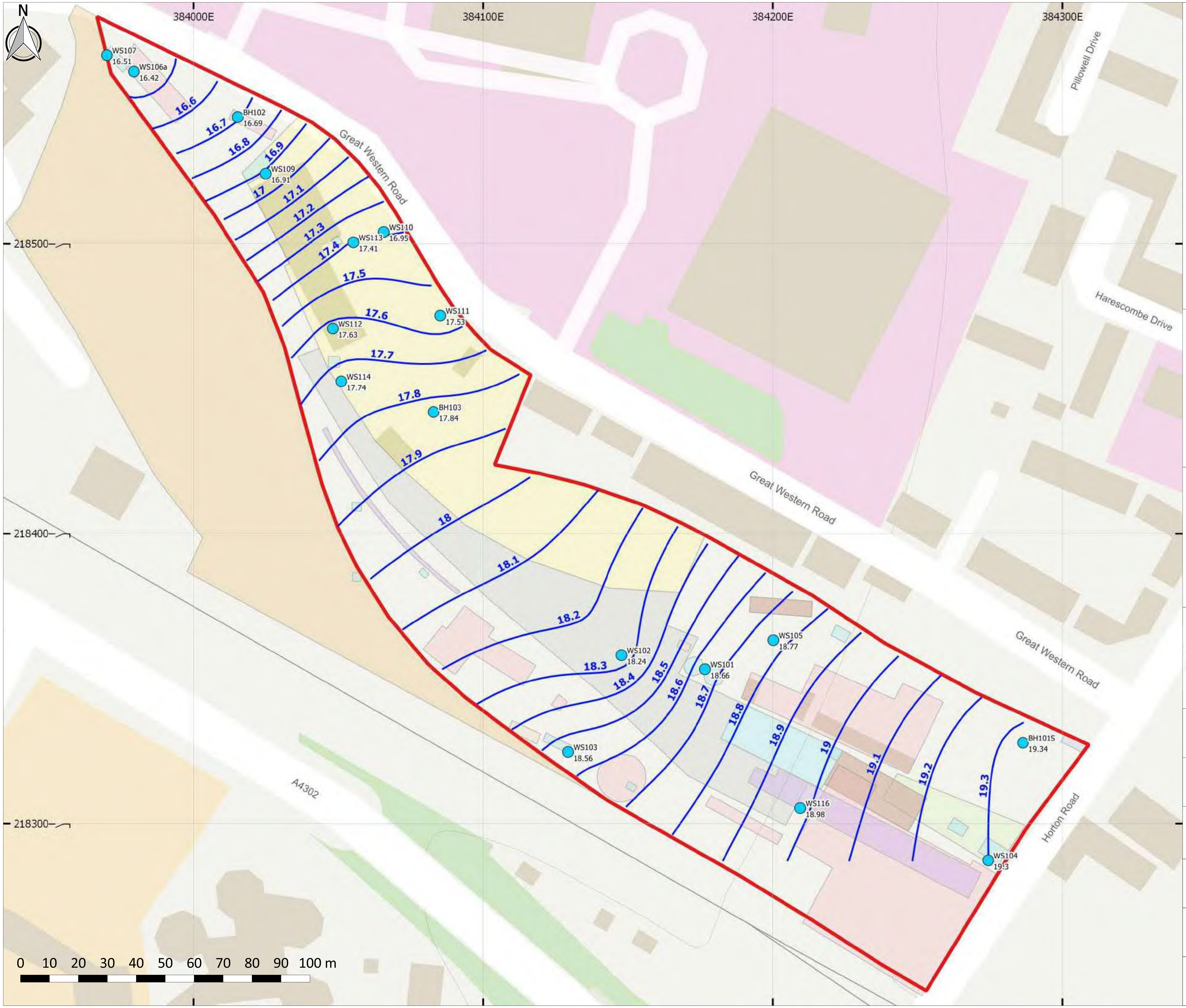
PROJECT
GREAT WESTERN ROAD YARD

TITLE
VISUAL AND OLFACTORY EVIDENCE OF PETROLEUM HYDROCARBONS

HYDROCK PROJECT NO.	SCALE @ A3
20775	1:1250

PURPOSE OF ISSUE	STATUS
SUITABLE FOR INFORMATION	S2

DRAWING NO.	REVISION
20775-HYD-XX-XX-DR-GE-1005	P01



KEY PLAN

☐ Site Boundary

● Groundwater elevations (JFHR Oct 2020)

— Groundwater contours (JFHR Oct 2020)

NOTES

1. Contains OS data © Crown copyright and database right (2022). License number: 100023353.
2. Groundwater elevations taken from third-party report (JFHR, 2021). Elevations are shown for wells screened within the Cheltenham Sand and Gravels.

REVISIONS

P01 | MK | 28 MARCH 2022 | FIRST ISSUE

Hydrock

CLIENT
EUTOPIA HOMES LTD.

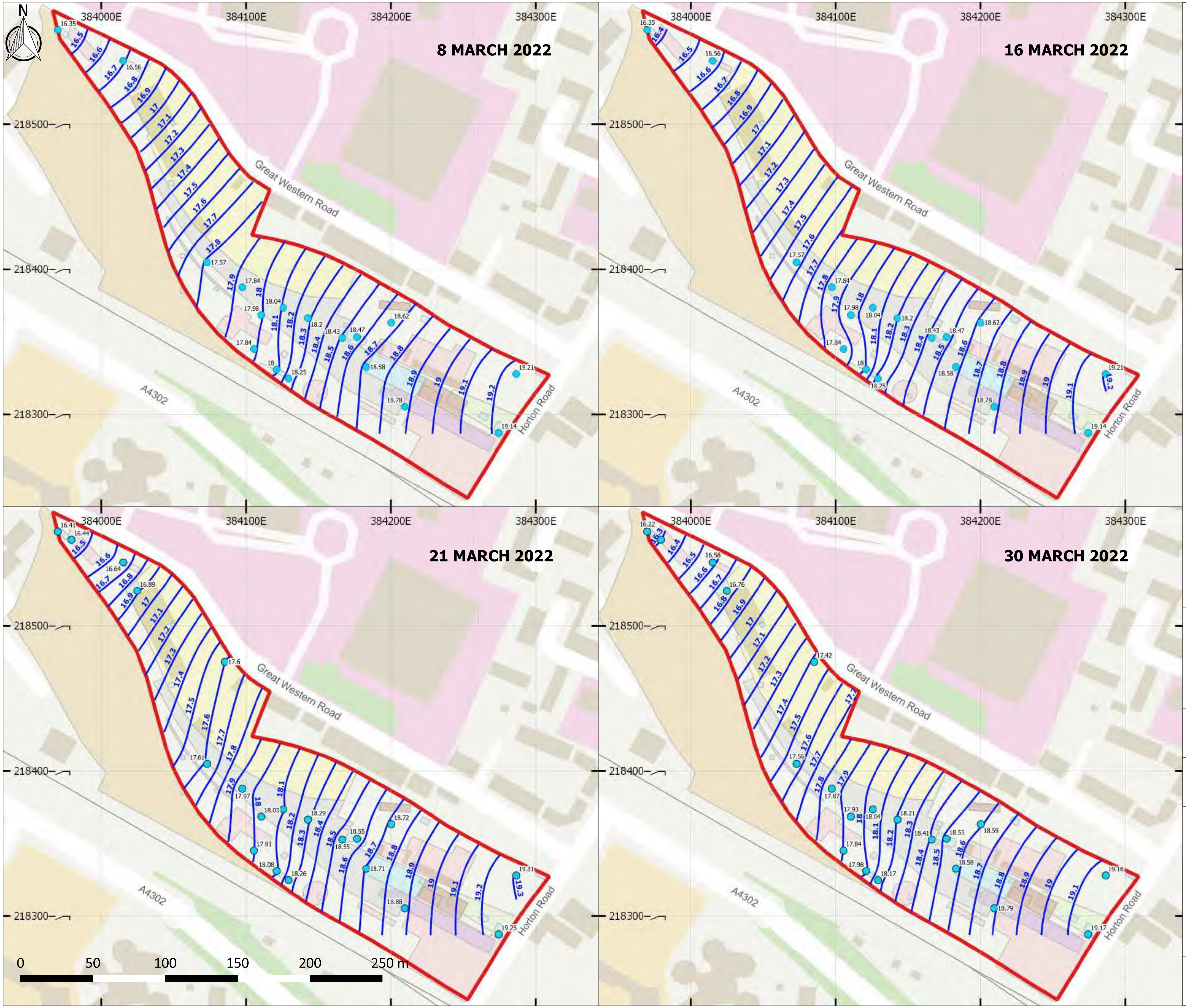
PROJECT
GREAT WESTERN ROAD YARD

TITLE
GROUNDWATER ELEVATIONS (OCTOBER 2020)

HYDROCK PROJECT NO.	SCALE @ A3
20775	1:1250

PURPOSE OF ISSUE	STATUS
SUITABLE FOR INFORMATION	S2

DRAWING NO.	REVISION
20775-HYD-XX-XX-DR-GE-1006	P01



KEY PLAN

🟥 Site Boundary

● Groundwater elevations (Hydrock March 2022)

— Groundwater contours (Hydrock March 2022)

NOTES

1. Contains OS data © Crown copyright and database right (2022). License number: 100023353.
2. Groundwater elevations from all Hydrock monitoring events in March 2022. Elevations are shown for wells screened within the Cheltenham Sand and Gravels.

REVISIONS

P01 | MK | 6 APRIL 2022 | FIRST ISSUE

Hydrock

CLIENT
EUTOPIA HOMES LTD.

PROJECT
GREAT WESTERN ROAD YARD

TITLE
GROUNDWATER ELEVATIONS (MARCH 2022)

HYDROCK PROJECT NO.	SCALE @ A3
20775	1:2500

PURPOSE OF ISSUE	STATUS
SUITABLE FOR INFORMATION	S2

DRAWING NO.	REVISION
20775-HYD-XX-XX-DR-GE-1007	P01

KEY PLAN

☐ Site Boundary

Low-Flow Stabilised Dissolved Oxygen (mg/L)

● 0 - 0.3

● 0.3 - 0.5

● 0.5 - 1.0

○ 2.0- 3.0

NOTES

1. Contains OS data © Crown copyright and database right (2022). License number: 100023353.
2. Stabilised DO (mg/L) from groundwater sampling event on 16 March 2022. Data shown for wells with screen installed in Cheltenham Sand and Gravels.
3. Groundwater elevations from Hydrock monitoring event on 30 March 2022. Elevations are shown for wells with screen installed in the Cheltenham Sand and Gravels.

REVISIONS

P01 | MK | 7 APRIL 2022 | FIRST ISSUE

Hydrock

CLIENT
EUTOPIA HOMES LTD.

PROJECT
GREAT WESTERN ROAD YARD

TITLE
GROUNDWATER STABILISED DISSOLVED OXYGEN (MARCH 2022)

HYDROCK PROJECT NO.	SCALE @ A3
20775	1:1250

PURPOSE OF ISSUE	STATUS
SUITABLE FOR INFORMATION	S2

DRAWING NO.	REVISION
20775-HYD-XX-XX-DR-GE-1008	P01

KEY PLAN

🟥 Site Boundary

Low-Flow Stabilised ORP (mg/L)

- ● -100 -> -50
- ● -50 -> 0
- ● 0 -> 50
- ● 150 -> 250

NOTES

1. Contains OS data © Crown copyright and database right (2022). License number: 100023353.
2. Stabilised oxidation-reduction potential (mV) from groundwater sampling event on 16 March 2022. Data shown for wells with screen installed in Cheltenham Sand and Gravels.
3. Groundwater elevations from Hydrock monitoring event on 30 March 2022. Elevations are shown for wells with screen installed in the Cheltenham Sand and Gravels.

REVISIONS

P01 | MK | 7 APRIL 2022 | FIRST ISSUE

Hydrock

CLIENT
EUTOPIA HOMES LTD.

PROJECT
GREAT WESTERN ROAD YARD

TITLE
GROUNDWATER STABILISED OXIDATION-REDUCTION POTENTIAL (MARCH 2022)

HYDROCK PROJECT NO.	SCALE @ A3
20775	1:1250

PURPOSE OF ISSUE	STATUS
SUITABLE FOR INFORMATION	S2

DRAWING NO.	REVISION
20775-HYD-XX-XX-DR-GE-1009	P01

KEY PLAN

□ Site Boundary

◆ LNAPL MEASURED IN WELL

TPH in groundwater ug/l (Round 1 - Oct 2020 - JFHR)

● <MDL

● 10 - 500

● 500 - 1,000

● 1,000 - 2,000

● >2,000

— Groundwater contours 30 March 2022

NOTES

1. Contains OS data © Crown copyright and database right (2022). License number: 100023353.
2. Groundwater contour data are shown from the Hydrock monitoring visit on 30 March 2022. Wells with screen section within the CHSG (partially or whole).
3. Groundwater concentration data are shown from the ground investigation undertaken by JFHR (2021). Wells with screen section within the CHSG (partially or whole).

REVISIONS

P01 | MK | 7 APRIL 2022 | FIRST ISSUE

Hydrock

CLIENT
EUTOPIA HOMES LTD.

PROJECT
GREAT WESTERN ROAD YARD

TITLE
TOTAL PETROLEUM HYDROCARBONS IN GROUNDWATER (ROUND 1 - OCT 2020)

HYDROCK PROJECT NO.	SCALE @ A3
20775	1:1250

PURPOSE OF ISSUE	STATUS
SUITABLE FOR INFORMATION	S2

DRAWING NO.	REVISION
20775-HYD-XX-XX-DR-GE-1017	P01

KEY PLAN

🟥 Site Boundary

◆ LNAPL MEASURED IN WELL

TPH in groundwater ug/l (Round 2 - Nov 2020 - JFHR)

- ● <MDL
- ● 10 - 500
- ● 500 - 1,000
- ● 1,000 - 2,000
- ● >2,000

— Groundwater contours 30 March 2022

NOTES

1. Contains OS data © Crown copyright and database right (2022). License number: 100023353.
2. Groundwater contour data are shown from the Hydrock monitoring visit on 30 March 2022. Wells with screen section within the CHSG (partially or whole).
3. Groundwater concentration data are shown from the ground investigation undertaken by JFHR (2021). Wells with screen section within the CHSG (partially or whole).

REVISIONS

P01 | MK | 7 APRIL 2022 | FIRST ISSUE

Hydrock

CLIENT
EUTOPIA HOMES LTD.

PROJECT
GREAT WESTERN ROAD YARD

TITLE
TOTAL PETROLEUM HYDROCARBONS IN GROUNDWATER (ROUND 2 - NOV 2020)

HYDROCK PROJECT NO.	SCALE @ A3
20775	1:1250

PURPOSE OF ISSUE	STATUS
SUITABLE FOR INFORMATION	S2

DRAWING NO.	REVISION
20775-HYD-XX-XX-DR-GE-1018	P01

KEY PLAN

▭ Site Boundary
◆ LNAPL MEASURED IN WELL
▲ LNAPL OBSERVED DURING EXCAVATION

TPH in groundwater ug/l (Round - March 2022 - Hydrock)
● <MDL
● 10 - 500
● 500 - 1,000
● 1,000 - 2,000
● >2,000
— Groundwater contours 30 March 2022

NOTES

1. Contains OS data © Crown copyright and database right (2022). License number: 100023353.
2. Groundwater contour data are shown from the Hydrock monitoring visit on 30 March 2022. Wells with shallow screen section within the MG and/or CHSG (partially or whole).
3. Groundwater concentration data are shown from the ground investigation undertaken by Hydrock (2022). Wells with screen section within the CHSG (partially or whole).

REVISIONS

P01 | MK | 7 APRIL 2022 | FIRST ISSUE

Hydrock

CLIENT
EUTOPIA HOMES LTD.

PROJECT
GREAT WESTERN ROAD YARD

TITLE
TOTAL PETROLEUM HYDROCARBONS IN GROUNDWATER (ROUND 3 - MARCH 2022)

HYDROCK PROJECT NO.	SCALE @ A3
20775	1:1250

PURPOSE OF ISSUE	STATUS
SUITABLE FOR INFORMATION	S2

DRAWING NO.	REVISION
20775-HYD-XX-XX-DR-GE-1019	P01

KEY PLAN

☐ Site Boundary

● Groundwater elevations (Hydrock 4-6 May 2022)

— Groundwater contours (Hydrock 4-6 May 2022)

NOTES

1. Contains OS data © Crown copyright and database right (2022). License number: 100023353.
2. Groundwater elevations from Hydrock monitoring event 4-6 May 2022. Elevations are shown for wells screened within the Cheltenham Sand and Gravel.

REVISIONS

P01 | MK | 17 MAY 2022 | FIRST ISSUE

Hydrock

CLIENT
EUTOPIA HOMES LTD.

PROJECT
GREAT WESTERN ROAD YARD

TITLE
GROUNDWATER ELEVATIONS (4-6 MAY 2022)

HYDROCK PROJECT NO. 20775	SCALE @ A3 1:1250
PURPOSE OF ISSUE SUITABLE FOR INFORMATION	STATUS S2
DRAWING NO. 20775-HYD-XX-XX-DR-GE-1021	REVISION P01

KEY PLAN

▭ Site Boundary

Low-Flow Stabilised Dissolved Oxygen (mg/L)

- ● 0.0 - 0.3
- ● 0.3 - 0.5
- ● 0.5 - 1.0
- ○ >1.0

NOTES

1. Contains OS data © Crown copyright and database right (2022). License number: 100023353.
2. Stabilised DO (mg/L) from groundwater sampling event on 4-6 May 2022. Data shown for wells with screen installed in Cheltenham Sand and Gravels. WS205 did not stabilise so reading is from 16 March 2022 for reference. Sample from WS103 was a grab samples so reading not considered representative (and not shown).
3. Groundwater elevations from Hydrock monitoring event 4-6 May 2022. Elevations are shown for wells screened within the Cheltenham Sand and Gravel.

REVISIONS

P01 | MK | 17 MAY 2022 | FIRST ISSUE

Hydrock

CLIENT
EUTOPIA HOMES LTD.

PROJECT
GREAT WESTERN ROAD YARD

TITLE
GROUNDWATER STABILISED DISSOLVED OXYGEN (4-6 MAY 2022)

HYDROCK PROJECT NO.	SCALE @ A3
20775	1:1250

PURPOSE OF ISSUE	STATUS
SUITABLE FOR INFORMATION	S2

DRAWING NO.	REVISION
20775-HYD-XX-XX-DR-GE-1022	P01

KEY PLAN

▭ Site Boundary

20777_GWRY - Low-FLow Parameters - May 2022 ORP

- ● <-50 (i.e., more negative)
- ● -50 - 0
- ● 0 - 50
- ● >50

NOTES

1. Contains OS data © Crown copyright and database right (2022). License number: 100023353.
2. Stabilised ORP (mV) from groundwater sampling event on 4-6 May 2022. Data shown for wells with screen installed in Cheltenham Sand and Gravel. WS205 did not stabilise so reading is from 16 March 2022 for reference. Sample from WS103 was a grab samples so reading not considered representative (and not shown).
3. Groundwater elevations from Hydrock monitoring event 4-6 May 2022. Elevations are shown for wells screened within the Cheltenham Sand and Gravel.

REVISIONS

P01 | MK | 17 MAY 2022 | FIRST ISSUE

Hydrock

CLIENT
EUTOPIA HOMES LTD.

PROJECT
GREAT WESTERN ROAD YARD

TITLE
GROUNDWATER STABILISED OXIDATION-REDUCTION POTENTIAL (4-6 MAY 2022)

HYDROCK PROJECT NO.	SCALE @ A3
20775	1:1250

PURPOSE OF ISSUE	STATUS
SUITABLE FOR INFORMATION	S2

DRAWING NO.	REVISION
20775-HYD-XX-XX-DR-GE-1023	P01

KEY PLAN

🟥 Site Boundary

TPH in groundwater ug/l (Round 4 - May 2022)

- ● <MDL
- ● 10 - 500
- ● 500 - 1,000
- ● 1,000 - 2,000
- ● >2,000

NOTES

1. Contains OS data © Crown copyright and database right (2022). License number: 100023353.
2. Groundwater contour and concentrations data are shown from the Hydrock monitoring 4-6 May 2022. Wells with shallow screen section within the MG and/or Cheltenham Sand and Gravel (partially or whole).

REVISIONS

P01 | MK | 17 MAY 2022 | FIRST ISSUE

Hydrock

CLIENT
EUTOPIA HOMES LTD.

PROJECT
GREAT WESTERN ROAD YARD

TITLE
TOTAL PETROLEUM HYDROCARBONS IN GROUNDWATER (ROUND 4 - 4-6 MAY 2022)

HYDROCK PROJECT NO.	SCALE @ A3
20775	1:1250

PURPOSE OF ISSUE	STATUS
SUITABLE FOR INFORMATION	S2

DRAWING NO.	REVISION
20775-HYD-XX-XX-DR-GE-1024	P01

KEY PLAN

□ Site Boundary

● Groundwater elevations (Weeks June 1998)

— Groundwater contours (Weeks June 1998)

NOTES

1. Contains OS data © Crown copyright and database right (2022). License number: 100023353.
2. Groundwater elevations from historical Weeks June 1998 monitoring event. Elevations are to a temporary benchmark (i.e., not m AOD) and shown for wells screened within the Cheltenham Sand and Gravel.

REVISIONS

P01 | MK | 1 JUN 2022 | FIRST ISSUE

Hydrock

CLIENT
EUTOPIA HOMES LTD.

PROJECT
GREAT WESTERN ROAD YARD

TITLE
GROUNDWATER ELEVATIONS (JUNE 1998)

HYDROCK PROJECT NO.	SCALE @ A3
20775	1:1,250

PURPOSE OF ISSUE	STATUS
SUITABLE FOR INFORMATION	S2

DRAWING NO.	REVISION
20775-HYD-XX-XX-DR-GE-1025	P01

KEY PLAN

🟥	Site Boundary
•	LNAPL recorded
🟥	1.2m buffer

Proposed development

🟪	Apartment Blocks
🟨	Terraced Townhouses

NOTES

1. Contains OS data © Crown copyright and database right (2022). License number: 100023353.

REVISIONS

P01 | MK | 23 JUN 2022 | FIRST ISSUE

Hydrock

CLIENT
EUTOPIA HOMES LTD.

PROJECT
GREAT WESTERN ROAD YARD

TITLE
VAPOUR INTRUSION SCREENING DISTANCE ASSESSMENT

HYDROCK PROJECT NO.
20775

SCALE @ A3
1:1,250

PURPOSE OF ISSUE
SUITABLE FOR INFORMATION

STATUS
S2

DRAWING NO.
20775-HYD-XX-XX-DR-GE-1026

REVISION
P01

Appendix B Groundwater Monitoring Data

20775 GREAT WESTERN ROAD YARD, GLOUCESTER
GROUNDWATER SAMPLING SUMMARY AND STABILISED FIELD MEASURED PARAMETERS - MARCH 2022

Area	ID	Well Installation Details			Monitoring 16 / 21 March 2022				Stabilised Low-Flow Parameters					Visual / Olfactory Evidence		Comment
		Well Screen Summary (m bgl)	Screen Strata	Groundwater Body	DTP (m bgl)	LNAPL Thickness (mm)	DTW (m bgl)	DTB (m bgl)	pH	ORP (mV)	Cond. (uS/cm)	Temp. (Deg C)	Disolved Oxygen (mg/L)	Appearance	Odour	
Railway Sidings	**WS101**	1.0 - 5	CHSG-CHAM	Shallow	--	--	1.130	4.030	7.58	-29.8	706	9.6	0.37	Clear	No odour	NA.
	WS102	1.0 - 5.0	CHSG-CHAM	Shallow	0.990	70	1.060	--	**-- LNAPL recorded in monitoring well (not sampled) --**							LNAPL recorded.
	WS103	1.0 - 2.0	MG	Shallow	--	--	1.250	1.930	**-- Grab sample using bailer --**					Cloudy / black silt (?)	NR	Collected using bailer techniques (not low-flow). Black specs noted in water.
	WS105	1.0 - 5.0	CHSG-CHAM	Shallow	--	--	1.080	3.660	**-- Grab sample using bailer --**					Slightly cloudy / sheen	NR	Collected using bailer techniques (not low-flow).
	WS107	1.0 - 5.0	CHSG-CHAM	Shallow	--	--	1.680	3.870	**-- Grab sample using bailer --**					Cloudy / orange globules (?)	NR	Collected using bailer techniques (not low-flow). Orange globules not present when rebailed.
	WS115	1.0 - 5.0	CHSG-CHAM	Shallow	1.340	270	1.610	--	**-- LNAPL recorded in monitoring well (not sampled) --**							LNAPL recorded.
	WS116	1.0 -5.0	CHSG-CHAM	Shallow	--	--	1.200	2.860	**-- Grab sample using bailer --**					Cloudy	NR	Collected using bailer techniques (not low-flow).
	BH201	6.0 - 14.7	CHAM	Deep	--	--	1.130	12.670	8.59	149.0	3,536	10.5	0.64	Clear	No odour	NA.
	BH202	1.3 - 2.3	CHSG	Shallow	--	--	1.130	3.000	7.13	167.9	635	10.4	2.96	Slightly cloudy	No odour	NA.
	BH203	0.8 - 2.8	CHSG	Shallow	--	--	1.310	3.600	7.48	-6.3	717	10.3	0.29	Very slightly cloudy	Slight hydrocarbon odour	NA.
	BH204S	0.5 - 2.5	CHSG	Shallow	--	--	1.180	2.720	6.95	-22.4	1,228	9.6	0.65	Cloudy	Slight hydrocarbon odour	NA.
	BH204D	4.0 - 5.5	CHAM	Deep	--	--	1.180	5.670	7.27	144.4	1,598	10.2	2.34	Clear	No odour	NA.
	BH205	0.5 - 2.5	CHSG	Shallow	--	--	1.240	3.450	7.13	235.9	1,012	9.8	2.70	Clear	No odour	NA.
	BH206	1.0 - 3.0	CHSG	Shallow	--	--	1.510	2.770	7.61	-93.5	716	9.7	0.29	Clear	Hydrocarbon odour	NA.
	WS203	1.0 - 3.6	CHSG	Shallow	--	--	1.370	2.240	7.41	4.5	1,225	9.8	0.41	Clear	Slight hydrocarbon odour	NA.
	WS204	1.0 - 1.9	CHSG	Shallow	--	--	1.200	1.880	7.59	-43.9	784	10.0	0.42	Clear	Slight hydrocarbon odour	NA.
	WS205	1.0 - 1.9	CHSG	Shallow	--	--	1.150	1.830	7.59	-55.1	945	9.9	0.47	Clear	Slight hydrocarbon odour	NA.
	WS206	1.0 - 1.9	CHSG	Shallow	--	--	1.430	2.010	7.04	-75.0	1,212	9.4	0.70	Very slightly cloudy	Slight hydrocarbon odour	NA.

Notes

m bgl	metres below ground level
CHSG	Cheltenham Sand and Gravel
CHAM	Charmouth Mudstone Formation
NR	Not recorded.

GROUNDWATER SAMPLING SUMMARY AND STABILISED FIELD MEASURED PARAMETERS - MAY 2022

Area	ID	Well Installation Details			Monitoring 4-6 May 2022				Stabilised Field Measured Low-Flow Parameters					Visual / Olfactory Evidence		Comment
		Well Screen Summary (m bgl)	Screen Strata	Groundwater Body	DTP (m bgl)	LNAPL Thickness (mm)	DTW (m bgl)	DTB (m bgl)	pH*	ORP (mV)	Cond. (uS/cm)	Temp. (Deg C)	Disolved Oxygen (mg/L)	Appearance	Odour	
Railway Sidings	**BH101S**	1.0 - 3.0	CHSG	Shallow	--	--	2.200	3.000	6.82	217.6	1,043	16.5	3.48	Slightly cloudy	No dour	NA.
	BH102	1.0 - 3.0	CHSG	Shallow	--	--	1.320	3.850	--	-81.2	916	15.1	1.80	Slightly cloudy	No dour	NA.
	WS101	1.0 - 5.0	CHSG-CHAM	Shallow	--	--	1.240	4.010	6.86	-36.5	814	13.1	0.31	Clear / slight sheen	Slight hydrocarbon odour	NA.
	WS102	1.0 - 5.0	CHSG-CHAM	Shallow	1.25	40	1.290	NR	**-- LNAPL recorded in monitoring well (not sampled) --**							LNAPL recorded.
	WS103	1.0 - 2.0	MG	Shallow	--	--	1.470	1.980	7.20	-145.8	775	19.1	1.07	Clear / black globules	Hydrocarbon odour	Water level falling so purge not completed - parameters not stabilised. Grab sample collected.
	WS104	1.0 - 5.0	MG-CHSG-CHAM	Shallow	--	--	1.410	3.445	--	63.9	593	117.0	2.00	Slightly cloudy	No dour	NA.
	WS105	1.0 - 5.0	CHSG-CHAM	Shallow	--	--	1.330	3.630	7.10	84.1	658	13.5	2.15	Clear	No dour	NA.
	WS107	1.0 - 5.0	CHSG-CHAM	Shallow	--	--	1.780	3.780	6.83	15.7	793	13.1	0.66	Slightly cloudy	Slight hydrocarbon odour	NA.
	WS115	1.0 - 5.0	CHSG-CHAM	Shallow	1.43	130	1.560	NR	**-- LNAPL recorded in monitoring well (not sampled) --**							LNAPL recorded.
	WS116	1.0 -5.0	CHSG-CHAM	Shallow	--	--	1.410	2.860	6.91	0.1	635	16.1	0.54	Clear	No dour	NA.
	BH202	1.3 - 2.3	CHSG	Shallow	--	--	1.170	2.870	7.40	167.0	464	14.2	6.34	Clear	No dour	NA.
	BH203	0.8 - 2.8	CHSG	Shallow	--	--	1.410	3.560	6.86	-61.7	816	13.4	0.33	Clear	Strong hydrocarbon odour	NA.
	BH204S	0.5 - 2.5	CHSG	Shallow	--	--	1.220	2.620	6.95	-110.6	780	14.0	0.31	Slightly cloudy	No dour	NA.
	BH205	0.5 - 2.5	CHSG	Shallow	--	--	1.190	3.245	7.13	53.2	765	15.6	1.20	Slightly cloudy	No dour	NA.
	BH206	1.0 - 3.0	CHSG	Shallow	--	--	1.500	2.740	7.61	-175.6	479	14.3	0.43	Clear	Hydrocarbon odour	NA.
	WS203	1.0 - 3.6	CHSG	Shallow	--	--	1.510	2.230	7.41	-138.1	996	16.0	0.60	Slightly cloudy	Hydrocarbon odour	NA.
	WS204	1.0 - 1.9	CHSG	Shallow	--	--	1.320	1.880	7.59	-156.8	965	15.1	0.01	Clear	Hydrocarbon odour	NA.
	WS205	1.0 - 1.9	CHSG	Shallow	--	--	1.220	1.680	6.74	-66.0	1,099	15.0	4.79	Cloudy	Strong hydrocarbon odour	Water level falling so purge not completed - parameters not stabilised. Grab sample collected.
	WS206	1.0 - 1.9	CHSG	Shallow	--	--	1.470	1.900	7.12	-104.0	823	21.0	0.72	Slightly cloudy	Slight hydrocarbon odour	NA.
	BH101D	6.0 - 9.0	CHAM	Deep	--	--	2.040	9.010	6.88	28.3	3,268	18.1	0.98	Clear	No dour	NA.
	BH201	6.0 - 14.7	CHAM	Deep	--	--	1.170	14.250	8.50	-10.1	1,234	20.1	0.82	Clear	No dour	NA.
	BH204D	4.0 - 5.5	CHAM	Deep	--	--	1.220	5.560	7.27	29.7	1,067	14.0	0.67	Clear	No dour	NA.
FLI Structures	**BH103**	1.0 - 4.0	CHSG-CHAM	Shallow	**-- Monitoring well located but well cover jammed and could not be opened (not sampled) --**											NA.
	WS114	1.0 - 4.0	CHSG	Shallow	--	--	1.675	2.675	--	82.7	1,101	12.6	1.05	Slightly cloudy	No dour	NA.
Jays Timber	**WS110**	1.0 - 5.0	CHSG-CHAM	Shallow	--	--	1.270	4.290	6.80	12.3	1,026	14.7	0.97	Clear	No dour	Parameters did not fully stabilise.
	WS111	1.0 - 4.0	CHSG-CHAM	Shallow	--	--	1.620	3.250	7.40	101.6	856	14.2	0.93	Clear	No dour	NA.
Carlton Motors	**WS109**	1.0 - 4.0	CHSG-CHAM	Shallow	--	--	1.550	3.790	6.77	-53.0	1,168	11.7	0.54	Clear	Slight 'eggy' smell	NA.

Notes

m bgl	metres below ground level
CHSG	Cheltenham Sand and Gravel
CHAM	Charmouth Mudstone Formation
NR	Not recorded.
*	pH data from one of the probes used during the monitoring is considered to be too low when compared to histroical low-flow data and laboratory certificates (i.e., probe malfunction), therefore, data from the either the previous round of low-flow monitoring or the laboratory certificate have been presented for these wells instead, where possible.

TECHNICAL NOTE

Project name:	Great Western Road Yard, Gloucester
Title:	Permeability Testing Analysis
Document reference:	20775-HYD-XX-XX-TN-GE-1000
Author:	Lisa Ho
Status / Revision:	S2 P01
Date:	18 May 2022

1. CONTEXT

On 5 May 2022, Structural Soils (on behalf of Hydrock) undertook variable head permeability testing on selected boreholes at Great Western Road Yard, Gloucester (the 'site').

Relevant borehole logs (BH101S, BH202, and BH204S) and the Exploratory Hole Location Plan (Ref: 20755-HYD-XX-XX-DR-GE-1004, dated 3 February 2022) are included as Annex A.

The testing was undertaken using the following procedures:

1. Pre-test manual dipping of borehole.
2. Pressure transducers installed near the base of the borehole, monitoring at a sufficient resolution to enable for groundwater levels responses to be captured, in this case every second.
3. The insertion on a solid object (the slug), causes an instantaneous rise in water levels (head) within the standpipe. The subsequent fall in water levels till equilibrium has been reached is monitored and is known as a falling head test.
4. Once water levels have stabilised, the slug is removed causing an instantaneous drop in water levels (head) within the standpipe. The subsequent rise in water levels till equilibrium has been reached is monitored and is known as a rising head test.
5. Repeat steps 3 and 4 as necessary, ideally three times per borehole if time permits, in this case two runs were completed per borehole.
6. Water level data acquired from the pressure transducers downloaded and subject to barometric compensation.

Manual dip and pressure transducer data and graphs (as appropriate) are included as Annex B and Annex C.

2. PARAMETERS AND ANALYSIS

Analysis of the variable head testing data is undertaken in line with BS EN ISO 22282-2:2012, with the analysis completed using the licensed software programme 'AquiferWin32'. The input parameters used in the assessment are summarised below in Table 1.

Table 1: Analysis parameters

Item	Value		
	BH101S	BH202	BH204S
Standpipe diameter (mm)	50	50	50
Drilled hole diameter (mm)	150	140	140
Screened depth (m bgl)	1.0 - 3.0	1.3 - 2.3	0.5 - 2.5
Screen top (below top of aquifer)*	0	0.13	0

Item	Value		
	BH101S	BH202	BH204S
Screen length (m)* *	0.50	1.0	1.27
Filter pack porosity (%)	30	30	30
Pre-test water Level (m bgl)	2.20	1.17	1.23
Aquifer thickness	0.50	1.13	1.27
Screened strata	Cheltenham Sand and Gravel	Cheltenham Sand and Gravel	Cheltenham Sand and Gravel
Strata characteristics	Medium dense very gravelly sand	Silty gravelly sand	Silty gravelly sand
Aquifer status	Confined	Unconfined	Unconfined
Analysis method	Bouwer & Rice (1976)***	Bouwer & Rice (1976)	Bouwer & Rice (1976)***
*0 if the borehole is screened across the water table ** If screen is across the water table, the calculation only includes screen length below water table. *** Includes correction for filter pack drainage			

3. RESULTS SUMMARY

The results of the variable head testing are summarised below in Table 2, with the full analysis included as Annex D.

Table 2: Hydraulic conductivity summary (m/d)

Borehole	BH101S		BH202		BH204S	
Test	Falling Head	Rising Head	Falling Head	Rising Head	Falling Head	Rising Head
Test 1 (m/d)	2.32	2.32	7.94	7.02	1.24	1.23
Test 2 (m/d)	1.22	2.02	7.02	7.81	0.85	1.92
Geomean	1.91		7.44		1.26	
Geomean (all)	**2.61**					

The following notes pertain to the above test results:

- The variable head permeability testing will only be accurate in the immediate vicinity of the tested borehole and only provides a guide to aquifer-wide hydraulic conditions.
- The data have been analysed for all tests using the Bower & Rice (1976) straight line approach for unconfined conditions. As shown in the results, the straight line has been fitted to the appropriate normalised head ranges.
- The effective well radius for boreholes where the screen is across the water table has been corrected to account for the porosity of the filter pack.
- The representative hydraulic conductivity for the system (given the caveats above) is considered to be **2.61 m/d**, which is the geometric mean of the results. This is indicative of moderate - high permeability conditions, which was expected given the granular nature of the screened aquifer.

4. REFERENCES

British Standard Institution. 2012. Geohydraulic testing. Water permeability tests in a borehole using open systems. BS EN ISO 22282-2:2012. BSI, London.

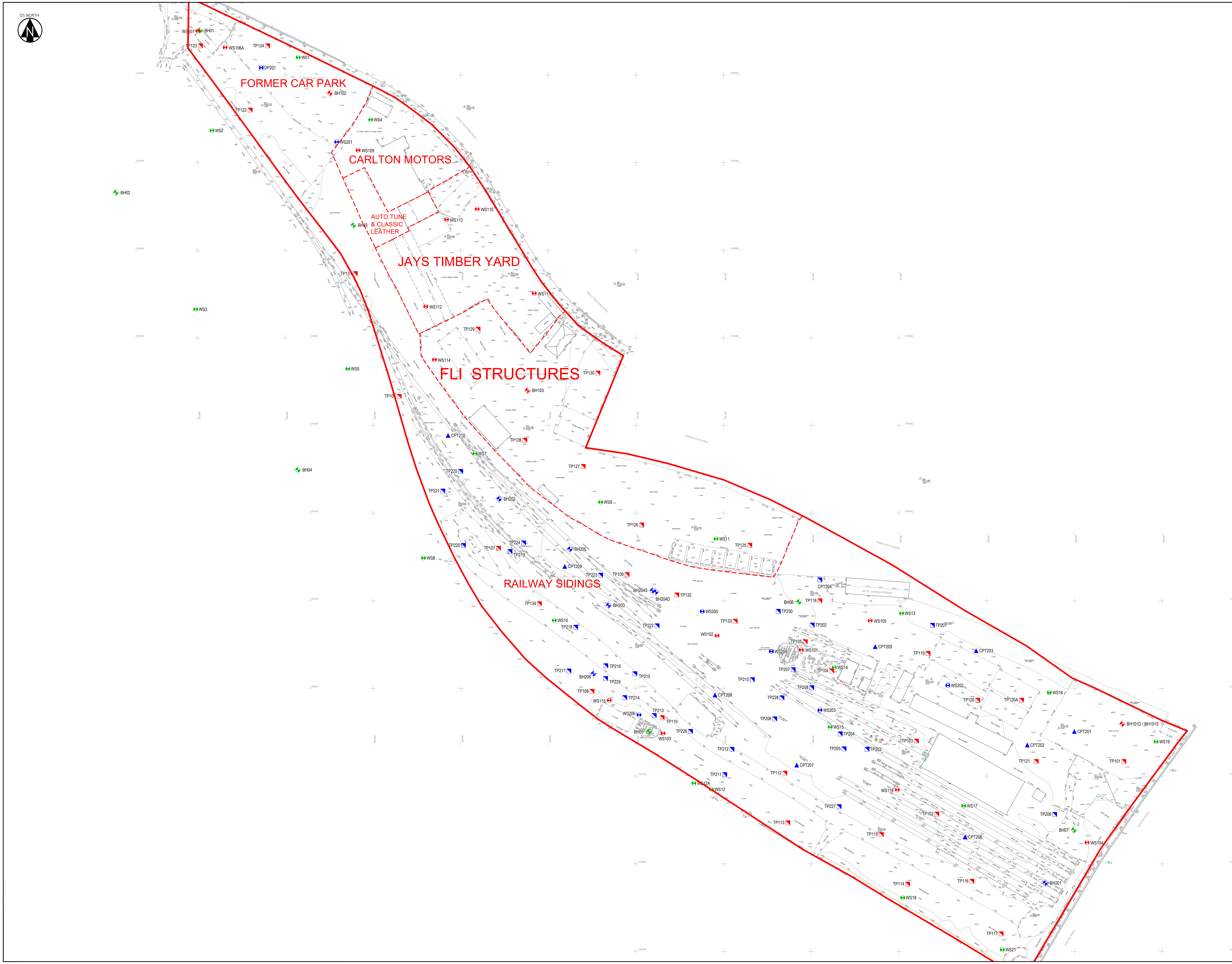
Bouwer, H., 1989. The Bouwer and Rice slug test--an update, Ground Water, vol. 27, no. 3, pp. 304-309.

Bouwer, H. and R.C. Rice, 1976. A slug test method for determining hydraulic conductivity of unconfined aquifers with completely or partially penetrating wells, Water Resources Research, vol. 12, no. 3, pp. 423-428.

Cooper, H.H., J.D. Bredehoeft and S.S. Papadopulos, 1967. Response of a finite-diameter well to an instantaneous charge of water, Water Resources Research, vol. 3, no. 1, pp. 263-269.

Hvorslev, M.J., 1951. Time Lag and Soil Permeability in Ground-Water Observations, Bull. No. 36, Waterways Exper. Sta. Corps of Engrs, U.S. Army, Vicksburg, Mississippi, pp. 1-50. [pdf].

Annex A - Exploratory Hole Location Plan and Relevant Borehole Logs



KEY

Site investigation boundary

Tenanted area boundaries

Hydrock 2022 Locations

WSi	⊗	Window sample hole
BHi	⊕	Borehole
TPi	◪	Trial pit
CPTi	▲	CPT Tests
DPi	⊗	Dynamic Probes

JFHR & GES 2020 Locations

WSi	⊗	Window sample hole
BHi	⊕	Borehole
TPi	◪	Trial pit

Weeks 1998 Locations

WSi	⊗	Window sample hole
BHi	⊕	Borehole

NOTES

1. All dimensions are to be checked on site before the commencement of works. Any discrepancies are to be reported to the Architect & Engineer for verification. Figured dimensions only are to be taken from this drawing.

2. This drawing is to be read in conjunction with all relevant Engineers' and Service Engineers' drawings and specifications.

3. This drawing has been based on the following drawings and information: TOPOGRAPHICAL SURVEY_53083/TOPO-1, 53083/TOPO-2, 53083/TOPO-3_ JANUARY 2019.

4. Historical exploratory locations from JFHR and Weeks investigations are based on either coordinates, if provided, or georeferencing of their EHLP. TP111 from the JFHR 2020 investigation is not shown on their plan, therefore, the location is unknown.

P1	FIRST ISSUE					
	EP	03/02/22	SW	03/02/22	SW	03/02/22
REV.	REVISION NOTES/COMMENTS					
	DRAWN BY	DATE	CHECKED BY	DATE	APPROVED BY	DATE

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CLIENT

EUTOPIA HOMES LTD

PROJECT

GREAT WESTERN ROAD YARD

TITLE

EXPLORATORY HOLE LOCATION PLAN

HYDROCK PROJECT NO.
C-20775-C

SCALE @ A0
1:400

PURPOSE OF ISSUE
SUITABLE FOR INFORMATION

STATUS
S2

DRAWING NO. (PROJECT CODE-ORGINATOR-ZONE-LEVEL-TYPE-ROLE-NUMBER)
20755-HYD-XX-XX-DR-GE-1004

REVISION
P1

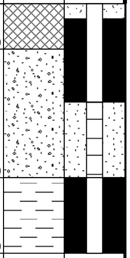
Hydrock	Project: Great Western Road Yard	Borehole No BH202 Page No. 1 of 1

Method: Dynamic Sampled	Date(s): 02/02/2022	Logged By: SW	Drilled By: CC GI
Client: Eutopia Homes Ltd.	Co-ords: 384073.17, 218404.85	Checked By: MK	Flush: Water
Hydrock Project No: 20775	Ground Level: 18.70m OD		Scale: 1:100

Sample/Core Run (m)	Samples / Tests Depth (m)	Type	Results	Mechanical Log TCR	SCR	RQD	If: Min Mean Max	Water-Strikes
	0.00 - 0.40	B						
	0.20	ES						
	0.20	PID	0.0ppm					
1.20 - 2.50	0.60 - 1.00	B						
	0.70	ES						
	0.70	PID	0.0ppm	100				
	1.20	ES						
2.50 - 3.30	1.20	PID	0.4ppm					
	1.50 - 2.00	B						
	1.80	ES		100				
	1.80	PID	0.4ppm					
	2.10 - 2.50	C						
	2.20	ES						
	2.20	PID	0.3ppm					
	2.50	HSV	78kPa					
	3.00	HSV	117kPa					

Stratum Description	Depth mbgl	Thickness (m)	Level m OD
Black ashy silty gravelly fine to coarse SAND. Gravel is angular fine to coarse of metal, brick, slag. (MADE GROUND)	0.60	(0.60)	18.10
Orangish brown silty gravelly fine to coarse SAND. Gravel is sub rounded to rounded fine to coarse of flint. (CHELTENHAM SAND AND GRAVEL)	2.30	(1.70)	16.40
Firm to stiff dark grey CLAY. (CHARMOUTH MUDSTONE FORMATION)	3.30	(1.00)	15.40

End of Borehole at 3.30m



Progress and Observations

Rig	Date	Time	Borehole Depth (m)	Casing Depth (m)	Casing Diam.(mm)	Water Depth (m)	Flush Type	Returns (colour)
Fraste	02/03	1000	0.00		110		Water	
Fraste	02/03	1100	3.30		110		Water	

Chiselling

From (m)	To (m)	Duration (HH:MM)

General Remarks:
1. Service clearance undertaken by EOD Contracts Ltd. 2. Inspection pit hand dug to 1.20m bgl. 3. Groundwater strike unknown. 4. 50mm monitoring well installed, response zone between 1.30m - 2.30m bgl with a 1m sump of plain pipe beneath. 5. No visual or olfactory evidence of contamination.

Groundwater: Unknown due to water flush installing casing.

Logged in general accordance with BS5930:2015

Hydrock

Project: Great Western Road Yard

Borehole No

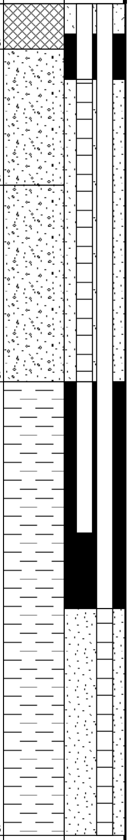
BH204

Page No. 1 of 1

Method: Dynamic Sampled & Rotary Cored	Date(s): 02/02/2022 - 03/02/2022	Logged By: SW	Drilled By: CC GI
Client: Eutopia Homes Ltd.	Co-ords: 384126.78, 218373.03	Checked By: MK	Flush: Water
Hydrock Project No: 20775	Ground Level: 19.23m OD		Scale: 1:50

Sample/Core Run (m) Smpl. Ø (mm) Smpl. rec. %	Samples / Tests Depth (m)	Type	Results	Mechanical Log TCR	SCR	RQD	If: Min Mean Max	Water-Strikes
	0.00 - 0.20	B						
	0.20	ES						
	0.20	PID	0.0ppm					
	0.50	ES						
	0.50 - 1.00	B						
	0.50	PID	0.0ppm					
1.20 - 2.50	1.20	SPT	N=25 (4,4,4,6,7,8)	100				
	1.40	ES						
	1.40	PID	1.7ppm					
	2.00	ES						
	2.00 - 2.50	B						
	2.00	PID	0.0ppm					
2.50 - 4.00	2.50	SPT	N=7 (1,1,1,1,2,3)	100				
	2.50	ES						
	2.50	PID	0.0ppm					
	2.75	HSV	130kPa					
	3.00	ES						
	3.00	PID	0.0ppm					
	3.10 - 3.50	C						
	3.25	HSV	>130kPa					
	3.50	ES						
	3.50	PID	0.0ppm					
	3.75 - 4.00	B						
4.00 - 5.50	4.00	SPT	N=25 (3,4,4,8,5,8)	100				
	4.50 - 4.90	C						
	5.10 - 5.50	C						
	5.50	SPT	N=25 (2,3,4,5,8,8)					

Stratum Description	Depth mbgl	Thickness (m)	Level m OD
Black ashy silty gravelly fine to coarse SAND. Gravel is angular fine to coarse of metal, brick, slag. (MADE GROUND)	0.30	(0.30)	18.93
Orangish brown silty gravelly fine to coarse SAND. Gravel is sub rounded to rounded fine to coarse of flint. (CHELTENHAM SAND AND GRAVEL)	1.20	(0.90)	18.03
Greyish brown silty gravelly fine to coarse SAND. Gravel is sub rounded to rounded fine to coarse of flint. Light hydrocarbon odour. (CHELTENHAM SAND AND GRAVEL) *... 1.30m-2.15m: stained grey.*	2.50	(1.30)	16.73
Firm to stiff dark grey CLAY with frequent locally abundant shells and ammonites. (CHARMOUTH MUDSTONE FORMATION) *... 4.00m bgl: very stiff.*	5.50	(3.00)	13.73
End of Borehole at 5.50m			



Progress and Observations

Rig	Date	Time	Borehole Depth (m)	Casing Depth (m)	Casing Diam.(mm)	Water Depth (m)	Flush Type	Returns (colour)
Fraste	02/03	1400	0.00		110		Water	
Fraste	02/03	1700	5.50		110		Water	

General Remarks:
1. Service clearance undertaken by EOD Contracts Ltd. 2. Inspection pit hand dug to 1.20m bgl. 3. Groundwater strike unknown. 4. 2 x seperate boreholes completed at this location to minimise cross contamination (approximately 1.5m apart referenced BH204S (Shallow) and BH204D (Deep)). 5. 2 x 50mm monitoring wells installed. A shallow response zone between 0.50m - 2.50m bgl with a 1m sump of plain pipe beneath (BH204S), and a deep response zone between 4.00m - 5.50m bgl (BH205D).

Groundwater: Unknown due to water flush installing casing.

Logged in general accordance with BS5930:2015

Ground and Environmental Services Limited

Unit 2 Montpelier Business Park,
Dencora Way, Ashford,
Kent TN23 4FG
Tel: 01233 646237

Borehole No. BH101

Sheet: 1 of 2

Equipment & Methods.
Dando 2500
_Backfill: 50mm Installation

Project Name: Great Western Yard
Project Location: Great Western Road, Gloucester
Client: Eutopia Homes Ltd

Job No:
12446

Co-ordinates:
E: 384286.395384286.395
N: 218327.833218327.833

Ground Level (m): 21.28 Local Datum
21.28 AOD

Date Started:06/10/2020
Date Completed:06/10/2020

Samples and In situ Testing				
Depth (m)	No.	Type	Result	Field Records
1.20		SS	SN=8	1,1/2,2,2,2
1.20- 1.70		B		
2.00- 2.45		SS	SN=15	1,2/3,3,4,5
2.30- 2.60		D		
3.00- 3.45		SS	SN=8	1,1/1,2,2,3
3.80		D		
4.00- 4.45		U100		
4.45- 4.50		CSS		
5.00- 5.45		SS	SN=20	3,4/4,5,5,6
6.00		D		
6.50- 6.95		SS	SN=35	3,5/7,9,12,15
7.50		D		
8.00- 8.37		SS	SN=R	9,14/15,17,18 - 85mm short
			SN=R	10,15/16,19,15 - 100mm short
8.80- 8.85		D		
9.00		D		
9.50- 9.87		SS	SN=R	7,8/10,18,22 - 80mm short

DESCRIPTION	Reduced Level (m)	Legend	Depth (Thick) (m)
MADE GROUND: Asphalt	21.18	☒	(0.10)
MADE GROUND: Brown and black sandy gravelly clay. Gravel is brick	20.18	☒	(1.00) 1.10
Firm brown sandy CLAY	18.98	⁚	(1.20) 2.30
Medium dense orange brown very gravelly SAND	18.48	⁘	(0.50) 2.80
Stiff to very stiff dark grey slightly silty fissured CLAY	13.38	⚋	(5.10) 7.90
Very stiff/hard dark bluish grey MUDSTONE	11.78	☰	(1.60) 9.50

End of Borehole 9.50 m
(Thickness of basal layer

Remarks:

Logged By: CS
Checked By: PAD
Scale: 1:50
Approved By:
FIG No. .1

Notes: For explanation of symbols and abbreviations, see Key Sheet.

Ground and Environmental Services Limited

Unit 2 Montpelier Business Park,
Dencora Way, Ashford,
Kent TN23 4FG

Tel: 01233 646237

Borehole No. BH101

Sheet: 2 of 2

Equipment & Methods. Dando 2500 _Backfill: 50mm Installation	Project Name: Great Western Yard Project Location: Great Western Road, Gloucester Client: Eutopia Homes Ltd	Job No: 12446
Co-ordinates: E: 384286.395384286.395 N: 218327.833218327.833	Ground Level (m): 21.28 Local Datum 21.28 AOD	Date Started:06/10/2020 Date Completed:06/10/2020

Water Level Observations During Boring

Date	Time	Depth of Hole (m)	Depth of Casing (m)	Depth to Water (m)	Remarks
6-10-20	00:00	9.50	3.00		End of borehole

Hole Diameter by Depth Table

Depth of Hole (m)	Diameter of Hole (mm)	Diameter of Casing (mm)	Depth of Casing (m) not proven)
9.50	150	150	3.00

Water Strike Table

Depth of Strike (m)	Casing Depth (m)	Date	Time	Post Strike Depth (m)	Minutes After Strike	Sealed At (m)	Remarks
2.30 6.50	0.00 3.00			2.00	15	3.00	slow inflow water seepage

Remarks:	Logged By: CS	Checked By: PAD
	Scale: 1:50	Approved By:
Notes: For explanation of symbols and abbreviations, see Key Sheet.	FIG No. .2	

Ground and Environmental Services Limited
Unit 2 Montpelier Business Park
Dencora Way, Ashford
Kent TN23 4FG
T: 01233 646237

Hole ID. BH101
Installation Details & Readings

Sheet: 1 of 1

Equipment & Methods.
Dando 2500
_Backfill: 50mm Installation

Project Name: Great Western Yard
Project Location: Great Western Road, Gloucester
Client: Eutopia Homes Ltd

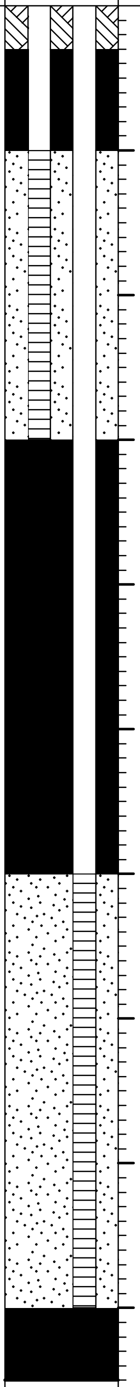
Job No: 12446

Co-ordinates:
E: 384286.395
N: 218327.833

Ground Level (m): 21.28 Local Datum
21.28 AOD

Date Started:06/10/2020
Date Completed:06/10/2020

Installation Date : 06/10/2020
Installation Type : SP
Depth to TOP Response Zone : 6 (m)
Depth to BASE Response Zone : 9 (m)

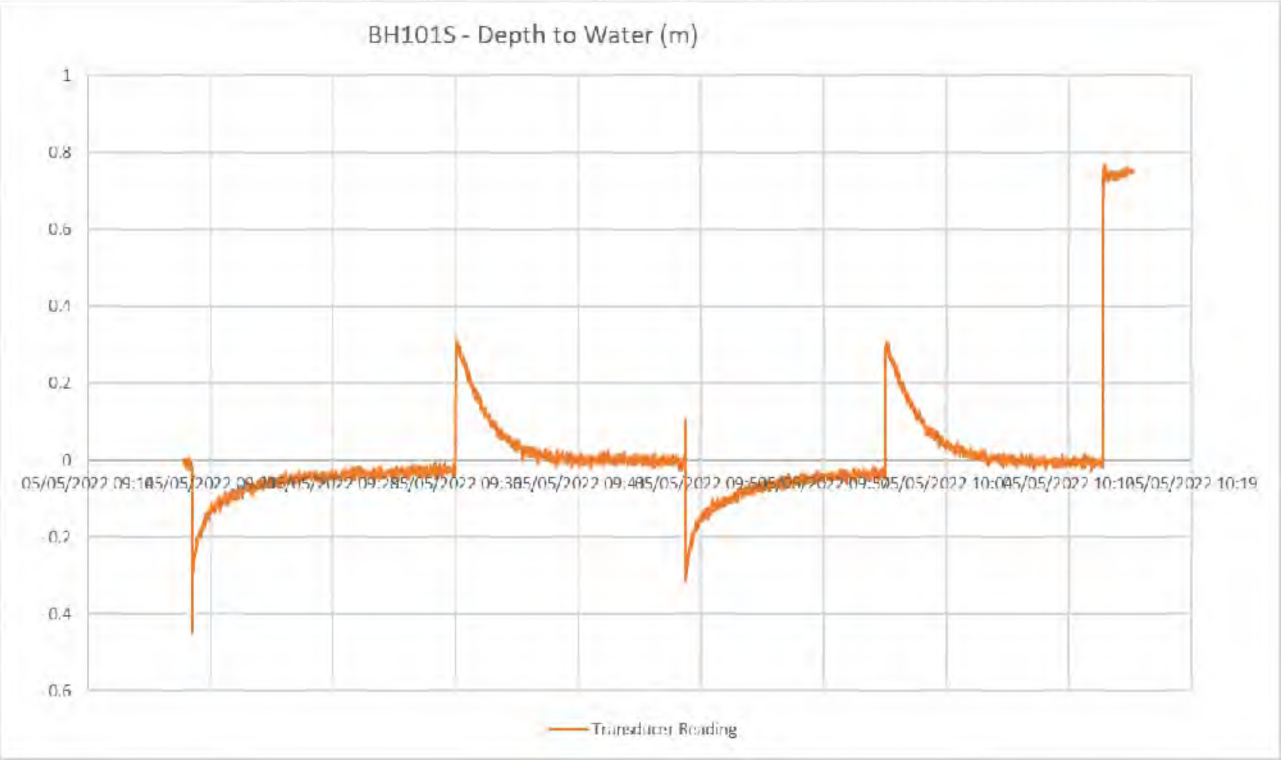
Installation Diagram		Depth Related Remarks (Elevation)
	0.3	Stopcock cover
		Bentonite seal
	1	(20.28)
		Slotted standpipe with gravel annulus
	3	(18.28)
		Bentonite seal
	6	(15.28)
		slotted standpipe with gravel annulus
	9	(12.28)
		Bentonite

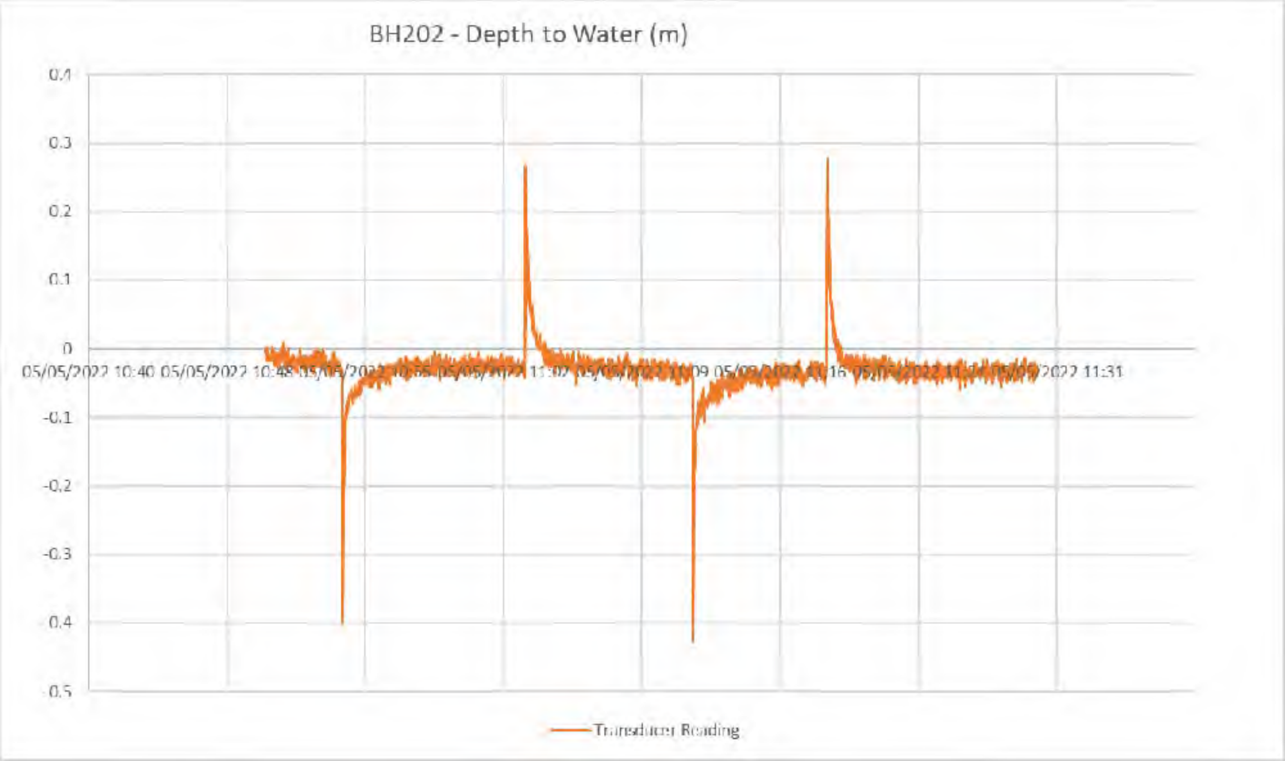
End of Hole 9.50 m

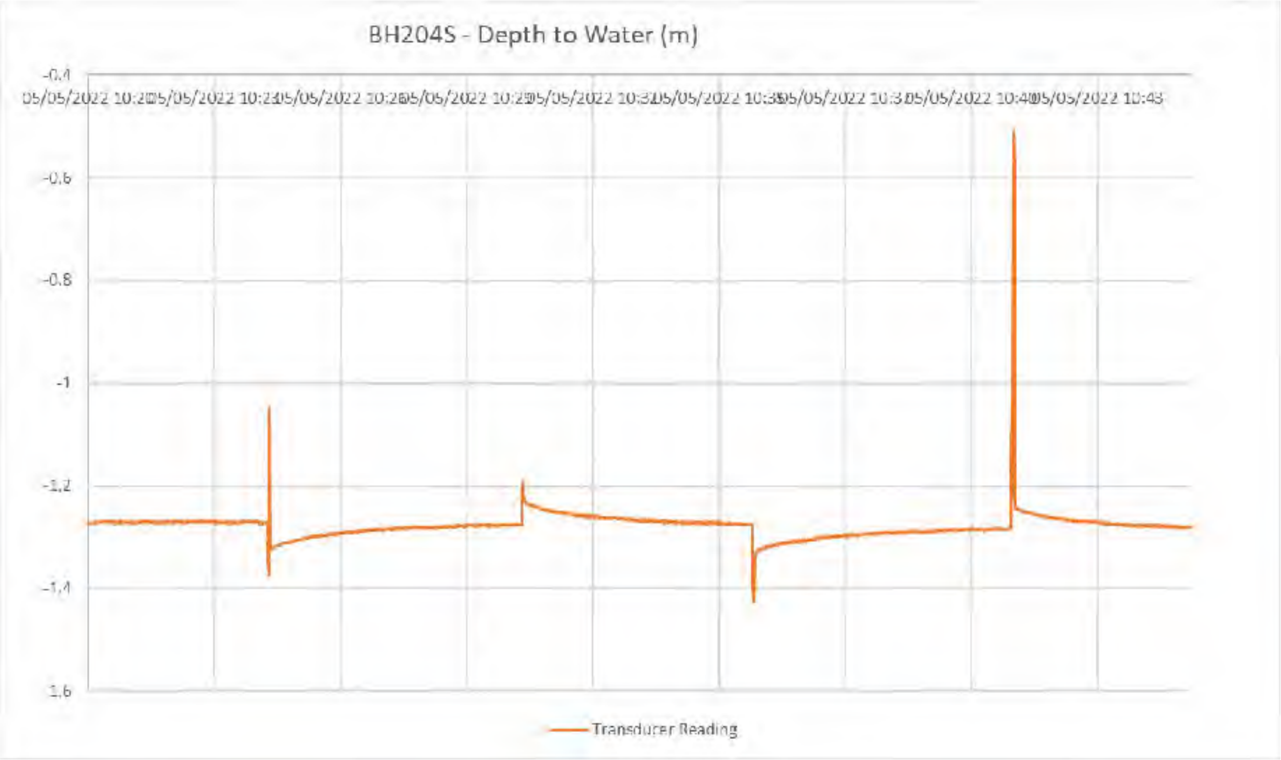
Compiled By:	Checked By:
CS	PAD
Scale:	Approved By:
FIG No.	

Notes: For explanation of symbols and abbreviations, see Key Sheet.

Annex B - Continuous Water Level Data


BH101S - Depth to Water (m)
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
05/05/2022 09:1
05/05/2022 09:2
05/05/2022 09:2
05/05/2022 09:3
05/05/2022 09:4
05/05/2022 09:5
05/05/2022 09:5
05/05/2022 10:0
05/05/2022 10:1
05/05/2022 10:19
Transducer Reading


BH202 - Depth to Water (m)
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
05/05/2022 10:40
05/05/2022 10:48
05/05/2022 10:5
05/05/2022 11:02
05/05/2022 11:09
05/05/2022 11:16
05/05/2022 11:2
05/05/2022 11:31
Transducer Reading


BH204S - Depth to Water (m)
-0.4
-0.6
-0.8
-1
-1.2
-1.4
1.6
05/05/2022 10:20
05/05/2022 10:23
05/05/2022 10:26
05/05/2022 10:29
05/05/2022 10:31
05/05/2022 10:35
05/05/2022 10:37
05/05/2022 10:40
05/05/2022 10:43
Transducer Reading

Annex C - Manual Monitoring Data

Slug Testing Form

Project Information	Project Name:	20775		
	Project Number:	Gloucester		
	Sampling Date:	5-5-22	Sampled by:	FD,AB
	Weather:	Clear		
	Well Notes - e.g. Condition, Access, Safety:			

Monitoring Information	Water Level Meter Used (as applicable):	Interface Probe:	x	Slug Length	64cm
		Dip Meter:		Slug Diameter	35mm

Well Location	BH101s	**Troll Number**	760789	**Test Number**	1

Pre-Slug

Depth to Water (mTOC)	2.20
Time troll entered (time)	09:11:25
Depth of troll (mTOC	2.90
Depth of Slug (mTOC)	1.50

Additional Notes

DTB 3m
Diver started @ 09:20:00

Diver out @ 10:14:00

Offset -0.16m

Slug in well		**Slug Removed from well**	
Slug lowered (time)	3 seconds	Slug removed (time)	3 seconds
Time (Seconds)	Depth (mTOC)	Time (Seconds)	Depth (mTOC)
09:20:30	Slug in		
09:20:45	1.99		
09:24:00	2.16		
09:29:30	2.19		
09:35:30	20.20		
09:36:00	Slug out>>>	09:36:30	2.45
		09:39:30	2.24
		09:48:15	2.20
09:49:30	Slug in	<<<<<	
09:49:50	2.01		
09:53:30	2.15		
10:00:30	2.20		
10:01:15	Slug out>>>>	10:01:30	2.48
		10:06:15	2.22
		10:13:00	2.20
		Test End	

mTOC = Metres below top of casing level. Record if measurements are taken to an alternate datum (e.g. ground level)

Slug Testing Form

Project Information	Project Name:	Gloucester		
	Project Number:	20775		
	Sampling Date:	5-5-22	Sampled by:	FD
	Weather:	Light cloud		
	Well Notes - e.g. Condition, Access, Safety:			

Monitoring Information	Water Level Meter Used (as applicable):	Interface Probe:	x	Slug Length	64cm
		Dip Meter:		Slug Diameter	35mm

Well Location	BH202	**Troll Number**	760853	**Test Number**	1

Pre-Slug

Depth to Water (mTOC)	1.17
Time troll entered (time)	10:47:00
Depth of troll (mTOC	2.60
Depth of Slug (mTOC)	1.40

Additional Notes

Diver start @ 10:50:00

DTB 2.86m

Nudged diver slightly at 11:12:50 ish

Offset -0.12

Slug in well		Slug Removed from well	
Slug lowered (time)	3 seconds	Slug removed (time)	3 seconds
Time (Seconds)	Depth (mTOC)	Time (Seconds)	Depth (mTOC)
10:54:00	Slug in		
10:54:45	1.14		
10:56:45	1.16		
11:03:00	1.17		
11:03:30	Slug out >>>>	11:04:00	1.21
		11:05:15	1.18
		11:11:15	1.17
11:12:15	Slug in	<<<	
11:12:45	1.13		
11:16:15	1.165		
11:18:45	1.17		
11:19:15	Slug out>>>	11:19:30	1.26
		11:23:00	1.18
		11:30:00	1.17
		Test End	

mTOC = Metres below top of casing level. Record if measurements are taken to an alternate datum (e.g. ground level)

Slug Testing Form

Project Information	Project Name:	Gloucester			
	Project Number:	20775			
	Sampling Date:	5-5-22		Sampled by:	AB
	Weather:	Clear			
	Well Notes - e.g. Condition, Access, Safety:				

Monitoring Information	Water Level Meter Used (as applicable):	Interface Probe:	x	Slug Length	640mm
		Dip Meter:		Slug Diameter	35mm

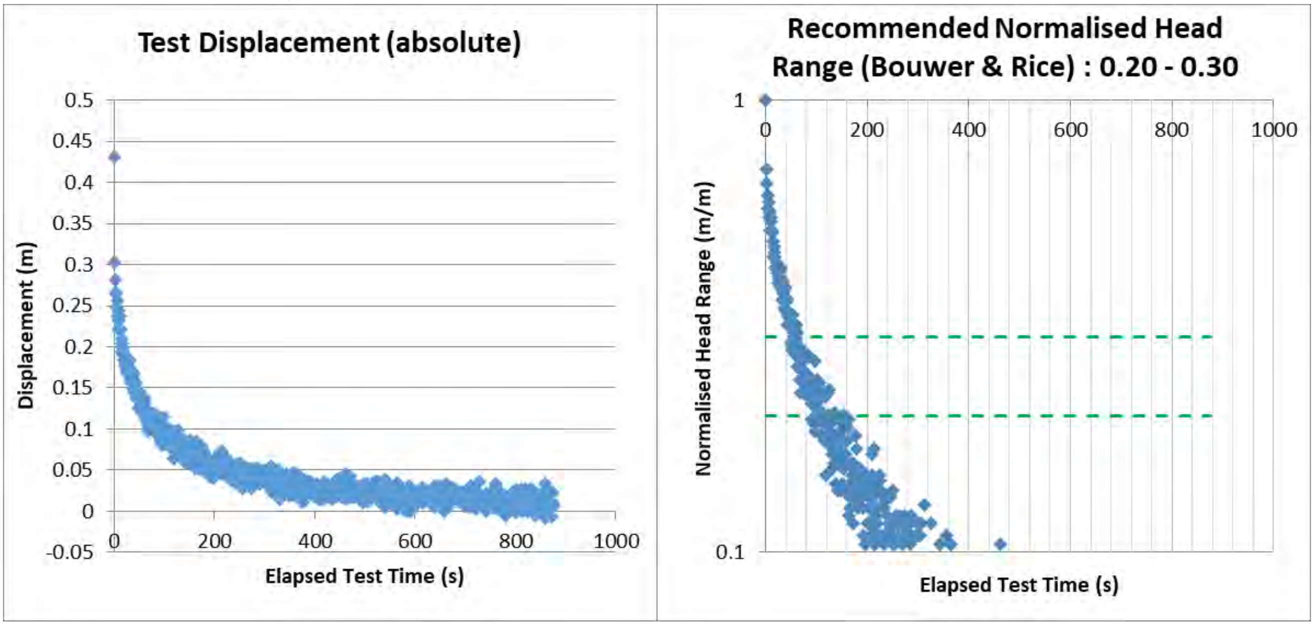
Well Location	BH204s	**Troll Number**	725495	**Test Number**	1

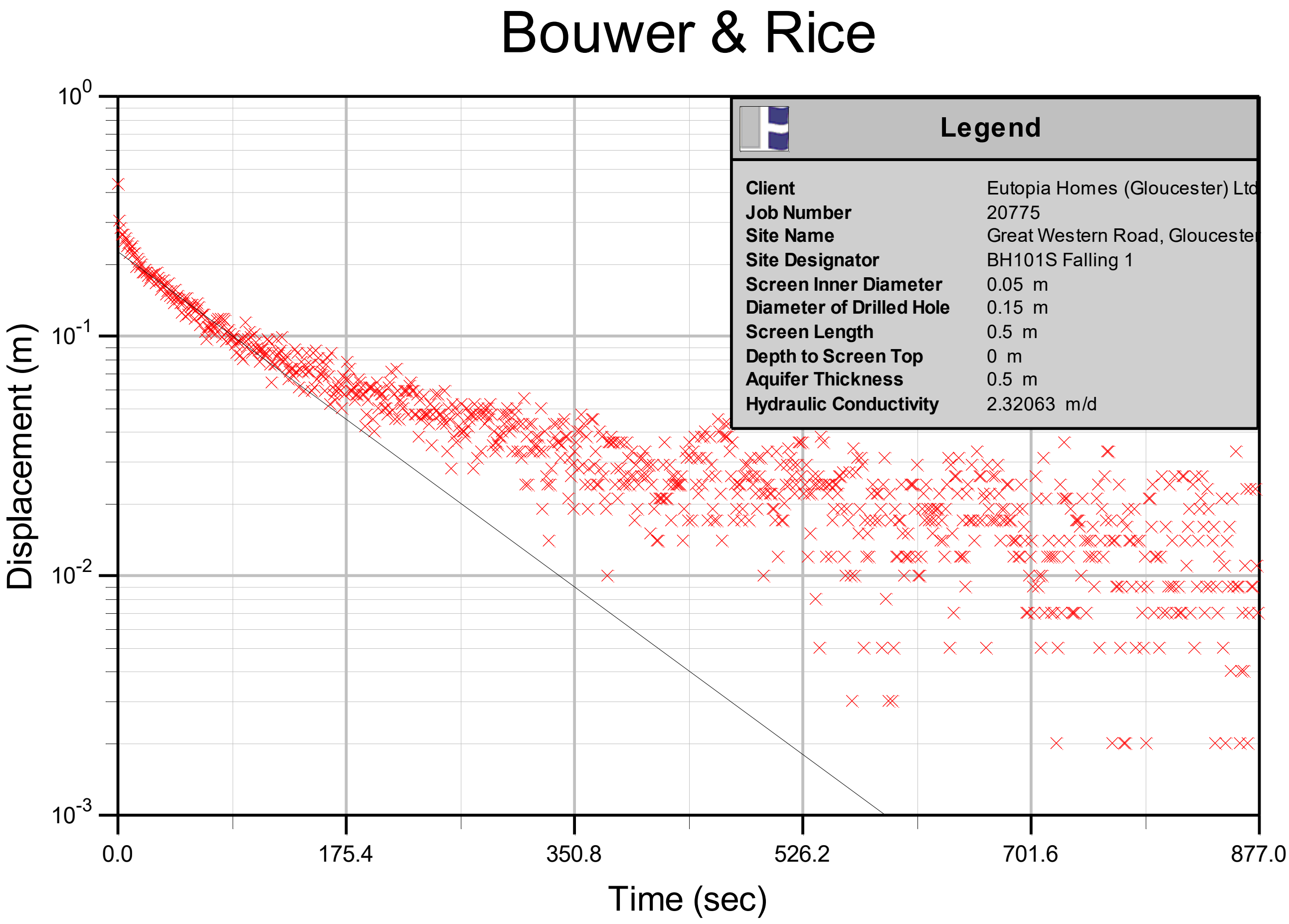
Pre-Slug		**Slug in well**		**Slug Removed from well**	
Depth to Water (mTOC)	1.23	Slug lowered (time)	10:22:00 and 10:33:00	Slug removed (time)	10:28:00 and 10:39:00
Time troll entered (time)	10:10	Time (Seconds)	Depth (mTOC)	Time (Seconds)	Depth (mTOC)
Depth of troll (mTOC	2.3		Slug in 10:22		
Depth of Slug (mTOC)	1.4	0	1.18		
Additional Notes		120	1.21		
Depth to base 2.62 Offset -0.08 Diver start at 10:05 Initial slug test abandoned due to issues with string attached to slug- not listed on this table.		180	1.22		
		300	1.23		
			Slug out 10:28	0	1.265
				60	1.245
				120	1.24
				180	1.235
				240	1.23
					Slug in 10:33
		0	1.185		
		60	1.2		
		120	1.21		
		180	1.22		
		240	1.225		
		300	1.23		
			Slug out 10:39	0	1.27
				60	1.25
				120	1.24
				180	1.235
				240	1.23

mTOC = Metres below top of casing level. Record if measurements are taken to an alternate datum (e.g. ground level)

Annex D - Analysis

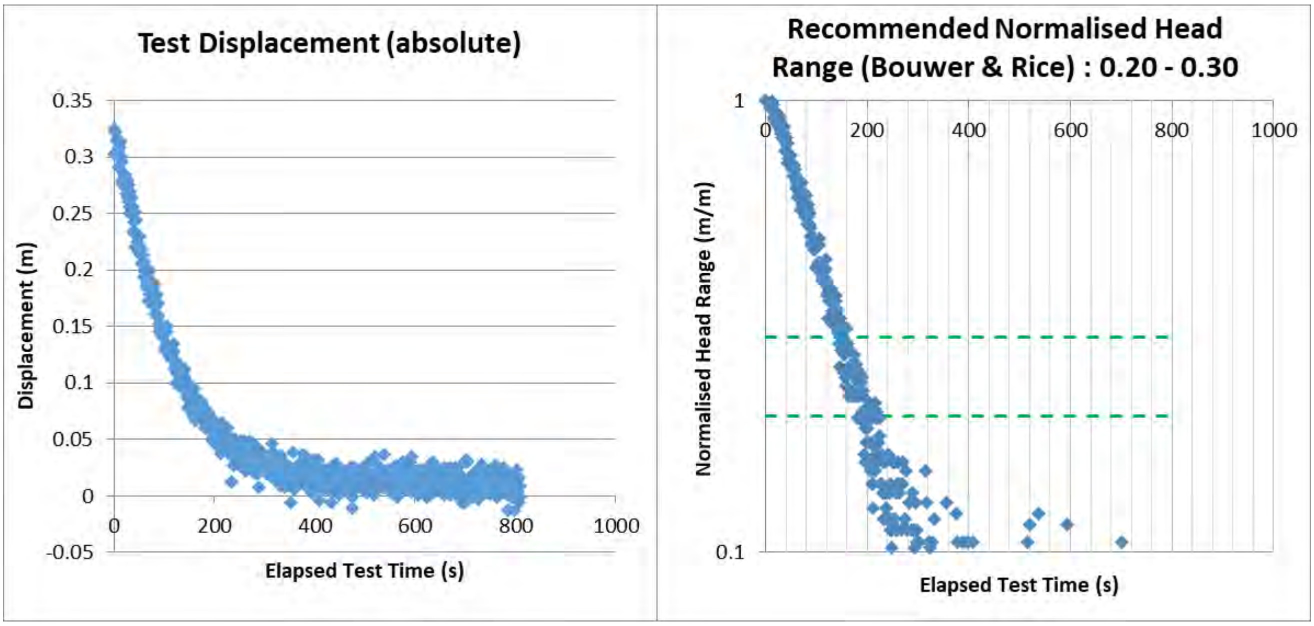
BH101S -Falling Head Test 1

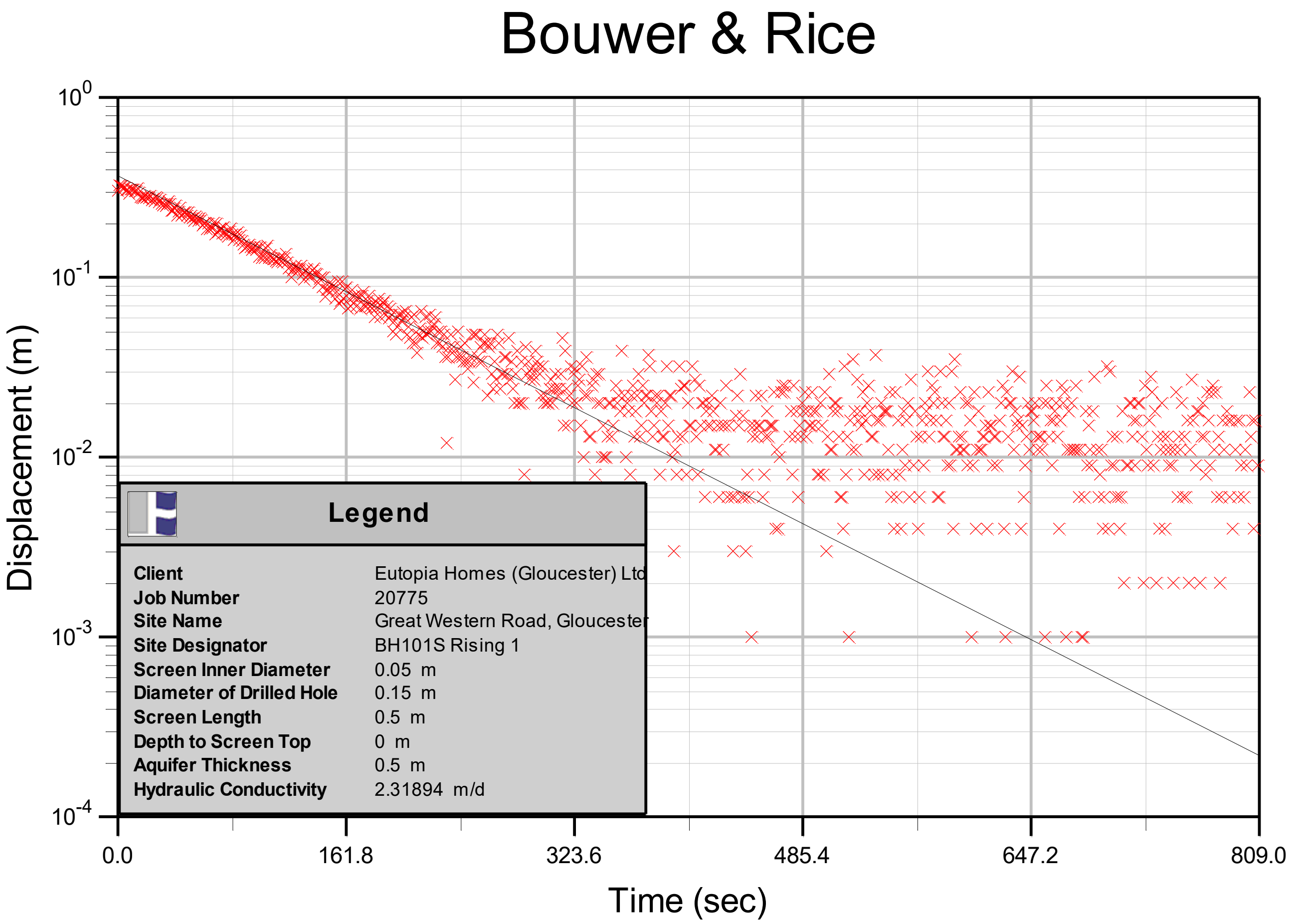




Client	Eutopia Homes (Gloucester) Ltd
Job Number	20775
Site Name	Great Western Road, Gloucester
Site Designator	BH101S Falling 1
Screen Inner Diameter	0.05 m
Diameter of Drilled Hole	0.15 m
Screen Length	0.5 m
Depth to Screen Top	0 m
Aquifer Thickness	0.5 m
Hydraulic Conductivity	2.32063 m/d

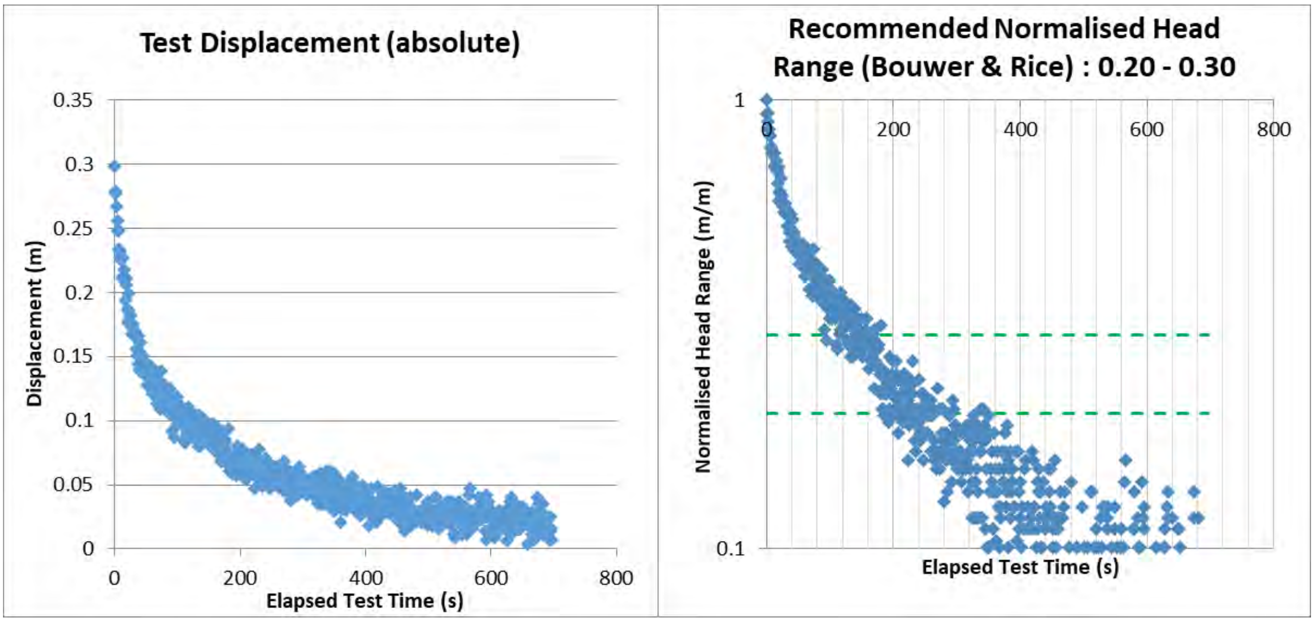
BH101S -Rising Head Test 1

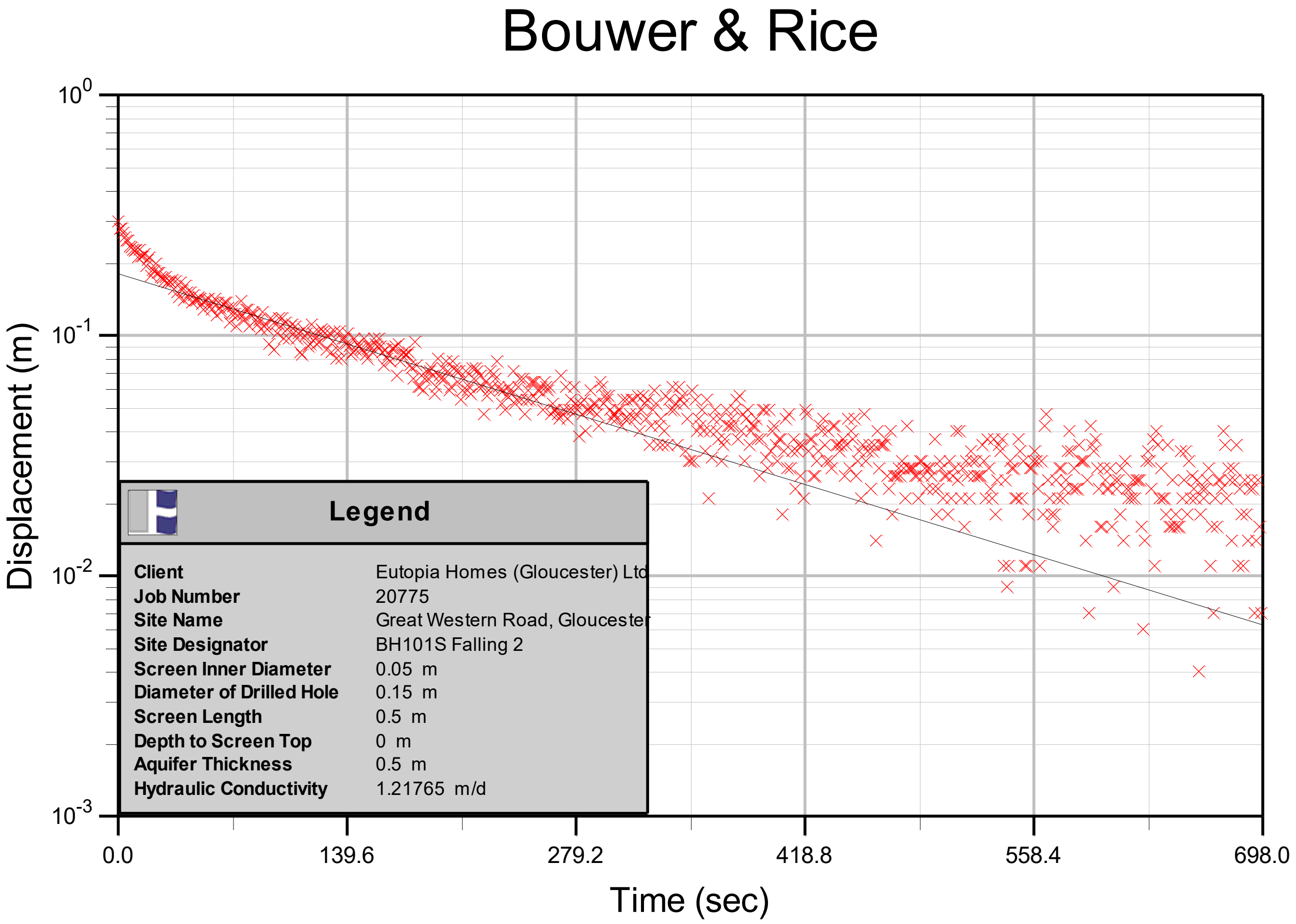




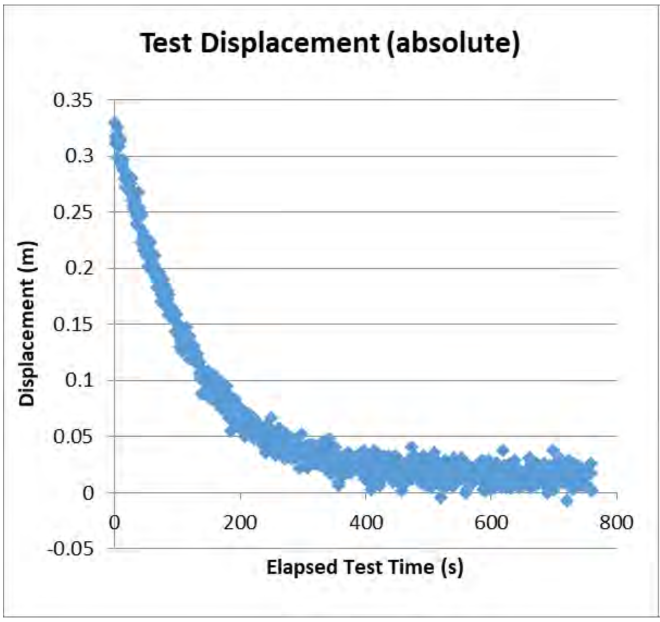
Client	Eutopia Homes (Gloucester) Ltd
Job Number	20775
Site Name	Great Western Road, Gloucester
Site Designator	BH101S Rising 1
Screen Inner Diameter	0.05 m
Diameter of Drilled Hole	0.15 m
Screen Length	0.5 m
Depth to Screen Top	0 m
Aquifer Thickness	0.5 m
Hydraulic Conductivity	2.31894 m/d

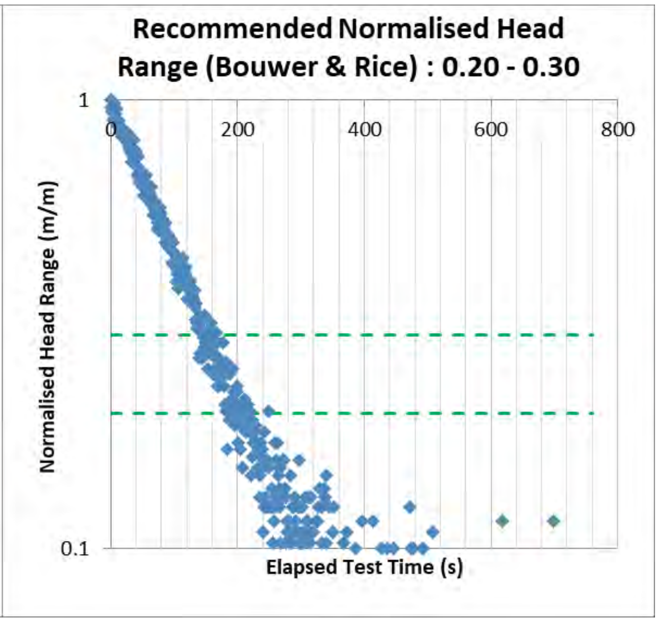
BH101S -Falling Head Test 2

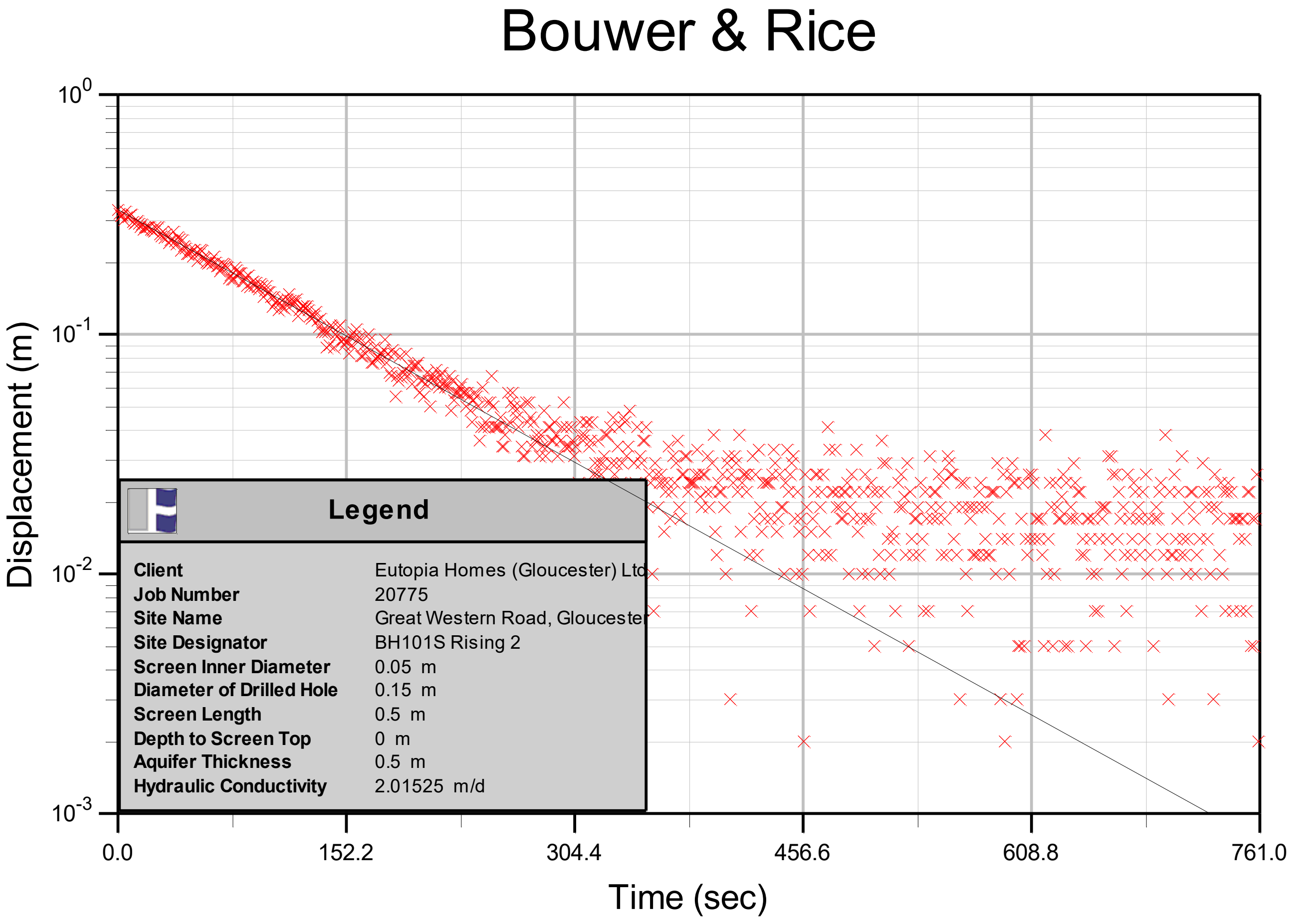




BH101S -Rising Head Test 2

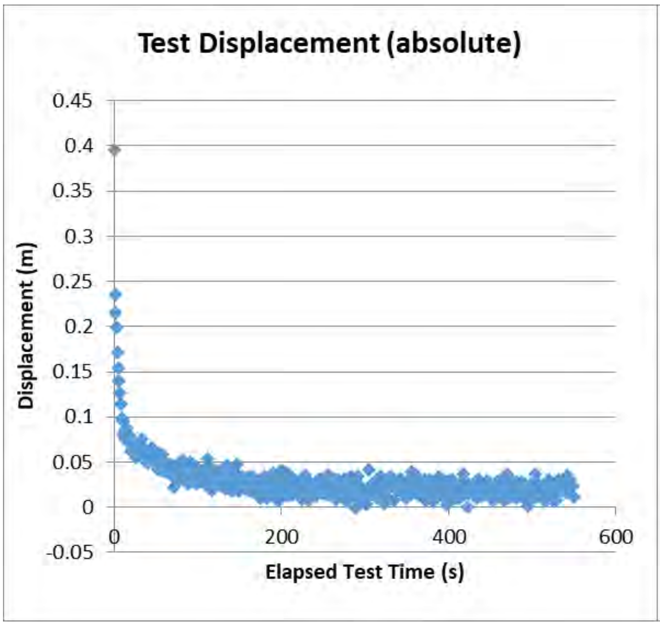


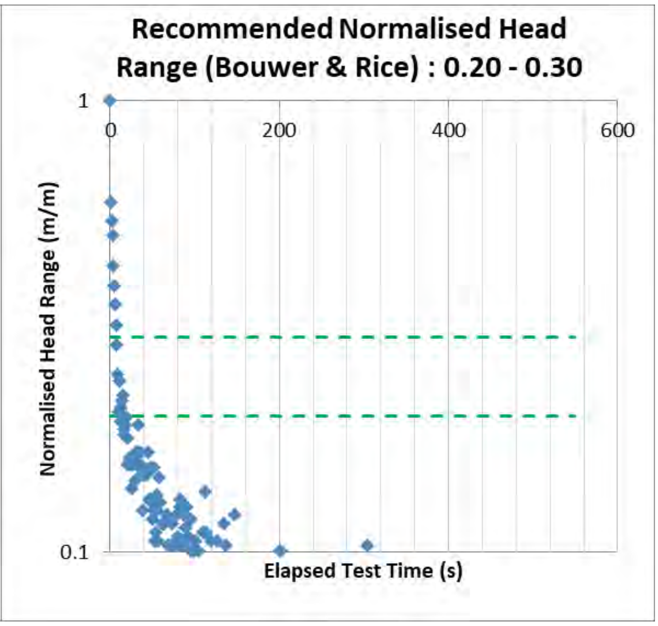


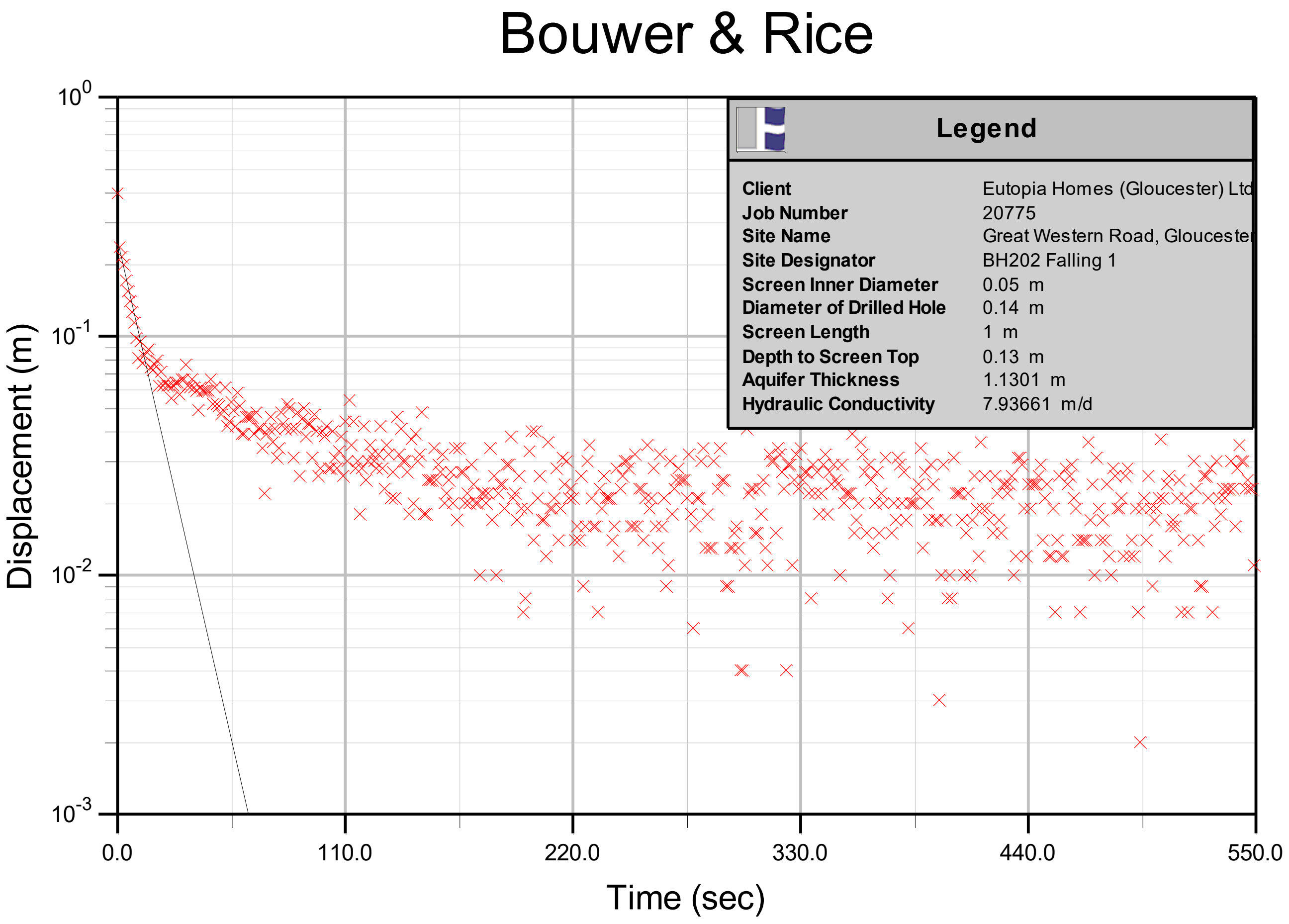


Client	Eutopia Homes (Gloucester) Ltd
Job Number	20775
Site Name	Great Western Road, Gloucester
Site Designator	BH101S Rising 2
Screen Inner Diameter	0.05 m
Diameter of Drilled Hole	0.15 m
Screen Length	0.5 m
Depth to Screen Top	0 m
Aquifer Thickness	0.5 m
Hydraulic Conductivity	2.01525 m/d

BH202 -Falling Head Test 1

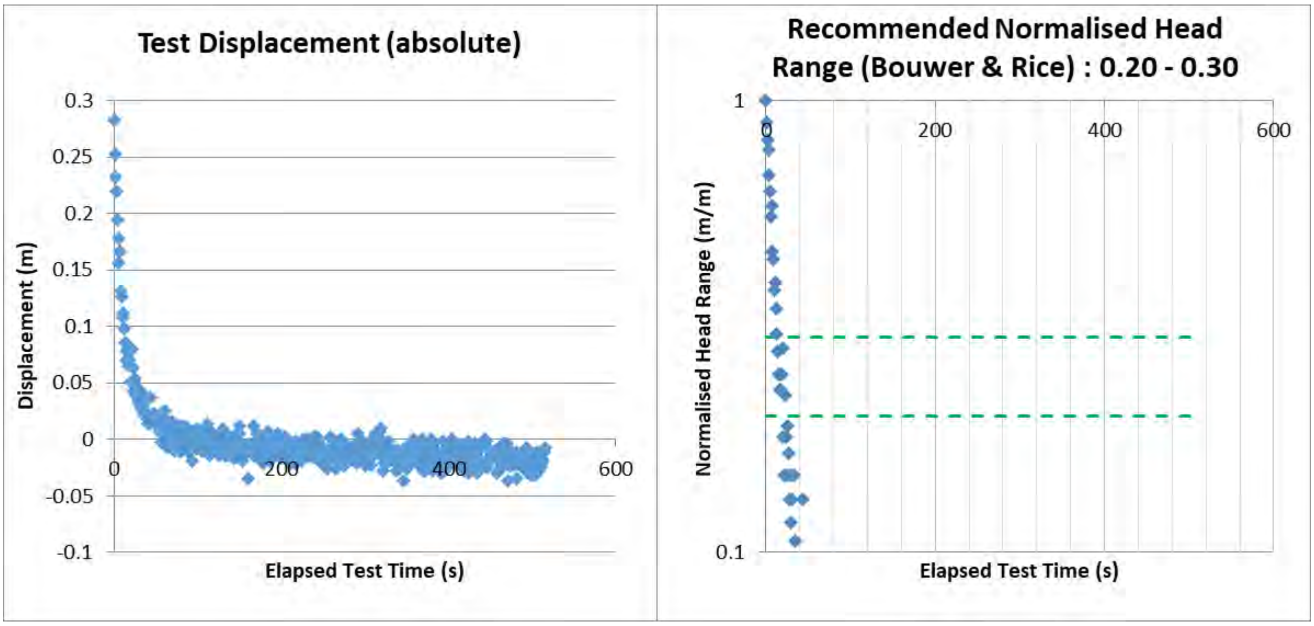


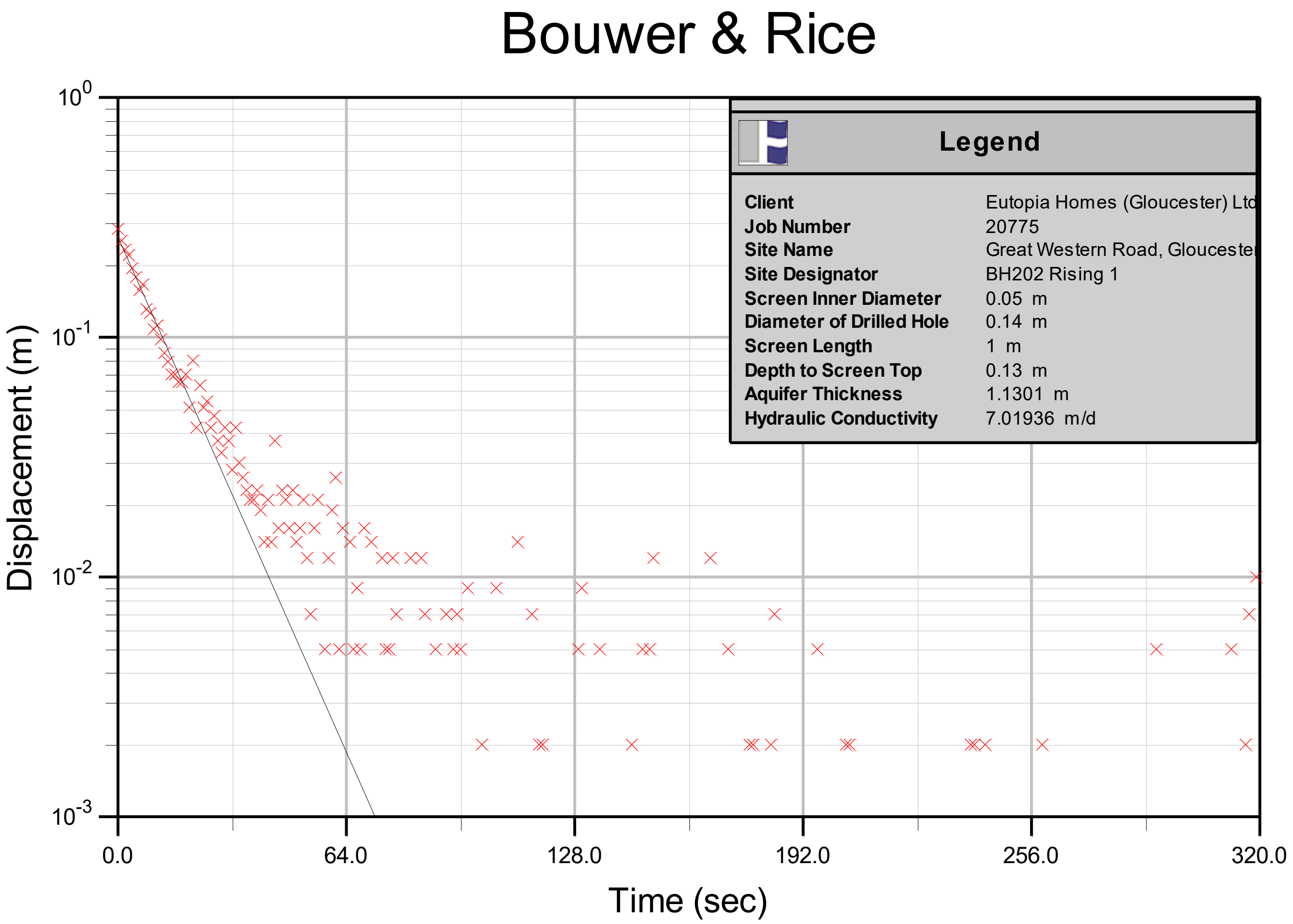




Client	Eutopia Homes (Gloucester) Ltd
Job Number	20775
Site Name	Great Western Road, Glouceste
Site Designator	BH202 Falling 1
Screen Inner Diameter	0.05 m
Diameter of Drilled Hole	0.14 m
Screen Length	1 m
Depth to Screen Top	0.13 m
Aquifer Thickness	1.1301 m
Hydraulic Conductivity	7.93661 m/d

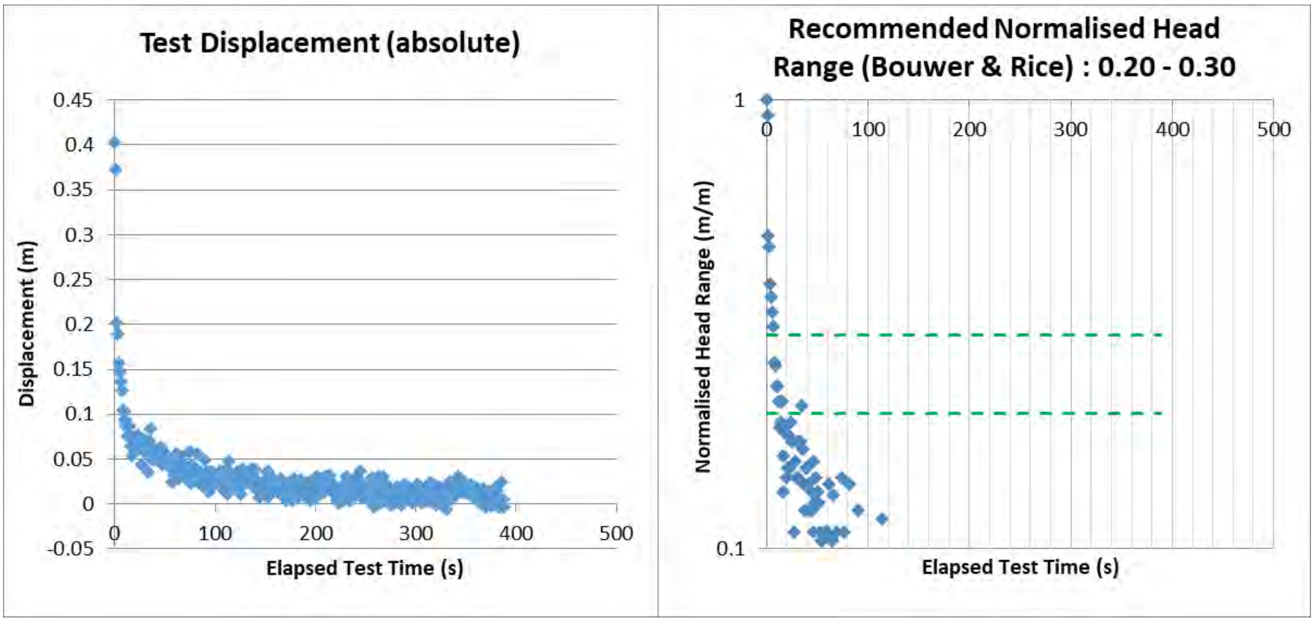
BH202 -Rising Head Test 1

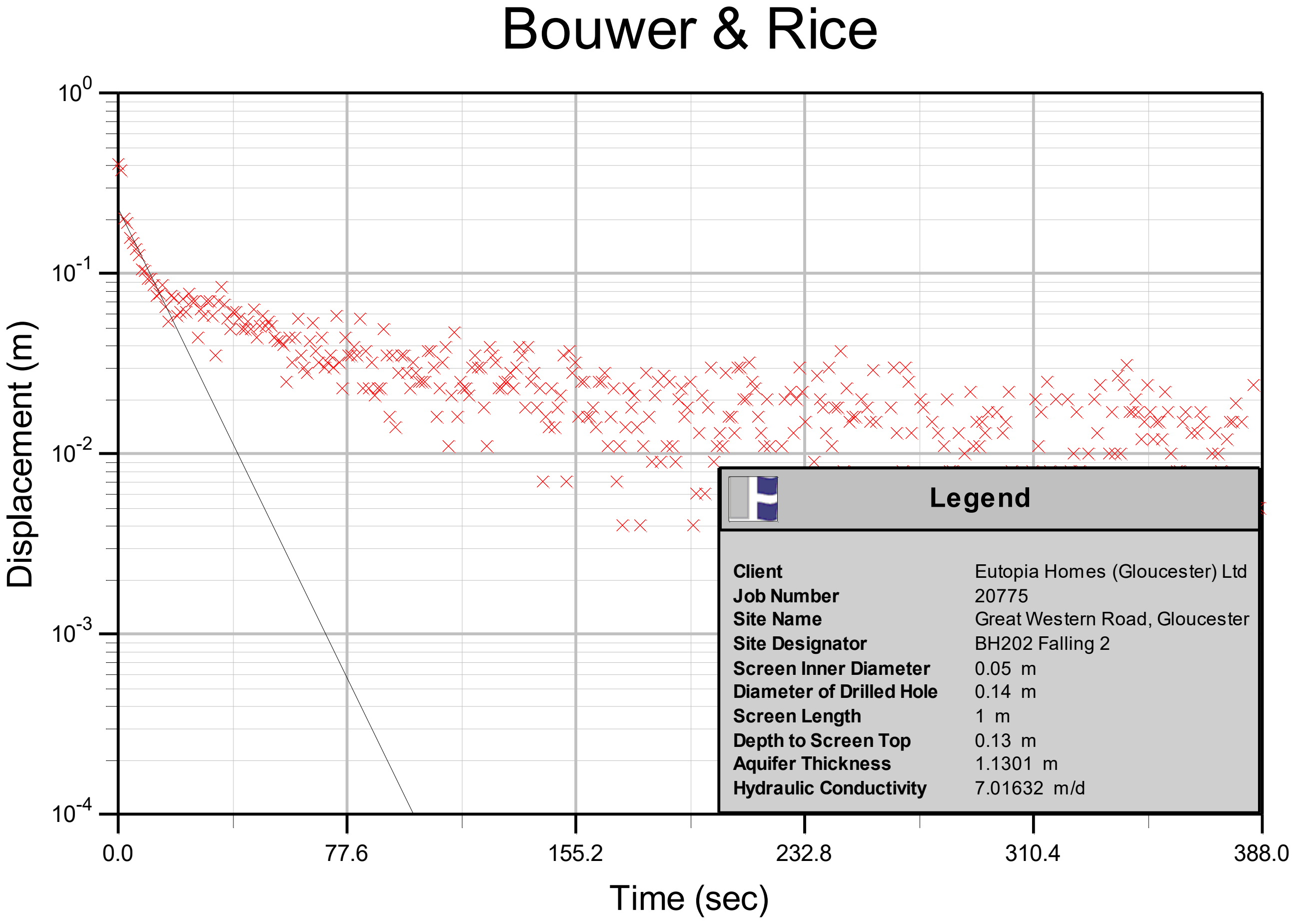




Client	Eutopia Homes (Gloucester) Ltd
Job Number	20775
Site Name	Great Western Road, Glouceste
Site Designator	BH202 Rising 1
Screen Inner Diameter	0.05 m
Diameter of Drilled Hole	0.14 m
Screen Length	1 m
Depth to Screen Top	0.13 m
Aquifer Thickness	1.1301 m
Hydraulic Conductivity	7.01936 m/d

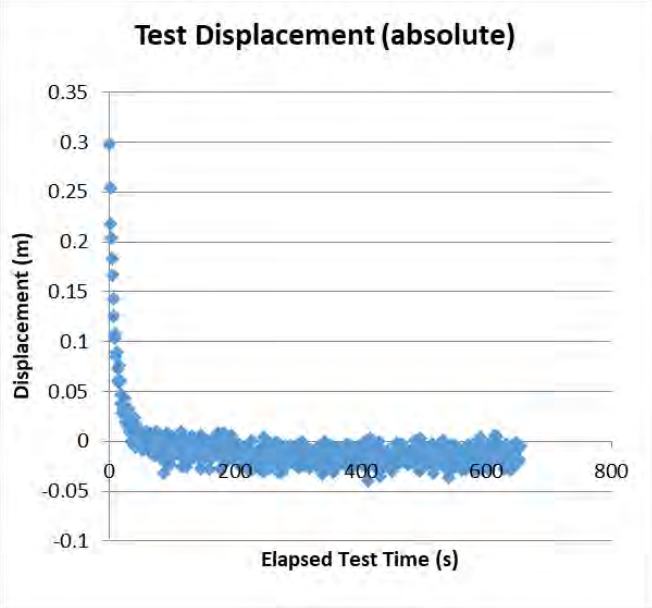
BH202 -Falling Head Test 2

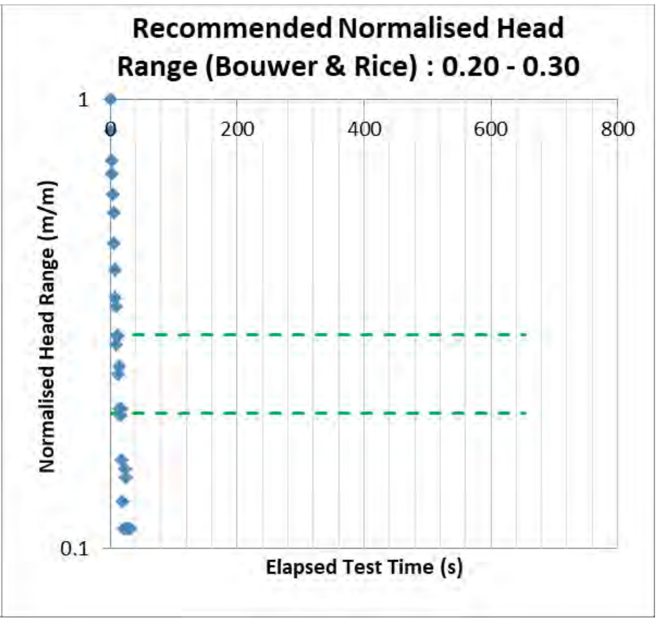


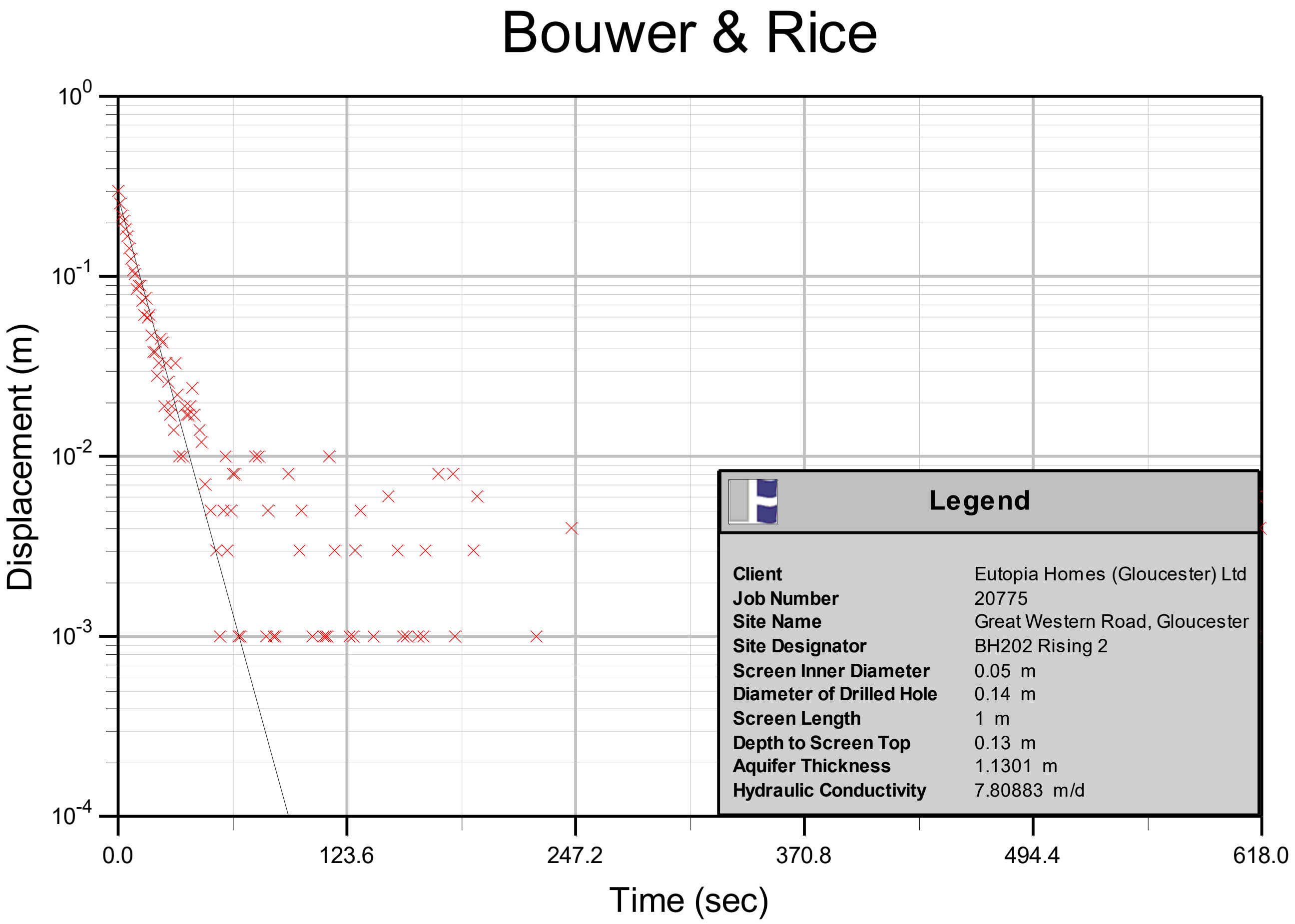


Client	Eutopia Homes (Gloucester) Ltd
Job Number	20775
Site Name	Great Western Road, Gloucester
Site Designator	BH202 Falling 2
Screen Inner Diameter	0.05 m
Diameter of Drilled Hole	0.14 m
Screen Length	1 m
Depth to Screen Top	0.13 m
Aquifer Thickness	1.1301 m
Hydraulic Conductivity	7.01632 m/d

BH202 -Rising Head Test 2

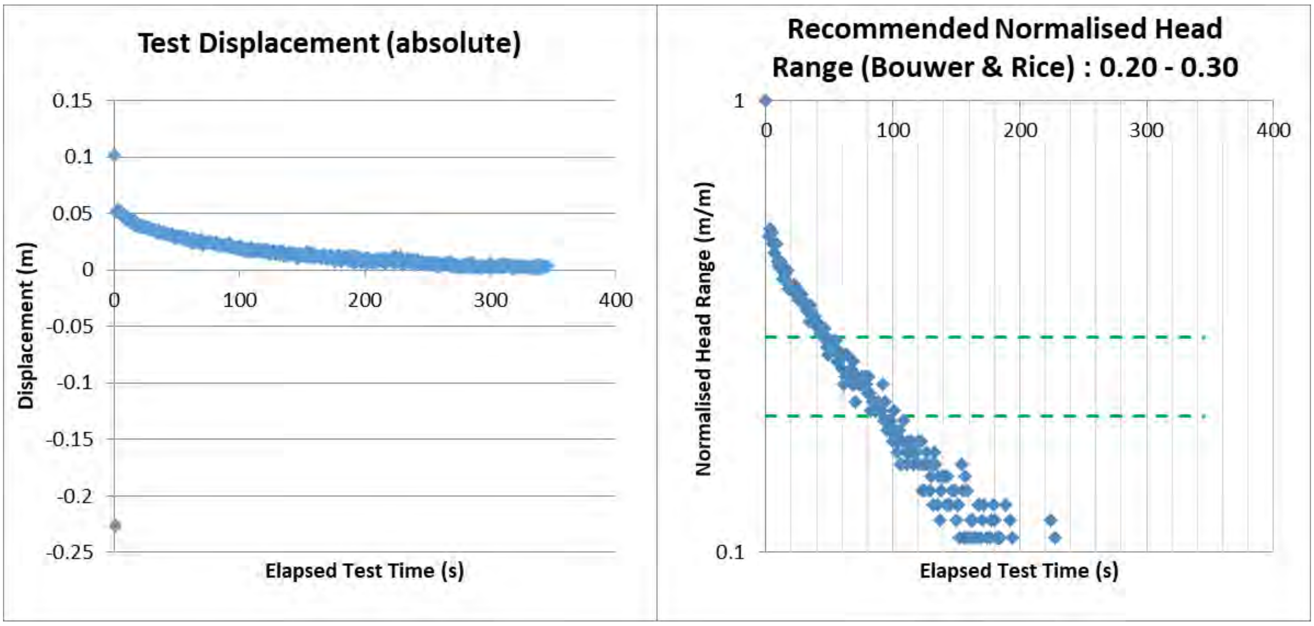


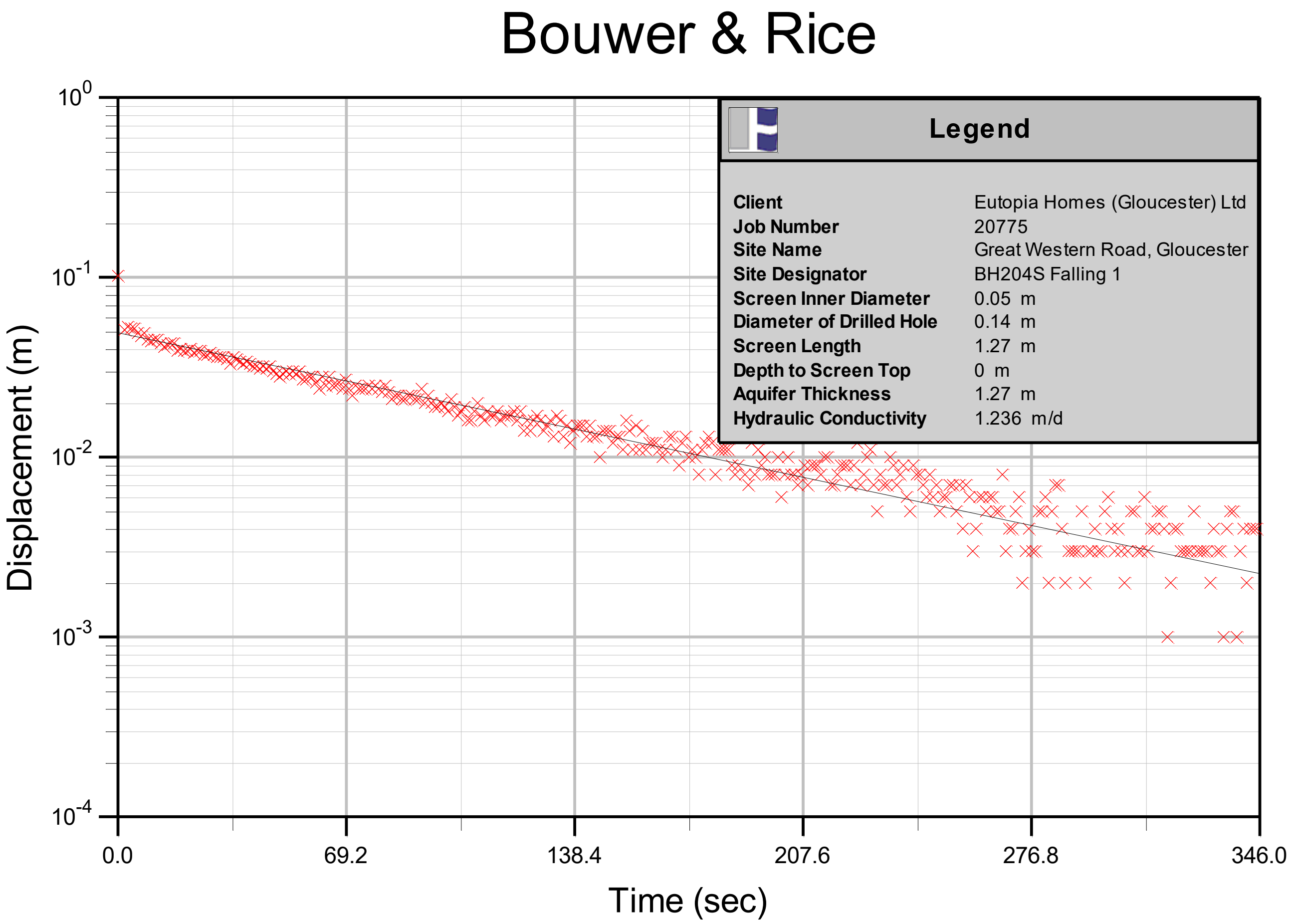




Client	Eutopia Homes (Gloucester) Ltd
Job Number	20775
Site Name	Great Western Road, Gloucester
Site Designator	BH202 Rising 2
Screen Inner Diameter	0.05 m
Diameter of Drilled Hole	0.14 m
Screen Length	1 m
Depth to Screen Top	0.13 m
Aquifer Thickness	1.1301 m
Hydraulic Conductivity	7.80883 m/d

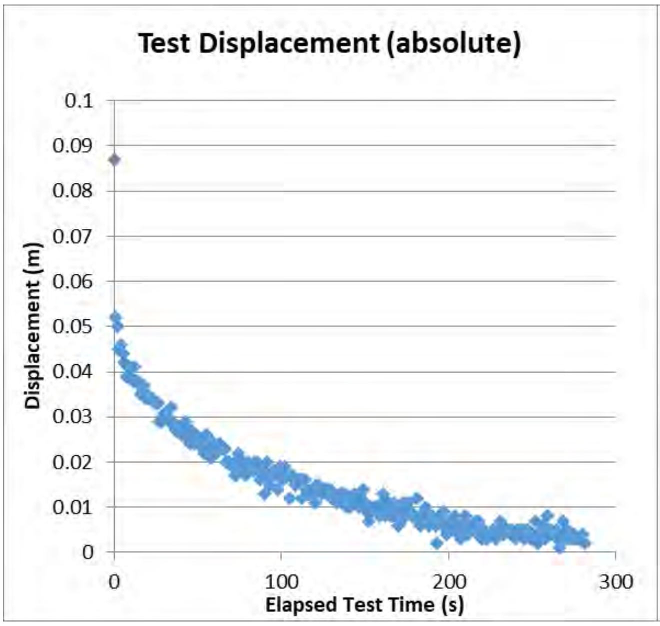
BH204S -Falling Head Test 1

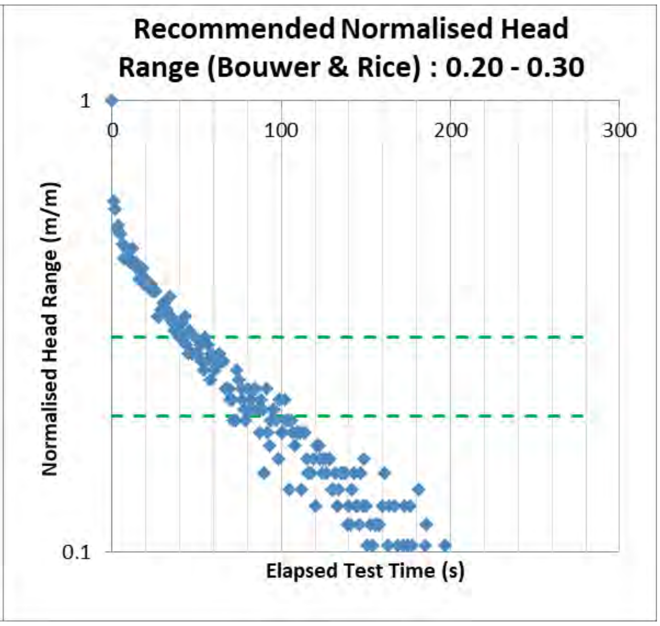


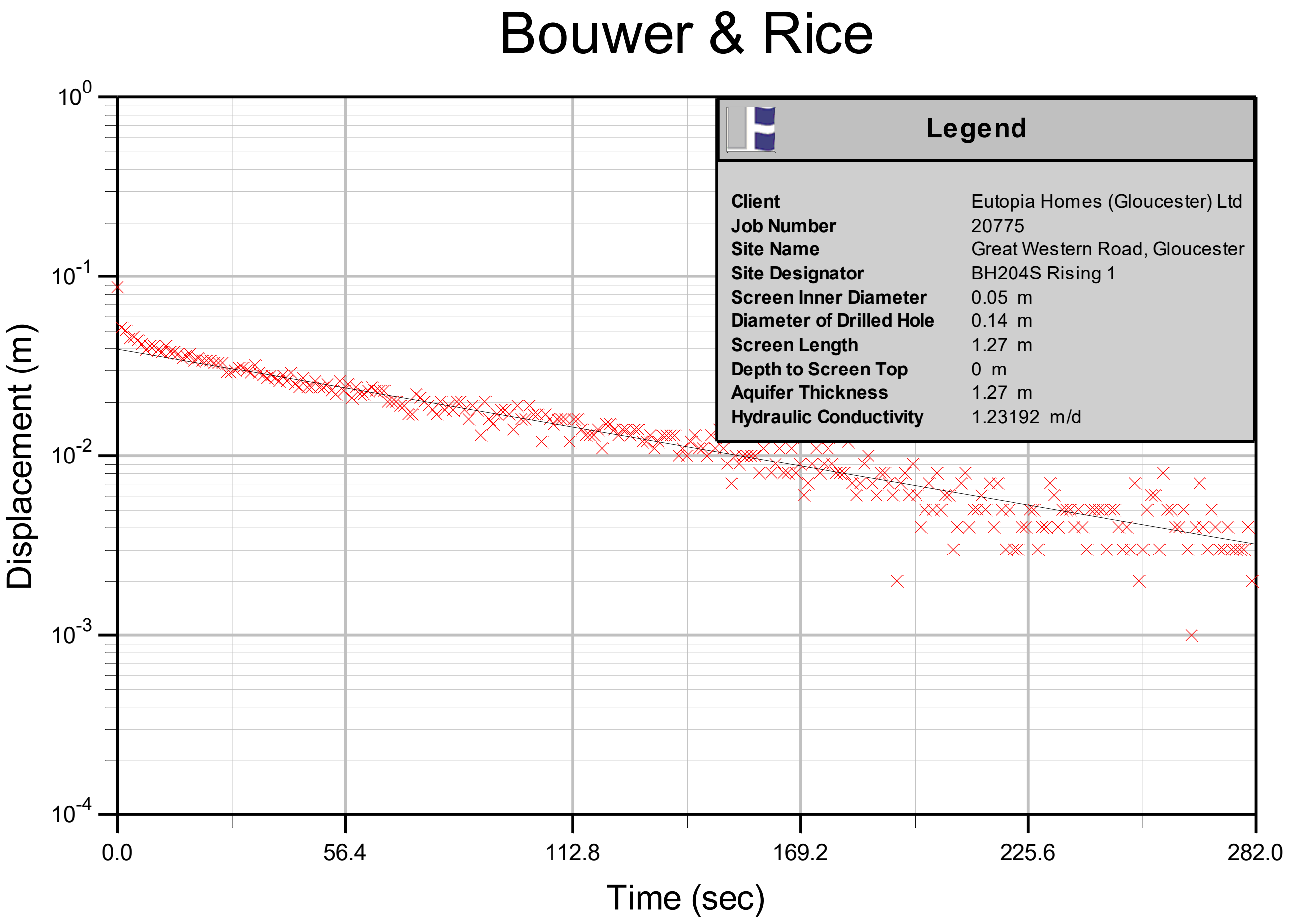


Client	Eutopia Homes (Gloucester) Ltd
Job Number	20775
Site Name	Great Western Road, Gloucester
Site Designator	BH204S Falling 1
Screen Inner Diameter	0.05 m
Diameter of Drilled Hole	0.14 m
Screen Length	1.27 m
Depth to Screen Top	0 m
Aquifer Thickness	1.27 m
Hydraulic Conductivity	1.236 m/d

BH204S -Rising Head Test 1

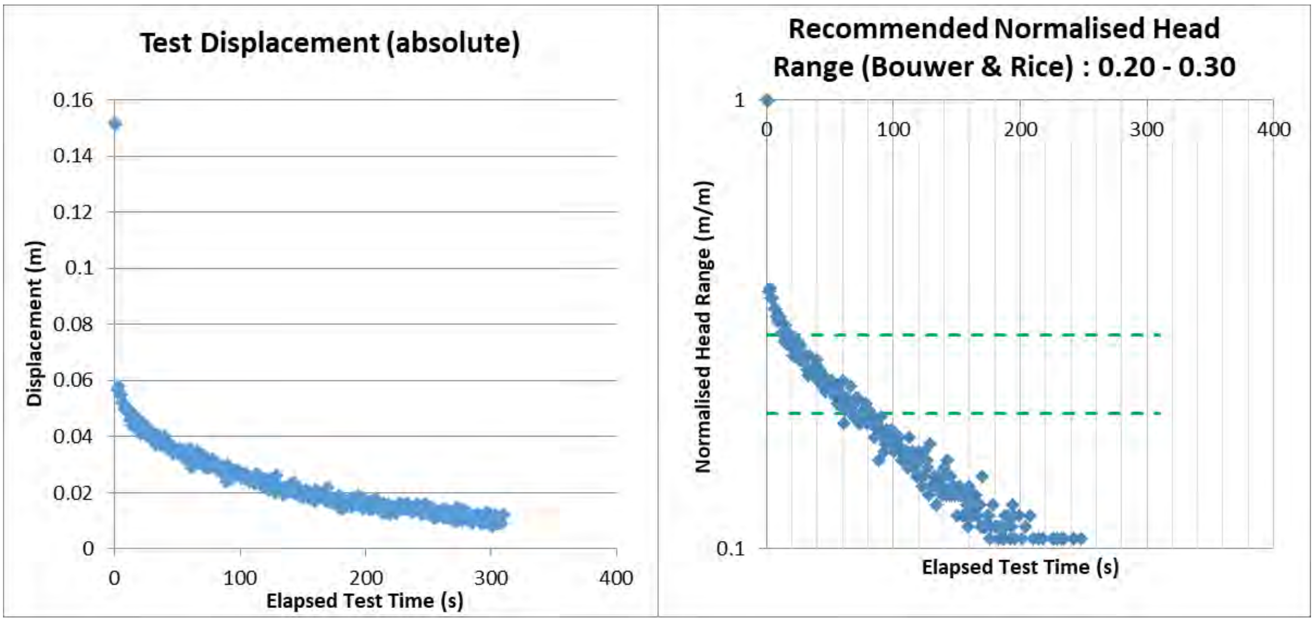


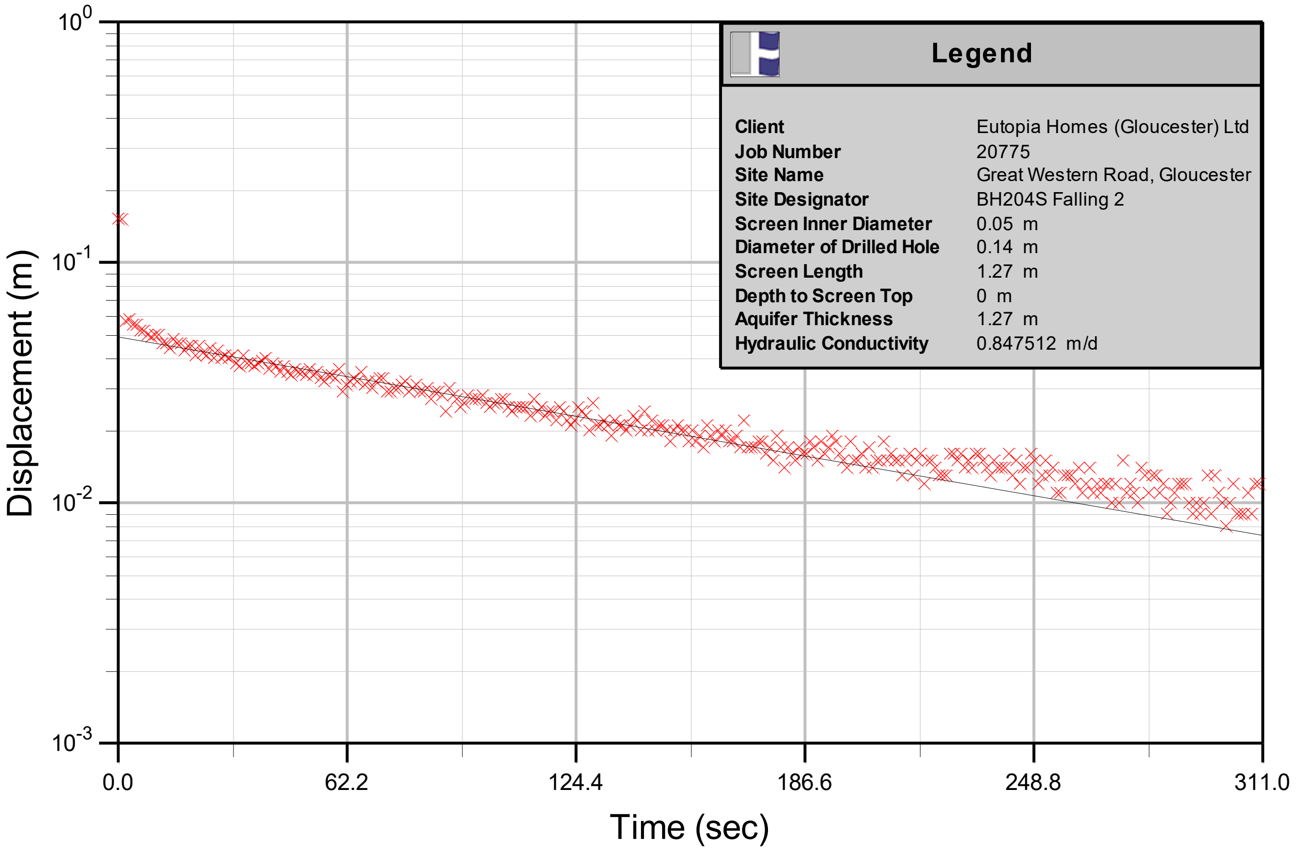




Client	Eutopia Homes (Gloucester) Ltd
Job Number	20775
Site Name	Great Western Road, Gloucester
Site Designator	BH204S Rising 1
Screen Inner Diameter	0.05 m
Diameter of Drilled Hole	0.14 m
Screen Length	1.27 m
Depth to Screen Top	0 m
Aquifer Thickness	1.27 m
Hydraulic Conductivity	1.23192 m/d

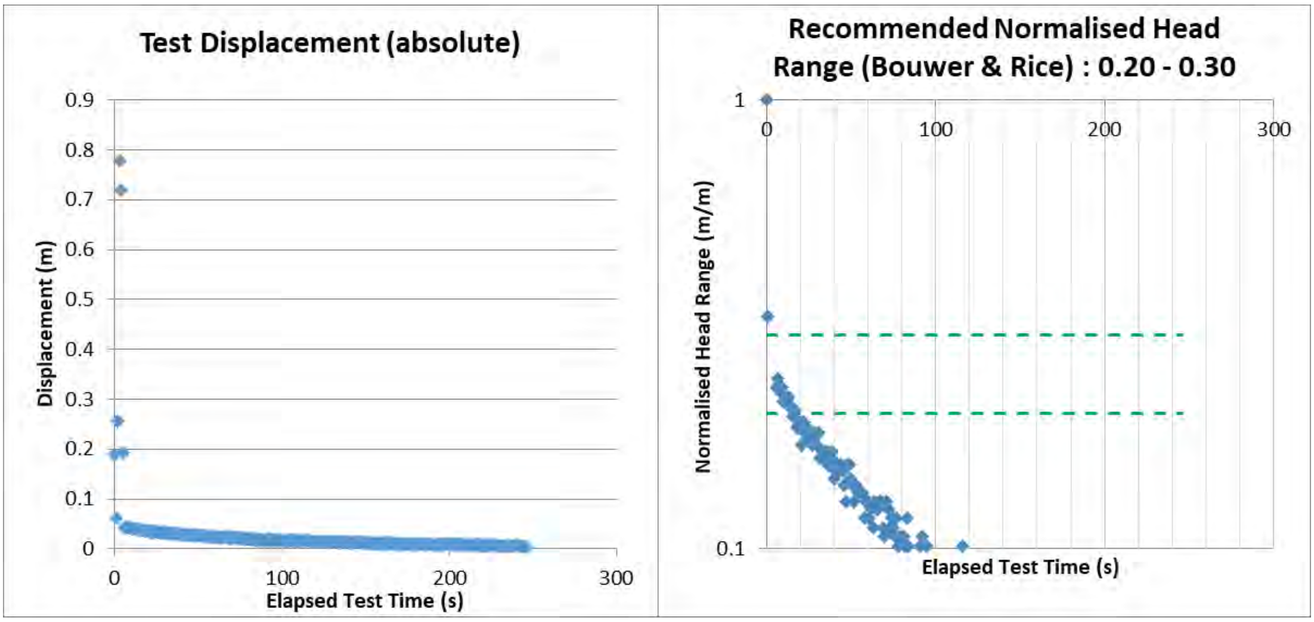
BH204S -Falling Head Test 2

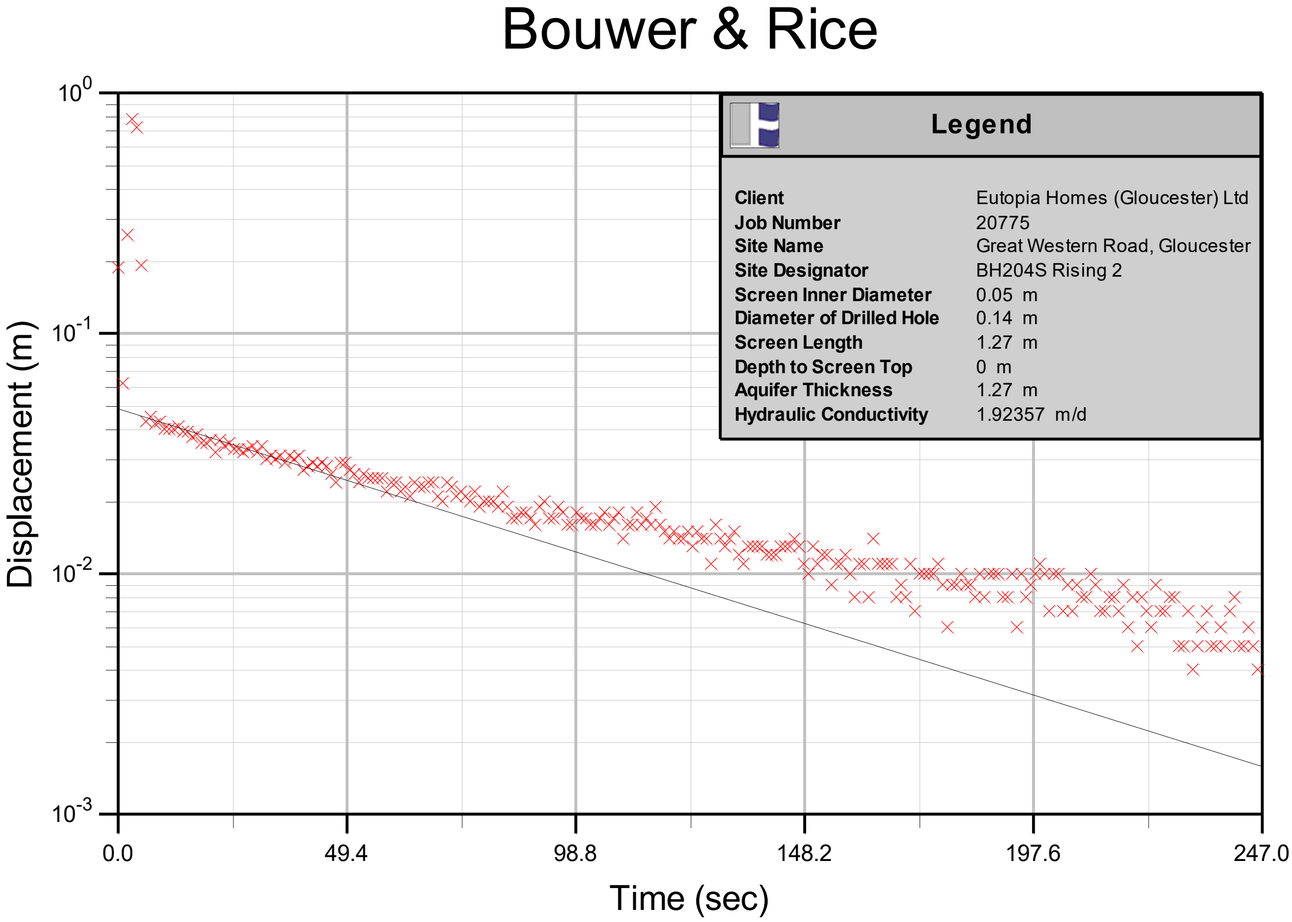




Client	Eutopia Homes (Gloucester) Ltd
Job Number	20775
Site Name	Great Western Road, Gloucester
Site Designator	BH204S Falling 2
Screen Inner Diameter	0.05 m
Diameter of Drilled Hole	0.14 m
Screen Length	1.27 m
Depth to Screen Top	0 m
Aquifer Thickness	1.27 m
Hydraulic Conductivity	0.847512 m/d

BH204S -Rising Head Test 2





Client	Eutopia Homes (Gloucester) Ltd
Job Number	20775
Site Name	Great Western Road, Gloucester
Site Designator	BH204S Rising 2
Screen Inner Diameter	0.05 m
Diameter of Drilled Hole	0.14 m
Screen Length	1.27 m
Depth to Screen Top	0 m
Aquifer Thickness	1.27 m
Hydraulic Conductivity	1.92357 m/d

Appendix C Photographs

Photograph 1	
Date: 4-6 May 2022	
Direction Photograph Taken: NA.	
Description: LNAPL from WS102.	

Photograph 2	
Date: 4-6 May 2022	
Direction Photograph Taken: NA.	
Description: LNAPL from WS115.	

Appendix D Laboratory Certificates

UKAS
TESTING
4041

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Hydrock Consultants Ltd
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BS32 4DF

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t: 01923 225404
f: 01923 237404
e: reception@i2analytical.com

Analytical Report Number : 22-56099

Project / Site name:	Gloucester, GWR Yard	**Samples received on:**	05/05/2022
Your job number:	20775	**Samples instructed on/ Analysis started on:**	05/05/2022
Your order number:	PO16135	**Analysis completed by:**	11/05/2022
Report Issue Number:	1	**Report issued on:**	11/05/2022
Samples Analysed:	12 water samples		

Signed:

Adam Fenwick
Technical Reviewer
For & on behalf of i2 Analytical Ltd.

Standard Geotechnical, Asbestos and Chemical Testing Laboratory located at: ul. Pionierów 39, 41 -711 Ruda Śląska, Poland.

Accredited tests are defined within the report, opinions and interpretations expressed herein are outside the scope of accreditation.

Standard sample disposal times, unless otherwise agreed with the laboratory, are :

soils	- 4 weeks from reporting
leachates	- 2 weeks from reporting
waters	- 2 weeks from reporting
asbestos	- 6 months from reporting

Excel copies of reports are only valid when accompanied by this PDF certificate.

Any assessments of compliance with specifications are based on actual analytical results with no contribution from uncertainty of measurement.
Application of uncertainty of measurement would provide a range within which the true result lies.
An estimate of measurement uncertainty can be provided on request.

Analytical Report Number: 22-56099
Project / Site name: Gloucester, GWR Yard

Your Order No: PO16135

Lab Sample Number				2263286	2263287	2263288	2263289	2263290
Sample Reference				BH102	BH205	BH204D	WS204	WS203
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				2.32	2.19	4.50	1.60	1.86
Date Sampled				04/05/2022	04/05/2022	04/05/2022	04/05/2022	04/05/2022
Time Taken				1045	1210	1315	1405	1500
Analytical Parameter (Water Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					

General Inorganics

pH	pH Units	N/A	ISO 17025	-	-	-	-	-
Electrical Conductivity at 20 °C	µS/cm	10	ISO 17025	-	-	-	-	-
Sulphate as SO4	µg/l	45	ISO 17025	-	-	-	-	-
Sulphate as SO4	mg/l	0.045	ISO 17025	-	-	-	-	-
Sulphide	µg/l	5	NONE	-	-	-	-	-
Nitrate as N	mg/l	0.01	ISO 17025	-	-	-	-	-
Nitrate as NO3	mg/l	0.05	ISO 17025	-	-	-	-	-
Nitrite as N	µg/l	1	ISO 17025	-	-	-	-	-
Nitrite as NO2	µg/l	5	ISO 17025	-	-	-	-	-
Alkalinity as CaCO3	mg/l	3	ISO 17025	-	-	-	-	-

Redox Potential	mV	-800	NONE	-	-	-	-	-

Heavy Metals / Metalloids

Iron (dissolved)	mg/l	0.004	ISO 17025	-	-	-	-	-
Fe2+	mg/l	0.2	NONE	-	-	-	-	-
Fe3+	mg/l	0.2	NONE	-	-	-	-	-
Mn (II)	mg/l	0.02	NONE	-	-	-	-	-
Mn (IV)	mg/l	0.02	NONE	-	-	-	-	-

Monoaromatics & Oxygenates

Benzene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Toluene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Ethylbenzene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
p & m-xylene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
o-xylene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
MTBE (Methyl Tertiary Butyl Ether)	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Sum of m, p & o-Xylene	µg/l	2	ISO 17025	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0

Analytical Report Number: 22-56099
Project / Site name: Gloucester, GWR Yard

Your Order No: PO16135

Lab Sample Number				2263286	2263287	2263288	2263289	2263290
Sample Reference				BH102	BH205	BH204D	WS204	WS203
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				2.32	2.19	4.50	1.60	1.86
Date Sampled				04/05/2022	04/05/2022	04/05/2022	04/05/2022	04/05/2022
Time Taken				1045	1210	1315	1405	1500
Analytical Parameter (Water Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Petroleum Hydrocarbons								
TPH-CWG - Aliphatic >C5 - C6 HS_1D_AL	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
TPH-CWG - Aliphatic >C6 - C8 HS_1D_AL	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
TPH-CWG - Aliphatic >C8 - C10 HS_1D_AL	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
TPH-CWG - Aliphatic >C10 - C12 EH_1D_AL_#1_#2_MS	µg/l	10	NONE	< 10	< 10	< 10	< 10	< 10
TPH-CWG - Aliphatic >C12 - C16 EH_1D_AL_#1_#2_MS	µg/l	10	NONE	< 10	< 10	< 10	790	540
TPH-CWG - Aliphatic >C16 - C21 EH_1D_AL_#1_#2_MS	µg/l	10	NONE	< 10	< 10	< 10	790	440
TPH-CWG - Aliphatic >C21 - C35 EH_1D_AL_#1_#2_MS	µg/l	10	NONE	< 10	< 10	< 10	240	180
TPH-CWG - Aliphatic >C16 - C35 EH_1D_AL_#1_#2_MS	µg/l	10	NONE	< 10	< 10	< 10	1000	630
TPH-CWG - Aliphatic >C35 - C44 EH_1D_AL_#1_#2_MS	µg/l	10	NONE	< 10	< 10	< 10	< 10	< 10
TPH-CWG - Aliphatic (C5 - C35) HS+EH_1D_AL_#1_#2_MS	µg/l	10	NONE	< 10	< 10	< 10	1800	1200
TPH-CWG - Aliphatic (C5 - C44) HS+EH_1D_AR_#1_#2_MS	µg/l	10	NONE	< 10	< 10	< 10	1800	1200
TPH-CWG - Aromatic >C5 - C7 HS_1D_AR	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
TPH-CWG - Aromatic >C7 - C8 HS_1D_AR	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
TPH-CWG - Aromatic >C8 - C10 HS_1D_AR	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
TPH-CWG - Aromatic >C10 - C12 EH_1D_AR_#1_#2_MS	µg/l	10	NONE	< 10	< 10	< 10	210	280
TPH-CWG - Aromatic >C12 - C16 EH_1D_AR_#1_#2_MS	µg/l	10	NONE	< 10	< 10	< 10	360	430
TPH-CWG - Aromatic >C16 - C21 EH_1D_AR_#1_#2_MS	µg/l	10	NONE	< 10	< 10	< 10	540	350
TPH-CWG - Aromatic >C21 - C35 EH_1D_AR_#1_#2_MS	µg/l	10	NONE	< 10	< 10	< 10	170	45
TPH-CWG - Aromatic >C35 - C44 EH_1D_AR_#1_#2_MS	µg/l	10	NONE	< 10	< 10	< 10	< 10	< 10
TPH-CWG - Aromatic (C5 - C35) HS+EH_1D_AR_#1_#2_MS	µg/l	10	NONE	< 10	< 10	< 10	1300	1100
TPH-CWG - Aromatic (C5 - C44) HS+EH_1D_AR_#1_#2_MS	µg/l	10	NONE	< 10	< 10	< 10	1300	1100
TPH-CWG Total C5 - C44 EH+HS_1D_TOTAL_#1_#2_MS	µg/l	10	NONE	< 10	< 10	< 10	3100	2300

Analytical Report Number: 22-56099
Project / Site name: Gloucester, GWR Yard

Your Order No: PO16135

Lab Sample Number				2263286	2263287	2263288	2263289	2263290
Sample Reference				BH102	BH205	BH204D	WS204	WS203
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				2.32	2.19	4.50	1.60	1.86
Date Sampled				04/05/2022	04/05/2022	04/05/2022	04/05/2022	04/05/2022
Time Taken				1045	1210	1315	1405	1500
Analytical Parameter (Water Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
SVOCs								
Aniline	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Phenol	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
2-Chlorophenol	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Bis(2-chloroethyl)ether	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
1,3-Dichlorobenzene	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
1,2-Dichlorobenzene	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
1,4-Dichlorobenzene	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Bis(2-chloroisopropyl)ether	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
2-Methylphenol	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Hexachloroethane	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Nitrobenzene	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
4-Methylphenol	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	4	< 0.05
Isophorone	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
2-Nitrophenol	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
2,4-Dimethylphenol	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	0.56	< 0.05
Bis(2-chloroethoxy)methane	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
1,2,4-Trichlorobenzene	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Naphthalene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
2,4-Dichlorophenol	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
4-Chloroaniline	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Hexachlorobutadiene	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
4-Chloro-3-methylphenol	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
2,4,6-Trichlorophenol	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
2,4,5-Trichlorophenol	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
2-Methylnaphthalene	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
2-Chloronaphthalene	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Dimethylphthalate	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
2,6-Dinitrotoluene	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Acenaphthylene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	0.46	0.38
Acenaphthene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	1.4	2.3
2,4-Dinitrotoluene	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Dibenzofuran	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	1.9
4-Chlorophenyl phenyl ether	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Diethyl phthalate	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
4-Nitroaniline	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Fluorene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	2.5	3.8
Azobenzene	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Bromophenyl phenyl ether	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Hexachlorobenzene	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Phenanthrene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	1.7	0.91
Anthracene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Carbazole	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	7.2
Dibutyl phthalate	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Anthraquinone	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Fluoranthene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Pyrene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Butyl benzyl phthalate	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Benzo(a)anthracene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Chrysene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Benzo(b)fluoranthene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Benzo(k)fluoranthene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Benzo(a)pyrene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Indeno(1,2,3-cd)pyrene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Dibenz(a,h)anthracene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Benzo(ghi)perylene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01

Analytical Report Number: 22-56099
Project / Site name: Gloucester, GWR Yard

Your Order No: PO16135

Lab Sample Number				2263286	2263287	2263288	2263289	2263290
Sample Reference				BH102	BH205	BH204D	WS204	WS203
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				2.32	2.19	4.50	1.60	1.86
Date Sampled				04/05/2022	04/05/2022	04/05/2022	04/05/2022	04/05/2022
Time Taken				1045	1210	1315	1405	1500
Analytical Parameter (Water Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
3&4-Methylphenol	µg/l	0.1	NONE	< 0.10	< 0.10	< 0.10	4	< 0.10

U/S = Unsuitable Sample I/S = Insufficient Sample

Analytical Report Number: 22-56099
Project / Site name: Gloucester, GWR Yard

Your Order No: PO16135

Lab Sample Number				2263291	2263292	2263293	2263294	2263295
Sample Reference				BH204S	BH203	WS107	WS205	BH202
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				1.84	2.10	2.20	1.55	1.70
Date Sampled				04/05/2022	04/05/2022	04/05/2022	04/05/2022	04/05/2022
Time Taken				1605	1226	1035	1310	1515
Analytical Parameter (Water Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					

General Inorganics

pH	pH Units	N/A	ISO 17025	-	7.5	6.9	-	7.5
Electrical Conductivity at 20 °C	µS/cm	10	ISO 17025	-	620	590	-	380
Sulphate as SO4	µg/l	45	ISO 17025	-	44400	31900	-	21500
Sulphate as SO4	mg/l	0.045	ISO 17025	-	44.4	31.9	-	21.5
Sulphide	µg/l	5	NONE	-	< 5.0	< 5.0	-	< 5.0
Nitrate as N	mg/l	0.01	ISO 17025	-	0.11	0.09	-	0.06
Nitrate as NO3	mg/l	0.05	ISO 17025	-	0.47	0.41	-	0.26
Nitrite as N	µg/l	1	ISO 17025	-	< 1.0	12	-	< 1.0
Nitrite as NO2	µg/l	5	ISO 17025	-	< 5.0	40	-	< 5.0
Alkalinity as CaCO3	mg/l	3	ISO 17025	-	360	390	-	230

Redox Potential	mV	-800	NONE	-	-79.3	91.4	-	-94.9

Heavy Metals / Metalloids

Iron (dissolved)	mg/l	0.004	ISO 17025	-	0.18	0.22	-	0.015
Fe2+	mg/l	0.2	NONE	-	< 0.20	< 0.20	-	< 0.20
Fe3+	mg/l	0.2	NONE	-	< 0.20	< 0.20	-	< 0.20
Mn (II)	mg/l	0.02	NONE	-	0.13	0.07	-	< 0.02
Mn (IV)	mg/l	0.02	NONE	-	0.67	0.38	-	< 0.02

Monoaromatics & Oxygenates

Benzene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Toluene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Ethylbenzene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
p & m-xylene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
o-xylene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
MTBE (Methyl Tertiary Butyl Ether)	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Sum of m, p & o-Xylene	µg/l	2	ISO 17025	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0

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Lab Sample Number				2263291	2263292	2263293	2263294	2263295
Sample Reference				BH204S	BH203	WS107	WS205	BH202
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				1.84	2.10	2.20	1.55	1.70
Date Sampled				04/05/2022	04/05/2022	04/05/2022	04/05/2022	04/05/2022
Time Taken				1605	1226	1035	1310	1515
Analytical Parameter (Water Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Petroleum Hydrocarbons								
TPH-CWG - Aliphatic >C5 - C6 $_{\text{HS\_1D\_AL}}$	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
TPH-CWG - Aliphatic >C6 - C8 $_{\text{HS\_1D\_AL}}$	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
TPH-CWG - Aliphatic >C8 - C10 $_{\text{HS\_1D\_AL}}$	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
TPH-CWG - Aliphatic >C10 - C12 $_{\text{EH\_1D\_AL\_\#1\_\#2\_MS}}$	µg/l	10	NONE	< 10	< 10	< 10	< 10	< 10
TPH-CWG - Aliphatic >C12 - C16 $_{\text{EH\_1D\_AL\_\#1\_\#2\_MS}}$	µg/l	10	NONE	< 10	< 10	< 10	1300	< 10
TPH-CWG - Aliphatic >C16 - C21 $_{\text{EH\_1D\_AL\_\#1\_\#2\_MS}}$	µg/l	10	NONE	< 10	< 10	< 10	1900	< 10
TPH-CWG - Aliphatic >C21 - C35 $_{\text{EH\_1D\_AL\_\#1\_\#2\_MS}}$	µg/l	10	NONE	< 10	< 10	< 10	620	< 10
TPH-CWG - Aliphatic >C16 - C35 $_{\text{EH\_1D\_AL\_\#1\_\#2\_MS}}$	µg/l	10	NONE	< 10	< 10	< 10	2500	< 10
TPH-CWG - Aliphatic >C35 - C44 $_{\text{EH\_1D\_AL\_\#1\_\#2\_MS}}$	µg/l	10	NONE	< 10	< 10	< 10	< 10	< 10
TPH-CWG - Aliphatic (C5 - C35) $_{\text{HS+EH\_1D\_AL\_\#1\_\#2\_MS}}$	µg/l	10	NONE	< 10	< 10	< 10	3800	< 10
TPH-CWG - Aliphatic (C5 - C44) $_{\text{HS+EH\_1D\_AR\_\#1\_\#2\_MS}}$	µg/l	10	NONE	< 10	< 10	< 10	3800	< 10
TPH-CWG - Aromatic >C5 - C7 $_{\text{HS\_1D\_AR}}$	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
TPH-CWG - Aromatic >C7 - C8 $_{\text{HS\_1D\_AR}}$	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
TPH-CWG - Aromatic >C8 - C10 $_{\text{HS\_1D\_AR}}$	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
TPH-CWG - Aromatic >C10 - C12 $_{\text{EH\_1D\_AR\_\#1\_\#2\_MS}}$	µg/l	10	NONE	52	37	< 10	130	< 10
TPH-CWG - Aromatic >C12 - C16 $_{\text{EH\_1D\_AR\_\#1\_\#2\_MS}}$	µg/l	10	NONE	140	99	< 10	380	< 10
TPH-CWG - Aromatic >C16 - C21 $_{\text{EH\_1D\_AR\_\#1\_\#2\_MS}}$	µg/l	10	NONE	130	< 10	< 10	520	< 10
TPH-CWG - Aromatic >C21 - C35 $_{\text{EH\_1D\_AR\_\#1\_\#2\_MS}}$	µg/l	10	NONE	< 10	< 10	< 10	< 10	< 10
TPH-CWG - Aromatic >C35 - C44 $_{\text{EH\_1D\_AR\_\#1\_\#2\_MS}}$	µg/l	10	NONE	< 10	< 10	< 10	< 10	< 10
TPH-CWG - Aromatic (C5 - C35) $_{\text{HS+EH\_1D\_AR\_\#1\_\#2\_MS}}$	µg/l	10	NONE	320	140	< 10	1000	< 10
TPH-CWG - Aromatic (C5 - C44) $_{\text{HS+EH\_1D\_AR\_\#1\_\#2\_MS}}$	µg/l	10	NONE	320	140	< 10	1000	< 10
TPH-CWG Total C5 - C44 $_{\text{EH+HS\_1D\_TOTAL\_\#1\_\#2\_MS}}$	µg/l	10	NONE	320	140	< 10	4800	< 10

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Lab Sample Number				2263291	2263292	2263293	2263294	2263295
Sample Reference				BH204S	BH203	WS107	WS205	BH202
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				1.84	2.10	2.20	1.55	1.70
Date Sampled				04/05/2022	04/05/2022	04/05/2022	04/05/2022	04/05/2022
Time Taken				1605	1226	1035	1310	1515
Analytical Parameter (Water Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
SVOCs								
Aniline	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Phenol	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
2-Chlorophenol	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Bis(2-chloroethyl)ether	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
1,3-Dichlorobenzene	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
1,2-Dichlorobenzene	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
1,4-Dichlorobenzene	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Bis(2-chloroisopropyl)ether	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
2-Methylphenol	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Hexachloroethane	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Nitrobenzene	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
4-Methylphenol	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	2.7	< 0.05
Isophorone	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
2-Nitrophenol	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
2,4-Dimethylphenol	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Bis(2-chloroethoxy)methane	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
1,2,4-Trichlorobenzene	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Naphthalene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
2,4-Dichlorophenol	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
4-Chloroaniline	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Hexachlorobutadiene	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
4-Chloro-3-methylphenol	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
2,4,6-Trichlorophenol	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
2,4,5-Trichlorophenol	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
2-Methylnaphthalene	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
2-Chloronaphthalene	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Dimethylphthalate	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
2,6-Dinitrotoluene	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Acenaphthylene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Acenaphthene	µg/l	0.01	ISO 17025	0.92	< 0.01	< 0.01	1.1	< 0.01
2,4-Dinitrotoluene	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Dibenzofuran	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
4-Chlorophenyl phenyl ether	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Diethyl phthalate	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
4-Nitroaniline	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Fluorene	µg/l	0.01	ISO 17025	2.6	< 0.01	< 0.01	2.1	< 0.01
Azobenzene	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Bromophenyl phenyl ether	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Hexachlorobenzene	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Phenanthrene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	1.2	< 0.01
Anthracene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Carbazole	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Dibutyl phthalate	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Anthraquinone	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Fluoranthene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Pyrene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Butyl benzyl phthalate	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Benzo(a)anthracene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Chrysene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Benzo(b)fluoranthene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Benzo(k)fluoranthene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Benzo(a)pyrene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Indeno(1,2,3-cd)pyrene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Dibenz(a,h)anthracene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Benzo(ghi)perylene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01

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Lab Sample Number				2263291	2263292	2263293	2263294	2263295
Sample Reference				BH204S	BH203	WS107	WS205	BH202
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				1.84	2.10	2.20	1.55	1.70
Date Sampled				04/05/2022	04/05/2022	04/05/2022	04/05/2022	04/05/2022
Time Taken				1605	1226	1035	1310	1515
Analytical Parameter (Water Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
3&4-Methylphenol	µg/l	0.1	NONE	< 0.10	< 0.10	< 0.10	2.7	< 0.10

U/S = Unsuitable Sample I/S = Insufficient Sample

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Project / Site name: Gloucester, GWR Yard

Your Order No: PO16135

Lab Sample Number				2263296	2263297
Sample Reference				WS101	BH101S
Sample Number				None Supplied	None Supplied
Depth (m)				2.00	2.60
Date Sampled				04/05/2022	04/05/2022
Time Taken				1350	1625
Analytical Parameter (Water Analysis)	**Units**	**Limit of detection**	**Accreditation Status**		

General Inorganics

pH	pH Units	N/A	ISO 17025	7.1	7.0
Electrical Conductivity at 20 °C	µS/cm	10	ISO 17025	620	810
Sulphate as SO4	µg/l	45	ISO 17025	101000	96800
Sulphate as SO4	mg/l	0.045	ISO 17025	101	96.8
Sulphide	µg/l	5	NONE	< 5.0	< 5.0
Nitrate as N	mg/l	0.01	ISO 17025	0.13	0.09
Nitrate as NO3	mg/l	0.05	ISO 17025	0.57	0.41
Nitrite as N	µg/l	1	ISO 17025	16	< 1.0
Nitrite as NO2	µg/l	5	ISO 17025	52	< 5.0
Alkalinity as CaCO3	mg/l	3	ISO 17025	320	420

Redox Potential	mV	-800	NONE	-94.3	47.9

Heavy Metals / Metalloids

Iron (dissolved)	mg/l	0.004	ISO 17025	0.28	0.022
Fe2+	mg/l	0.2	NONE	0.23	< 0.20
Fe3+	mg/l	0.2	NONE	< 0.20	< 0.20
Mn (II)	mg/l	0.02	NONE	0.16	< 0.02
Mn (IV)	mg/l	0.02	NONE	0.85	< 0.02

Monoaromatics & Oxygenates

Benzene	µg/l	1	ISO 17025	< 1.0	< 1.0
Toluene	µg/l	1	ISO 17025	< 1.0	< 1.0
Ethylbenzene	µg/l	1	ISO 17025	< 1.0	< 1.0
p & m-xylene	µg/l	1	ISO 17025	< 1.0	< 1.0
o-xylene	µg/l	1	ISO 17025	< 1.0	< 1.0
MTBE (Methyl Tertiary Butyl Ether)	µg/l	1	ISO 17025	< 1.0	< 1.0
Sum of m, p & o-Xylene	µg/l	2	ISO 17025	< 2.0	< 2.0

Analytical Report Number: 22-56099
Project / Site name: Gloucester, GWR Yard

Your Order No: PO16135

Lab Sample Number				2263296	2263297
Sample Reference				WS101	BH101S
Sample Number				None Supplied	None Supplied
Depth (m)				2.00	2.60
Date Sampled				04/05/2022	04/05/2022
Time Taken				1350	1625
Analytical Parameter (Water Analysis)	**Units**	**Limit of detection**	**Accreditation Status**		
Petroleum Hydrocarbons					
TPH-CWG - Aliphatic >C5 - C6 $_{\text{HS\_1D\_AL}}$	µg/l	1	ISO 17025	< 1.0	< 1.0
TPH-CWG - Aliphatic >C6 - C8 $_{\text{HS\_1D\_AL}}$	µg/l	1	ISO 17025	< 1.0	< 1.0
TPH-CWG - Aliphatic >C8 - C10 $_{\text{HS\_1D\_AL}}$	µg/l	1	ISO 17025	< 1.0	< 1.0
TPH-CWG - Aliphatic >C10 - C12 $_{\text{EH\_1D\_AL\_\#1\_\#2\_MS}}$	µg/l	10	NONE	< 10	< 10
TPH-CWG - Aliphatic >C12 - C16 $_{\text{EH\_1D\_AL\_\#1\_\#2\_MS}}$	µg/l	10	NONE	< 10	< 10
TPH-CWG - Aliphatic >C16 - C21 $_{\text{EH\_1D\_AL\_\#1\_\#2\_MS}}$	µg/l	10	NONE	< 10	< 10
TPH-CWG - Aliphatic >C21 - C35 $_{\text{EH\_1D\_AL\_\#1\_\#2\_MS}}$	µg/l	10	NONE	< 10	< 10
TPH-CWG - Aliphatic >C16 - C35 $_{\text{EH\_1D\_AL\_\#1\_\#2\_MS}}$	µg/l	10	NONE	< 10	< 10
TPH-CWG - Aliphatic >C35 - C44 $_{\text{EH\_1D\_AL\_\#1\_\#2\_MS}}$	µg/l	10	NONE	< 10	< 10
TPH-CWG - Aliphatic (C5 - C35) $_{\text{HS+EH\_1D\_AL\_\#1\_\#2\_MS}}$	µg/l	10	NONE	< 10	< 10
TPH-CWG - Aliphatic (C5 - C44) $_{\text{HS+EH\_1D\_AR\_\#1\_\#2\_MS}}$	µg/l	10	NONE	< 10	< 10
TPH-CWG - Aromatic >C5 - C7 $_{\text{HS\_1D\_AR}}$	µg/l	1	ISO 17025	< 1.0	< 1.0
TPH-CWG - Aromatic >C7 - C8 $_{\text{HS\_1D\_AR}}$	µg/l	1	ISO 17025	< 1.0	< 1.0
TPH-CWG - Aromatic >C8 - C10 $_{\text{HS\_1D\_AR}}$	µg/l	1	ISO 17025	< 1.0	< 1.0
TPH-CWG - Aromatic >C10 - C12 $_{\text{EH\_1D\_AR\_\#1\_\#2\_MS}}$	µg/l	10	NONE	29	< 10
TPH-CWG - Aromatic >C12 - C16 $_{\text{EH\_1D\_AR\_\#1\_\#2\_MS}}$	µg/l	10	NONE	95	< 10
TPH-CWG - Aromatic >C16 - C21 $_{\text{EH\_1D\_AR\_\#1\_\#2\_MS}}$	µg/l	10	NONE	25	< 10
TPH-CWG - Aromatic >C21 - C35 $_{\text{EH\_1D\_AR\_\#1\_\#2\_MS}}$	µg/l	10	NONE	< 10	< 10
TPH-CWG - Aromatic >C35 - C44 $_{\text{EH\_1D\_AR\_\#1\_\#2\_MS}}$	µg/l	10	NONE	< 10	< 10
TPH-CWG - Aromatic (C5 - C35) $_{\text{HS+EH\_1D\_AR\_\#1\_\#2\_MS}}$	µg/l	10	NONE	150	< 10
TPH-CWG - Aromatic (C5 - C44) $_{\text{HS+EH\_1D\_AR\_\#1\_\#2\_MS}}$	µg/l	10	NONE	150	< 10
TPH-CWG Total C5 - C44 $_{\text{EH+HS\_1D\_TOTAL\_\#1\_\#2\_MS}}$	µg/l	10	NONE	150	< 10

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Project / Site name: Gloucester, GWR Yard

Your Order No: PO16135

Lab Sample Number				2263296	2263297
Sample Reference				WS101	BH101S
Sample Number				None Supplied	None Supplied
Depth (m)				2.00	2.60
Date Sampled				04/05/2022	04/05/2022
Time Taken				1350	1625
Analytical Parameter (Water Analysis)	**Units**	**Limit of detection**	**Accreditation Status**		
SVOCs					
Aniline	µg/l	0.05	NONE	< 0.05	< 0.05
Phenol	µg/l	0.05	NONE	< 0.05	< 0.05
2-Chlorophenol	µg/l	0.05	NONE	< 0.05	< 0.05
Bis(2-chloroethyl)ether	µg/l	0.05	NONE	< 0.05	< 0.05
1,3-Dichlorobenzene	µg/l	0.05	NONE	< 0.05	< 0.05
1,2-Dichlorobenzene	µg/l	0.05	NONE	< 0.05	< 0.05
1,4-Dichlorobenzene	µg/l	0.05	NONE	< 0.05	< 0.05
Bis(2-chloroisopropyl)ether	µg/l	0.05	NONE	< 0.05	< 0.05
2-Methylphenol	µg/l	0.05	NONE	< 0.05	< 0.05
Hexachloroethane	µg/l	0.05	NONE	< 0.05	< 0.05
Nitrobenzene	µg/l	0.05	NONE	< 0.05	< 0.05
4-Methylphenol	µg/l	0.05	NONE	< 0.05	< 0.05
Isophorone	µg/l	0.05	NONE	< 0.05	< 0.05
2-Nitrophenol	µg/l	0.05	NONE	< 0.05	< 0.05
2,4-Dimethylphenol	µg/l	0.05	NONE	< 0.05	< 0.05
Bis(2-chloroethoxy)methane	µg/l	0.05	NONE	< 0.05	< 0.05
1,2,4-Trichlorobenzene	µg/l	0.05	NONE	< 0.05	< 0.05
Naphthalene	µg/l	0.01	ISO 17025	< 0.01	< 0.01
2,4-Dichlorophenol	µg/l	0.05	NONE	< 0.05	< 0.05
4-Chloroaniline	µg/l	0.05	NONE	< 0.05	< 0.05
Hexachlorobutadiene	µg/l	0.05	NONE	< 0.05	< 0.05
4-Chloro-3-methylphenol	µg/l	0.05	NONE	< 0.05	< 0.05
2,4,6-Trichlorophenol	µg/l	0.05	NONE	< 0.05	< 0.05
2,4,5-Trichlorophenol	µg/l	0.05	NONE	< 0.05	< 0.05
2-Methylnaphthalene	µg/l	0.05	NONE	< 0.05	< 0.05
2-Chloronaphthalene	µg/l	0.05	NONE	< 0.05	< 0.05
Dimethylphthalate	µg/l	0.05	NONE	< 0.05	< 0.05
2,6-Dinitrotoluene	µg/l	0.05	NONE	< 0.05	< 0.05
Acenaphthylene	µg/l	0.01	ISO 17025	< 0.01	< 0.01
Acenaphthene	µg/l	0.01	ISO 17025	0.35	< 0.01
2,4-Dinitrotoluene	µg/l	0.05	NONE	< 0.05	< 0.05
Dibenzofuran	µg/l	0.05	NONE	< 0.05	< 0.05
4-Chlorophenyl phenyl ether	µg/l	0.05	NONE	< 0.05	< 0.05
Diethyl phthalate	µg/l	0.05	NONE	< 0.05	< 0.05
4-Nitroaniline	µg/l	0.05	NONE	< 0.05	< 0.05
Fluorene	µg/l	0.01	ISO 17025	0.75	< 0.01
Azobenzene	µg/l	0.05	NONE	< 0.05	< 0.05
Bromophenyl phenyl ether	µg/l	0.05	NONE	< 0.05	< 0.05
Hexachlorobenzene	µg/l	0.05	NONE	< 0.05	< 0.05
Phenanthrene	µg/l	0.01	ISO 17025	< 0.01	< 0.01
Anthracene	µg/l	0.01	ISO 17025	< 0.01	< 0.01
Carbazole	µg/l	0.05	NONE	< 0.05	< 0.05
Dibutyl phthalate	µg/l	0.05	NONE	< 0.05	< 0.05
Anthraquinone	µg/l	0.05	NONE	< 0.05	< 0.05
Fluoranthene	µg/l	0.01	ISO 17025	< 0.01	< 0.01
Pyrene	µg/l	0.01	ISO 17025	< 0.01	< 0.01
Butyl benzyl phthalate	µg/l	0.05	NONE	< 0.05	< 0.05
Benzo(a)anthracene	µg/l	0.01	ISO 17025	< 0.01	< 0.01
Chrysene	µg/l	0.01	ISO 17025	< 0.01	< 0.01
Benzo(b)fluoranthene	µg/l	0.01	ISO 17025	< 0.01	< 0.01
Benzo(k)fluoranthene	µg/l	0.01	ISO 17025	< 0.01	< 0.01
Benzo(a)pyrene	µg/l	0.01	ISO 17025	< 0.01	< 0.01
Indeno(1,2,3-cd)pyrene	µg/l	0.01	ISO 17025	< 0.01	< 0.01
Dibenz(a,h)anthracene	µg/l	0.01	ISO 17025	< 0.01	< 0.01
Benzo(ghi)perylene	µg/l	0.01	ISO 17025	< 0.01	< 0.01

Analytical Report Number: 22-56099
Project / Site name: Gloucester, GWR Yard

Your Order No: PO16135

Lab Sample Number				2263296	2263297
Sample Reference				WS101	BH101S
Sample Number				None Supplied	None Supplied
Depth (m)				2.00	2.60
Date Sampled				04/05/2022	04/05/2022
Time Taken				1350	1625
Analytical Parameter (Water Analysis)	**Units**	**Limit of detection**	**Accreditation Status**		
3&4-Methylphenol	µg/l	0.1	NONE	< 0.10	< 0.10

U/S = Unsuitable Sample I/S = Insufficient Sample

Analytical Report Number : 22-56099
Project / Site name: Gloucester, GWR Yard

Water matrix abbreviations:
Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Waters (PrW) Final Sewage Effluent (FSE) Landfill Leachate (LL)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Electrical conductivity at 20oC of water	Determination of electrical conductivity in water by electrometric measurement. Accredited Matrices SW, GW, PW	In-house method	L031-PL	W	ISO 17025
Iron (II) and Iron (III) in water	Determination of Iron II and Iron III in water by coloration with phenanthroline and calculation.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton	L079-PL	W	NONE
Metals in water by ICP-OES (dissolved)	Determination of metals in water by acidification followed by ICP-OES. Accredited Matrices SW, GW, PW, PrW.(Al, Cu,Fe,Zn).	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil.	L039-PL	W	ISO 17025
Nitrite in water	Determination of nitrite in water by addition of sulphanilamide and NED followed by discrete analyser (colorimetry).Accredited matrices SW, GW, PW.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton	L082-PL	W	ISO 17025
Nitrate in water	Determination of nitrate by reaction with sodium salicylate and colorimetry. Accredited matrices SW, GW, PW	In-house method based on Examination of Water and Wastewatern & Polish Standard Method PN-82/C-04579.08,	L078-PL	W	ISO 17025
Redox Potential of waters	Determination of redox potential in water by electrometric measurement versus Ag/AgCl electrode.	In house method.	L084-PL	W	NONE
Sulphide in water	Determination of sulphide in water by ion selective electrode.	In-house method	L029-PL	W	NONE
Sulphate in water	Determination of sulphate in water after filtration by acidification followed by ICP-OES. Accredited Matrices SW, GW, PW.	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil.	L039-PL	W	ISO 17025
Semi-volatile organic compounds in water	Determination of semi-volatile organic compounds in leachate by extraction in dichloromethane followed by GC-MS.	In-house method based on USEPA 8270	L102B-PL	W	ISO 17025
TPHCWG (Waters)	Determination of dichloromethane extractable hydrocarbons in water by GC-MS, speciation by interpretation.	In-house method	L070-PL	W	ISO 17025
BTEX and MTBE in water (Monoaromatics)	Determination of BTEX and MTBE in water by headspace GC-MS. Accredited matrices: SW PW GW	In-house method based on USEPA8260	L073B-PL	W	ISO 17025
TPH in (Water)	Determination of TPH bands by HS-GC-MS/GC-FID	In-house method, TPH with carbon banding.	L070-PL	W	NONE
Nitrite as N in water	Determination of nitrite in water by addition of sulphanilamide and NED followed by discrete analyser (colorimetry). Accredited matrices SW, GW, PW.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton	L082-PL	W	ISO 17025
Nitrate as N in water	Determination of nitrate by reaction with sodium salicylate and colorimetry. Accredited matrices SW, GW, PW.	In-house method based on Examination of Water and Wastewatern & Polish Standard Method PN-82/C-04579.08,	L078-PL	W	ISO 17025
TPH Chromatogram in Water	TPH Chromatogram in Water.	In-house method	L070-PL	W	NONE
pH at 20oC in water (automated)	Determination of pH in water by electrometric measurement. Accredited matrices: SW PW GW	In house method.	L099-PL	W	ISO 17025
Manganese II and IV in Water	Analysis of manganese compounds by periodate oxidation method.	In house method and calculation based on standard methods for the examination of water and waste water.	L090-PL	W	NONE

Analytical Report Number : 22-56099
Project / Site name: Gloucester, GWR Yard

Water matrix abbreviations:
Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Waters (PrW) Final Sewage Effluent (FSE) Landfill Leachate (LL)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Alkalinity in Water (by discreet analyser)	Determination of Alkalinity by discreet analyser (colorimetry). Accredited matrices: SW, PW, GW.	In house method based on MEWAM & USEPA Method 310.2.	L082-PL	W	ISO 17025

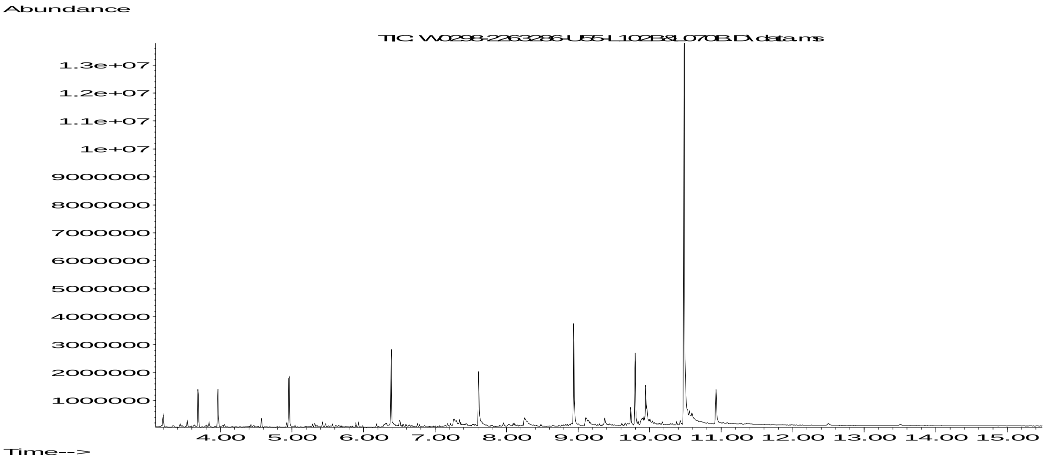
For method numbers ending in 'UK' analysis have been carried out in our laboratory in the United Kingdom.
For method numbers ending in 'PL' analysis have been carried out in our laboratory in Poland.
Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 30oC.

Unless otherwise indicated, site information, order number, project number, sampling date, time, sample reference and depth are provided by the client. The instructed on date indicates the date on which this information was provided to the laboratory.

Information in Support of Analytical Results

List of HWOL Acronyms and Operators

Acronym	Descriptions
HS	Headspace Analysis
MS	Mass spectrometry
FID	Flame Ionisation Detector
GC	Gas Chromatography
EH	Extractable Hydrocarbons (i.e. everything extracted by the solvent(s))
CU	Clean-up - e.g. by Florisil®, silica gel
1D	GC - Single coil/column gas chromatography
2D	GC-GC - Double coil/column gas chromatography
Total	Aliphatics & Aromatics
AL	Aliphatics
AR	Aromatics
#1	EH_2D_Total but with humics mathematically subtracted
#2	EH_2D_Total but with fatty acids mathematically subtracted
_	Operator - understore to separate acronyms (exception for +)
+	Operator to indicate cumulative e.g. EH+HS_Total or EH_CU+HS_Total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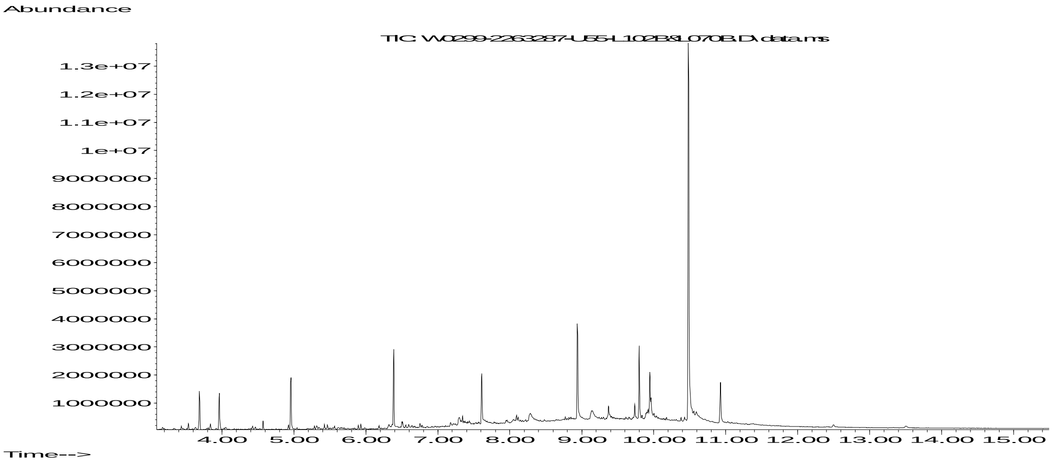
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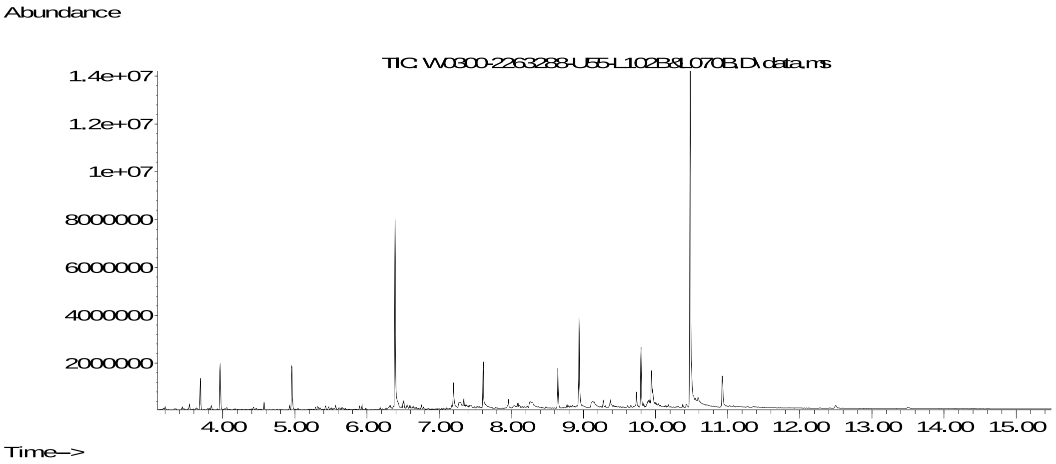
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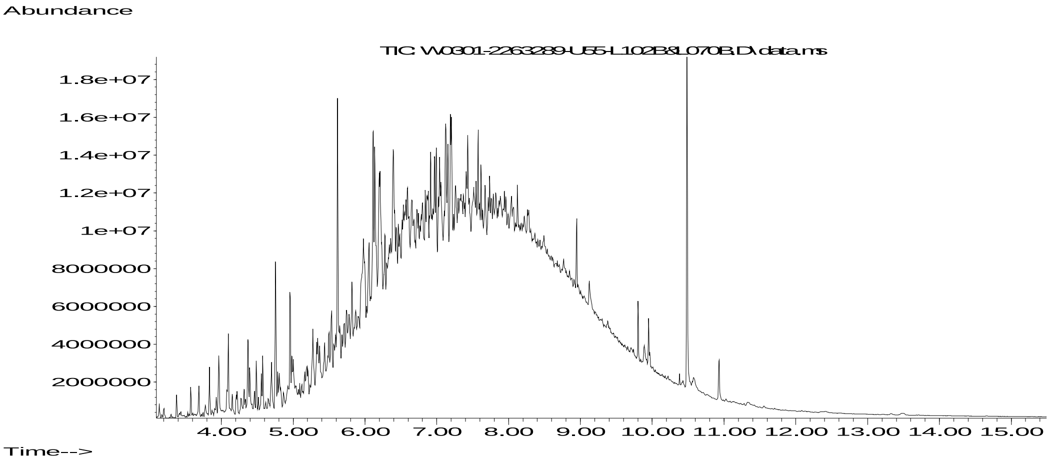
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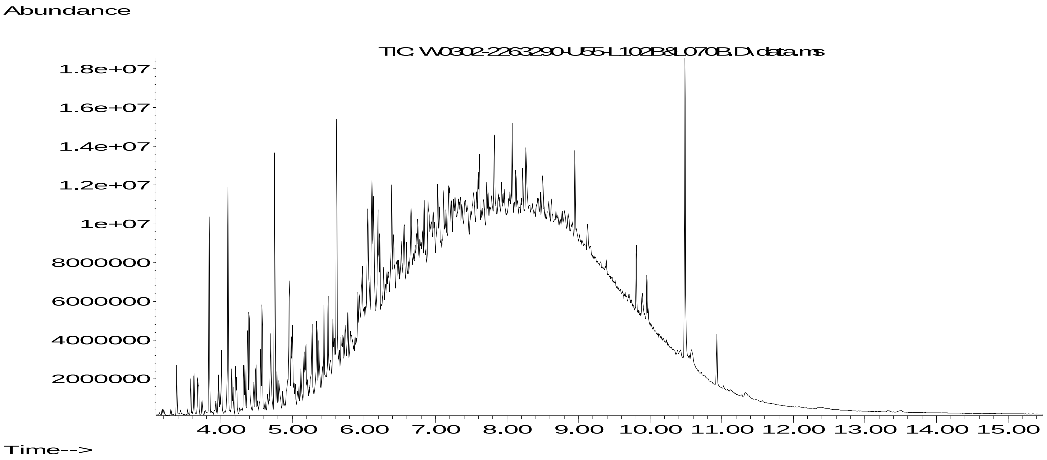
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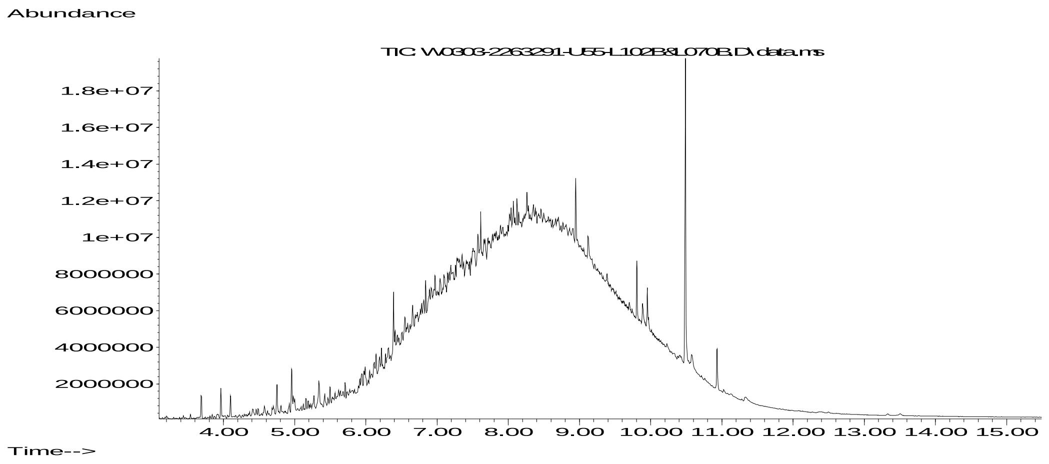
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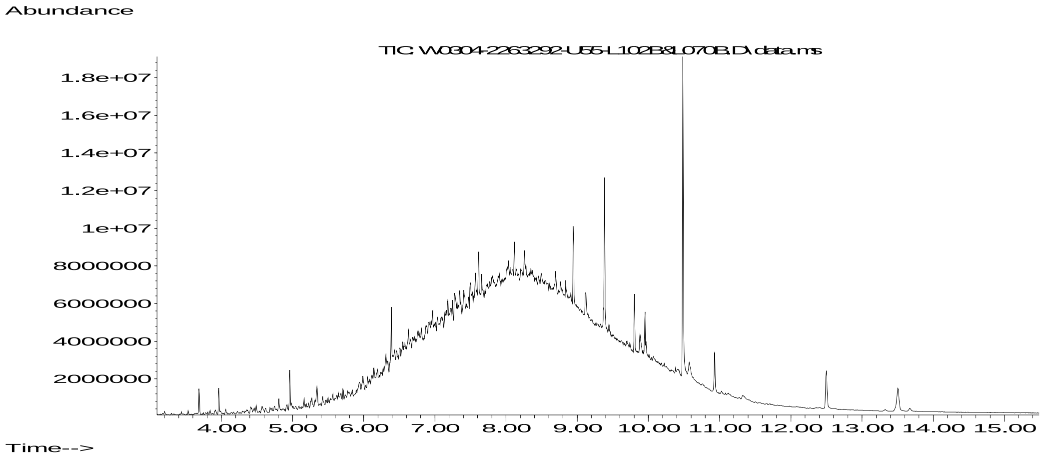
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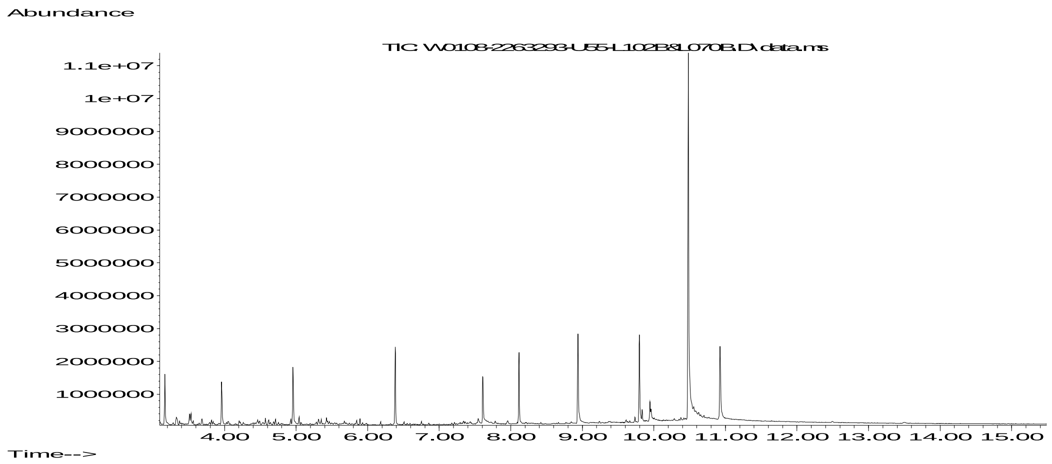
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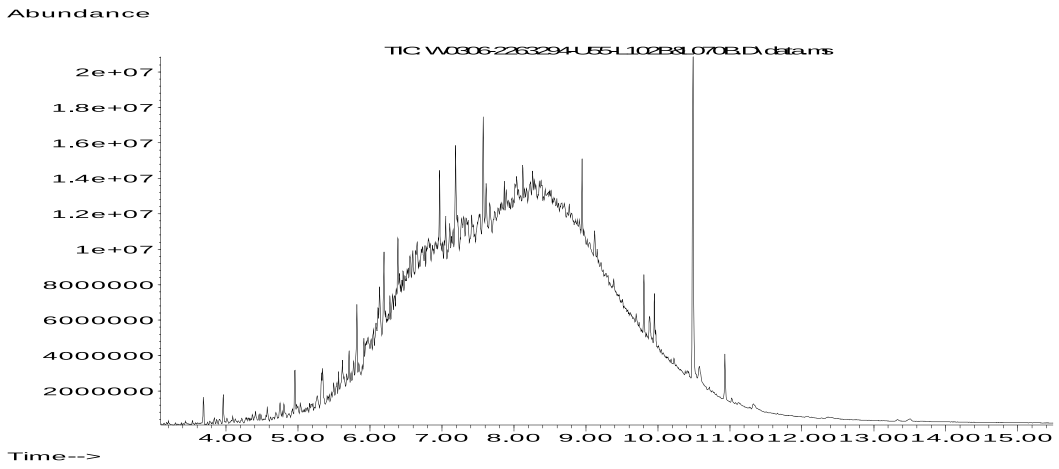

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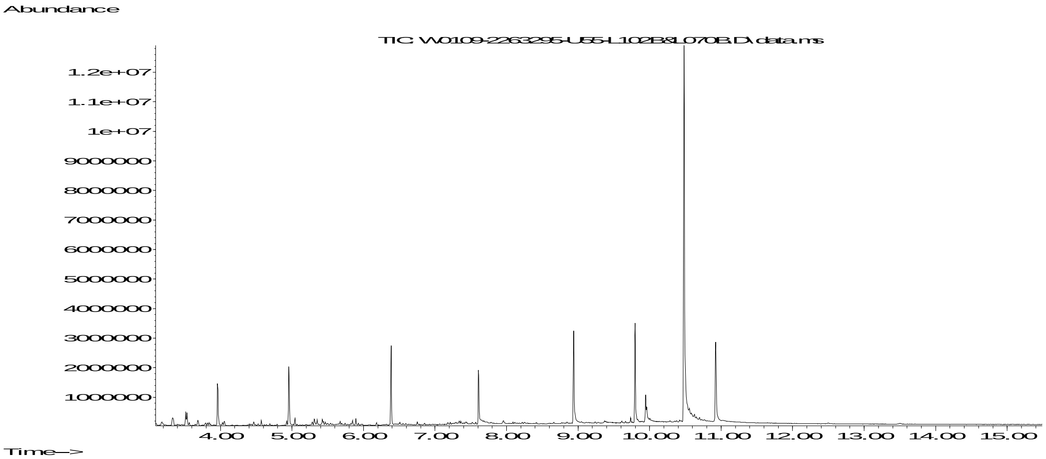
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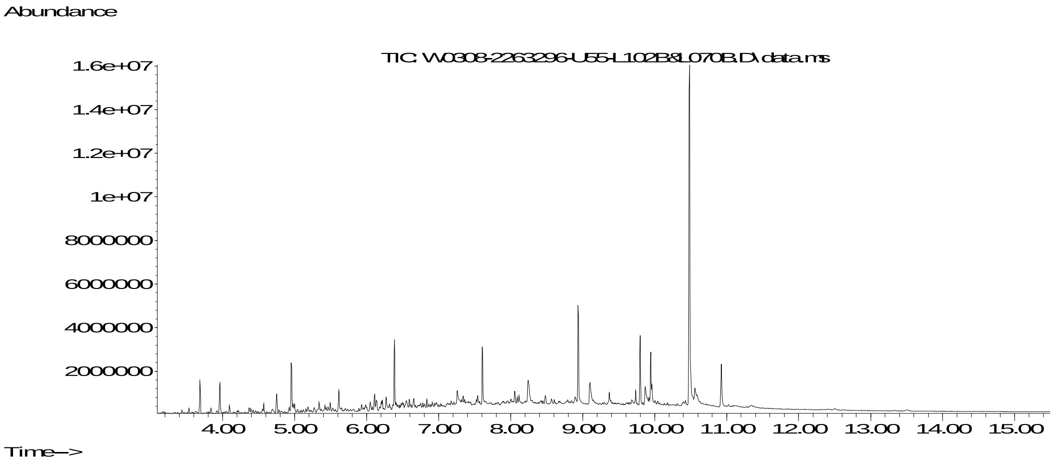
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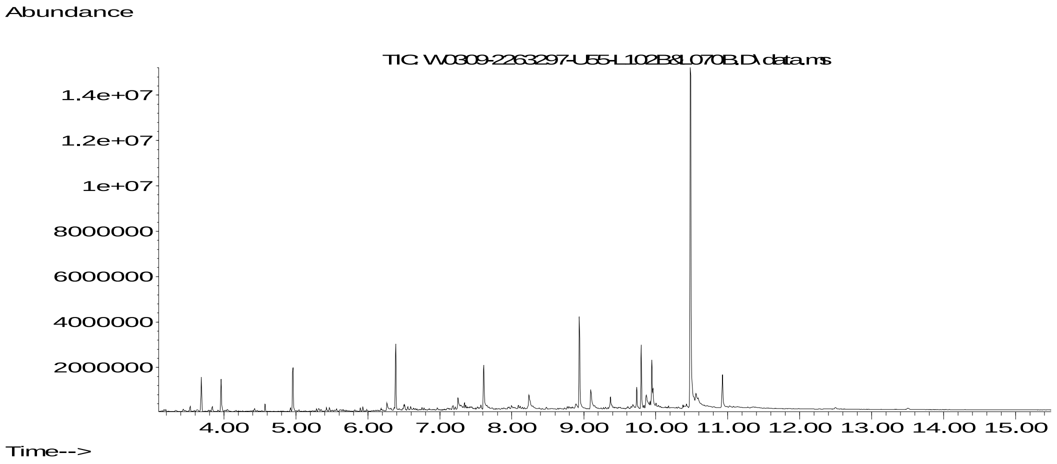
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UKAS TESTING
4041

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f: 01454 614125
e: Group Bristol cc engineer

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Watford,
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WD18 8YS

t: 01923 225404
f: 01923 237404
e: reception@i2analytical.com

Analytical Report Number : 22-56484

Project / Site name:	Gloucester	**Samples received on:**	06/05/2022
Your job number:	20775	**Samples instructed on/ Analysis started on:**	06/05/2022
Your order number:	PO16135	**Analysis completed by:**	12/05/2022
Report Issue Number:	1	**Report issued on:**	12/05/2022
Samples Analysed:	8 water samples		

Signed:

Adam Fenwick
Technical Reviewer
For & on behalf of i2 Analytical Ltd.

Standard Geotechnical, Asbestos and Chemical Testing Laboratory located at: ul. Pionierów 39, 41 -711 Ruda Śląska, Poland.

Accredited tests are defined within the report, opinions and interpretations expressed herein are outside the scope of accreditation.

Standard sample disposal times, unless otherwise agreed with the laboratory, are :

- soils - 4 weeks from reporting
- leachates - 2 weeks from reporting
- waters - 2 weeks from reporting
- asbestos - 6 months from reporting

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Any assessments of compliance with specifications are based on actual analytical results with no contribution from uncertainty of measurement.
Application of uncertainty of measurement would provide a range within which the true result lies.
An estimate of measurement uncertainty can be provided on request.

Analytical Report Number: 22-56484
Project / Site name: Gloucester

Your Order No: PO16135

Lab Sample Number				2265384	2265385	2265386	2265387	2265388	2265389
Sample Reference				WS116	WS206	BH101D	WS103	BH206	BH201
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				2.00	1.68	6.50	1.72	2.70	6.50
Date Sampled				05/05/2022	05/05/2022	05/05/2022	05/05/2022	05/05/2022	05/05/2022
Time Taken				1330	1220	1450	1300	1230	1350
Analytical Parameter (Water Analysis)	**Units**	**Limit of detection**	**Accreditation Status**						
General Inorganics									
pH	pH Units	N/A	ISO 17025	7.2	-	-	7.2	-	-
Electrical Conductivity at 20 °C	µS/cm	10	ISO 17025	590	-	-	600	-	-
Sulphate as SO4	µg/l	45	ISO 17025	32600	-	-	21500	-	-
Sulphate as SO4	mg/l	0.045	ISO 17025	32.6	-	-	21.5	-	-
Sulphide	µg/l	5	NONE	< 5.0	-	-	< 5.0	-	-
Nitrate as N	mg/l	0.01	ISO 17025	0.4	-	-	0.08	-	-
Nitrate as NO3	mg/l	0.05	ISO 17025	1.76	-	-	0.36	-	-
Nitrite as N	µg/l	1	ISO 17025	8.4	-	-	< 1.0	-	-
Nitrite as NO2	µg/l	5	ISO 17025	28	-	-	< 5.0	-	-
Alkalinity as CaCO3	mg/l	3	ISO 17025	360	-	-	470	-	-
Redox Potential	mV	-800	NONE	21.4	-	-	19.2	-	-
Heavy Metals / Metalloids									
Iron (dissolved)	mg/l	0.004	ISO 17025	0.031	-	-	0.018	-	-
Fe2+	mg/l	0.2	NONE	< 0.20	-	-	< 0.20	-	-
Fe3+	mg/l	0.2	NONE	< 0.20	-	-	< 0.20	-	-
Mn (II)	mg/l	0.02	NONE	0.07	-	-	0.15	-	-
Mn (IV)	mg/l	0.02	NONE	0.69	-	-	0.64	-	-
Monoaromatics & Oxygenates									
Benzene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Toluene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Ethylbenzene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
p & m-xylene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
o-xylene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	7110	< 1.0	< 1.0
MTBE (Methyl Tertiary Butyl Ether)	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Sum of m, p & o-Xylene	µg/l	2	ISO 17025	< 2.0	< 2.0	< 2.0	7100	< 2.0	< 2.0
Petroleum Hydrocarbons									
TPH-CWG - Aliphatic >C5 - C6 $_{\text{HS\_1D\_AL}}$	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
TPH-CWG - Aliphatic >C6 - C8 $_{\text{HS\_1D\_AL}}$	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
TPH-CWG - Aliphatic >C8 - C10 $_{\text{HS\_1D\_AL}}$	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
TPH-CWG - Aliphatic >C10 - C12 $_{\text{EH\_1D\_AL\_\#1\_\#2\_MS}}$	µg/l	10	NONE	< 10	< 10	< 10	< 10	< 10	< 10
TPH-CWG - Aliphatic >C12 - C16 $_{\text{EH\_1D\_AL\_\#1\_\#2\_MS}}$	µg/l	10	NONE	< 10	290	< 10	140	< 10	< 10
TPH-CWG - Aliphatic >C16 - C21 $_{\text{EH\_1D\_AL\_\#1\_\#2\_MS}}$	µg/l	10	NONE	< 10	280	< 10	280	< 10	< 10
TPH-CWG - Aliphatic >C21 - C35 $_{\text{EH\_1D\_AL\_\#1\_\#2\_MS}}$	µg/l	10	NONE	< 10	200	< 10	240	< 10	< 10
TPH-CWG - Aliphatic >C16 - C35 $_{\text{EH\_1D\_AL\_\#1\_\#2\_MS}}$	µg/l	10	NONE	< 10	470	< 10	510	< 10	< 10
TPH-CWG - Aliphatic >C35 - C44 $_{\text{EH\_1D\_AL\_\#1\_\#2\_MS}}$	µg/l	10	NONE	< 10	< 10	< 10	< 10	< 10	< 10
TPH-CWG - Aliphatic (C5 - C35) $_{\text{HS+EH\_1D\_AL\_\#1\_\#2\_MS}}$	µg/l	10	NONE	< 10	760	< 10	650	< 10	< 10
TPH-CWG - Aliphatic (C5 - C44) $_{\text{HS+EH\_1D\_AR\_\#1\_\#2\_MS}}$	µg/l	10	NONE	< 10	760	< 10	650	< 10	< 10
TPH-CWG - Aromatic >C5 - C7 $_{\text{HS\_1D\_AR}}$	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	38	< 1.0	< 1.0
TPH-CWG - Aromatic >C7 - C8 $_{\text{HS\_1D\_AR}}$	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
TPH-CWG - Aromatic >C8 - C10 $_{\text{HS\_1D\_AR}}$	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
TPH-CWG - Aromatic >C10 - C12 $_{\text{EH\_1D\_AR\_\#1\_\#2\_MS}}$	µg/l	10	NONE	< 10	100	< 10	53	39	< 10
TPH-CWG - Aromatic >C12 - C16 $_{\text{EH\_1D\_AR\_\#1\_\#2\_MS}}$	µg/l	10	NONE	< 10	330	< 10	240	110	< 10
TPH-CWG - Aromatic >C16 - C21 $_{\text{EH\_1D\_AR\_\#1\_\#2\_MS}}$	µg/l	10	NONE	< 10	340	< 10	170	66	< 10
TPH-CWG - Aromatic >C21 - C35 $_{\text{EH\_1D\_AR\_\#1\_\#2\_MS}}$	µg/l	10	NONE	< 10	83	< 10	28	11	< 10
TPH-CWG - Aromatic >C35 - C44 $_{\text{EH\_1D\_AR\_\#1\_\#2\_MS}}$	µg/l	10	NONE	< 10	< 10	< 10	< 10	< 10	< 10
TPH-CWG - Aromatic (C5 - C35) $_{\text{HS+EH\_1D\_AR\_\#1\_\#2\_MS}}$	µg/l	10	NONE	< 10	850	< 10	530	220	< 10
TPH-CWG - Aromatic (C5 - C44) $_{\text{HS+EH\_1D\_AR\_\#1\_\#2\_MS}}$	µg/l	10	NONE	< 10	850	< 10	530	220	< 10

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Lab Sample Number				2265384	2265385	2265386	2265387	2265388	2265389
Sample Reference				WS116	WS206	BH101D	WS103	BH206	BH201
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				2.00	1.68	6.50	1.72	2.70	6.50
Date Sampled				05/05/2022	05/05/2022	05/05/2022	05/05/2022	05/05/2022	05/05/2022
Time Taken				1330	1220	1450	1300	1230	1350
Analytical Parameter (Water Analysis)	**Units**	**Limit of detection**	**Accreditation Status**						
TPH-CWG Total C5 - C44 EH+HS_1D_TOTAL_#1_#2_MS	µg/l	10	NONE	< 10	1600	< 10	1200	220	< 10

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Lab Sample Number				2265384	2265385	2265386	2265387	2265388	2265389
Sample Reference				WS116	WS206	BH101D	WS103	BH206	BH201
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				2.00	1.68	6.50	1.72	2.70	6.50
Date Sampled				05/05/2022	05/05/2022	05/05/2022	05/05/2022	05/05/2022	05/05/2022
Time Taken				1330	1220	1450	1300	1230	1350
Analytical Parameter (Water Analysis)	**Units**	**Limit of detection**	**Accreditation Status**						
SVOCs									
Aniline	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Phenol	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
2-Chlorophenol	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Bis(2-chloroethyl)ether	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	2	2.9	2.7
1,3-Dichlorobenzene	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
1,2-Dichlorobenzene	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
1,4-Dichlorobenzene	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Bis(2-chloroisopropyl)ether	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	110	180	220
2-Methylphenol	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Hexachloroethane	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Nitrobenzene	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
4-Methylphenol	µg/l	0.05	NONE	< 0.05	2.7	< 0.05	< 0.05	< 0.05	< 0.05
Isophorone	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
2-Nitrophenol	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
2,4-Dimethylphenol	µg/l	0.05	NONE	< 0.05	0.47	< 0.05	< 0.05	< 0.05	< 0.05
Bis(2-chloroethoxy)methane	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
1,2,4-Trichlorobenzene	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Naphthalene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
2,4-Dichlorophenol	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
4-Chloroaniline	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Hexachlorobutadiene	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
4-Chloro-3-methylphenol	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
2,4,6-Trichlorophenol	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
2,4,5-Trichlorophenol	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
2-Methylnaphthalene	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
2-Chloronaphthalene	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Dimethylphthalate	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
2,6-Dinitrotoluene	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Acenaphthylene	µg/l	0.01	ISO 17025	< 0.01	0.27	< 0.01	< 0.01	< 0.01	< 0.01
Acenaphthene	µg/l	0.01	ISO 17025	< 0.01	1	< 0.01	0.91	0.88	< 0.01
2,4-Dinitrotoluene	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Dibenzofuran	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
4-Chlorophenyl phenyl ether	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Diethyl phthalate	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
4-Nitroaniline	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Fluorene	µg/l	0.01	ISO 17025	< 0.01	2.1	< 0.01	1.9	1.3	< 0.01
Azobenzene	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Bromophenyl phenyl ether	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Hexachlorobenzene	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Phenanthrene	µg/l	0.01	ISO 17025	< 0.01	1.5	< 0.01	0.76	< 0.01	< 0.01
Anthracene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Carbazole	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Dibutyl phthalate	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Anthraquinone	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Fluoranthene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Pyrene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Butyl benzyl phthalate	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Benzo(a)anthracene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Chrysene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Benzo(b)fluoranthene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Benzo(k)fluoranthene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Benzo(a)pyrene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Indeno(1,2,3-cd)pyrene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Dibenz(a,h)anthracene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01

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Lab Sample Number				2265384	2265385	2265386	2265387	2265388	2265389
Sample Reference				WS116	WS206	BH101D	WS103	BH206	BH201
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				2.00	1.68	6.50	1.72	2.70	6.50
Date Sampled				05/05/2022	05/05/2022	05/05/2022	05/05/2022	05/05/2022	05/05/2022
Time Taken				1330	1220	1450	1300	1230	1350
Analytical Parameter (Water Analysis)	**Units**	**Limit of detection**	**Accreditation Status**						
Benzo(ghi)perylene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
3&4-Methylphenol	µg/l	0.1	NONE	< 0.10	2.7	< 0.10	< 0.10	< 0.10	< 0.10

U/S = Unsuitable Sample   I/S = Insufficient Sample

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Lab Sample Number				2265390	2265391
Sample Reference				WS104	WS105
Sample Number				None Supplied	None Supplied
Depth (m)				2.10	2.10
Date Sampled				05/05/2022	05/05/2022
Time Taken				1500	1540
Analytical Parameter (Water Analysis)	**Units**	**Limit of detection**	**Accreditation Status**		

General Inorganics

pH	pH Units	N/A	ISO 17025	-	7.1
Electrical Conductivity at 20 °C	µS/cm	10	ISO 17025	-	610
Sulphate as SO4	µg/l	45	ISO 17025	-	37700
Sulphate as SO4	mg/l	0.045	ISO 17025	-	37.7
Sulphide	µg/l	5	NONE	-	< 5.0
Nitrate as N	mg/l	0.01	ISO 17025	-	0.98
Nitrate as NO3	mg/l	0.05	ISO 17025	-	4.35
Nitrite as N	µg/l	1	ISO 17025	-	< 1.0
Nitrite as NO2	µg/l	5	ISO 17025	-	< 5.0
Alkalinity as CaCO3	mg/l	3	ISO 17025	-	370

Redox Potential	mV	-800	NONE	-	101.7

Heavy Metals / Metalloids

Iron (dissolved)	mg/l	0.004	ISO 17025	-	0.032
Fe2+	mg/l	0.2	NONE	-	< 0.20
Fe3+	mg/l	0.2	NONE	-	< 0.20
Mn (II)	mg/l	0.02	NONE	-	< 0.02
Mn (IV)	mg/l	0.02	NONE	-	< 0.02

Monoaromatics & Oxygenates

Benzene	µg/l	1	ISO 17025	< 1.0	< 1.0
Toluene	µg/l	1	ISO 17025	< 1.0	< 1.0
Ethylbenzene	µg/l	1	ISO 17025	< 1.0	< 1.0
p & m-xylene	µg/l	1	ISO 17025	< 1.0	< 1.0
o-xylene	µg/l	1	ISO 17025	< 1.0	< 1.0
MTBE (Methyl Tertiary Butyl Ether)	µg/l	1	ISO 17025	< 1.0	< 1.0
Sum of m, p & o-Xylene	µg/l	2	ISO 17025	< 2.0	< 2.0

Petroleum Hydrocarbons

TPH-CWG - Aliphatic >C5 - C6 HS_1D_AL	µg/l	1	ISO 17025	< 1.0	< 1.0
TPH-CWG - Aliphatic >C6 - C8 HS_1D_AL	µg/l	1	ISO 17025	< 1.0	< 1.0
TPH-CWG - Aliphatic >C8 - C10 HS_1D_AL	µg/l	1	ISO 17025	< 1.0	< 1.0
TPH-CWG - Aliphatic >C10 - C12 EH_1D_AL_#1_#2_MS	µg/l	10	NONE	< 10	< 10
TPH-CWG - Aliphatic >C12 - C16 EH_1D_AL_#1_#2_MS	µg/l	10	NONE	< 10	< 10
TPH-CWG - Aliphatic >C16 - C21 EH_1D_AL_#1_#2_MS	µg/l	10	NONE	< 10	< 10
TPH-CWG - Aliphatic >C21 - C35 EH_1D_AL_#1_#2_MS	µg/l	10	NONE	< 10	< 10
TPH-CWG - Aliphatic >C16 - C35 EH_1D_AL_#1_#2_MS	µg/l	10	NONE	< 10	< 10
TPH-CWG - Aliphatic >C35 - C44 EH_1D_AL_#1_#2_MS	µg/l	10	NONE	< 10	< 10
TPH-CWG - Aliphatic (C5 - C35) HS+EH_1D_AL_#1_#2_MS	µg/l	10	NONE	< 10	< 10
TPH-CWG - Aliphatic (C5 - C44) HS+EH_1D_AR_#1_#2_MS	µg/l	10	NONE	< 10	< 10

TPH-CWG - Aromatic >C5 - C7 HS_1D_AR	µg/l	1	ISO 17025	< 1.0	< 1.0
TPH-CWG - Aromatic >C7 - C8 HS_1D_AR	µg/l	1	ISO 17025	< 1.0	< 1.0
TPH-CWG - Aromatic >C8 - C10 HS_1D_AR	µg/l	1	ISO 17025	< 1.0	< 1.0
TPH-CWG - Aromatic >C10 - C12 EH_1D_AR_#1_#2_MS	µg/l	10	NONE	< 10	< 10
TPH-CWG - Aromatic >C12 - C16 EH_1D_AR_#1_#2_MS	µg/l	10	NONE	< 10	< 10
TPH-CWG - Aromatic >C16 - C21 EH_1D_AR_#1_#2_MS	µg/l	10	NONE	< 10	< 10
TPH-CWG - Aromatic >C21 - C35 EH_1D_AR_#1_#2_MS	µg/l	10	NONE	< 10	< 10
TPH-CWG - Aromatic >C35 - C44 EH_1D_AR_#1_#2_MS	µg/l	10	NONE	< 10	< 10
TPH-CWG - Aromatic (C5 - C35) HS+EH_1D_AR_#1_#2_MS	µg/l	10	NONE	< 10	< 10
TPH-CWG - Aromatic (C5 - C44) HS+EH_1D_AR_#1_#2_MS	µg/l	10	NONE	< 10	< 10

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Lab Sample Number				2265390	2265391
Sample Reference				WS104	WS105
Sample Number				None Supplied	None Supplied
Depth (m)				2.10	2.10
Date Sampled				05/05/2022	05/05/2022
Time Taken				1500	1540
Analytical Parameter (Water Analysis)	**Units**	**Limit of detection**	**Accreditation Status**		
TPH-CWG Total C5 - C44 $_{\text{EH+HS\_1D\_TOTAL\_\#1\_\#2\_MS}}$	µg/l	10	NONE	< 10	< 10

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Lab Sample Number				2265390	2265391
Sample Reference				WS104	WS105
Sample Number				None Supplied	None Supplied
Depth (m)				2.10	2.10
Date Sampled				05/05/2022	05/05/2022
Time Taken				1500	1540
Analytical Parameter (Water Analysis)	**Units**	**Limit of detection**	**Accreditation Status**		

SVOCs

Aniline	µg/l	0.05	NONE	< 0.05	< 0.05
Phenol	µg/l	0.05	NONE	< 0.05	< 0.05
2-Chlorophenol	µg/l	0.05	NONE	< 0.05	< 0.05
Bis(2-chloroethyl)ether	µg/l	0.05	NONE	1.5	5.4
1,3-Dichlorobenzene	µg/l	0.05	NONE	< 0.05	0.84
1,2-Dichlorobenzene	µg/l	0.05	NONE	< 0.05	< 0.05
1,4-Dichlorobenzene	µg/l	0.05	NONE	< 0.05	< 0.05
Bis(2-chloroisopropyl)ether	µg/l	0.05	NONE	120	530
2-Methylphenol	µg/l	0.05	NONE	< 0.05	< 0.05
Hexachloroethane	µg/l	0.05	NONE	< 0.05	< 0.05
Nitrobenzene	µg/l	0.05	NONE	< 0.05	< 0.05
4-Methylphenol	µg/l	0.05	NONE	< 0.05	19
Isophorone	µg/l	0.05	NONE	< 0.05	< 0.05
2-Nitrophenol	µg/l	0.05	NONE	< 0.05	< 0.05
2,4-Dimethylphenol	µg/l	0.05	NONE	< 0.05	< 0.05
Bis(2-chloroethoxy)methane	µg/l	0.05	NONE	< 0.05	< 0.05
1,2,4-Trichlorobenzene	µg/l	0.05	NONE	< 0.05	< 0.05
Naphthalene	µg/l	0.01	ISO 17025	< 0.01	< 0.01
2,4-Dichlorophenol	µg/l	0.05	NONE	< 0.05	< 0.05
4-Chloroaniline	µg/l	0.05	NONE	< 0.05	< 0.05
Hexachlorobutadiene	µg/l	0.05	NONE	< 0.05	< 0.05
4-Chloro-3-methylphenol	µg/l	0.05	NONE	< 0.05	< 0.05
2,4,6-Trichlorophenol	µg/l	0.05	NONE	< 0.05	< 0.05
2,4,5-Trichlorophenol	µg/l	0.05	NONE	< 0.05	< 0.05
2-Methylnaphthalene	µg/l	0.05	NONE	< 0.05	0.21
2-Chloronaphthalene	µg/l	0.05	NONE	< 0.05	< 0.05
Dimethylphthalate	µg/l	0.05	NONE	< 0.05	< 0.05
2,6-Dinitrotoluene	µg/l	0.05	NONE	< 0.05	< 0.05
Acenaphthylene	µg/l	0.01	ISO 17025	< 0.01	< 0.01
Acenaphthene	µg/l	0.01	ISO 17025	< 0.01	< 0.01
2,4-Dinitrotoluene	µg/l	0.05	NONE	< 0.05	< 0.05
Dibenzofuran	µg/l	0.05	NONE	< 0.05	< 0.05
4-Chlorophenyl phenyl ether	µg/l	0.05	NONE	< 0.05	< 0.05
Diethyl phthalate	µg/l	0.05	NONE	< 0.05	< 0.05
4-Nitroaniline	µg/l	0.05	NONE	< 0.05	< 0.05
Fluorene	µg/l	0.01	ISO 17025	< 0.01	< 0.01
Azobenzene	µg/l	0.05	NONE	< 0.05	< 0.05
Bromophenyl phenyl ether	µg/l	0.05	NONE	< 0.05	< 0.05
Hexachlorobenzene	µg/l	0.05	NONE	< 0.05	< 0.05
Phenanthrene	µg/l	0.01	ISO 17025	< 0.01	< 0.01
Anthracene	µg/l	0.01	ISO 17025	< 0.01	< 0.01
Carbazole	µg/l	0.05	NONE	< 0.05	< 0.05
Dibutyl phthalate	µg/l	0.05	NONE	< 0.05	11
Anthraquinone	µg/l	0.05	NONE	< 0.05	< 0.05
Fluoranthene	µg/l	0.01	ISO 17025	< 0.01	< 0.01
Pyrene	µg/l	0.01	ISO 17025	< 0.01	< 0.01
Butyl benzyl phthalate	µg/l	0.05	NONE	< 0.05	< 0.05
Benzo(a)anthracene	µg/l	0.01	ISO 17025	< 0.01	< 0.01
Chrysene	µg/l	0.01	ISO 17025	< 0.01	< 0.01
Benzo(b)fluoranthene	µg/l	0.01	ISO 17025	< 0.01	< 0.01
Benzo(k)fluoranthene	µg/l	0.01	ISO 17025	< 0.01	< 0.01
Benzo(a)pyrene	µg/l	0.01	ISO 17025	< 0.01	< 0.01
Indeno(1,2,3-cd)pyrene	µg/l	0.01	ISO 17025	< 0.01	< 0.01
Dibenz(a,h)anthracene	µg/l	0.01	ISO 17025	< 0.01	< 0.01

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Lab Sample Number				2265390	2265391
Sample Reference				WS104	WS105
Sample Number				None Supplied	None Supplied
Depth (m)				2.10	2.10
Date Sampled				05/05/2022	05/05/2022
Time Taken				1500	1540
Analytical Parameter (Water Analysis)	**Units**	**Limit of detection**	**Accreditation Status**		
Benzo(ghi)perylene	µg/l	0.01	ISO 17025	< 0.01	< 0.01

3&4-Methylphenol	µg/l	0.1	NONE	< 0.10	19

U/S = Unsuitable Sample I/S = Insufficient Sample

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Project / Site name: Gloucester

Water matrix abbreviations:
Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Waters (PrW) Final Sewage Effluent (FSE) Landfill Leachate (LL)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Electrical conductivity at 20oC of water	Determination of electrical conductivity in water by electrometric measurement. Accredited Matrices SW, GW, PW	In-house method	L031-PL	W	ISO 17025
Iron (II) and Iron (III) in water	Determination of Iron II and Iron III in water by coloration with phenanthroline and calculation.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton	L079-PL	W	NONE
Metals in water by ICP-OES (dissolved)	Determination of metals in water by acidification followed by ICP-OES. Accredited Matrices SW, GW, PW, PrW.(Al, Cu,Fe,Zn).	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil.	L039-PL	W	ISO 17025
Nitrite in water	Determination of nitrite in water by addition of sulphanilamide and NED followed by discrete analyser (colorimetry).Accredited matrices SW, GW, PW.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton	L082-PL	W	ISO 17025
Nitrate in water	Determination of nitrate by reaction with sodium salicylate and colorimetry. Accredited matrices SW, GW, PW	In-house method based on Examination of Water and Wastewatern & Polish Standard Method PN-82/C-04579.08,	L078-PL	W	ISO 17025
Redox Potential of waters	Determination of redox potential in water by electrometric measurement versus Ag/AgCl electrode.	In house method.	L084-PL	W	NONE
Sulphide in water	Determination of sulphide in water by ion selective electrode.	In-house method	L029-PL	W	NONE
Sulphate in water	Determination of sulphate in water after filtration by acidification followed by ICP-OES. Accredited Matrices SW, GW, PW.	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil.	L039-PL	W	ISO 17025
Semi-volatile organic compounds in water	Determination of semi-volatile organic compounds in leachate by extraction in dichloromethane followed by GC-MS.	In-house method based on USEPA 8270	L102B-PL	W	ISO 17025
TPHCWG (Waters)	Determination of dichloromethane extractable hydrocarbons in water by GC-MS, speciation by interpretation.	In-house method	L070-PL	W	ISO 17025
BTEX and MTBE in water (Monoaromatics)	Determination of BTEX and MTBE in water by headspace GC-MS. Accredited matrices: SW PW GW	In-house method based on USEPA8260	L073B-PL	W	ISO 17025
TPH in (Water)	Determination of TPH bands by HS-GC-MS/GC-FID	In-house method, TPH with carbon banding.	L070-PL	W	NONE
Nitrite as N in water	Determination of nitrite in water by addition of sulphanilamide and NED followed by discrete analyser (colorimetry). Accredited matrices SW, GW, PW.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton	L082-PL	W	ISO 17025
Nitrate as N in water	Determination of nitrate by reaction with sodium salicylate and colorimetry. Accredited matrices SW, GW, PW.	In-house method based on Examination of Water and Wastewatern & Polish Standard Method PN-82/C-04579.08,	L078-PL	W	ISO 17025
TPH Chromatogram in Water	TPH Chromatogram in Water.	In-house method	L070-PL	W	NONE
pH at 20oC in water (automated)	Determination of pH in water by electrometric measurement. Accredited matrices: SW PW GW	In house method.	L099-PL	W	ISO 17025
Manganese II and IV in Water	Analysis of manganese compounds by periodate oxidation method.	In house method and calculation based on standard methods for the examination of water and waste water.	L090-PL	W	NONE

UKAS TESTING 4041

Analytical Report Number : 22-56484
Project / Site name: Gloucester

Water matrix abbreviations:
Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Waters (PrW) Final Sewage Effluent (FSE) Landfill Leachate (LL)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Alkalinity in Water (by discreet analyser)	Determination of Alkalinity by discreet analyser (colorimetry). Accredited matrices: SW, PW, GW.	In house method based on MEWAM & USEPA Method 310.2.	L082-PL	W	ISO 17025

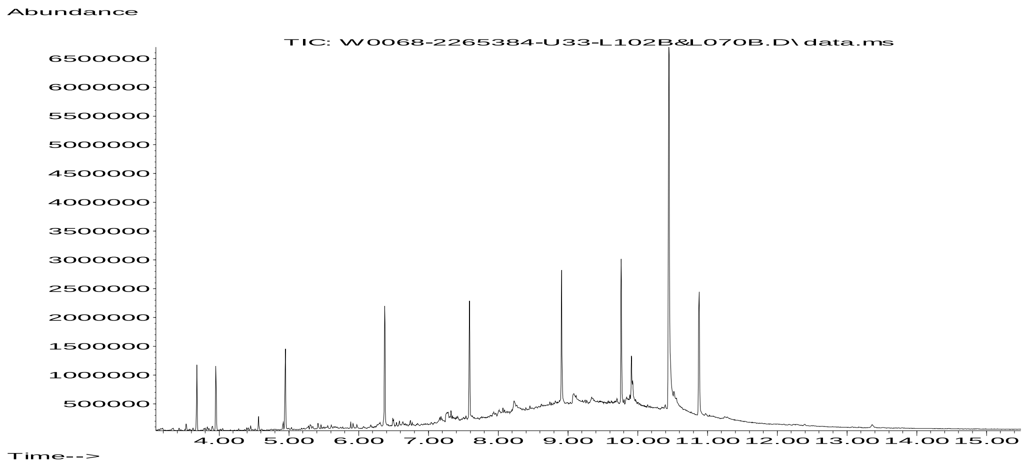
For method numbers ending in 'UK' analysis have been carried out in our laboratory in the United Kingdom.
For method numbers ending in 'PL' analysis have been carried out in our laboratory in Poland.
Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 30oC.

Unless otherwise indicated, site information, order number, project number, sampling date, time, sample reference and depth are provided by the client. The instructed on date indicates the date on which this information was provided to the laboratory.

Information in Support of Analytical Results

List of HWOL Acronyms and Operators

Acronym	Descriptions
HS	Headspace Analysis
MS	Mass spectrometry
FID	Flame Ionisation Detector
GC	Gas Chromatography
EH	Extractable Hydrocarbons (i.e. everything extracted by the solvent(s))
CU	Clean-up - e.g. by Florisil®, silica gel
1D	GC - Single coil/column gas chromatography
2D	GC-GC - Double coil/column gas chromatography
Total	Aliphatics & Aromatics
AL	Aliphatics
AR	Aromatics
#1	EH_2D_Total but with humics mathematically subtracted
#2	EH_2D_Total but with fatty acids mathematically subtracted
_	Operator - understore to separate acronyms (exception for +)
+	Operator to indicate cumulative e.g. EH+HS_Total or EH_CU+HS_Total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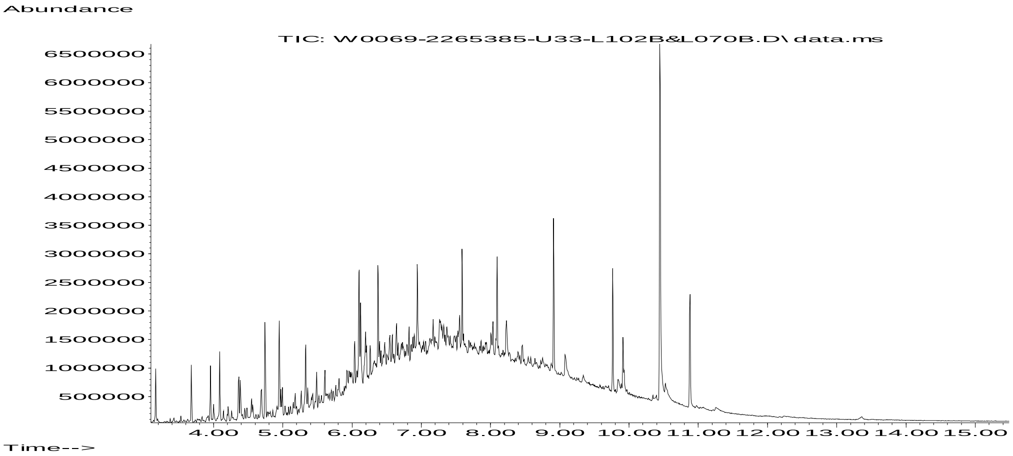
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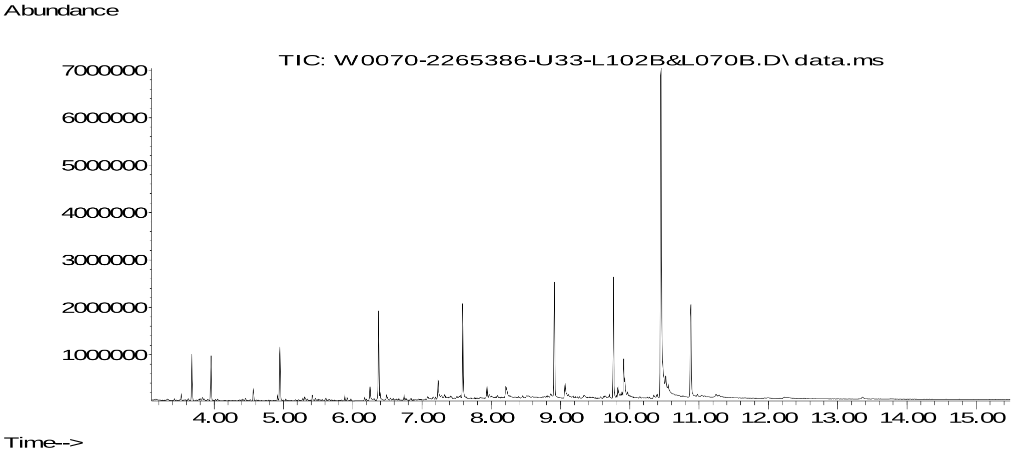
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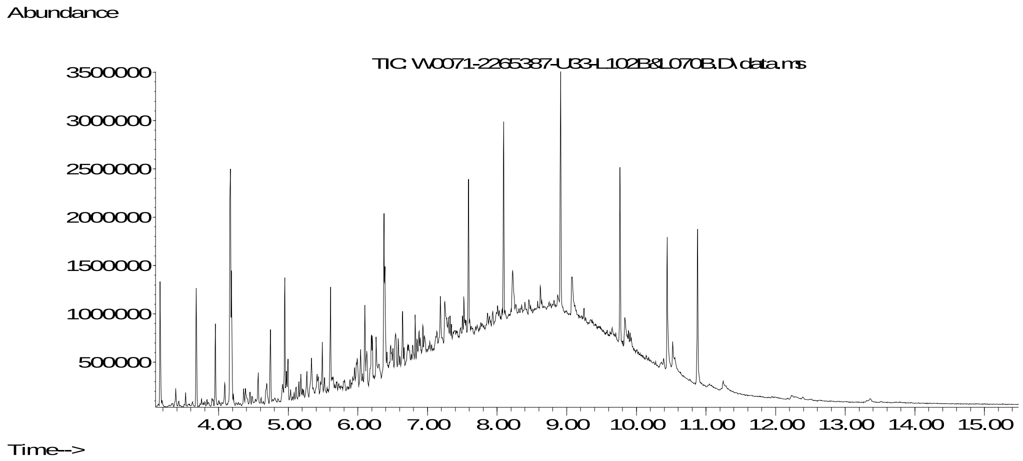
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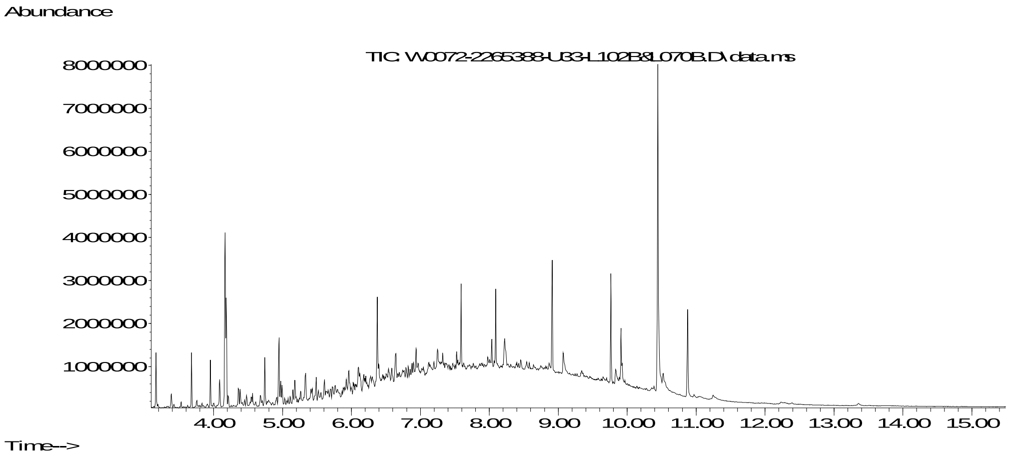
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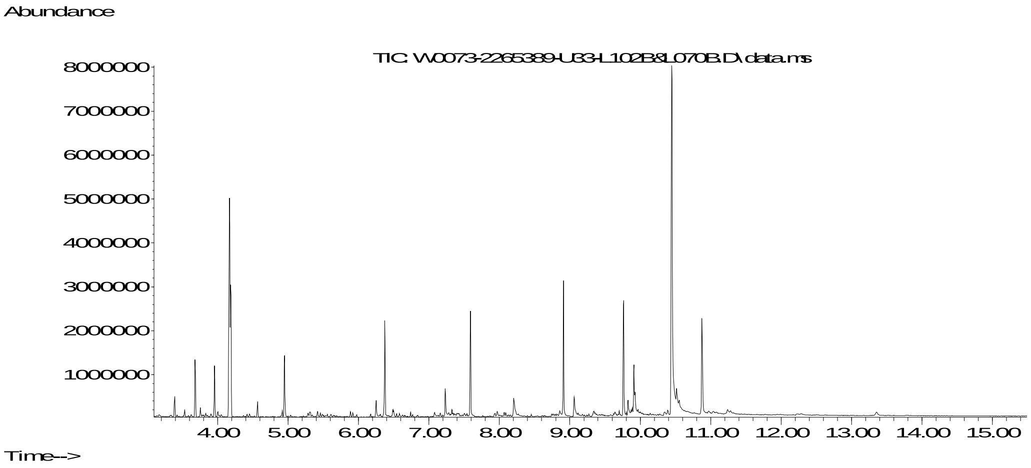
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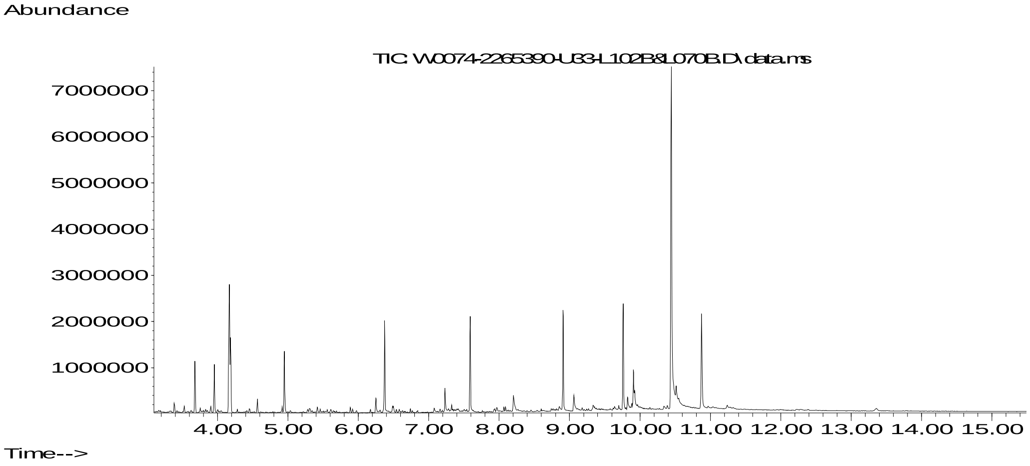
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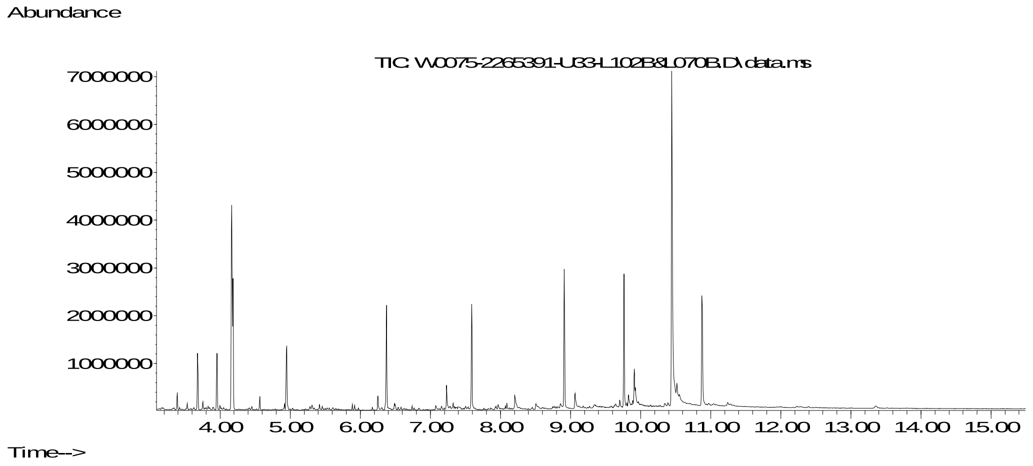
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Analytical Report Number : 22-56759

Project / Site name:	Gloucester GWR Yard	**Samples received on:**	09/05/2022
Your job number:	20775	**Samples instructed on/ Analysis started on:**	09/05/2022
Your order number:	PO16135	**Analysis completed by:**	13/05/2022
Report Issue Number:	1	**Report issued on:**	13/05/2022
Samples Analysed:	4 water samples		

Signed: Izabela Wójcik

Izabela Wójcik
Reporting Specialist
For & on behalf of i2 Analytical Ltd.

Standard Geotechnical, Asbestos and Chemical Testing Laboratory located at: ul. Pionierów 39, 41 -711 Ruda Śląska, Poland.

Accredited tests are defined within the report, opinions and interpretations expressed herein are outside the scope of accreditation.

Standard sample disposal times, unless otherwise agreed with the laboratory, are :

soils - 4 weeks from reporting
leachates - 2 weeks from reporting
waters - 2 weeks from reporting
asbestos - 6 months from reporting

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Any assessments of compliance with specifications are based on actual analytical results with no contribution from uncertainty of measurement.
Application of uncertainty of measurement would provide a range within which the true result lies.
An estimate of measurement uncertainty can be provided on request.

Analytical Report Number: 22-56759
Project / Site name: Gloucester GWR Yard

Your Order No: PO16135

Lab Sample Number				2267036	2267037	2267038	2267039
Sample Reference				WS114	WS111	WS109	WS110
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				2.00	2.30	1.80	1.70
Date Sampled				06/05/2022	06/05/2022	06/05/2022	06/05/2022
Time Taken				1030	1115	1000	1110
Analytical Parameter (Water Analysis)	**Units**	**Limit of detection**	**Accreditation Status**				

General Inorganics

pH	pH Units	N/A	ISO 17025	-	7.4	-	-
Electrical Conductivity at 20 °C	µS/cm	10	ISO 17025	-	780	-	-
Sulphate as SO4	mg/l	0.045	ISO 17025	-	82.5	-	-
Sulphide	µg/l	5	NONE	-	< 5.0	-	-
Nitrate as N	mg/l	0.01	ISO 17025	-	10.5	-	-
Nitrate as NO3	mg/l	0.05	ISO 17025	-	46.6	-	-
Nitrite as N	µg/l	1	ISO 17025	-	< 1.0	-	-
Nitrite as NO2	µg/l	5	ISO 17025	-	< 5.0	-	-
Alkalinity as CaCO3	mg/l	3	ISO 17025	-	380	-	-

Redox Potential	mV	-800	NONE	-	7.5	-	-

Heavy Metals / Metalloids

Iron (dissolved)	mg/l	0.004	ISO 17025	-	0.008	-	-
Fe2+	mg/l	0.2	NONE	-	< 0.20	-	-
Fe3+	mg/l	0.2	NONE	-	< 0.20	-	-
Mn (II)	mg/l	0.02	NONE	-	< 0.02	-	-
Mn (IV)	mg/l	0.02	NONE	-	< 0.02	-	-

Monoaromatics & Oxygenates

Benzene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0
Toluene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0
Ethylbenzene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0
p & m-xylene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0
o-xylene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0
MTBE (Methyl Tertiary Butyl Ether)	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0
Sum of m, p & o-Xylene	µg/l	2	ISO 17025	< 2.0	< 2.0	< 2.0	< 2.0

Petroleum Hydrocarbons

TPH-CWG - Aliphatic >C5 - C6 $_{\text{HS\_1D\_AL}}$	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0
TPH-CWG - Aliphatic >C6 - C8 $_{\text{HS\_1D\_AL}}$	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0
TPH-CWG - Aliphatic >C8 - C10 $_{\text{HS\_1D\_AL}}$	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0
TPH-CWG - Aliphatic >C10 - C12 $_{\text{EH\_1D\_AL\_\#1\_\#2\_MS}}$	µg/l	10	NONE	< 10	< 10	< 10	< 10
TPH-CWG - Aliphatic >C12 - C16 $_{\text{EH\_1D\_AL\_\#1\_\#2\_MS}}$	µg/l	10	NONE	< 10	< 10	< 10	< 10
TPH-CWG - Aliphatic >C16 - C21 $_{\text{EH\_1D\_AL\_\#1\_\#2\_MS}}$	µg/l	10	NONE	< 10	< 10	< 10	< 10
TPH-CWG - Aliphatic >C21 - C35 $_{\text{EH\_1D\_AL\_\#1\_\#2\_MS}}$	µg/l	10	NONE	< 10	< 10	< 10	< 10
TPH-CWG - Aliphatic >C16 - C35 $_{\text{EH\_1D\_AL\_\#1\_\#2\_MS}}$	µg/l	10	NONE	< 10	< 10	< 10	< 10
TPH-CWG - Aliphatic >C35 - C44 $_{\text{EH\_1D\_AL\_\#1\_\#2\_MS}}$	µg/l	10	NONE	< 10	< 10	< 10	< 10
TPH-CWG - Aliphatic (C5 - C35) $_{\text{HS+EH\_1D\_AL\_\#1\_\#2\_MS}}$	µg/l	10	NONE	< 10	< 10	< 10	< 10
TPH-CWG - Aliphatic (C5 - C44) $_{\text{HS+EH\_1D\_AR\_\#1\_\#2\_MS}}$	µg/l	10	NONE	< 10	< 10	< 10	< 10

TPH-CWG - Aromatic >C5 - C7 $_{\text{HS\_1D\_AR}}$	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0
TPH-CWG - Aromatic >C7 - C8 $_{\text{HS\_1D\_AR}}$	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0
TPH-CWG - Aromatic >C8 - C10 $_{\text{HS\_1D\_AR}}$	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0
TPH-CWG - Aromatic >C10 - C12 $_{\text{EH\_1D\_AR\_\#1\_\#2\_MS}}$	µg/l	10	NONE	< 10	< 10	< 10	< 10
TPH-CWG - Aromatic >C12 - C16 $_{\text{EH\_1D\_AR\_\#1\_\#2\_MS}}$	µg/l	10	NONE	< 10	< 10	< 10	< 10
TPH-CWG - Aromatic >C16 - C21 $_{\text{EH\_1D\_AR\_\#1\_\#2\_MS}}$	µg/l	10	NONE	< 10	< 10	< 10	< 10
TPH-CWG - Aromatic >C21 - C35 $_{\text{EH\_1D\_AR\_\#1\_\#2\_MS}}$	µg/l	10	NONE	< 10	< 10	< 10	< 10
TPH-CWG - Aromatic >C35 - C44 $_{\text{EH\_1D\_AR\_\#1\_\#2\_MS}}$	µg/l	10	NONE	< 10	< 10	< 10	< 10
TPH-CWG - Aromatic (C5 - C35) $_{\text{HS+EH\_1D\_AR\_\#1\_\#2\_MS}}$	µg/l	10	NONE	< 10	< 10	< 10	< 10
TPH-CWG - Aromatic (C5 - C44) $_{\text{HS+EH\_1D\_AR\_\#1\_\#2\_MS}}$	µg/l	10	NONE	< 10	< 10	< 10	< 10

Analytical Report Number: 22-56759
Project / Site name: Gloucester GWR Yard

Your Order No: PO16135

Lab Sample Number				2267036	2267037	2267038	2267039
Sample Reference				WS114	WS111	WS109	WS110
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				2.00	2.30	1.80	1.70
Date Sampled				06/05/2022	06/05/2022	06/05/2022	06/05/2022
Time Taken				1030	1115	1000	1110
Analytical Parameter (Water Analysis)	**Units**	**Limit of detection**	**Accreditation Status**				
TPH-CWG Total C5 - C44 EH+HS_1D_TOTAL_#1_#2_MS	µg/l	10	NONE	< 10	< 10	< 10	< 10

SVOCs

Aniline	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05
Phenol	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05
2-Chlorophenol	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05
Bis(2-chloroethyl)ether	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05
1,3-Dichlorobenzene	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05
1,2-Dichlorobenzene	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05
1,4-Dichlorobenzene	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05
Bis(2-chloroisopropyl)ether	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05
2-Methylphenol	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05
Hexachloroethane	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05
Nitrobenzene	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05
4-Methylphenol	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05
Isophorone	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05
2-Nitrophenol	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05
2,4-Dimethylphenol	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05
Bis(2-chloroethoxy)methane	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05
1,2,4-Trichlorobenzene	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05
Naphthalene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01
2,4-Dichlorophenol	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05
4-Chloroaniline	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05
Hexachlorobutadiene	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05
4-Chloro-3-methylphenol	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05
2,4,6-Trichlorophenol	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05
2,4,5-Trichlorophenol	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05
2-Methylnaphthalene	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05
2-Chloronaphthalene	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05
Dimethylphthalate	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05
2,6-Dinitrotoluene	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05
Acenaphthylene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01
Acenaphthene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01
2,4-Dinitrotoluene	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05
Dibenzofuran	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05
4-Chlorophenyl phenyl ether	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05
Diethyl phthalate	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05
4-Nitroaniline	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05
Fluorene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01
Azobenzene	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05
Bromophenyl phenyl ether	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05
Hexachlorobenzene	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05
Phenanthrene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01
Anthracene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01
Carbazole	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05
Dibutyl phthalate	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05
Anthraquinone	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05
Fluoranthene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01
Pyrene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01
Butyl benzyl phthalate	µg/l	0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05
Benzo(a)anthracene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01
Chrysene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01

Analytical Report Number: 22-56759
Project / Site name: Gloucester GWR Yard

Your Order No: PO16135

Lab Sample Number				2267036	2267037	2267038	2267039
Sample Reference				WS114	WS111	WS109	WS110
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				2.00	2.30	1.80	1.70
Date Sampled				06/05/2022	06/05/2022	06/05/2022	06/05/2022
Time Taken				1030	1115	1000	1110
Analytical Parameter (Water Analysis)	**Units**	**Limit of detection**	**Accreditation Status**				
Benzo(b)fluoranthene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01
Benzo(k)fluoranthene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01
Benzo(a)pyrene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01
Indeno(1,2,3-cd)pyrene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01
Dibenz(a,h)anthracene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01
Benzo(ghi)perylene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01

3&4-Methylphenol	µg/l	0.1	NONE	< 0.10	< 0.10	< 0.10	< 0.10

U/S = Unsuitable Sample   I/S = Insufficient Sample

Analytical Report Number : 22-56759
Project / Site name: Gloucester GWR Yard

Water matrix abbreviations:
Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Waters (PrW) Final Sewage Effluent (FSE) Landfill Leachate (LL)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Electrical conductivity at 20oC of water	Determination of electrical conductivity in water by electrometric measurement. Accredited Matrices SW, GW, PW	In-house method	L031-PL	W	ISO 17025
Iron (II) and Iron (III) in water	Determination of Iron II and Iron III in water by coloration with phenanthroline and calculation.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton	L079-PL	W	NONE
Metals in water by ICP-OES (dissolved)	Determination of metals in water by acidification followed by ICP-OES. Accredited Matrices SW, GW, PW, PrW.(Al, Cu,Fe,Zn).	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil.	L039-PL	W	ISO 17025
Nitrite in water	Determination of nitrite in water by addition of sulphanilamide and NED followed by discrete analyser (colorimetry).Accredited matrices SW, GW, PW.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton	L082-PL	W	ISO 17025
Nitrate in water	Determination of nitrate by reaction with sodium salicylate and colorimetry. Accredited matrices SW, GW, PW	In-house method based on Examination of Water and Wastewatern & Polish Standard Method PN-82/C-04579.08,	L078-PL	W	ISO 17025
Redox Potential of waters	Determination of redox potential in water by electrometric measurement versus Ag/AgCl electrode.	In house method.	L084-PL	W	NONE
Sulphide in water	Determination of sulphide in water by ion selective electrode.	In-house method	L029-PL	W	NONE
Sulphate in water	Determination of sulphate in water after filtration by acidification followed by ICP-OES. Accredited Matrices SW, GW, PW.	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil.	L039-PL	W	ISO 17025
Semi-volatile organic compounds in water	Determination of semi-volatile organic compounds in leachate by extraction in dichloromethane followed by GC-MS.	In-house method based on USEPA 8270	L102B-PL	W	ISO 17025
TPHCWG (Waters)	Determination of dichloromethane extractable hydrocarbons in water by GC-MS, speciation by interpretation.	In-house method	L070-PL	W	ISO 17025
BTEX and MTBE in water (Monoaromatics)	Determination of BTEX and MTBE in water by headspace GC-MS. Accredited matrices: SW PW GW	In-house method based on USEPA8260	L073B-PL	W	ISO 17025
TPH in (Water)	Determination of TPH bands by HS-GC-MS/GC-FID	In-house method, TPH with carbon banding.	L070-PL	W	NONE
Nitrite as N in water	Determination of nitrite in water by addition of sulphanilamide and NED followed by discrete analyser (colorimetry). Accredited matrices SW, GW, PW.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton	L082-PL	W	ISO 17025
Nitrate as N in water	Determination of nitrate by reaction with sodium salicylate and colorimetry. Accredited matrices SW, GW, PW.	In-house method based on Examination of Water and Wastewatern & Polish Standard Method PN-82/C-04579.08,	L078-PL	W	ISO 17025
TPH Chromatogram in Water	TPH Chromatogram in Water.	In-house method	L070-PL	W	NONE
pH at 20oC in water (automated)	Determination of pH in water by electrometric measurement. Accredited matrices: SW PW GW	In house method.	L099-PL	W	ISO 17025
Manganese II and IV in Water	Analysis of manganese compounds by periodate oxidation method.	In house method and calculation based on standard methods for the examination of water and waste water.	L090-PL	W	NONE

Analytical Report Number : 22-56759
Project / Site name: Gloucester GWR Yard

Water matrix abbreviations:
Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Waters (PrW) Final Sewage Effluent (FSE) Landfill Leachate (LL)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Alkalinity in Water (by discreet analyser)	Determination of Alkalinity by discreet analyser (colorimetry). Accredited matrices: SW, PW, GW.	In house method based on MEWAM & USEPA Method 310.2.	L082-PL	W	ISO 17025

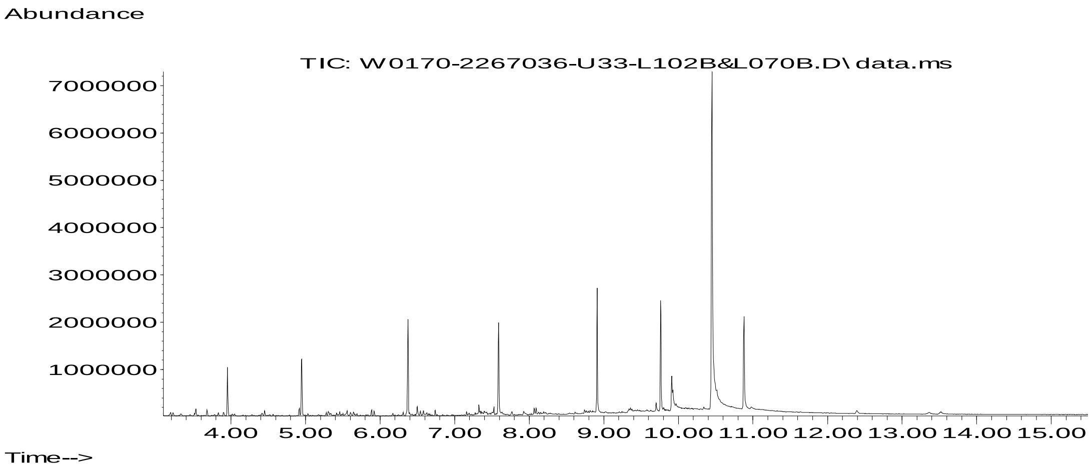
For method numbers ending in 'UK' analysis have been carried out in our laboratory in the United Kingdom.
For method numbers ending in 'PL' analysis have been carried out in our laboratory in Poland.
Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 30oC.

Unless otherwise indicated, site information, order number, project number, sampling date, time, sample reference and depth are provided by the client. The instructed on date indicates the date on which this information was provided to the laboratory.

Information in Support of Analytical Results

List of HWOL Acronyms and Operators

Acronym	Descriptions
HS	Headspace Analysis
MS	Mass spectrometry
FID	Flame Ionisation Detector
GC	Gas Chromatography
EH	Extractable Hydrocarbons (i.e. everything extracted by the solvent(s))
CU	Clean-up - e.g. by Florisil®, silica gel
1D	GC - Single coil/column gas chromatography
2D	GC-GC - Double coil/column gas chromatography
Total	Aliphatics & Aromatics
AL	Aliphatics
AR	Aromatics
#1	EH_2D_Total but with humics mathematically subtracted
#2	EH_2D_Total but with fatty acids mathematically subtracted
_	Operator - understore to separate acronyms (exception for +)
+	Operator to indicate cumulative e.g. EH+HS_Total or EH_CU+HS_Total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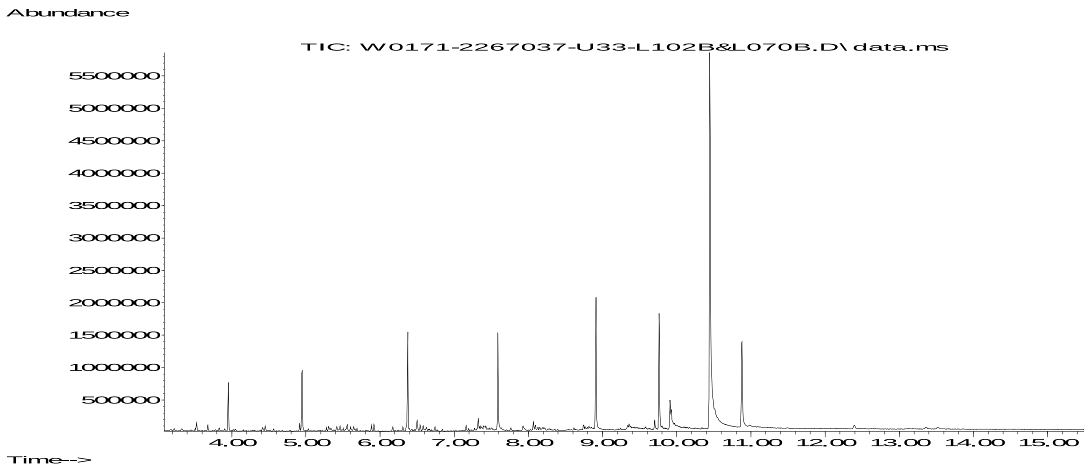
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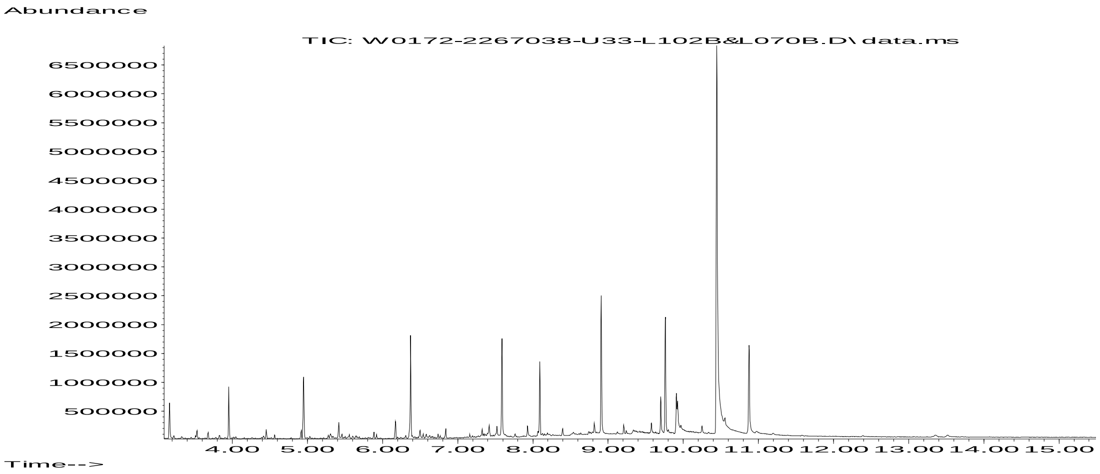
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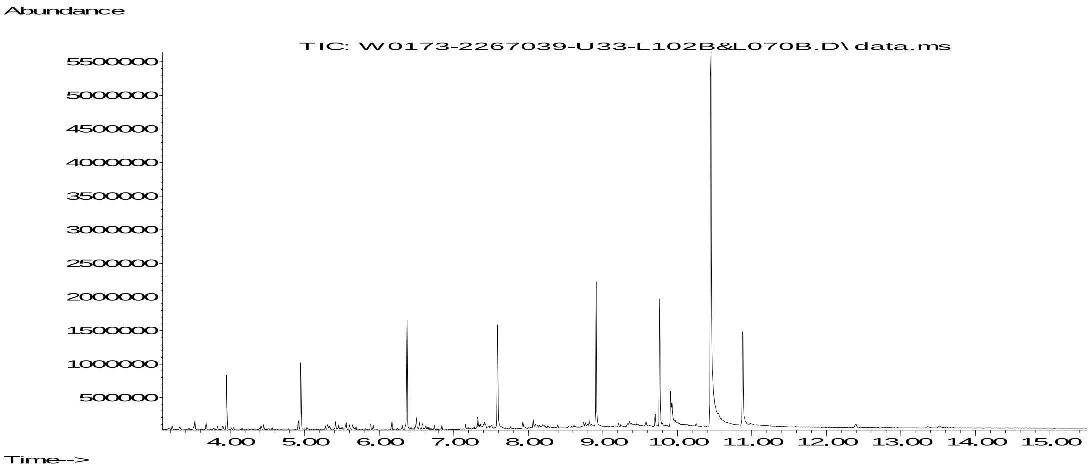
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Appendix E Groundwater Assessment Sheets

Remedial Targets Methodology Data Table

Hydrock Scenario: Scenario B - EQS (inland)
RTM Level: RTM Level 2 - Groundwater Beneath Source Assessment - groundwater samples
Water body receptor(s): Groundwater and surface water
Secondary receptor(s): 0
Data set: Groundwater (Round 1 - JFHR October 2020)
Client: Eutpia Homes Ltd.
Site: Great Western Road Yard
Job no: 20775
Test Certificates(s): JFH: Multiple

Dataset ALL ZONES

🟩	PNEC calculated (inland EQS)
123*	Exceeds solubility value
<1	Grey text and "<" sign if value <= LoD
🟧	Red fill if value > Inland Waters EQS

Surface Water Representative Hardness as mg/l $CaCO_3$ 10

								Strata / Zone	SHALLOW	DEEP	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW
								Date sampled:	20/10/2020	20/10/2020	20/10/2020	21/10/2020	21/10/2020	20/10/2020	21/10/2020	20/10/2020	20/10/2020	20/10/2020	21/10/2020	21/10/2020	21/10/2020	21/10/2020	21/10/2020	21/10/2020	20/10/2020
CAS / AGS Number	**Chemical of Potential Concern (µg/l)**	**WFD Designation**	**Hazardous Substance Status**	**Solubility Limit (µg/l)**	**No. of samples**	**Limit of Detection**		**Inland Waters EQS**	**BH101S**	**BH101D**	**BH102**	**BH103**	**WS101**	**WS102**	**WS103**	**WS104**	**WS105**	**WS107**	**WS109**	**WS110**	**WS111**	**WS112**	**WS113**	**WS114**	**WS116**
7440-38-2	Arsenic (As) (dissolved)	SP	H		17	0.5		50	<0.5	0.654	0.629	<0.5	2.73	11.1	1.1	<0.5	<0.5	6.27	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.786
7440-42-8	Boron (B) (dissolved)		NP		17	10		2000	343	772	578	569	179	326	140	191	199	198	192	507	379	738	570	602	196
7440-39-3	Barium (Ba) (dissolved)				17	0.2		n/a	39.7	23.2	89.2	65	102	107	137	50.6	40.5	158	83.8	114	131	70.6	402	110	64.9
7440-43-9	Cadmium (Cd) (dissolved)	PH	NP		17	0.08		0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
7440-47-3	Chromium (Cr) (total) (dissolved)				17	1		n/a	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
7440-50-8	Copper (Cu) (dissolved)	SP	NP		17	0.3		1	2.37	<0.3	0.458	1.74	<0.3	<0.3	6.95	0.484	0.366	<0.3	1.56	1.2	2.26	1.27	0.68	<0.3	<0.3
7439-89-6	Iron (Fe) (dissolved)	SP			17	19		1000	<19	792	341	<19	6080	8680	130	<19	<19	10700	<19	<19	<19	<19	53.8	<19	1070
7439-97-6	Mercury (Hg) (dissolved)	PH	H		17	0.01		0.07	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
P1286	Manganese (Mn) (dissolved)	SP			17	3		123	73	117	715	502	648	364	127	4.17	58.9	671	90.6	877	249	378	1340	765	578
7440-02-0	Nickel (Ni) (dissolved)	P	NP		17	0.4		4	2.43	4.26	5.69	3.88	3.85	2.55	6.99	1.22	2.7	3.15	4.87	5.58	7.58	2.57	6.45	11.3	4.65
7439-92-1	Lead (Pb) (dissolved)	P	H		17	0.2		1.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.326	0.213	<0.2	<0.2	<0.2
7440-36-0	Antimony (Sb) (dissolved)		NP		17	1		n/a	<1	<1	<1	<1	<1	<1	4.03	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
7782-49-2	Selenium (Se) (dissolved)		NP		17	1		n/a	2.34	3.48	<1	1.1	<1	<1	1.79	<1	2.38	<1	<1	<1	3.54	1.48	1.8	<1	<1
7440-66-6	Zinc (Zn) (dissolved)	SP	NP		17	1		12.3	2.84	3.9	2.01	13.2	<1	1.06	15.1	<1	<1	4	11.1	1.82	52.7	3.86	3.75	3.6	3.28
16887-00-6	Chloride (Cl^-)				17	2000		250000	32200	124000	55900	59700	8300	17300	9600	18900	7700	8300	18900	70700	57100	53900	50700	128000	16700
16984-48-8	Fluoride (F^-)				17	500		1000	<500	<500	<500	<500	<500	<500	<500	<500	<500	<500	<500	<500	<500	<500	<500	<500	<500
P1348	Nitrate (NO_3^-)				17	300		n/a	741	<300	<300	57800	1500	561	3530	8030	4430	<300	539	26800	38000	24300	11000	14100	963
P1349	Nitrite (NO_2^-)				17	50		n/a	<50	<50	<50	327	71	<50	75	71	<50	<50	265	265	232	581	359	78	85
14808-79-8	Sulfate (SO_4^{2-})				17	2000		400000	58300	1330000	171000	135000	46300	39200	43500	41700	32200	113000	37300	78100	78900	80600	69100	143000	44300
P1134	pH (min.) (su)				17	0		6	7.18	7.17	7.84	7.3	7.4	7.21	7.09	7.8	7.18	7.12	7.34	7.32	7.31	7.13	7.19	7.45	7.57
P1134	pH (max.) (su)				17	0		9	7.18	7.17	7.84	7.3	7.4	7.21	7.09	7.8	7.18	7.12	7.34	7.32	7.31	7.13	7.19	7.45	7.57
P1287	Electrical conductivity (µS/cm)				17	20		n/a	851	2950	960	997	628	722	801	584	691	892	746	1000	975	950	975	1150	704
120-12-7	Anthracene	PH	H	56	17	0.005		0.1	<0.005	<0.005	<0.005	0.00584	<0.005	<0.005	<0.005	<0.005	<0.005	0.00504	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
50-32-8	Benzo(a)pyrene	PH	H	3.8	17	0.002		0.00017	<0.002	<0.002	<0.002	0.0598	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.0643	0.0161	0.18	0.0154	<0.002
206-44-0	Fluoranthene	P	H	230	17	0.005		0.0063	0.00777	<0.005	<0.005	0.0734	0.0306	0.0179	<0.005	<0.005	<0.005	0.00844	<0.005	<0.005	0.0117	0.0337	0.0665	0.0234	0.00586
91-20-3	Naphthalene	P	NP	19000	17	0.01		2	<0.01	<0.01	<0.01	0.0126	<0.01	0.131	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.0188	<0.01
GRP01	PAHs = sum of benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(ghi)perylene, indeno(1,2,3-cd)pyrene	P	H		17	0.02		n/a	<0.02	<0.02	<0.02	0.2699	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.3089	0.06343	0.5418	0.05355	<0.02
P1877	Phenol	SP	NP	84100000	17	2		7.7	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
P1407	Ali EC5-EC6			35900	17	10		10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
P1408	Ali >EC6-EC8			5370	17	10		10	<10	<10	<10	<10	<10	<10	<10	<10	<10	31	<10	<10	<10	<10	<10	<10	<10
P1409	Ali >EC8-EC10			427	17	10		10	<10	<10	<10	<10	<10	<10	<10	<10	<10	79	<10	<10	<10	<10	<10	<10	<10
P1410	Ali >EC10-EC12			33.9	17	10		10	<10	<10	<10	<10	<10	31	<10	<10	<10	**71 ***	<10	<10	<10	<10	<10	<10	<10
P1411	Ali >EC12-EC16			0.759	17	10		10	<10	<10	<10	<10	**89 ***	**97 ***	<10	<10	<10	<10	<10	<10	**31 ***	<10	<10	<10	<10
P1938	Ali >EC16-EC35			0.00254	17	20		10	<20	<20	<20	<20	**126 ***	**118 ***	<20	<20	<20	<20	<20	<20	**68 ***	<20	<20	<20	<20
P1441	Aro EC5-EC7			1780000	17	10		10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
P1355	Aro >EC7-EC8			590000	17	10		10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
P1356	Aro >EC8-EC10			64600	17	10		10	<10	<10	<10	<10	<10	<10	<10	<10	<10	53	<10	<10	<10	<10	<10	<10	<10
P1357	Aro >EC10-EC12			24500	17	10		10	<10	<10	<10	<10	<10	20	<10	<10	<10	47	<10	<10	<10	<10	<10	<10	<10
P1358	Aro > EC12-EC16			5750	17	10		10	<10	<10	<10	<10	129	122	<10	<10	<10	18	<10	<10	<10	<10	<10	<10	17
P1359	Aro >EC16-EC21			653	17	10		10	<10	<10	<10	<10	93	59	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
P1360	Aro >EC21-EC35			6.61	17	10		10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	**104 ***	<10	<10
71-43-2	Benzene	P	H	1780000	17	7		10	<7	<7	<7	<7	<7	<7	<7	<7	<7	<7	<7	<7	<7	<7	<7	<7	<7
108-88-3	Toluene	SP	H	590000	17	4		74	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
100-41-4	Ethylbenzene		H	180000	17	5		20	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
95-47-6	o-Xylene		H	173000	17	3		30	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3
P1374	m,p-Xylene		H	200000	17	8		30	<8	<8	<8	<8	<8	<8	<8	<8	<8	<8	<8	<8	<8	<8	<8	<8	<8
1634-04-04	Methyl tertiary butyl ether (MTBE)		NP	48000000	17	3		n/a	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3

Summary of Remedial Targets Methodology Screening

Hydrock

Hydrock Scenario: Scenario B - EQS (inland)
RTM Level: RTM Level 2 - Groundwater Beneath Source Assessment - groundwater samples
Water body receptor(s): Groundwater and surface water
Secondary receptor(s):
Data set: Groundwater (Round 1 - JFHR October 2020)
Client: Eutopia Homes Ltd.
Site: Great Western Road Yard
Job no: 20775
Test Certificates(s): JFH: Multiple
Dataset DEEP

	PNEC calculated (inland EQS)

2013/39/EU Annex I
P = priority substance
PH = priority hazardous substances.
WFD Designation (2015 Directions)
OP = Other substance identical to previous legislation
SP = Specific Pollutant
JAGDAG Hazardous Substances Determination (UK)

H	Hazardous substance
NP	Non-hazardous pollutant
(blank)	Not included in assessment

CAS / AGS Number	Chemicals of Potential Concern (concentrations in µg/l)	WFD Designation	Hazardous Substance Status	Summary of Sample Data						Value Being Compared to Target = Maximum Value	Water Quality Target (Exceeded if Red		No. Samples Exceeding Water Quality Target		No. Samples above LoD Exceeding Water		Notes
				No. of Samples	No. of Samples > LoD	Limit of Detection	Minimum Value	Maximum Value	95-%ile Value			Inland Waters EQS		Inland Waters EQS		Inland Waters EQS	EQS compared to dissolved metals as an initial screen, with no adjustment for bioavailability or ABC.
P1133	Hardness as mg/l $CaCO_3$			-	-	-	10	-	-	-		-					Representative hardness of receiving surface water environment used in some inland EQS
7440-38-2	Arsenic (As) (dissolved)	SP	**H**	1	1	0.5	0.654	0.654	0.654	0.654		50		0		0	
7440-42-8	Boron (B) (dissolved)		NP	1	1	10	772	772	772	772		2000		0		0	
7440-39-3	Barium (Ba) (dissolved)			1	1	0.2	23.2	23.2	23.2	23.2		n/a					
7440-43-9	Cadmium (Cd) (dissolved)	**PH**	NP	1	0	0.08	<0.08	<0.08	<0.08	<0.08		0.08		0		0	EQS (inland) dependent on hardness of receiving surface water environment
7440-47-3	Chromium (Cr) (total) (dissolved)			1	0	1	<1	<1	<1	<1		n/a					
7440-50-8	Copper (Cu) (dissolved)	SP	NP	1	0	0.3	<0.3	<0.3	<0.3	<0.3		1		0		0	Bioavailable EQS (inland)
7439-89-6	Iron (Fe) (dissolved)	SP		1	1	19	792	792	792	792		1000		0		0	
7439-97-6	Mercury (Hg) (dissolved)	**PH**	**H**	1	0	0.01	<0.01	<0.01	<0.01	<0.01		0.07		0		0	
P1286	Manganese (Mn) (dissolved)	SP		1	1	3	117	117	117	117		123		0		0	Bioavailable EQS (inland)
7440-02-0	Nickel (Ni) (dissolved)	***P***	NP	1	1	0.4	4.26	4.26	4.26	4.26		4		1		1	Bioavailable EQS (inland)
7439-92-1	Lead (Pb) (dissolved)	***P***	**H**	1	0	0.2	<0.2	<0.2	<0.2	<0.2		1.2		0		0	Bioavailable EQS (inland)
7440-36-0	Antimony (Sb) (dissolved)		NP	1	0	1	<1	<1	<1	<1		n/a					
7782-49-2	Selenium (Se) (dissolved)		NP	1	1	1	3.48	3.48	3.48	3.48		n/a					
7440-66-6	Zinc (Zn) (dissolved)	SP	NP	1	1	1	3.9	3.9	3.9	3.9		12.3		0		0	Bioavailable EQS (inland) + ambient background concentration (ABC)
16887-00-6	Chloride (Cl^-)			1	1	2000	124000	124000	124000	124000		250000		0		0	
16984-48-8	Fluoride (F^-)			1	0	500	<500	<500	<500	<500		1000		0		0	EQS (inland) dependent on hardness of receiving surface water environment
P1348	Nitrate (NO_3^-)			1	0	300	<300	<300	<300	<300		n/a					
P1349	Nitrite (NO_2^-)			1	0	50	<50	<50	<50	<50		n/a					
14808-79-8	Sulfate (SO_4^{2-})			1	1	2000	1330000	1330000	1330000	1330000		400000		1		1	
P1134	pH (min.) (su)			1	1	0	7.17	7.17	7.17	7.17		6		0		0	
P1134	pH (max.) (su)			1	1	0	7.17	7.17	7.17	7.17		9		0		0	
P1287	Electrical conductivity (µS/cm)			1	1	20	2950	2950	2950	2950		n/a					
120-12-7	Anthracene	***PH***	**H**	1	0	0.005	<0.005	<0.005	<0.005	<0.005		0.1		0		0	
50-32-8	Benzo(a)pyrene	***PH***	H	1	0	0.002	<0.002	<0.002	<0.002	<0.002		0.00017		1		0	Benzo(a)pyrene EQS used as marker substance for the group of benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene & indeno (1,2,3-cd)pyrene
206-44-0	Fluoranthene	***P***	**H**	1	0	0.005	<0.005	<0.005	<0.005	<0.005		0.0063		0		0	
91-20-3	Naphthalene	P	NP	1	0	0.01	<0.01	<0.01	<0.01	<0.01		2		0		0	
GRP01	PAHs = sum of benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(ghi)perylene, indeno(1,2,3-cd)pyrene	***P***	**H**	1	0	0.02	<0.02	<0.02	<0.02	<0.02		n/a					
P1877	Phenol	SP	**NP**	1	0	2	<2	<2	<2	<2		7.7		0		0	
P1407	Ali EC5-EC6			1	0	10	<10	<10	<10	<10		10		0		0	n-hexane fall within this fraction
P1408	Ali >EC6-EC8			1	0	10	<10	<10	<10	<10		10		0		0	n-heptane falls within this fraction
P1409	Ali >EC8-EC10			1	0	10	<10	<10	<10	<10		10		0		0	n-octane and n-nonane fall within this fraction
P1410	Ali >EC10-EC12			1	0	10	<10	<10	<10	<10		10		0		0	
P1411	Ali >EC12-EC16			1	0	10	<10	<10	<10	<10		10		0		0	
P1938	Ali >EC16-EC35			1	0	20	<20	<20	<20	<20		10		1		0	
P1441	Aro EC5-EC7			1	0	10	<10	<10	<10	<10		10		0		0	Benzene wholly representative of this fraction
P1355	Aro >EC7-EC8			1	0	10	<10	<10	<10	<10		10		0		0	Toluene wholly representative of this fraction
P1356	Aro >EC8-EC10			1	0	10	<10	<10	<10	<10		10		0		0	Ethylbenzene / xylene / trimethylbenzene representative of this range
P1357	Aro >EC10-EC12			1	0	10	<10	<10	<10	<10		10		0		0	Naphthalene often forms a reasonable percentage of this fraction
P1358	Aro > EC12-EC16			1	0	10	<10	<10	<10	<10		10		0		0	2-methylnaphthalene, acenpthylene, acenapthene falls within this fraction
P1359	Aro >EC16-EC21			1	0	10	<10	<10	<10	<10		10		0		0	fluorene, anthracene, phenanthrene, pyrene falls within this range
P1360	Aro >EC21-EC35			1	0	10	<10	<10	<10	<10		10		0		0	Benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(ghi)perylene, indeno(cd)pyrene fall within this fraction
71-43-2	Benzene	P	**H**	1	0	7	<7	<7	<7	<7		10		0		0	
108-88-3	Toluene	SP	**H**	1	0	4	<4	<4	<4	<4		74		0		0	
100-41-4	Ethylbenzene		**H**	1	0	5	<5	<5	<5	<5		20		0		0	Proposed EQS for Ethylbenzene in Water, R&D Technical Report P2-115/TR4. EA 2001
95-47-6	o-Xylene		**H**	1	0	3	<3	<3	<3	<3		30		0		0	EQS for total xylene
P1374	m,p-Xylene		**H**	1	0	8	<8	<8	<8	<8		30		0		0	EQS for total xylene
1634-04-04	Methyl tertiary butyl ether (MTBE)		**NP**	1	0	3	<3	<3	<3	<3		n/a					

Summary of Remedial Targets Methodology Screening

Hydrock Scenario: Scenario B - EQS (inland)
RTM Level: RTM Level 2 - Groundwater Beneath Source Assessment - groundwater samples
Water body receptor(s): Groundwater and surface water
Secondary receptor(s):
Data set: Groundwater (Round 1 - JFHR October 2020)
Client: Eutpia Homes Ltd.
Site: Great Western Road Yard
Job no: 20775
Test Certificates(s): JFH: Multiple
Dataset SHALLOW

🟩	PNEC calculated (inland EQS)

2013/39/EU Annex I
P = priority substance
PH = priority hazardous substances.
WFD Designation (2015 Directions)
OP = Other substance identical to previous legislation
SP = Specific Pollutant
JAGDAG Hazardous Substances Determination (UK)

H	Hazardous substance
NP	Non-hazardous pollutant
(blank)	Not included in assessment

CAS / AGS Number	Chemicals of Potential Concern (concentrations in µg/l)	WFD Designation	Hazardous Substance Status	Summary of Sample Data						Value Being Compared to Target = Maximum Value	Water Quality Target (Exceeded if Red)	No. Samples Exceeding Water Quality Target	No. Samples above LoD Exceeding Water	Notes
				No. of Samples	No. of Samples > LoD	Limit of Detection	Minimum Value	Maximum Value	95-%ile Value		Inland Waters EQS	Inland Waters EQS	Inland Waters EQS	EQS compared to dissolved metals as an initial screen, with no adjustment for bioavailability or ABC.
P1133	Hardness as mg/l CaCO$_3$			-	-	-	10	-	-	-	-			Representative hardness of receiving surface water environment used in some inland EQS
7440-38-2	Arsenic (As) (dissolved)	SP	**H**	16	6	0.5	<0.5	11.1	7.4775	11.1	50	0	0	
7440-42-8	Boron (B) (dissolved)		NP	16	16	10	140	738	636	738	2000	0	0	
7440-39-3	Barium (Ba) (dissolved)			16	16	0.2	39.7	402	219	402	n/a			
7440-43-9	Cadmium (Cd) (dissolved)	**PH**	NP	16	0	0.08	<0.08	<0.08	<0.08	<0.08	0.08	0	0	EQS (inland) dependent on hardness of receiving surface water environment
7440-47-3	Chromium (Cr) (total) (dissolved)			16	0	1	<1	<1	<1	<1	n/a			
7440-50-8	Copper (Cu) (dissolved)	SP	NP	16	11	0.3	<0.3	6.95	3.515	6.95	1	7	7	Bioavailable EQS (inland)
7439-89-6	Iron (Fe) (dissolved)	SP		16	7	19	<19	10700	9185	10700	1000	4	4	
7439-97-6	Mercury (Hg) (dissolved)	**PH**	**H**	16	0	0.01	<0.01	<0.01	<0.01	<0.01	0.07	0	0	
P1286	Manganese (Mn) (dissolved)	SP		16	16	3	4.17	1340	992.75	1340	123	12	12	Bioavailable EQS (inland)
7440-02-0	Nickel (Ni) (dissolved)	***P***	NP	16	16	0.4	1.22	11.3	8.51	11.3	4	8	8	Bioavailable EQS (inland)
7439-92-1	Lead (Pb) (dissolved)	***P***	**H**	16	2	0.2	<0.2	0.326	0.24125	0.326	1.2	0	0	Bioavailable EQS (inland)
7440-36-0	Antimony (Sb) (dissolved)		NP	16	1	1	<1	4.03	1.7575	4.03	n/a			
7782-49-2	Selenium (Se) (dissolved)		NP	16	7	1	<1	3.54	2.67	3.54	n/a			
7440-66-6	Zinc (Zn) (dissolved)	SP	NP	16	13	1	<1	52.7	24.5	52.7	12.3	3	3	Bioavailable EQS (inland) + ambient background concentration (ABC)
16887-00-6	Chloride (Cl$^-$)			16	16	2000	7700	128000	85025	128000	250000	0	0	
16984-48-8	Fluoride (F$^-$)			16	0	500	<500	<500	<500	<500	1000	0	0	EQS (inland) dependent on hardness of receiving surface water environment
P1348	Nitrate (NO$_3$$^-$)			16	14	300	<300	57800	42950	57800	n/a			
P1349	Nitrite (NO$_2$$^-$)			16	11	50	<50	581	414.5	581	n/a			
14808-79-8	Sulfate (SO$_4$$^{2-}$)			16	16	2000	32200	171000	150000	171000	400000	0	0	
P1134	pH (min.) (su)			16	16	0	7.09	7.84	7.81	7.84	6	0	0	
P1134	pH (max.) (su)			16	16	0	7.09	7.84	7.81	7.84	9	0	0	
P1287	Electrical conductivity (µS/cm)			16	16	20	584	1150	1037.5	1150	n/a			
120-12-7	Anthracene	***PH***	**H**	16	2	0.005	<0.005	0.00584	0.00524	0.00584	0.1	0	0	
50-32-8	Benzo(a)pyrene	***PH***	H	16	5	0.002	<0.002	0.18	0.093225	0.18	0.00017	16	5	Benzo(a)pyrene EQS used as marker substance for the group of benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene & indeno (1,2,3-cd)pyrene
206-44-0	Fluoranthene	***P***	**H**	16	10	0.005	<0.005	0.0734	0.068225	0.0734	0.0063	9	9	
91-20-3	Naphthalene	P	NP	16	3	0.01	<0.01	0.131	0.04685	0.131	2	0	0	
GRP01	PAHs = sum of benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(ghi)perylene, indeno(1,2,3-cd)pyrene	***P***	**H**	16	5	0.02	<0.02	0.5418	0.367125	0.5418	n/a			
P1877	Phenol	SP	**NP**	16	0	2	<2	<2	<2	<2	7.7	0	0	
P1407	Ali EC5-EC6			16	0	10	<10	<10	<10	<10	10	0	0	n-hexane fall within this fraction
P1408	Ali >EC6-EC8			16	1	10	<10	31	15.25	31	10	1	1	n-heptane falls within this fraction
P1409	Ali >EC8-EC10			16	1	10	<10	79	27.25	79	10	1	1	n-octane and n-nonane fall within this fraction
P1410	Ali >EC10-EC12			16	2	10	<10	71	41	71	10	2	2	
P1411	Ali >EC12-EC16			16	3	10	<10	97	91	97	10	3	3	
P1938	Ali >EC16-EC35			16	3	20	<20	126	120	126	10	16	3	
P1441	Aro EC5-EC7			16	0	10	<10	<10	<10	<10	10	0	0	Benzene wholly representative of this fraction
P1355	Aro >EC7-EC8			16	0	10	<10	<10	<10	<10	10	0	0	Toluene wholly representative of this fraction
P1356	Aro >EC8-EC10			16	1	10	<10	53	20.75	53	10	1	1	Ethylbenzene / xylene / trimethylbenzene representative of this range
P1357	Aro >EC10-EC12			16	2	10	<10	47	26.75	47	10	2	2	Naphthalene often forms a reasonable percentage of this fraction
P1358	Aro > EC12-EC16			16	4	10	<10	129	123.75	129	10	4	4	2-methylnaphthalene, acenpthylene, acenapthene falls within this fraction
P1359	Aro >EC16-EC21			16	2	10	<10	93	67.5	93	10	2	2	fluorene, anthracene, phenanthrene, pyrene falls within this range
P1360	Aro >EC21-EC35			16	1	10	<10	104	33.5	104	10	1	1	Benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(ghi)perylene, indeno(cd)pyrene fall within this fraction
71-43-2	Benzene	P	**H**	16	0	7	<7	<7	<7	<7	10	0	0	
108-88-3	Toluene	SP	**H**	16	0	4	<4	<4	<4	<4	74	0	0	
100-41-4	Ethylbenzene		**H**	16	0	5	<5	<5	<5	<5	20	0	0	Proposed EQS for Ethylbenzene in Water, R&D Technical Report P2-115/TR4. EA 2001
95-47-6	o-Xylene		**H**	16	0	3	<3	<3	<3	<3	30	0	0	EQS for total xylene
P1374	m,p-Xylene		**H**	16	0	8	<8	<8	<8	<8	30	0	0	EQS for total xylene
1634-04-04	Methyl tertiary butyl ether (MTBE)		**NP**	16	0	3	<3	<3	<3	<3	n/a			

Remedial Targets Methodology Data Table

Hydrock Scenario: Scenario B - EQS (inland)

RTM Level: RTM Level 2 - Groundwater Beneath Source Assessment - groundwater samples

Water body receptor(s): Groundwater and surface water
Secondary receptor(s): 0
Data set: Groundwater (Round 2 - JFHR November 2020)
Client: Eutpia Homes Ltd.
Site: Great Western Road Yard
Job no: 20775
Test Certificates(s): JFH: Multiple

🟩 PNEC calculated (inland EQS)

123* Exceeds solubility value
<1 Grey text and "<" sign if value <= LoD
🟧 Red fill if value > Inland Waters EQS

Surface Water Representative Hardness as mg/l $CaCO_3$ 10

Dataset ALL ZONES

								Strata / Zone	SHALLOW	DEEP	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW
								Date sampled:	03/11/2020	03/11/2020	04/11/2020	04/11/2020	03/11/2020	03/11/2020	03/11/2020	03/11/2020	03/11/2020	04/11/2020	04/11/2020	04/11/2020	04/11/2020	04/11/2020	04/11/2020	04/11/2020	03/11/2020
CAS / AGS Number	**Chemical of Potential Concern (µg/l)**	**WFD Designation**	**Hazardous Substance Status**	**Solubility Limit (µg/l)**	**No. of samples**	**Limit of Detection**		**Inland Waters EQS**	**BH101S**	**BH101D**	**BH102**	**BH103**	**WS101**	**WS102**	**WS103**	**WS104**	**WS105**	**WS107**	**WS109**	**WS110**	**WS111**	**WS112**	**WS113**	**WS114**	**WS116**
7440-38-2	Arsenic (As) (dissolved)	SP	H		17	0.5		50	<0.5	1.14	0.794	0.557	4.64	20.1	1.31	0.731	<0.5	4.36	<0.5	<0.5	<0.5	<0.5	1.07	<0.5	0.584
7440-42-8	Boron (B) (dissolved)		NP		17	10		2000	393	895	549	460	164	385	116	168	184	135	168	503	364	757	530	603	214
7440-43-9	Cadmium (Cd) (dissolved)	PH	NP		17	0.08		0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
7440-47-3	Chromium (Cr) (total) (dissolved)				17	1		n/a	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
7440-50-8	Copper (Cu) (dissolved)	SP	NP		17	0.3		1	0.785	0.354	<0.3	2.42	<0.3	1.01	4	0.754	0.359	<0.3	1.64	0.655	1.25	9.09	0.462	0.324	<0.3
7439-97-6	Mercury (Hg) (dissolved)	PH	H		17	0.01		0.07	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
7440-02-0	Nickel (Ni) (dissolved)	P	NP		17	0.4		4	1.19	6.36	5.24	2.58	4.57	3.51	6.46	1.22	1.95	3.91	3.18	5.8	6.88	1.98	6.4	7.88	4.44
7439-92-1	Lead (Pb) (dissolved)	P	H		17	0.2		1.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.249	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.558	<0.2	<0.2	<0.2
7782-49-2	Selenium (Se) (dissolved)		NP		17	1		n/a	4.04	<1	<1	<1	<1	<1	4.67	4.49	2.98	1.91	<1	<1	2.73	3.49	<1	<1	<1
7440-66-6	Zinc (Zn) (dissolved)	SP	NP		17	1		12.3	6.01	<1	3.17	27.4	<1	2.86	13.2	1.21	1.32	4.24	19.4	<1	1.78	2.52	1.37	3.1	1.73
14808-79-8	Sulfate (SO_4^{2-})				17	2000		400000	58300	1410000	166000	128000	84500	33300	34400	46700	30700	58700	19900	68100	68300	75700	61500	150000	47100
P1134	pH (min.) (su)				17	0		6	6.96	7.24	7.28	7.38	7.15	6.91	7.01	7.35	7.1	6.94	6.77	7.11	7.07	7.19	7.19	7.18	7.08
P1134	pH (max.) (su)				17	0		9	6.96	7.24	7.28	7.38	7.15	6.91	7.01	7.35	7.1	6.94	6.77	7.11	7.07	7.19	7.19	7.18	7.08
120-12-7	Anthracene	PH	H	56	17	0.005		0.1	<0.005	<0.005	<0.005	0.0112	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.00501	<0.005	<0.005
50-32-8	Benzo(a)pyrene	PH	H	3.8	17	0.002		0.00017	<0.002	<0.002	<0.002	0.101	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.00775	<0.002	<0.002
206-44-0	Fluoranthene	P	H	230	17	0.005		0.0063	<0.005	<0.005	<0.005	0.104	<0.005	0.0125	<0.005	<0.005	<0.005	0.00709	<0.005	0.0126	<0.005	<0.005	0.0676	0.00565	<0.005
91-20-3	Naphthalene	P	NP	19000	17	0.01		2	<0.01	0.0126	<0.01	0.0186	<0.01	0.176	<0.01	<0.01	0.0118	0.0273	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
GRP01	PAHs = sum of benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(ghi)perylene, indeno(1,2,3-cd)pyrene	P	H		17	0.02		n/a	<0.02	<0.02	<0.02	0.5421	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.02585	<0.02	<0.02
P1877	Phenol	SP	NP	84100000	17	2		7.7	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
P1407	Ali EC5-EC6			35900	17	10		10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
P1408	Ali >EC6-EC8			5370	17	10		10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
P1409	Ali >EC8-EC10			427	17	10		10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
P1410	Ali >EC10-EC12			33.9	17	10		10	<10	<10	<10	<10	<10	16	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
P1411	Ali >EC12-EC16			0.759	17	10		10	<10	<10	<10	<10	<10	**13 ***	<10	<10	**11 ***	<10	<10	<10	<10	<10	<10	<10	<10
P1938	Ali >EC16-EC35			0.00254	17	20		10	<20	<20	<20	<20	<20	**29 ***	<20	<20	**21 ***	<20	<20	<20	<20	<20	<20	<20	<20
P1441	Aro EC5-EC7			1780000	17	10		10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
P1355	Aro >EC7-EC8			590000	17	10		10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
P1356	Aro >EC8-EC10			64600	17	10		10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
P1357	Aro >EC10-EC12			24500	17	10		10	<10	<10	<10	<10	<10	11	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
P1358	Aro > EC12-EC16			5750	17	10		10	<10	<10	<10	<10	116	109	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
P1359	Aro >EC16-EC21			653	17	10		10	<10	<10	<10	<10	74	39	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
P1360	Aro >EC21-EC35			6.61	17	10		10	<10	<10	<10	<10	**58 ***	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
71-43-2	Benzene	P	H	1780000	17	7		10	<7	<7	<7	<7	<7	<7	<7	<7	<7	<7	<7	<7	<7	<7	<7	<7	<7
108-88-3	Toluene	SP	H	590000	17	4		74	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
100-41-4	Ethylbenzene		H	180000	17	5		20	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
95-47-6	o-Xylene		H	173000	17	3		30	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3
P1374	m,p-Xylene		H	200000	17	8		30	<8	<8	<8	<8	<8	<8	<8	<8	<8	<8	<8	<8	<8	<8	<8	<8	<8
1634-04-04	Methyl tertiary butyl ether (MTBE)		NP	48000000	17	3		n/a	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3

Summary of Remedial Targets Methodology Screening

Hydrock Scenario: Scenario B - EQS (inland)
RTM Level: RTM Level 2 - Groundwater Beneath Source Assessment - groundwater samples
Water body receptor(s): Groundwater and surface water
Secondary receptor(s):
Data set: Groundwater (Round 2 - JFHR November 2020)
Client: Eutpia Homes Ltd.
Site: Great Western Road Yard
Job no: 20775
Test Certificates(s): JFH: Multiple
Dataset DEEP

▨	PNEC calculated (inland EQS)

2013/39/EU Annex I	
P = priority substance	
PH = priority hazardous substances.	
WFD Designation (2015 Directions)	
OP = Other substance identical to previous legislation	
SP = Specific Pollutant	
JAGDAG Hazardous Substances Determination (UK)	
H	Hazardous substance
NP	Non-hazardous pollutant
(blank)	Not included in assessment

CAS / AGS Number	Chemicals of Potential Concern (concentrations in µg/l)	WFD Designation	Hazardous Substance Status	Summary of Sample Data						Value Being Compared to Target = Maximum Value	Water Quality Target (Exceeded if Red		No. Samples Exceeding Water Quality Target		No. Samples above LoD Exceeding Water		Notes
				No. of Samples	No. of Samples > LoD	Limit of Detection	Minimum Value	Maximum Value	95-%ile Value			Inland Waters EQS		Inland Waters EQS		Inland Waters EQS	EQS compared to dissolved metals as an initial screen, with no adjustment for bioavailability or ABC.
P1133	Hardness as mg/l $CaCO_3$			-	-	-	10	-	-	-		-					Representative hardness of receiving surface water environment used in some inland EQS
7440-38-2	Arsenic (As) (dissolved)	SP	**H**	1	1	0.5	1.14	1.14	1.14	1.14		50		0		0	
7440-42-8	Boron (B) (dissolved)		NP	1	1	10	895	895	895	895		2000		0		0	
7440-43-9	Cadmium (Cd) (dissolved)	**PH**	NP	1	0	0.08	<0.08	<0.08	<0.08	<0.08		0.08		0		0	EQS (inland) dependent on hardness of receiving surface water environment
7440-47-3	Chromium (Cr) (total) (dissolved)			1	0	1	<1	<1	<1	<1		n/a					
7440-50-8	Copper (Cu) (dissolved)	SP	NP	1	1	0.3	0.354	0.354	0.354	0.354		1		0		0	Bioavailable EQS (inland)
7439-97-6	Mercury (Hg) (dissolved)	**PH**	**H**	1	0	0.01	<0.01	<0.01	<0.01	<0.01		0.07		0		0	
7440-02-0	Nickel (Ni) (dissolved)	***P***	NP	1	1	0.4	6.36	6.36	6.36	6.36		4		1		1	Bioavailable EQS (inland)
7439-92-1	Lead (Pb) (dissolved)	***P***	**H**	1	0	0.2	<0.2	<0.2	<0.2	<0.2		1.2		0		0	Bioavailable EQS (inland)
7782-49-2	Selenium (Se) (dissolved)		NP	1	0	1	<1	<1	<1	<1		n/a					
7440-66-6	Zinc (Zn) (dissolved)	SP	NP	1	0	1	<1	<1	<1	<1		12.3		0		0	Bioavailable EQS (inland) + ambient background concentration (ABC)
14808-79-8	Sulfate (SO_4^{2-})			1	1	2000	1410000	1410000	1410000	1410000		400000		1		1	
P1134	pH (min.) (su)			1	1	0	7.24	7.24	7.24	7.24		6		0		0	
P1134	pH (max.) (su)			1	1	0	7.24	7.24	7.24	7.24		9		0		0	
120-12-7	Anthracene	***PH***	**H**	1	0	0.005	<0.005	<0.005	<0.005	<0.005		0.1		0		0	
50-32-8	Benzo(a)pyrene	***PH***	H	1	0	0.002	<0.002	<0.002	<0.002	<0.002		0.00017		1		0	Benzo(a)pyrene EQS used as marker substance for the group of benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene & indeno (1,2,3-cd)pyrene
206-44-0	Fluoranthene	***P***	**H**	1	0	0.005	<0.005	<0.005	<0.005	<0.005		0.0063		0		0	
91-20-3	Naphthalene	P	NP	1	1	0.01	0.0126	0.0126	0.0126	0.0126		2		0		0	
GRP01	PAHs = sum of benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(ghi)perylene, indeno(1,2,3-cd)pyrene	***P***	**H**	1	0	0.02	<0.02	<0.02	<0.02	<0.02		n/a					
P1877	Phenol	SP	**NP**	1	0	2	<2	<2	<2	<2		7.7		0		0	
P1407	Ali EC5-EC6			1	0	10	<10	<10	<10	<10		10		0		0	n-hexane fall within this fraction
P1408	Ali >EC6-EC8			1	0	10	<10	<10	<10	<10		10		0		0	n-heptane falls within this fraction
P1409	Ali >EC8-EC10			1	0	10	<10	<10	<10	<10		10		0		0	n-octane and n-nonane fall within this fraction
P1410	Ali >EC10-EC12			1	0	10	<10	<10	<10	<10		10		0		0	
P1411	Ali >EC12-EC16			1	0	10	<10	<10	<10	<10		10		0		0	
P1938	Ali >EC16-EC35			1	0	20	<20	<20	<20	<20		10		1		0	
P1441	Aro EC5-EC7			1	0	10	<10	<10	<10	<10		10		0		0	Benzene wholly representative of this fraction
P1355	Aro >EC7-EC8			1	0	10	<10	<10	<10	<10		10		0		0	Toluene wholly representative of this fraction
P1356	Aro >EC8-EC10			1	0	10	<10	<10	<10	<10		10		0		0	Ethylbenzene / xylene / trimethylbenzene representative of this range
P1357	Aro >EC10-EC12			1	0	10	<10	<10	<10	<10		10		0		0	Naphthalene often forms a reasonable percentage of this fraction
P1358	Aro > EC12-EC16			1	0	10	<10	<10	<10	<10		10		0		0	2-methylnaphthalene, acenpthylene, acenapthene falls within this fraction
P1359	Aro >EC16-EC21			1	0	10	<10	<10	<10	<10		10		0		0	fluorene, anthracene, phenanthrene, pyrene falls within this range
P1360	Aro >EC21-EC35			1	0	10	<10	<10	<10	<10		10		0		0	Benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(ghi)perylene, indeno(cd)pyrene fall within this fraction
71-43-2	Benzene	P	**H**	1	0	7	<7	<7	<7	<7		10		0		0	
108-88-3	Toluene	SP	**H**	1	0	4	<4	<4	<4	<4		74		0		0	
100-41-4	Ethylbenzene		**H**	1	0	5	<5	<5	<5	<5		20		0		0	Proposed EQS for Ethylbenzene in Water, R&D Technical Report P2-115/TR4. EA 2001
95-47-6	o-Xylene		**H**	1	0	3	<3	<3	<3	<3		30		0		0	EQS for total xylene
P1374	m,p-Xylene		**H**	1	0	8	<8	<8	<8	<8		30		0		0	EQS for total xylene
1634-04-04	Methyl tertiary butyl ether (MTBE)		**NP**	1	0	3	<3	<3	<3	<3		n/a					

Summary of Remedial Targets Methodology Screening

Hydrock

Hydrock Scenario: Scenario B - EQS (inland)
RTM Level: RTM Level 2 - Groundwater Beneath Source Assessment - groundwater samples
Water body receptor(s): Groundwater and surface water
Secondary receptor(s):
Data set: Groundwater (Round 2 - JFHR November 2020)
Client: Eutopia Homes Ltd.
Site: Great Western Road Yard
Job no: 20775
Test Certificates(s): JFH: Multiple
Dataset SHALLOW

▨	PNEC calculated (inland EQS)

2013/39/EU Annex I	
P = priority substance	
PH = priority hazardous substances.	
WFD Designation (2015 Directions)	
OP = Other substance identical to previous legislation	
SP = Specific Pollutant	
JAGDAG Hazardous Substances Determination (UK)	
H	Hazardous substance
NP	Non-hazardous pollutant
(blank)	Not included in assessment

CAS / AGS Number	Chemicals of Potential Concern (concentrations in µg/l)	WFD Designation	Hazardous Substance Status	Summary of Sample Data						Value Being Compared to Target = Maximum Value	Water Quality Target (Exceeded if Red		No. Samples Exceeding Water Quality Target		No. Samples above LoD Exceeding Water		Notes
				No. of Samples	No. of Samples > LoD	Limit of Detection	Minimum Value	Maximum Value	95-%ile Value			Inland Waters EQS		Inland Waters EQS		Inland Waters EQS	EQS compared to dissolved metals as an initial screen, with no adjustment for bioavailability or ABC.
P1133	Hardness as mg/l CaCO$_3$			-	-	-	10	-	-	-		-					Representative hardness of receiving surface water environment used in some inland EQS
7440-38-2	Arsenic (As) (dissolved)	SP	**H**	16	9	0.5	<0.5	20.1	8.505	20.1		50		0		0	
7440-42-8	Boron (B) (dissolved)		NP	16	16	10	116	757	641.5	757		2000		0		0	
7440-43-9	Cadmium (Cd) (dissolved)	**PH**	NP	16	0	0.08	<0.08	<0.08	<0.08	<0.08		0.08		0		0	EQS (inland) dependent on hardness of receiving surface water environment
7440-47-3	Chromium (Cr) (total) (dissolved)			16	0	1	<1	<1	<1	<1		n/a					
7440-50-8	Copper (Cu) (dissolved)	SP	NP	16	12	0.3	<0.3	9.09	5.2725	9.09		1		6		6	Bioavailable EQS (inland)
7439-97-6	Mercury (Hg) (dissolved)	**PH**	**H**	16	0	0.01	<0.01	<0.01	<0.01	<0.01		0.07		0		0	
7440-02-0	Nickel (Ni) (dissolved)	***P***	NP	16	16	0.4	1.19	7.88	7.13	7.88		4		8		8	Bioavailable EQS (inland)
7439-92-1	Lead (Pb) (dissolved)	***P***	**H**	16	2	0.2	<0.2	0.558	0.32625	0.558		1.2		0		0	Bioavailable EQS (inland)
7782-49-2	Selenium (Se) (dissolved)		NP	16	7	1	<1	4.67	4.535	4.67		n/a					
7440-66-6	Zinc (Zn) (dissolved)	SP	NP	16	14	1	<1	27.4	21.4	27.4		12.3		3		3	Bioavailable EQS (inland) + ambient background concentration (ABC)
14808-79-8	Sulfate (SO$_4^{2-}$)			16	16	2000	19900	166000	154000	166000		400000		0		0	
P1134	pH (min.) (su)			16	16	0	6.77	7.38	7.3575	7.38		6		0		0	
P1134	pH (max.) (su)			16	16	0	6.77	7.38	7.3575	7.38		9		0		0	
120-12-7	Anthracene	***PH***	**H**	16	2	0.005	<0.005	0.0112	0.006558	0.0112		0.1		0		0	
50-32-8	Benzo(a)pyrene	***PH***	H	16	2	0.002	<0.002	0.101	0.031063	0.101		0.00017		16		2	Benzo(a)pyrene EQS used as marker substance for the group of benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene & indeno (1,2,3-cd)pyrene
206-44-0	Fluoranthene	***P***	**H**	16	6	0.005	<0.005	0.104	0.0767	0.104		0.0063		5		5	
91-20-3	Naphthalene	P	NP	16	4	0.01	<0.01	0.176	0.064475	0.176		2		0		0	
GRP01	PAHs = sum of benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(ghi)perylene, indeno(1,2,3-cd)pyrene	***P***	**H**	16	2	0.02	<0.02	0.5421	0.154913	0.5421		n/a					
P1877	Phenol	SP	**NP**	16	0	2	<2	<2	<2	<2		7.7		0		0	
P1407	Ali EC5-EC6			16	0	10	<10	<10	<10	<10		10		0		0	n-hexane fall within this fraction
P1408	Ali >EC6-EC8			16	0	10	<10	<10	<10	<10		10		0		0	n-heptane falls within this fraction
P1409	Ali >EC8-EC10			16	0	10	<10	<10	<10	<10		10		0		0	n-octane and n-nonane fall within this fraction
P1410	Ali >EC10-EC12			16	1	10	<10	16	11.5	16		10		1		1	
P1411	Ali >EC12-EC16			16	2	10	<10	13	11.5	13		10		2		2	
P1938	Ali >EC16-EC35			16	2	20	<20	29	23	29		10		16		2	
P1441	Aro EC5-EC7			16	0	10	<10	<10	<10	<10		10		0		0	Benzene wholly representative of this fraction
P1355	Aro >EC7-EC8			16	0	10	<10	<10	<10	<10		10		0		0	Toluene wholly representative of this fraction
P1356	Aro >EC8-EC10			16	0	10	<10	<10	<10	<10		10		0		0	Ethylbenzene / xylene / trimethylbenzene representative of this range
P1357	Aro >EC10-EC12			16	1	10	<10	11	10.25	11		10		1		1	Naphthalene often forms a reasonable percentage of this fraction
P1358	Aro > EC12-EC16			16	2	10	<10	116	110.75	116		10		2		2	2-methylnaphthalene, acenpthylene, acenapthene falls within this fraction
P1359	Aro >EC16-EC21			16	2	10	<10	74	47.75	74		10		2		2	fluorene, anthracene, phenanthrene, pyrene falls within this range
P1360	Aro >EC21-EC35			16	1	10	<10	58	22	58		10		1		1	Benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(ghi)perylene, indeno(cd)pyrene fall within this fraction
71-43-2	Benzene	P	**H**	16	0	7	<7	<7	<7	<7		10		0		0	
108-88-3	Toluene	SP	**H**	16	0	4	<4	<4	<4	<4		74		0		0	
100-41-4	Ethylbenzene		**H**	16	0	5	<5	<5	<5	<5		20		0		0	Proposed EQS for Ethylbenzene in Water, R&D Technical Report P2-115/TR4. EA 2001
95-47-6	o-Xylene		**H**	16	0	3	<3	<3	<3	<3		30		0		0	EQS for total xylene
P1374	m,p-Xylene		**H**	16	0	8	<8	<8	<8	<8		30		0		0	EQS for total xylene
1634-04-04	Methyl tertiary butyl ether (MTBE)		**NP**	16	0	3	<3	<3	<3	<3		n/a					

Remedial Targets Methodology Data Table

Hydrock Scenario: Scenario B - EQS (inland)

RTM Level: RTM Level 2 - Groundwater Beneath Source Assessment - groundwater samples

Water body receptor(s): Groundwater and surface water
Secondary receptor(s): 0
Data set: Groundwater (Round 3 - Hydrock 2022)
Client: Eutpia Homes Ltd.
Site: Great Western Road Yard
Job no: 20775
Test Certificates(s): Multiple
Dataset ALL ZONES

PNEC calculated (inland EQS)

123* Exceeds solubility value
<1 Grey text and "<" sign if value <= LoD
Red fill if value > Inland Waters EQS

Surface Water Representative Hardness as mg/l $CaCO_3$ 10

								Strata / Zone	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	DEEP	DEEP
								Date sampled:	16/03/2022	16/03/2022	16/03/2022	16/03/2022	16/03/2022	16/03/2022	16/03/2022	16/03/2022	16/03/2022	16/03/2022	21/03/2022	21/03/2022	21/03/2022	21/03/2022	16/03/2022	16/03/2022
CAS / AGS Number	**Chemical of Potential Concern (µg/l)**	**WFD Designation**	**Hazardous Substance Status**	**Solubility Limit (µg/l)**	**No. of samples**	**Limit of Detection**		**Inland Waters EQS**	**WS101**	**BH202**	**BH203**	**BH204S**	**BH205**	**BH206**	**WS203**	**WS204**	**WS205**	**WS206**	**WS103**	**WS105**	**WS107**	**WS116**	**BH201**	**BH204D**
7440-22-4	Silver (Ag) (dissolved)				12	0.05		0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05					<0.05	<0.05
7429-90-5	Aluminium (Al) (dissolved)				12	1		n/a	2.1	1.8	<1	1.3	2.3	2.2	<1	<1	1.1	2.2					1.8	2.3
7440-38-2	Arsenic (As) (dissolved)	SP	H		12	0.15		50	0.95	0.8	1.1	2.02	0.31	1.25	5.27	4.17	4.47	7.58					11.3	0.85
7440-42-8	Boron (B) (dissolved)		NP		12	10		2000	150	87	300	330	160	650	530	200	450	230					2200	700
7440-39-3	Barium (Ba) (dissolved)				12	0.06		n/a	55	42	110	92	48	89	150	140	170	200					13	43
7440-43-9	Cadmium (Cd) (dissolved)	PH	NP		12	0.02		0.08	<0.02	0.03	<0.02	<0.02	0.03	0.05	<0.02	0.05	<0.02	<0.02					0.13	0.03
7440-48-4	Cobalt (Co) (dissolved)		NP		12	0.2		3	1.5	0.5	4.2	8.4	0.7	1.2	3.8	4.3	2.4	2.7					<0.2	1.9
18540-29-9	Chromium (VI) (Cr) (dissolved)	SP	H		12	5		3.4	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5					<5	<5
16065-83-1	Chromium (III) (Cr) (dissolved)	SP			12	5		4.7	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5					<5	<5
7440-47-3	Chromium (Cr) (total) (dissolved)				12	0.2		n/a	1.8	2.2	2.6	3.7	2.3	1.4	4.5	2.4	2.5	2.9					2	2.7
7440-50-8	Copper (Cu) (dissolved)	SP	NP		12	0.5		1	3.1	3.6	2.4	2.7	4	3	1.8	6.1	1.7	5.9					7.5	4.3
7439-89-6	Iron (Fe) (dissolved)	SP			12	4		1000	56	100	42	64	23	54	69	76	110	31					50	26
7439-97-6	Mercury (Hg) (dissolved)	PH	H		12	0.05		0.07	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05					0.49	<0.05
P1286	Manganese (Mn) (dissolved)	SP			12	0.05		123	710	140	670	830	50	290	1100	790	270	630					1.9	170
7440-23-5	Sodium (Na) (dissolved)				12	1		n/a	14000	34000	13000	11000	20000	10000	11000	16000	12000	10000					530000	120000
7440-02-0	Nickel (Ni) (dissolved)	P	NP		12	0.5		4	3.7	3.5	8.5	16	4.2	7.1	9	9.5	9.9	4.5					1	4.2
7439-92-1	Lead (Pb) (dissolved)	P	H		12	0.2		1.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	6.1	<0.2	<0.2					<0.2	<0.2
7440-36-0	Antimony (Sb) (dissolved)		NP		12	0.4		n/a	<0.4	0.9	<0.4	<0.4	<0.4	<0.4	0.7	<0.4	<0.4	0.5					2	0.8
7782-49-2	Selenium (Se) (dissolved)		NP		12	0.6		n/a	<0.6	8.4	<0.6	<0.6	1.7	<0.6	0.7	0.7	<0.6	0.7					4	0.7
7440-31-5	Tin (Sn) (dissolved)				12	0.2		25	<0.2	0.26	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.39	<0.2					<0.2	<0.2
7440-62-2	Vanadium (V) (dissolved)				12	0.2		20	<0.2	0.4	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2					2.6	0.4
7440-66-6	Zinc (Zn) (dissolved)	SP	NP		12	0.5		12.3	2	3.5	1	4.8	2.8	9.8	2.8	1.2	1.5	1.5					1.1	3.9
P1095	Cyanide (free) (hydrogen cyanide)	SP	NP		12	1		1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1					<1	<1
57-12-5	Cyanide (total)				12	1		n/a	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1					<1	<1
P1140	Ammonium (NH_4^+)		NP		12	15		n/a	690	47	1000	1800	35	5200	2400	1200	3700	3800					1000	220
P1238	Ammnoniacal Nitrogen (as N)		NP		12	15		300	540	36	810	1400	27	4000	1900	940	2900	3000					790	170
P1720	Ammonia (unionised) (NH_3 as N) {free ammonia}	SP	NP		12	15		n/a	650	44	980	1700	33	4900	2300	1100	3500	3600					950	210
15541-45-4	Bromate (BrO_3)				12	2		n/a	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2					<2	<2
16887-00-6	Chloride (Cl^-)				12	150		250000	9000	18000	12000	11000	9900	8400	9300	12000	9600	8100					460000	88000
16984-48-8	Fluoride (F^-)				12	50		1000	150	210	150	120	170	270	160	170	93	140					2100	310
P1348	Nitrate (NO_3^-)				12	50		n/a	310	2900	570	830	2070	260	520	520	780	780					410	520
P1349	Nitrite (NO_2^-)				12	5		n/a	37	530	<5	6	51	<5	<5	6.5	<5	<5					24	120
14808-79-8	Sulfate (SO_4^{2-})				12	45		400000	84200	87000	24100	20200	35700	5290	118000	22900	35800	6370					198000	131000
P1134	pH (min.) (su)				12	0		6	7.5	7.8	7.5	7.6	7.5	7.8	6.9	7.3	7.1	7.2					8.5	7.6
P1287	Electrical conductivity (µS/cm)				12	10		n/a	600	550	600	630	650	450	1100	710	810	700					2300	1000
120-12-7	Anthracene	PH	H	56	12	0.01		0.1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01					<0.01	<0.01
50-32-8	Benzo(a)pyrene	PH	H	3.8	12	0.01		0.00017	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01					<0.01	<0.01
206-44-0	Fluoranthene	P	H	230	12	0.01		0.0063	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01					<0.01	<0.01
91-20-3	Naphthalene	P	NP	19000	12	0.01		2	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01					<0.01	<0.01
GRP01	PAHs = sum of benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(ghi)perylene, indeno(1,2,3-cd)pyrene	P	H		12	0.04		n/a	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04					<0.04	<0.04
P1877	Phenol	SP	NP	84100000	12	1		7.7	<1	<1	<1	<1	<1	<1	<1	<1	<1	15					<1	<1
P1407	Ali EC5-EC6			35900	16	1		10	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
P1408	Ali >EC6-EC8			5370	16	1		10	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
P1409	Ali >EC8-EC10			427	16	1		10	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
P1410	Ali >EC10-EC12			33.9	16	10		10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	**320 ***	<10	<10	<10	<10	<10
P1411	Ali >EC12-EC16			0.759	16	10		10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	**3400 ***	<10	<10	<10	<10	<10
P1938	Ali >EC16-EC35			0.00254	16	10		10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	**4600 ***	<10	<10	<10	<10	<10
P1415	Ali >EC35-EC44			0.00254	16	10		10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
P1441	Aro EC5-EC7			1780000	16	1		10	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
P1355	Aro >EC7-EC8			590000	16	1		10	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
P1356	Aro >EC8-EC10			64600	16	1		10	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
P1357	Aro >EC10-EC12			24500	16	10		10	40	<10	33	35	<10	100	270	120	85	190	150	<10	<10	<10	<10	<10
P1358	Aro > EC12-EC16			5750	16	10		10	130	<10	240	320	<10	270	1100	590	800	870	970	<10	<10	<10	<10	<10
P1359	Aro >EC16-EC21			653	16	10		10	110	<10	370	380	<10	160	570	340	530	**720 ***	**1300 ***	<10	<10	<10	<10	<10
P1360	Aro >EC21-EC35			6.61	16	10		10	<10	<10	**90 ***	**170 ***	<10	<10	**290 ***	**68 ***	**140 ***	**68 ***	**170 ***	<10	<10	<10	<10	<10
P1362	Aro >EC35-EC44			6.61	16	10		10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
71-43-2	Benzene	P	H	1780000	16	1		10	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
108-88-3	Toluene	SP	H	590000	16	1		74	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
100-41-4	Ethylbenzene		H	180000	16	1		20	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
95-47-6	o-Xylene		H	173000	16	1		30	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
P1374	m,p-Xylene		H	200000	16	1		30	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
1634-04-04	Methyl tertiary butyl ether (MTBE)		NP	48000000	16	1		n/a	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
71-55-6	1,1,1-Trichloroethane		NP	1300000	7	1		100				<1	<1	<1	<1	<1	<1	<1						
79-00-5	1,1,2-Trichloroethane		NP	4490000	7	1		400				<1	<1	<1	<1	<1	<1	<1						
96-12-8	1,2-Dibromo-3-chloropropane			1230000	7	1		n/a				<1	<1	<1	<1	<1	<1	<1						
106-93-4	1,2-Dibromoethane		H	4300000	7	1		n/a				<1	<1	<1	<1	<1	<1	<1						
95-50-1	1,2-Dichlorobenzene		H	133000	7	1		20				<1	<1	<1	<1	<1	<1	<1						
107-06-2	1,2-Dichloroethane (EDC)	P	NP	8680000	7	1		10				<1	<1	<1	<1	<1	<1	<1						
156-59-2	cis 1,2-Dichloroethene (cis 1,2 DCE)		NP	7550000	7	1		n/a				<1	<1	<1	<1	<1	<1	<1						
156-60-5	trans 1,2-Dichloroethene (trans 1,2 DCE)		NP	5250000	7	1		n/a				<1	<1	<1	<1	<1	<1	<1						
78-87-5	1,2-Dichloropropane		H	2050000	7	1		n/a				<1	<1	<1	<1	<1	<1	<1						
10061-01-5	cis 1,3-Dichloropropene		H	2700000	7	1		n/a				<1	<1	<1	<1	<1	<1	<1						
10061-02-6	trans 1,3-Dichloropropene		H	2800000	7	1		n/a				<1	<1	<1	<1	<1	<1	<1						
106-46-7	1,4-Dichlorobenzene		H	103000	7	1		20				<1	<1	<1	<1	<1	<1	<1						
75-27-4	Bromodichloromethane			3000000	7	1		n/a				<1	<1	<1	<1	<1	<1	<1						
75-01-4	Chloroethene (vinyl chloride)		H	2760000	7	1		n/a				<1	<1	<1	<1	<1	<1	<1						
124-48-1	Dibromochloromethane			1050000	7	1		n/a				<1	<1	<1	<1	<1	<1	<1						
25321-22-6	Dichlorobenzenes (1,2-, 1,3- & 1,4-)				7	1		20				<1	<1	<1	<1	<1	<1	<1						
75-09-2	Dichloromethane	P	NP	20100000	7	1		20				<1	<1	<1	<1	<1	<1	<1						
87-68-3	Hexachlorobutadiene (HCBD)	PH	H	4800	7	1		0.6				<1	<1	<1	<1	<1	<1	<1						
100-42-5	Styrene		H	290000	7	1		50				<1	<1	<1	<1	<1	<1	<1						
127-18-4	Tetrachloroethene (PCE)	OP	NP	225000	7	1		10				<1	<1	<1	<1	<1	<1	<1						
GRP02	Tetrachloroethene (PCE) and trichloroethene (TCE)				7	1		n/a				<1	<1	<1	<1	<1	<1	<1						
56-23-5	Tetrachloromethane (Carbon Tetrachloride)	OP	H	846000	7	1		12				<1	<1	<1	<1	<1	<1	<1						
75-25-2	Tribromomethane (bromoform)			3000000	7	1		n/a				<1	<1	<1	<1	<1	<1	<1						
12002-48-1	Trichlorobenzenes	P	NP		7	1		0.4				<1	<1	<1	<1	<1	<1	<1						
79-01-6	Trichloroethene	OP	H	1370000	7	1		10				<1	<1	<1	<1	<1	<1	<1						
67-66-3	Trichloromethane (chloroform)	P	H	8950000	7	1		2.5				<1	<1	<1	<1	<1	<1	<1						

Remedial Targets Methodology Data Table

Water body receptor(s): Groundwater and surface water
Secondary receptor(s): 0
Data set: Groundwater (Round 3 - Hydrock 2022)
Client: Eutpia Homes Ltd.
Site: Great Western Road Yard
Job no: 20775
Test Certificates(s): Multiple
Dataset ALL ZONES

🟩 PNEC calculated (inland EQS)

123* Exceeds solubility value
<1 Grey text and "<" sign if value <= LoD
🟧 Red fill if value > Inland Waters EQS

Surface Water Representative Hardness as mg/l $CaCO_3$ 10

								Strata / Zone	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	DEEP	DEEP
								Date sampled:	16/03/2022	16/03/2022	16/03/2022	16/03/2022	16/03/2022	16/03/2022	16/03/2022	16/03/2022	16/03/2022	16/03/2022	21/03/2022	21/03/2022	21/03/2022	21/03/2022	16/03/2022	16/03/2022
CAS / AGS Number	**Chemical of Potential Concern (µg/l)**	**WFD Designation**	**Hazardous Substance Status**	**Solubility Limit (µg/l)**	**No. of samples**	**Limit of Detection**		**Inland Waters EQS**	**WS101**	**BH202**	**BH203**	**BH204S**	**BH205**	**BH206**	**WS203**	**WS204**	**WS205**	**WS206**	**WS103**	**WS105**	**WS107**	**WS116**	**BH201**	**BH204D**
GRP03	Trihalomethanes, sum of trichloromethane, tribromomethane, dibromchloromethane & bromodichloromethane				7	4		n/a				<4	<4	<4	<4	<4	<4	<4						
88-06-2	2.4.6-Trichlorophenol		H	434000	1	0.05		n/a							<0.05									
120-83-2	2.4-Dichlorophenol	SP	H	4500000	1	0.05		4.2							<0.05									
95-57-8	2-Chlorophenol		H	22700000	1	0.05		50							<0.05									
59-50-7	4-Chloro, 3-methylphenol		H		1	0.05		40							<0.05									
85-68-7	Benzyl butyl phthalate	SP			1	0.05		7.5							<0.05									
84-74-2	Dibutyl phthalate		NP		1	0.05		8							<0.05									
84-66-2	Diethyl phthalate (DEP)				1	0.05		200							<0.05									
131-11-3	Dimethyl phthalate (DMP)				1	0.05		800							<0.05									
118-74-1	Hexachlorobenzene	PH	H	9.6	1	0.05		0.05							<0.05									
1336-36-3	Polychlorinated Biphenyls (PCB)		H		1	0.14		n/a							<0.14									

Summary of Remedial Targets Methodology Screening

Hydrock Scenario: Scenario B - EQS (inland)
RTM Level: RTM Level 2 - Groundwater Beneath Source Assessment - groundwater samples
Water body receptor(s): Groundwater and surface water
Secondary receptor(s):
Data set: Groundwater (Round 3 - Hydrock 2022)
Client: Eutopia Homes Ltd.
Site: Great Western Road Yard
Job no: 20775
Test Certificates(s): Multiple
Dataset DEEP

PNEC calculated (inland EQS)

2013/39/EU Annex I
P = priority substance
PH = priority hazardous substances.
WFD Designation (2015 Directions)
OP = Other substance identical to previous legislation
SP = Specific Pollutant
JAGDAG Hazardous Substances Determination (UK)

H	Hazardous substance
NP	Non-hazardous pollutant
(blank)	Not included in assessment

CAS / AGS Number	Chemicals of Potential Concern (concentrations in µg/l)	WFD Designation	Hazardous Substance Status	Summary of Sample Data: No. of Samples	No. of Samples > LoD	Limit of Detection	Minimum Value	Maximum Value	95-%ile Value	Value Being Compared to Target = Maximum Value	Water Quality Target (Exceeded if Red) Inland Waters EQS	No. Samples Exceeding Water Quality Target Inland Waters EQS	No. Samples above LoD Exceeding Water Inland Waters EQS	Notes EQS compared to dissolved metals as an initial screen, with no adjustment for bioavailability or ABC.
P1133	Hardness as mg/l $CaCO_3$			-	-	-	10	-	-	-	-			Representative hardness of receiving surface water environment used in some inland EQS
7440-22-4	Silver (Ag) (dissolved)			2	0	0.05	<0.05	<0.05	<0.05	<0.05	0.05	0	0	
7429-90-5	Aluminium (Al) (dissolved)			2	2	1	1.8	2.3	2.275	2.3	n/a			
7440-38-2	Arsenic (As) (dissolved)	SP	**H**	2	2	0.15	0.85	11.3	10.7775	11.3	50	0	0	
7440-42-8	Boron (B) (dissolved)		NP	2	2	10	700	2200	2125	2200	2000	1	1	
7440-39-3	Barium (Ba) (dissolved)			2	2	0.06	13	43	41.5	43	n/a			
7440-43-9	Cadmium (Cd) (dissolved)	**PH**	NP	2	2	0.02	0.03	0.13	0.125	0.13	0.08	1	1	EQS (inland) dependent on hardness of receiving surface water environment
7440-48-4	Cobalt (Co) (dissolved)		NP	2	1	0.2	<0.2	1.9	1.815	1.9	3	0	0	
18540-29-9	Chromium (VI) (Cr) (dissolved)	SP	**H**	2	0	5	<5	<5	<5	<5	3.4	2	0	
16065-83-1	Chromium (III) (Cr) (dissolved)	SP		2	0	5	<5	<5	<5	<5	4.7	2	0	
7440-47-3	Chromium (Cr) (total) (dissolved)			2	2	0.2	2	2.7	2.665	2.7	n/a			
7440-50-8	Copper (Cu) (dissolved)	SP	NP	2	2	0.5	4.3	7.5	7.34	7.5	1	2	2	Bioavailable EQS (inland)
7439-89-6	Iron (Fe) (dissolved)	SP		2	2	4	26	50	48.8	50	1000	0	0	
7439-97-6	Mercury (Hg) (dissolved)	**PH**	**H**	2	1	0.05	<0.05	0.49	0.468	0.49	0.07	1	1	
P1286	Manganese (Mn) (dissolved)	SP		2	2	0.05	1.9	170	161.595	170	123	1	1	Bioavailable EQS (inland)
7440-23-5	Sodium (Na) (dissolved)			2	2	1	120000	530000	509500	530000	n/a			
7440-02-0	Nickel (Ni) (dissolved)	***P***	NP	2	2	0.5	1	4.2	4.04	4.2	4	1	1	Bioavailable EQS (inland)
7439-92-1	Lead (Pb) (dissolved)	***P***	**H**	2	0	0.2	<0.2	<0.2	<0.2	<0.2	1.2	0	0	Bioavailable EQS (inland)
7440-36-0	Antimony (Sb) (dissolved)		NP	2	2	0.4	0.8	2	1.94	2	n/a			
7782-49-2	Selenium (Se) (dissolved)		NP	2	2	0.6	0.7	4	3.835	4	n/a			
7440-31-5	Tin (Sn) (dissolved)			2	0	0.2	<0.2	<0.2	<0.2	<0.2	25	0	0	
7440-62-2	Vanadium (V) (dissolved)			2	2	0.2	0.4	2.6	2.49	2.6	20	0	0	EQS (inland) dependent on hardness of receiving surface water environment
7440-66-6	Zinc (Zn) (dissolved)	SP	NP	2	2	0.5	1.1	3.9	3.76	3.9	12.3	0	0	Bioavailable EQS (inland) + ambient background concentration (ABC)
P1095	Cyanide (free) (hydrogen cyanide)	SP	NP	2	0	1	<1	<1	<1	<1	1	0	0	
57-12-5	Cyanide (total)			2	0	1	<1	<1	<1	<1	n/a			
P1140	Ammonium (NH_4^+)		NP	2	2	15	220	1000	961	1000	n/a			
P1238	Ammnoniacal Nitrogen (as N)		NP	2	2	15	170	790	759	790	300	1	1	
P1720	Ammonia (unionised) (NH_3 as N) {free ammonia}	SP	NP	2	2	15	210	950	913	950	n/a			
15541-45-4	Bromate (BrO_3)			2	0	2	<2	<2	<2	<2	n/a			
16887-00-6	Chloride (Cl^-)			2	2	150	88000	460000	441400	460000	250000	1	1	
16984-48-8	Fluoride (F^-)			2	2	50	310	2100	2010.5	2100	1000	1	1	EQS (inland) dependent on hardness of receiving surface water environment
P1348	Nitrate (NO_3^-)			2	2	50	410	520	514.5	520	n/a			
P1349	Nitrite (NO_2^-)			2	2	5	24	120	115.2	120	n/a			
14808-79-8	Sulfate (SO_4^{2-})			2	2	45	131000	198000	194650	198000	400000	0	0	
P1134	pH (min.) (su)			2	2	0	7.6	8.5	8.455	8.5	6	0	0	
P1287	Electrical conductivity (µS/cm)			2	2	10	1000	2300	2235	2300	n/a			
120-12-7	Anthracene	***PH***	**H**	2	0	0.01	<0.01	<0.01	<0.01	<0.01	0.1	0	0	
50-32-8	Benzo(a)pyrene	***PH***	H	2	0	0.01	<0.01	<0.01	<0.01	<0.01	0.00017	2	0	Benzo(a)pyrene EQS used as marker substance for the group of benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene & indeno (1,2,3-cd)pyrene
206-44-0	Fluoranthene	***P***	**H**	2	0	0.01	<0.01	<0.01	<0.01	<0.01	0.0063	2	0	
91-20-3	Naphthalene	P	NP	2	0	0.01	<0.01	<0.01	<0.01	<0.01	2	0	0	
GRP01	PAHs = sum of benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(ghi)perylene, indeno(1,2,3-cd)pyrene	***P***	**H**	2	0	0.04	<0.04	<0.04	<0.04	<0.04	n/a			
P1877	Phenol	SP	**NP**	2	0	1	<1	<1	<1	<1	7.7	0	0	
P1407	Ali EC5-EC6			2	0	1	<1	<1	<1	<1	10	0	0	n-hexane fall within this fraction
P1408	Ali >EC6-EC8			2	0	1	<1	<1	<1	<1	10	0	0	n-heptane falls within this fraction
P1409	Ali >EC8-EC10			2	0	1	<1	<1	<1	<1	10	0	0	n-octane and n-nonane fall within this fraction
P1410	Ali >EC10-EC12			2	0	10	<10	<10	<10	<10	10	0	0	
P1411	Ali >EC12-EC16			2	0	10	<10	<10	<10	<10	10	0	0	
P1938	Ali >EC16-EC35			2	0	10	<10	<10	<10	<10	10	0	0	
P1415	Ali >EC35-EC44			2	0	10	<10	<10	<10	<10	10	0	0	
P1441	Aro EC5-EC7			2	0	1	<1	<1	<1	<1	10	0	0	Benzene wholly representative of this fraction
P1355	Aro >EC7-EC8			2	0	1	<1	<1	<1	<1	10	0	0	Toluene wholly representative of this fraction
P1356	Aro >EC8-EC10			2	0	1	<1	<1	<1	<1	10	0	0	Ethylbenzene / xylene / trimethylbenzene representative of this range
P1357	Aro >EC10-EC12			2	0	10	<10	<10	<10	<10	10	0	0	Naphthalene often forms a reasonable percentage of this fraction
P1358	Aro > EC12-EC16			2	0	10	<10	<10	<10	<10	10	0	0	2-methylnaphthalene, acenpthylene, acenapthene falls within this fraction
P1359	Aro >EC16-EC21			2	0	10	<10	<10	<10	<10	10	0	0	fluorene, anthracene, phenanthrene, pyrene falls within this range
P1360	Aro >EC21-EC35			2	0	10	<10	<10	<10	<10	10	0	0	Benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(ghi)perylene, indeno(cd)pyrene fall within this fraction
P1362	Aro >EC35-EC44			2	0	10	<10	<10	<10	<10	10	0	0	
71-43-2	Benzene	P	**H**	2	0	1	<1	<1	<1	<1	10	0	0	
108-88-3	Toluene	SP	**H**	2	0	1	<1	<1	<1	<1	74	0	0	

Summary of Remedial Targets Methodology Screening

RTM Level: RTM Level 2 - Groundwater Beneath Source Assessment - groundwater samples
Water body receptor(s): Groundwater and surface water
Secondary receptor(s):
Data set: Groundwater (Round 3 - Hydrock 2022)
Client: Eutpia Homes Ltd.
Site: Great Western Road Yard
Job no: 20775
Test Certificates(s): Multiple
Dataset DEEP

	PNEC calculated (inland EQS)

P = priority substance
PH = priority hazardous substances.

WFD Designation (2015 Directions)
OP = Other substance identical to previous legislation
SP = Specific Pollutant

JAGDAG Hazardous Substances Determination (UK)

H	Hazardous substance
NP	Non-hazardous pollutant
(blank)	Not included in assessment

CAS / AGS Number	Chemicals of Potential Concern (concentrations in µg/l)	WFD Designation	Hazardous Substance Status	Summary of Sample Data						Value Being Compared to Target = Maximum Value	Water Quality Target (Exceeded if Red		No. Samples Exceeding Water Quality Target		No. Samples above LoD Exceeding Water		Notes
				No. of Samples	No. of Samples > LoD	Limit of Detection	Minimum Value	Maximum Value	95-%ile Value			Inland Waters EQS		Inland Waters EQS		Inland Waters EQS	EQS compared to dissolved metals as an initial screen, with no adjustment for bioavailability or ABC.
100-41-4	Ethylbenzene		**H**	2	0	1	<1	<1	<1	<1		20		0		0	Proposed EQS for Ethylbenzene in Water, R&D Technical Report P2-115/TR4. EA 2001
95-47-6	o-Xylene		**H**	2	0	1	<1	<1	<1	<1		30		0		0	EQS for total xylene
P1374	m,p-Xylene		**H**	2	0	1	<1	<1	<1	<1		30		0		0	EQS for total xylene
1634-04-04	Methyl tertiary butyl ether (MTBE)		**NP**	2	0	1	<1	<1	<1	<1		n/a					

Summary of Remedial Targets Methodology Screening

Hydrock Scenario: Scenario B - EQS (inland)
RTM Level: RTM Level 2 - Groundwater Beneath Source Assessment - groundwater samples
Water body receptor(s): Groundwater and surface water
Secondary receptor(s):
Data set: Groundwater (Round 3 - Hydrock 2022)
Client: Eutpia Homes Ltd.
Site: Great Western Road Yard
Job no: 20775
Test Certificates(s): Multiple
Dataset SHALLOW

▨	PNEC calculated (inland EQS)

2013/39/EU Annex I	
P = priority substance	
PH = priority hazardous substances.	
WFD Designation (2015 Directions)	
OP = Other substance identical to previous legislation	
SP = Specific Pollutant	
JAGDAG Hazardous Substances Determination (UK)	
H	Hazardous substance
NP	Non-hazardous pollutant
(blank)	Not included in assessment

CAS / AGS Number	Chemicals of Potential Concern (concentrations in µg/l)	WFD Designation	Hazardous Substance Status	Summary of Sample Data						Value Being Compared to Target = Maximum Value	Water Quality Target (Exceeded if Red)		No. Samples Exceeding Water Quality Target		No. Samples above LoD Exceeding Water		Notes
				No. of Samples	No. of Samples > LoD	Limit of Detection	Minimum Value	Maximum Value	95-%ile Value			Inland Waters EQS		Inland Waters EQS		Inland Waters EQS	EQS compared to dissolved metals as an initial screen, with no adjustment for bioavailability or ABC.
P1133	Hardness as mg/l $CaCO_3$			-	-	-	10	-	-	-		-					Representative hardness of receiving surface water environment used in some inland EQS
7440-22-4	Silver (Ag) (dissolved)			10	0	0.05	<0.05	<0.05	<0.05	<0.05		0.05		0		0	
7429-90-5	Aluminium (Al) (dissolved)			10	7	1	<1	2.3	2.255	2.3		n/a					
7440-38-2	Arsenic (As) (dissolved)	SP	**H**	10	10	0.15	0.31	7.58	6.5405	7.58		50		0		0	
7440-42-8	Boron (B) (dissolved)		NP	10	10	10	87	650	596	650		2000		0		0	
7440-39-3	Barium (Ba) (dissolved)			10	10	0.06	42	200	186.5	200		n/a					
7440-43-9	Cadmium (Cd) (dissolved)	**PH**	NP	10	4	0.02	<0.02	0.05	0.05	0.05		0.08		0		0	EQS (inland) dependent on hardness of receiving surface water environment
7440-48-4	Cobalt (Co) (dissolved)		NP	10	10	0.2	0.5	8.4	6.555	8.4		3		4		4	
18540-29-9	Chromium (VI) (Cr) (dissolved)	SP	**H**	10	0	5	<5	<5	<5	<5		3.4		10		0	
16065-83-1	Chromium (III) (Cr) (dissolved)	SP		10	0	5	<5	<5	<5	<5		4.7		10		0	
7440-47-3	Chromium (Cr) (total) (dissolved)			10	10	0.2	1.4	4.5	4.14	4.5		n/a					
7440-50-8	Copper (Cu) (dissolved)	SP	NP	10	10	0.5	1.7	6.1	6.01	6.1		1		10		10	Bioavailable EQS (inland)
7439-89-6	Iron (Fe) (dissolved)	SP		10	10	4	23	110	105.5	110		1000		0		0	
7439-97-6	Mercury (Hg) (dissolved)	**PH**	**H**	10	0	0.05	<0.05	<0.05	<0.05	<0.05		0.07		0		0	
P1286	Manganese (Mn) (dissolved)	SP		10	10	0.05	50	1100	978.5	1100		123		9		9	Bioavailable EQS (inland)
7440-23-5	Sodium (Na) (dissolved)			10	10	1	10000	34000	27700	34000		n/a					
7440-02-0	Nickel (Ni) (dissolved)	***P***	NP	10	10	0.5	3.5	16	13.255	16		4		8		8	Bioavailable EQS (inland)
7439-92-1	Lead (Pb) (dissolved)	***P***	**H**	10	1	0.2	<0.2	6.1	3.445	6.1		1.2		1		1	Bioavailable EQS (inland)
7440-36-0	Antimony (Sb) (dissolved)		NP	10	3	0.4	<0.4	0.9	0.81	0.9		n/a					
7782-49-2	Selenium (Se) (dissolved)		NP	10	5	0.6	<0.6	8.4	5.385	8.4		n/a					
7440-31-5	Tin (Sn) (dissolved)			10	2	0.2	<0.2	0.39	0.3315	0.39		25		0		0	
7440-62-2	Vanadium (V) (dissolved)			10	1	0.2	<0.2	0.4	0.31	0.4		20		0		0	EQS (inland) dependent on hardness of receiving surface water environment
7440-66-6	Zinc (Zn) (dissolved)	SP	NP	10	10	0.5	1	9.8	7.55	9.8		12.3		0		0	Bioavailable EQS (inland) + ambient background concentration (ABC)
P1095	Cyanide (free) (hydrogen cyanide)	SP	NP	10	0	1	<1	<1	<1	<1		1		0		0	
57-12-5	Cyanide (total)			10	0	1	<1	<1	<1	<1		n/a					
P1140	Ammonium (NH_4^+)		NP	10	10	15	35	5200	4570	5200		n/a					
P1238	Ammnoniacal Nitrogen (as N)		NP	10	10	15	27	4000	3550	4000		300		8		8	
P1720	Ammonia (unionised) (NH_3 as N) {free ammonia}	SP	NP	10	10	15	33	4900	4315	4900		n/a					
15541-45-4	Bromate (BrO_3)			10	0	2	<2	<2	<2	<2		n/a					
16887-00-6	Chloride (Cl^-)			10	10	150	8100	18000	15300	18000		250000		0		0	
16984-48-8	Fluoride (F^-)			10	10	50	93	270	243	270		1000		0		0	EQS (inland) dependent on hardness of receiving surface water environment
P1348	Nitrate (NO_3^-)			10	10	50	260	2900	2526.5	2900		n/a					
P1349	Nitrite (NO_2^-)			10	5	5	<5	530	314.45	530		n/a					
14808-79-8	Sulfate (SO_4^{2-})			10	10	45	5290	118000	104050	118000		400000		0		0	
P1134	pH (min.) (su)			10	10	0	6.9	7.8	7.8	7.8		6		0		0	
P1287	Electrical conductivity (µS/cm)			10	10	10	450	1100	969.5	1100		n/a					
120-12-7	Anthracene	***PH***	**H**	10	0	0.01	<0.01	<0.01	<0.01	<0.01		0.1		0		0	
50-32-8	Benzo(a)pyrene	***PH***	H	10	0	0.01	<0.01	<0.01	<0.01	<0.01		0.00017		10		0	Benzo(a)pyrene EQS used as marker substance for the group of benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene & indeno (1,2,3-cd)pyrene
206-44-0	Fluoranthene	***P***	**H**	10	0	0.01	<0.01	<0.01	<0.01	<0.01		0.0063		10		0	
91-20-3	Naphthalene	P	NP	10	0	0.01	<0.01	<0.01	<0.01	<0.01		2		0		0	
GRP01	PAHs = sum of benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(ghi)perylene, indeno(1,2,3-cd)pyrene	***P***	**H**	10	0	0.04	<0.04	<0.04	<0.04	<0.04		n/a					
P1877	Phenol	SP	**NP**	10	1	1	<1	15	8.7	15		7.7		1		1	
P1407	Ali EC5-EC6			14	0	1	<1	<1	<1	<1		10		0		0	n-hexane fall within this fraction
P1408	Ali >EC6-EC8			14	0	1	<1	<1	<1	<1		10		0		0	n-heptane falls within this fraction
P1409	Ali >EC8-EC10			14	0	1	<1	<1	<1	<1		10		0		0	n-octane and n-nonane fall within this fraction
P1410	Ali >EC10-EC12			14	1	10	<10	320	118.5	320		10		1		1	
P1411	Ali >EC12-EC16			14	1	10	<10	3400	1196.5	3400		10		1		1	
P1938	Ali >EC16-EC35			14	1	10	<10	4600	1616.5	4600		10		1		1	
P1415	Ali >EC35-EC44			14	0	10	<10	<10	<10	<10		10		0		0	
P1441	Aro EC5-EC7			14	0	1	<1	<1	<1	<1		10		0		0	Benzene wholly representative of this fraction
P1355	Aro >EC7-EC8			14	0	1	<1	<1	<1	<1		10		0		0	Toluene wholly representative of this fraction
P1356	Aro >EC8-EC10			14	0	1	<1	<1	<1	<1		10		0		0	Ethylbenzene / xylene / trimethylbenzene representative of this range
P1357	Aro >EC10-EC12			14	9	10	<10	270	218	270		10		9		9	Naphthalene often forms a reasonable percentage of this fraction
P1358	Aro > EC12-EC16			14	9	10	<10	1100	1015.5	1100		10		9		9	2-methylnaphthalene, acenpthylene, acenapthene falls within this fraction
P1359	Aro >EC16-EC21			14	9	10	<10	1300	923	1300		10		9		9	fluorene, anthracene, phenanthrene, pyrene falls within this range
P1360	Aro >EC21-EC35			14	7	10	<10	290	212	290		10		7		7	Benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(ghi)perylene, indeno(cd)pyrene fall within this fraction
P1362	Aro >EC35-EC44			14	0	10	<10	<10	<10	<10		10		0		0	
71-43-2	Benzene	P	**H**	14	0	1	<1	<1	<1	<1		10		0		0	
108-88-3	Toluene	SP	**H**	14	0	1	<1	<1	<1	<1		74		0		0	

Summary of Remedial Targets Methodology Screening

RTM Level: RTM Level 2 - Groundwater Beneath Source Assessment - groundwater samples
Water body receptor(s): Groundwater and surface water
Secondary receptor(s):
Data set: Groundwater (Round 3 - Hydrock 2022)
Client: Eutpia Homes Ltd.
Site: Great Western Road Yard
Job no: 20775
Test Certificates(s): Multiple
Dataset SHALLOW

🟩 PNEC calculated (inland EQS)

P = priority substance
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WFD Designation (2015 Directions)
OP = Other substance identical to previous legislation
SP = Specific Pollutant

JAGDAG Hazardous Substances Determination (UK)

H	Hazardous substance
NP	Non-hazardous pollutant
(blank)	Not included in assessment

CAS / AGS Number	Chemicals of Potential Concern (concentrations in µg/l)	WFD Designation	Hazardous Substance Status	Summary of Sample Data						Value Being Compared to Target = Maximum Value	Water Quality Target (Exceeded if Red		No. Samples Exceeding Water Quality Target		No. Samples above LoD Exceeding Water		Notes
				No. of Samples	No. of Samples > LoD	Limit of Detection	Minimum Value	Maximum Value	95-%ile Value			Inland Waters EQS		Inland Waters EQS		Inland Waters EQS	EQS compared to dissolved metals as an initial screen, with no adjustment for bioavailability or ABC.
100-41-4	Ethylbenzene		**H**	14	0	1	<1	<1	<1	<1		20		0		0	Proposed EQS for Ethylbenzene in Water, R&D Technical Report P2-115/TR4. EA 2001
95-47-6	o-Xylene		**H**	14	0	1	<1	<1	<1	<1		30		0		0	EQS for total xylene
P1374	m,p-Xylene		**H**	14	0	1	<1	<1	<1	<1		30		0		0	EQS for total xylene
1634-04-04	Methyl tertiary butyl ether (MTBE)		**NP**	14	0	1	<1	<1	<1	<1		n/a					
71-55-6	1,1,1-Trichloroethane		**NP**	7	0	1	<1	<1	<1	<1		100		0		0	
79-00-5	1,1,2-Trichloroethane		**NP**	7	0	1	<1	<1	<1	<1		400		0		0	
96-12-8	1,2-Dibromo-3-chloropropane			7	0	1	<1	<1	<1	<1		n/a					
106-93-4	1,2-Dibromoethane		**H**	7	0	1	<1	<1	<1	<1		n/a					
95-50-1	1,2-Dichlorobenzene		**H**	7	0	1	<1	<1	<1	<1		20		0		0	
107-06-2	1,2-Dichloroethane (EDC)	P	**NP**	7	0	1	<1	<1	<1	<1		10		0		0	
156-59-2	cis 1,2-Dichloroethene (cis 1,2 DCE)		**NP**	7	0	1	<1	<1	<1	<1		n/a					
156-60-5	trans 1,2-Dichloroethene (trans 1,2 DCE)		**NP**	7	0	1	<1	<1	<1	<1		n/a					
78-87-5	1,2-Dichloropropane		**H**	7	0	1	<1	<1	<1	<1		n/a					
10061-01-5	cis 1,3-Dichloropropene		**H**	7	0	1	<1	<1	<1	<1		n/a					
10061-02-6	trans 1,3-Dichloropropene		**H**	7	0	1	<1	<1	<1	<1		n/a					
106-46-7	1,4-Dichlorobenzene		**H**	7	0	1	<1	<1	<1	<1		20		0		0	
75-27-4	Bromodichloromethane			7	0	1	<1	<1	<1	<1		n/a					
75-01-4	Chloroethene (vinyl chloride)		**H**	7	0	1	<1	<1	<1	<1		n/a					
124-48-1	Dibromochloromethane			7	0	1	<1	<1	<1	<1		n/a					
25321-22-6	Dichlorobenzenes (1,2-, 1,3- & 1,4-)			7	0	1	<1	<1	<1	<1		20		0		0	
75-09-2	Dichloromethane	P	**NP**	7	0	1	<1	<1	<1	<1		20		0		0	
87-68-3	Hexachlorobutadiene (HCBD)	PH	**H**	7	0	1	<1	<1	<1	<1		0.6		7		0	
100-42-5	Styrene		**H**	7	0	1	<1	<1	<1	<1		50		0		0	
127-18-4	Tetrachloroethene (PCE)	OP	**NP**	7	0	1	<1	<1	<1	<1		10		0		0	
GRP02	Tetrachloroethene (PCE) and trichloroethene (TCE)			7	0	1	<1	<1	<1	<1		n/a					
56-23-5	Tetrachloromethane (Carbon Tetrachloride)	OP	**H**	7	0	1	<1	<1	<1	<1		12		0		0	
75-25-2	Tribromomethane (bromoform)			7	0	1	<1	<1	<1	<1		n/a					
12002-48-1	Trichlorobenzenes	P	**NP**	7	0	1	<1	<1	<1	<1		0.4		7		0	
79-01-6	Trichloroethene	OP	**H**	7	0	1	<1	<1	<1	<1		10		0		0	
67-66-3	Trichloromethane (chloroform)	P	**H**	7	0	1	<1	<1	<1	<1		2.5		0		0	
GRP03	Trihalomethanes, sum of trichloromethane, tribromomethane, dibromchloromethane & bromodichloromethane			7	0	4	<4	<4	<4	<4		n/a					
88-06-2	2,4,6-Trichlorophenol		**H**	1	0	0.05	<0.05	<0.05	<0.05	<0.05		n/a					
120-83-2	2,4-Dichlorophenol	SP	**H**	1	0	0.05	<0.05	<0.05	<0.05	<0.05		4.2		0		0	
95-57-8	2-Chlorophenol		**H**	1	0	0.05	<0.05	<0.05	<0.05	<0.05		50		0		0	
59-50-7	4-Chloro, 3-methylphenol		**H**	1	0	0.05	<0.05	<0.05	<0.05	<0.05		40		0		0	
85-68-7	Benzyl butyl phthalate	SP		1	0	0.05	<0.05	<0.05	<0.05	<0.05		7.5		0		0	
84-74-2	Dibutyl phthalate		**NP**	1	0	0.05	<0.05	<0.05	<0.05	<0.05		8		0		0	
84-66-2	Diethyl phthalate (DEP)			1	0	0.05	<0.05	<0.05	<0.05	<0.05		200		0		0	
131-11-3	Dimethyl phthalate (DMP)			1	0	0.05	<0.05	<0.05	<0.05	<0.05		800		0		0	
118-74-1	Hexachlorobenzene	PH	**H**	1	0	0.05	<0.05	<0.05	<0.05	<0.05		0.05		0		0	
1336-36-3	Polychlorinated Biphenyls (PCB)		**H**	1	0	0.14	<0.14	<0.14	<0.14	<0.14		n/a					

Remedial Targets Methodology Data Table

Hydrock Scenario: Scenario B - EQS (inland)
RTM Level: RTM Level 2 - Groundwater Beneath Source Assessment - groundwater samples

Water body receptor(s): Groundwater and surface water
Secondary receptor(s): 0
Data set: Groundwater (Round 4 - Hydrock 2022)
Client: Eutpia Homes Ltd.
Site: Great Western Road Yard
Job no: 20775
Test Certificates(s): Multiple
Dataset ALL ZONES

▨ PNEC calculated (inland EQS)
123* Exceeds solubility value
<1 Grey text and "<" sign if value <= LoD
🟧 Red fill if value > Inland Waters EQS

Surface Water Representative Hardness as mg/l CaCO₃ 10

								Strata / Zone	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	DEEP	DEEP	DEEP
								Date sampled:	04/05/2022	04/05/2022	04/05/2022	05/05/2022	05/05/2022	05/05/2022	04/05/2022	06/05/2022	06/05/2022	06/05/2022	06/05/2022	05/05/2022	04/05/2022	04/05/2022	04/05/2022	04/05/2022	05/05/2022	04/05/2022	04/05/2022	04/05/2022	05/05/2022	05/05/2022	05/05/2022	04/05/2022
CAS / AGS Number	Chemical of Potential Concern (µg/l)	WFD Designation	Hazardous Substance Status	Solubility Limit (µg/l)	No. of samples	Limit of Detection		Inland Waters EQS	BH101S	BH102	WS101	WS103	WS104	WS105	WS107	WS109	WS110	WS111	WS114	WS116	BH202	BH203	BH204S	BH205	BH206	WS203	WS204	WS205	WS206	BH101D	BH201	BH204D
P1348	Nitrate (NO₃⁻)				9	50		n/a	410		570	360		4350	410			46600		1760	260	470										
P1349	Nitrite (NO₂⁻)				9	5		n/a	<5		52	<5		<5	40			<5		28	<5	<5										
14808-79-8	Sulfate (SO₄²⁻)				9	45		400000	96800		101000	21500		37700	31900			82500		32600	21500	44400										
P1134	pH (min.) (su)				9	0		6	7		7.1	7.2		7.1	6.9			7.4		7.2	7.5	7.5										
P1134	pH (max.) (su)				9	0		9	7		7.1	7.2		7.1	6.9			7.4		7.2	7.5	7.5										
P1287	Electrical conductivity (uS/cm)				9	10		n/a	810		620	600		610	590			780		590	380	620										
120-12-7	Anthracene	PH	H	56	24	0.01		0.1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
50-32-8	Benzo(a)pyrene	PH	H	3.8	24	0.01		0.00017	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
206-44-0	Fluoranthene	P	H	230	24	0.01		0.0063	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
91-20-3	Naphthalene	P	NP	19000	24	0.01		2	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
GRP01	PAHs = sum of benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(ghi)perylene, indeno(1,2,3-cd)pyrene	P	H		24	0.04		n/a	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
P1877	Phenol	SP	NP	84100000	24	0.05		7.7	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
P1407	Ali EC5-EC6			35900	24	1		10	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
P1408	Ali >EC6-EC8			5370	24	1		10	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
P1409	Ali >EC8-EC10			427	24	1		10	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
P1410	Ali >EC10-EC12			33.9	24	10		10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
P1411	Ali >EC12-EC16			0.759	24	10		10	<10	<10	<10	140 *	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	540 *	790 *	1300 *	290 *	<10	<10	<10
P1938	Ali >EC16-EC35			0.00254	24	10		10	<10	<10	<10	510 *	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	630 *	1000 *	2500 *	470 *	<10	<10	<10
P1415	Ali >EC35-EC44			0.00254	24	10		10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
P1441	Aro EC5-EC7			1780000	24	1		10	<1	<1	<1	38	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
P1355	Aro >EC7-EC8			590000	24	1		10	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
P1356	Aro >EC8-EC10			64600	24	1		10	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
P1357	Aro >EC10-EC12			24500	24	10		10	<10	<10	29	53	<10	<10	<10	<10	<10	<10	<10	<10	<10	37	52	<10	39	280	210	130	100	<10	<10	<10
P1358	Aro > EC12-EC16			5750	24	10		10	<10	<10	95	240	<10	<10	<10	<10	<10	<10	<10	<10	<10	99	140	<10	110	430	360	380	330	<10	<10	<10
P1359	Aro >EC16-EC21			653	24	10		10	<10	<10	25	170	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	130	<10	66	350	540	520	340	<10	<10	<10
P1360	Aro >EC21-EC35			6.61	24	10		10	<10	<10	<10	28 *	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	11 *	45 *	170 *	<10	83 *	<10	<10	<10
P1362	Aro >EC35-EC44			6.61	24	10		10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
71-43-2	Benzene	P	H	1780000	24	1		10	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
108-88-3	Toluene	SP	H	590000	24	1		74	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
100-41-4	Ethylbenzene		H	180000	24	1		20	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
95-47-6	o-Xylene		H	173000	24	1		30	<1	<1	<1	7110	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
P1374	m,p-Xylene		H	200000	24	1		30	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
1634-04-04	Methyl tertiary butyl ether (MTBE)		NP	48000000	24	1		n/a	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
88-06-2	2,4,6-Trichlorophenol		H	434000	24	0.05		n/a	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
120-83-2	2,4-Dichlorophenol	SP	H	4500000	24	0.05		4.2	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
95-57-8	2-Chlorophenol		H	22700000	24	0.05		50	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
59-50-7	4-Chloro, 3-methylphenol		H		24	0.05		40	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
85-68-7	Benzyl butyl phthalate	SP			24	0.05		7.5	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
84-74-2	Dibutyl phthalate		NP		24	0.05		8	<0.05	<0.05	<0.05	<0.05	<0.05	11	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
84-66-2	Diethyl phthalate (DEP)				24	0.05		200	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
131-11-3	Dimethyl phthalate (DMP)				24	0.05		800	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
118-74-1	Hexachlorobenzene	PH	H	9.6	24	0.05		0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

Summary of Remedial Targets Methodology Screening

Hydrock Scenario: Scenario B - EQS (inland)
RTM Level: RTM Level 2 - Groundwater Beneath Source Assessment - groundwater samples
Water body receptor(s): Groundwater and surface water
Secondary receptor(s):
Data set: Groundwater (Round 4 - Hydrock 2022)
Client: Eutpia Homes Ltd.
Site: Great Western Road Yard
Job no: 20775
Test Certificates(s): Multiple
Dataset DEEP

	PNEC calculated (inland EQS)

2013/39/EU Annex I	
P = priority substance	
PH = priority hazardous substances.	
WFD Designation (2015 Directions)	
OP = Other substance identical to previous legislation	
SP = Specific Pollutant	
JAGDAG Hazardous Substances Determination (UK)	
H	Hazardous substance
NP	Non-hazardous pollutant
(blank)	Not included in assessment

CAS / AGS Number	Chemicals of Potential Concern (concentrations in µg/l)	WFD Designation	Hazardous Substance Status	Summary of Sample Data						Value Being Compared to Target = Maximum Value	Water Quality Target (Exceeded if Red		No. Samples Exceeding Water Quality Target		No. Samples above LoD Exceeding Water		Notes
				No. of Samples	No. of Samples > LoD	Limit of Detection	Minimum Value	Maximum Value	95-%ile Value			Inland Waters EQS		Inland Waters EQS		Inland Waters EQS	EQS compared to dissolved metals as an initial screen, with no adjustment for bioavailability or ABC.
P1133	Hardness as mg/l $CaCO_3$			-	-	-	10	-	-	-		-					Representative hardness of receiving surface water environment used in some inland EQS
120-12-7	Anthracene	***PH***	**H**	3	0	0.01	<0.01	<0.01	<0.01	<0.01		0.1		0		0	
50-32-8	Benzo(a)pyrene	***PH***	H	3	0	0.01	<0.01	<0.01	<0.01	<0.01		0.00017		3		0	Benzo(a)pyrene EQS used as marker substance for the group of benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene & indeno (1,2,3-cd)pyrene
206-44-0	Fluoranthene	***P***	**H**	3	0	0.01	<0.01	<0.01	<0.01	<0.01		0.0063		3		0	
91-20-3	Naphthalene	P	NP	3	0	0.01	<0.01	<0.01	<0.01	<0.01		2		0		0	
GRP01	PAHs = sum of benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(ghi)perylene, indeno(1,2,3-cd)pyrene	***P***	**H**	3	0	0.04	<0.04	<0.04	<0.04	<0.04		n/a					
P1877	Phenol	SP	**NP**	3	0	0.05	<0.05	<0.05	<0.05	<0.05		7.7		0		0	
P1407	Ali EC5-EC6			3	0	1	<1	<1	<1	<1		10		0		0	n-hexane fall within this fraction
P1408	Ali >EC6-EC8			3	0	1	<1	<1	<1	<1		10		0		0	n-heptane falls within this fraction
P1409	Ali >EC8-EC10			3	0	1	<1	<1	<1	<1		10		0		0	n-octane and n-nonane fall within this fraction
P1410	Ali >EC10-EC12			3	0	10	<10	<10	<10	<10		10		0		0	
P1411	Ali >EC12-EC16			3	0	10	<10	<10	<10	<10		10		0		0	
P1938	Ali >EC16-EC35			3	0	10	<10	<10	<10	<10		10		0		0	
P1415	Ali >EC35-EC44			3	0	10	<10	<10	<10	<10		10		0		0	
P1441	Aro EC5-EC7			3	0	1	<1	<1	<1	<1		10		0		0	Benzene wholly representative of this fraction
P1355	Aro >EC7-EC8			3	0	1	<1	<1	<1	<1		10		0		0	Toluene wholly representative of this fraction
P1356	Aro >EC8-EC10			3	0	1	<1	<1	<1	<1		10		0		0	Ethylbenzene / xylene / trimethylbenzene representative of this range
P1357	Aro >EC10-EC12			3	0	10	<10	<10	<10	<10		10		0		0	Naphthalene often forms a reasonable percentage of this fraction
P1358	Aro > EC12-EC16			3	0	10	<10	<10	<10	<10		10		0		0	2-methylnaphthalene, acenpthylene, acenapthene falls within this fraction
P1359	Aro >EC16-EC21			3	0	10	<10	<10	<10	<10		10		0		0	fluorene, anthracene, phenanthrene, pyrene falls within this range
P1360	Aro >EC21-EC35			3	0	10	<10	<10	<10	<10		10		0		0	Benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(ghi)perylene, indeno(cd)pyrene fall within this fraction
P1362	Aro >EC35-EC44			3	0	10	<10	<10	<10	<10		10		0		0	
71-43-2	Benzene	P	**H**	3	0	1	<1	<1	<1	<1		10		0		0	
108-88-3	Toluene	SP	**H**	3	0	1	<1	<1	<1	<1		74		0		0	
100-41-4	Ethylbenzene		**H**	3	0	1	<1	<1	<1	<1		20		0		0	Proposed EQS for Ethylbenzene in Water, R&D Technical Report P2-115/TR4. EA 2001
95-47-6	o-Xylene		**H**	3	0	1	<1	<1	<1	<1		30		0		0	EQS for total xylene
P1374	m,p-Xylene		**H**	3	0	1	<1	<1	<1	<1		30		0		0	EQS for total xylene
1634-04-04	Methyl tertiary butyl ether (MTBE)		**NP**	3	0	1	<1	<1	<1	<1		n/a					
88-06-2	2,4,6-Trichlorophenol		**H**	3	0	0.05	<0.05	<0.05	<0.05	<0.05		n/a					
120-83-2	2,4-Dichlorophenol	SP	**H**	3	0	0.05	<0.05	<0.05	<0.05	<0.05		4.2		0		0	
95-57-8	2-Chlorophenol		**H**	3	0	0.05	<0.05	<0.05	<0.05	<0.05		50		0		0	
59-50-7	4-Chloro, 3-methylphenol		**H**	3	0	0.05	<0.05	<0.05	<0.05	<0.05		40		0		0	
85-68-7	Benzyl butyl phthalate	SP		3	0	0.05	<0.05	<0.05	<0.05	<0.05		7.5		0		0	
84-74-2	Dibutyl phthalate		**NP**	3	0	0.05	<0.05	<0.05	<0.05	<0.05		8		0		0	
84-66-2	Diethyl phthalate (DEP)			3	0	0.05	<0.05	<0.05	<0.05	<0.05		200		0		0	
131-11-3	Dimethyl phthalate (DMP)			3	0	0.05	<0.05	<0.05	<0.05	<0.05		800		0		0	
118-74-1	Hexachlorobenzene	PH	**H**	3	0	0.05	<0.05	<0.05	<0.05	<0.05		0.05		0		0	

Summary of Remedial Targets Methodology Screening

Hydrock Scenario: Scenario B - EQS (inland)
RTM Level: RTM Level 2 - Groundwater Beneath Source Assessment - groundwater samples
Water body receptor(s): Groundwater and surface water
Secondary receptor(s):
Data set: Groundwater (Round 4 - Hydrock 2022)
Client: Eutpia Homes Ltd.
Site: Great Western Road Yard
Job no: 20775
Test Certificates(s): Multiple
Dataset SHALLOW

	PNEC calculated (inland EQS)

2013/39/EU Annex I	
P = priority substance	
PH = priority hazardous substances.	
WFD Designation (2015 Directions)	
OP = Other substance identical to previous legislation	
SP = Specific Pollutant	
JAGDAG Hazardous Substances Determination (UK)	
H	Hazardous substance
NP	Non-hazardous pollutant
(blank)	Not included in assessment

CAS / AGS Number	Chemicals of Potential Concern (concentrations in μg/l)	WFD Designation	Hazardous Substance Status	Summary of Sample Data						Value Being Compared to Target = Maximum Value	Water Quality Target (Exceeded if Red		No. Samples Exceeding Water Quality Target		No. Samples above LoD Exceeding Water		Notes
				No. of Samples	No. of Samples > LoD	Limit of Detection	Minimum Value	Maximum Value	95-%ile Value			Inland Waters EQS		Inland Waters EQS		Inland Waters EQS	EQS compared to dissolved metals as an initial screen, with no adjustment for bioavailability or ABC.
P1133	Hardness as mg/l $CaCO_3$			-	-	-	10	-	-	-		-					Representative hardness of receiving surface water environment used in some inland EQS
P1348	Nitrate (NO_3^-)			9	9	50	260	46600	29700	46600		n/a					
P1349	Nitrite (NO_2^-)			9	3	5	<5	52	47.2	52		n/a					
14808-79-8	Sulfate (SO_4^{2-})			9	9	45	21500	101000	99320	101000		400000		0		0	
P1134	pH (min.) (su)			9	9	0	6.9	7.5	7.5	7.5		6		0		0	
P1134	pH (max.) (su)			9	9	0	6.9	7.5	7.5	7.5		9		0		0	
P1287	Electrical conductivity (μS/cm)			9	9	10	380	810	798	810		n/a					
120-12-7	Anthracene	***PH***	**H**	21	0	0.01	<0.01	<0.01	<0.01	<0.01		0.1		0		0	
50-32-8	Benzo(a)pyrene	***PH***	H	21	0	0.01	<0.01	<0.01	<0.01	<0.01		0.00017		21		0	Benzo(a)pyrene EQS used as marker substance for the group of benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene & indeno (1,2,3-cd)pyrene
206-44-0	Fluoranthene	***P***	**H**	21	0	0.01	<0.01	<0.01	<0.01	<0.01		0.0063		21		0	
91-20-3	Naphthalene	P	NP	21	0	0.01	<0.01	<0.01	<0.01	<0.01		2		0		0	
GRP01	PAHs = sum of benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(ghi)perylene, indeno(1,2,3-cd)pyrene	***P***	**H**	21	0	0.04	<0.04	<0.04	<0.04	<0.04		n/a					
P1877	Phenol	SP	**NP**	21	0	0.05	<0.05	<0.05	<0.05	<0.05		7.7		0		0	
P1407	Ali EC5-EC6			21	0	1	<1	<1	<1	<1		10		0		0	n-hexane fall within this fraction
P1408	Ali >EC6-EC8			21	0	1	<1	<1	<1	<1		10		0		0	n-heptane falls within this fraction
P1409	Ali >EC8-EC10			21	0	1	<1	<1	<1	<1		10		0		0	n-octane and n-nonane fall within this fraction
P1410	Ali >EC10-EC12			21	0	10	<10	<10	<10	<10		10		0		0	
P1411	Ali >EC12-EC16			21	5	10	<10	1300	790	1300		10		5		5	
P1938	Ali >EC16-EC35			21	5	10	<10	2500	1000	2500		10		5		5	
P1415	Ali >EC35-EC44			21	0	10	<10	<10	<10	<10		10		0		0	
P1441	Aro EC5-EC7			21	1	1	<1	38	<1	38		10		1		1	Benzene wholly representative of this fraction
P1355	Aro >EC7-EC8			21	0	1	<1	<1	<1	<1		10		0		0	Toluene wholly representative of this fraction
P1356	Aro >EC8-EC10			21	0	1	<1	<1	<1	<1		10		0		0	Ethylbenzene / xylene / trimethylbenzene representative of this range
P1357	Aro >EC10-EC12			21	9	10	<10	280	210	280		10		9		9	Naphthalene often forms a reasonable percentage of this fraction
P1358	Aro > EC12-EC16			21	9	10	<10	430	380	430		10		9		9	2-methylnaphthalene, acenpthylene, acenapthene falls within this fraction
P1359	Aro >EC16-EC21			21	8	10	<10	540	520	540		10		8		8	fluorene, anthracene, phenanthrene, pyrene falls within this range
P1360	Aro >EC21-EC35			21	5	10	<10	170	83	170		10		5		5	Benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(ghi)perylene, indeno(cd)pyrene fall within this fraction
P1362	Aro >EC35-EC44			21	0	10	<10	<10	<10	<10		10		0		0	
71-43-2	Benzene	P	**H**	21	0	1	<1	<1	<1	<1		10		0		0	
108-88-3	Toluene	SP	**H**	21	0	1	<1	<1	<1	<1		74		0		0	
100-41-4	Ethylbenzene		**H**	21	0	1	<1	<1	<1	<1		20		0		0	Proposed EQS for Ethylbenzene in Water, R&D Technical Report P2-115/TR4. EA 2001
95-47-6	o-Xylene		**H**	21	1	1	<1	7110	<1	7110		30		1		1	EQS for total xylene
P1374	m,p-Xylene		**H**	21	0	1	<1	<1	<1	<1		30		0		0	EQS for total xylene
1634-04-04	Methyl tertiary butyl ether (MTBE)		**NP**	21	0	1	<1	<1	<1	<1		n/a					
88-06-2	2,4,6-Trichlorophenol		**H**	21	0	0.05	<0.05	<0.05	<0.05	<0.05		n/a					
120-83-2	2,4-Dichlorophenol	SP	**H**	21	0	0.05	<0.05	<0.05	<0.05	<0.05		4.2		0		0	
95-57-8	2-Chlorophenol		**H**	21	0	0.05	<0.05	<0.05	<0.05	<0.05		50		0		0	
59-50-7	4-Chloro, 3-methylphenol		**H**	21	0	0.05	<0.05	<0.05	<0.05	<0.05		40		0		0	
85-68-7	Benzyl butyl phthalate	SP		21	0	0.05	<0.05	<0.05	<0.05	<0.05		7.5		0		0	
84-74-2	Dibutyl phthalate		**NP**	21	1	0.05	<0.05	11	<0.05	11		8		1		1	
84-66-2	Diethyl phthalate (DEP)			21	0	0.05	<0.05	<0.05	<0.05	<0.05		200		0		0	
131-11-3	Dimethyl phthalate (DMP)			21	0	0.05	<0.05	<0.05	<0.05	<0.05		800		0		0	
118-74-1	Hexachlorobenzene	PH	**H**	21	0	0.05	<0.05	<0.05	<0.05	<0.05		0.05		0		0	

20775 GREAT WESTERN ROAD YARD, GLOUCESTER
ADDITIONAL SVOCS WITH NO GENERIC WATER QUALITY TARGET - ROUND 4 MAY 2022

Determinand	BH101S	BH101D	BH102	WS101	WS103	WS104	WS105	WS107	WS109	WS110	WS111	WS114	WS116	BH201	BH202	BH203	BH204S	BH204D	BH205	BH206	WS203	WS204	WS205	WS206
Semi-Volatile Organic Compound (ug/l)																								
1,3-Dichlorobenzene	--	--	--	--	--	--	0.84	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2,4-Dimethylphenol	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.56	--	0.47
2-Methylnaphthalene	--	--	--	--	--	--	0.21	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Methylphenol	--	--	--	--	--	--	19	--	--	--	--	--	--	--	--	--	--	--	--	--	--	4	2.7	2.7
Acenaphthene	--	--	--	0.35	0.91	--	--	--	--	--	--	--	--	--	--	--	0.92	--	--	0.88	2.3	1.4	1.1	1
Acenaphthylene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.38	0.46	--	0.27
Bis(2-chloroethyl)ether	--	--	--	--	2	1.5	5.4	--	--	--	--	--	--	2.7	--	--	--	--	--	2.9	--	--	--	--
Bis(2-chloroisopropyl)ether	--	--	--	--	110	120	530	--	--	--	--	--	--	220	--	--	--	--	--	180	--	--	--	--
Carbazole	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	7.2	--	--	--
Dibenzofuran	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.9	--	--	--
Fluorene	--	--	--	0.75	1.9	--	--	--	--	--	--	--	--	--	--	--	2.6	--	--	1.3	3.8	2.5	2.1	2.1
Phenanthrene	--	--	--	--	0.76	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.91	1.7	1.2	1.5

Notes:

-- Not recorded above laboratory method detecton limit.

Aliphatic >EC10-EC12

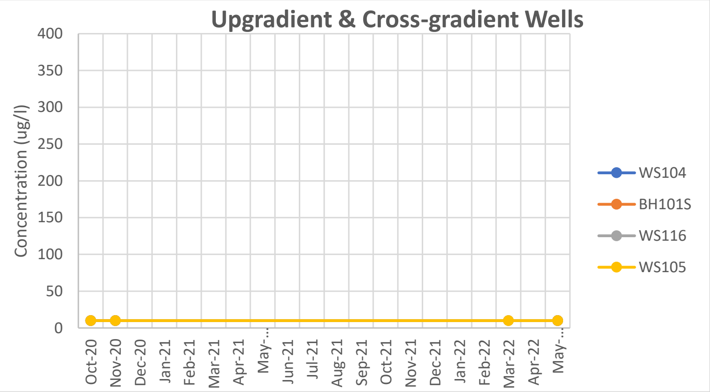
Date	Upgradient			Cross	Source Area								Downgradient					Sentinel		
	WS104	BH101S	WS116	WS105	WS203	WS101	WS204	WS102	WS205	WS103	WS206	WS115	BH204S	BH203	BH206	BH205	BH202	WS114	WS111	WS110
Oct-20	10	10	10	10		10		31		10								10	10	10
Nov-20	10	10	10	10		10		16		10								10	10	10
Mar-22			10	10	10	10	10		10	320	10		10	10	10	10	10			
May-22	10	10	10	10	10	10	10		10	10	10		10	10	10	10	10	10	10	10

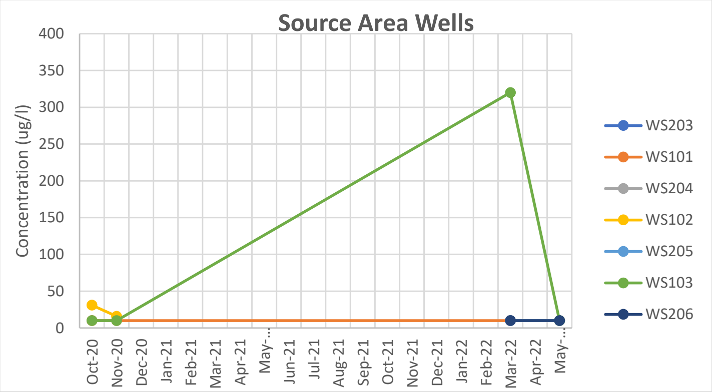
All data are in ug/l.

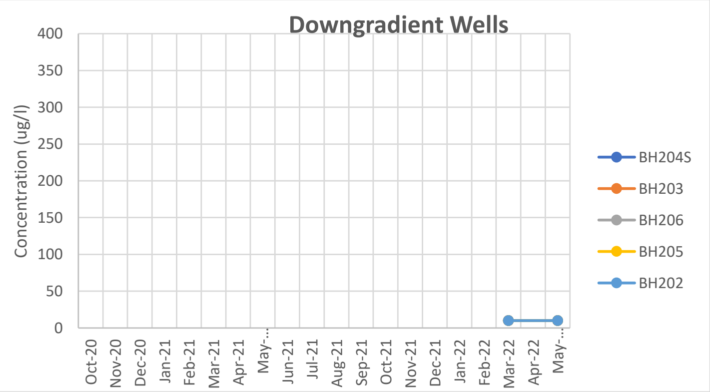
Limit of detection = 10 ug/l.

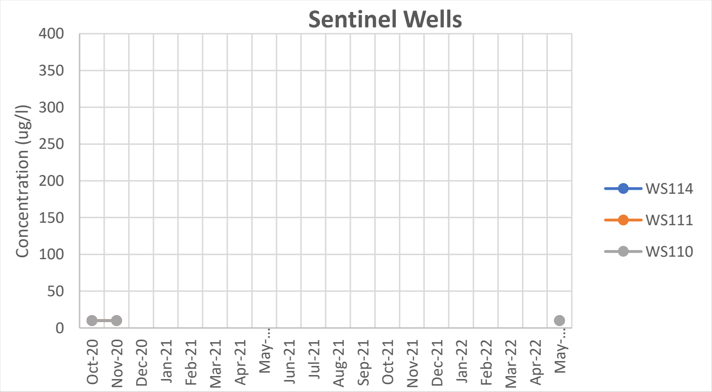
A blank cell indicates analysis was not undertaken during monitoring event.

Trend Graphs:


Upgradient & Cross-gradient Wells


Source Area Wells


Downgradient Wells

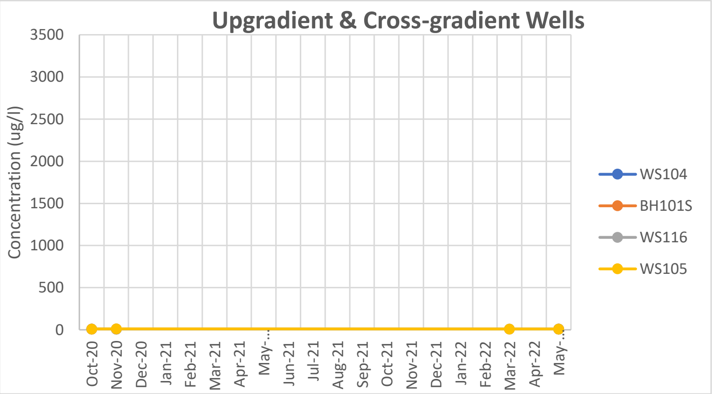

Sentinel Wells

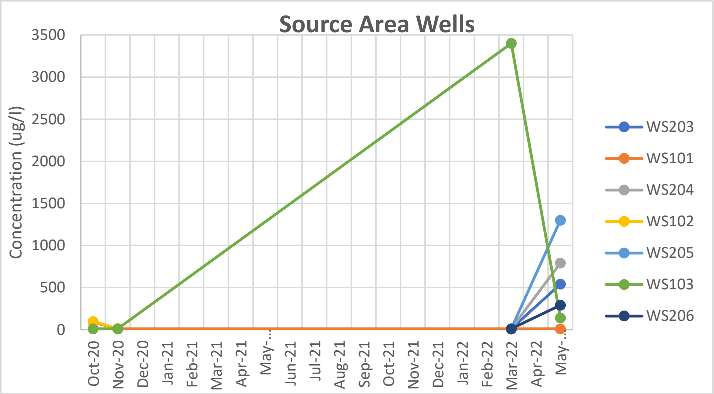
Aliphatic >EC12-EC16

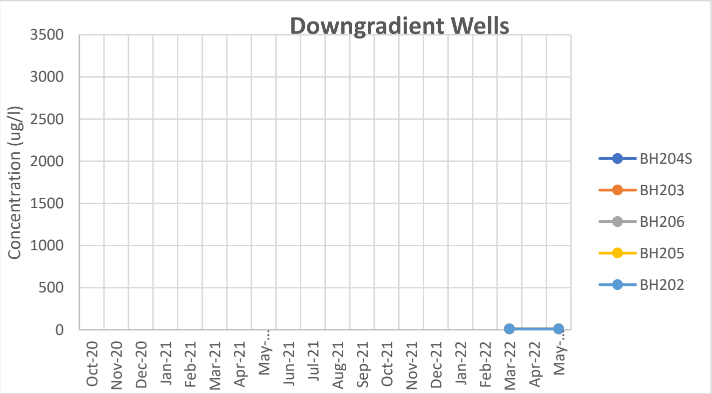
Date	Upgradient			Cross	Source Area								Downgradient					Sentinel		
	WS104	BH101S	WS116	WS105	WS203	WS101	WS204	WS102	WS205	WS103	WS206	WS115	BH204S	BH203	BH206	BH205	BH202	WS114	WS111	WS110
Oct-20	10	10	10	10		89		97		10								10	31	10
Nov-20	10	10	10	11		10		13		10								10	10	10
Mar-22			10	10	10	10	10		10	3400	10		10	10	10	10	10			
May-22	10	10	10	10	540	10	790		1300	140	290		10	10	10	10	10	10	10	10

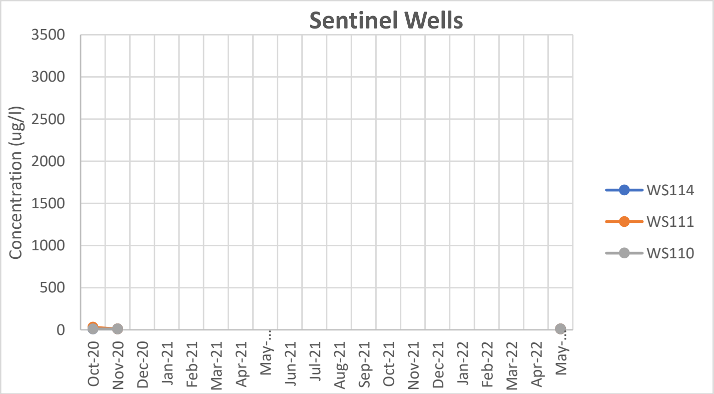
All data are in ug/l.
Limit of detection = 10 ug/l.
A blank cell indicates analysis was not undertaken during monitoring event.

Trend Graphs:









Aliphatic >EC16-EC21

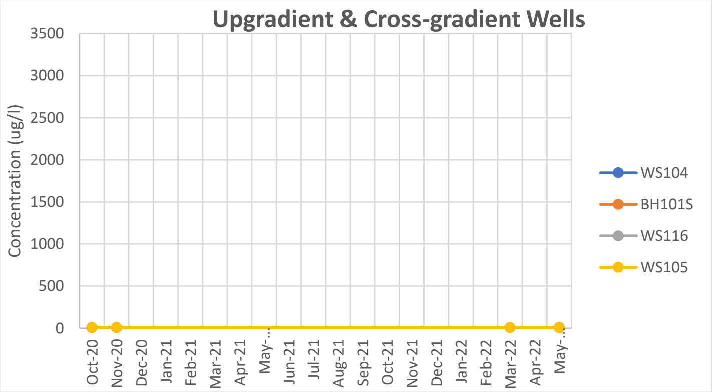
Date	Upgradient			Cross	Source Area								Downgradient					Sentinel		
	WS104	BH101S	WS116	WS105	WS203	WS101	WS204	WS102	WS205	WS103	WS206	WS115	BH204S	BH203	BH206	BH205	BH202	WS114	WS111	WS110
Oct-20	10	10	10	10		107		98		10								10	10	10
Nov-20	10	10	10	10		10		16		10								10	10	10
Mar-22			10	10	10	10	10		10	3300	10		10	10	10	10	10			
May-22	10	10	10	10	440	10	790		1900	280	280		10	10	10	10	10	10	10	10

All data are in ug/l.

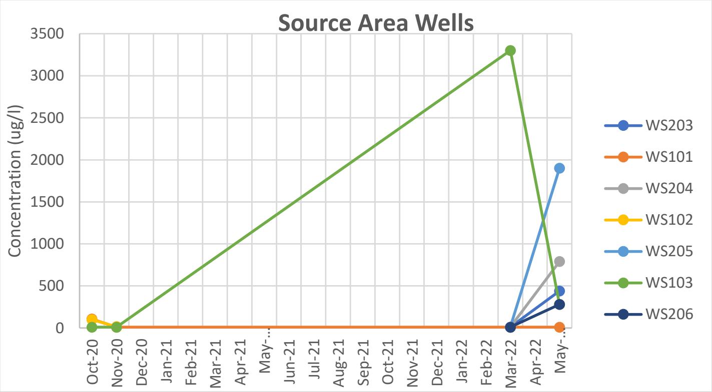
Limit of detection = 10 ug/l.

A blank cell indicates analysis was not undertaken during monitoring event.

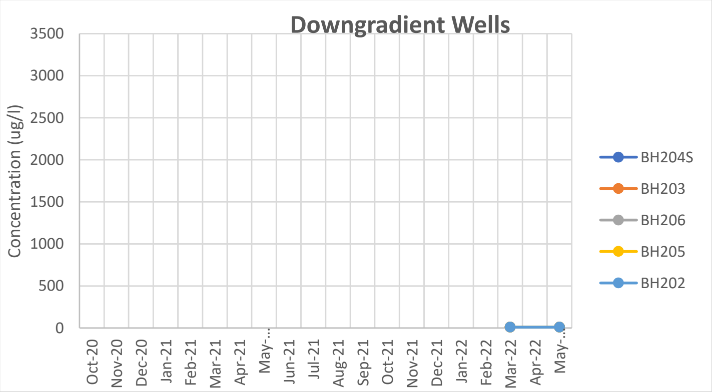
Trend Graphs:



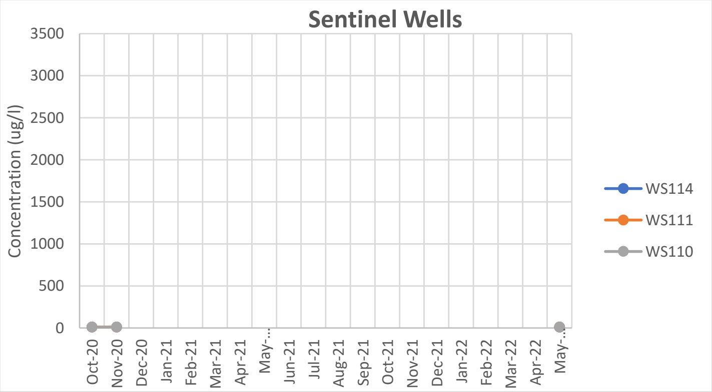
Upgradient & Cross-gradient Wells



Source Area Wells



Downgradient Wells



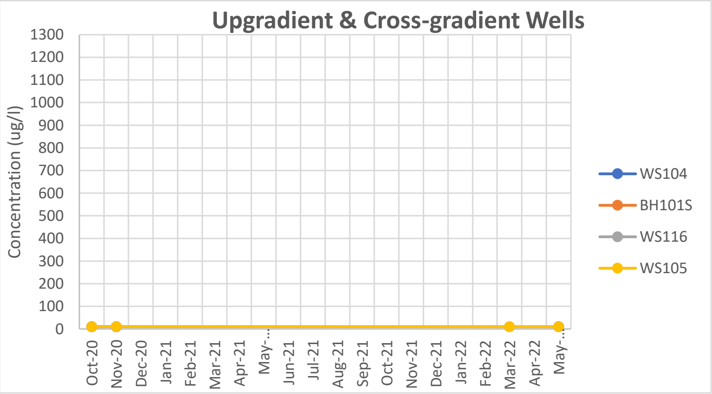
Sentinel Wells

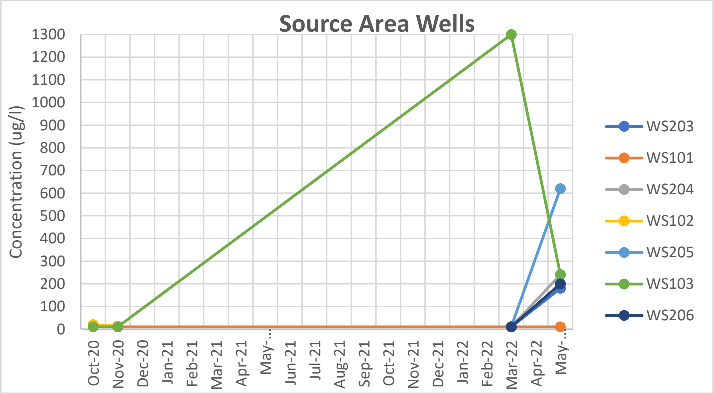
Aliphatic >EC21-EC35

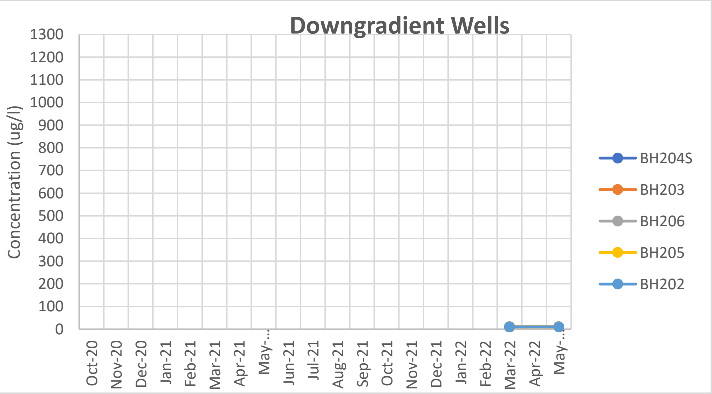
Date	Upgradient			Cross	Source Area								Downgradient					Sentinel		
	WS104	BH101S	WS116	WS105	WS203	WS101	WS204	WS102	WS205	WS103	WS206	WS115	BH204S	BH203	BH206	BH205	BH202	WS114	WS111	WS110
Oct-20	10	10	10	10		19		20		10								10	10	10
Nov-20	10	10	10	11		10		13		10								10	10	10
Mar-22			10	10	10	10	10		10	1300	10		10	10	10	10	10			
May-22	10	10	10	10	180	10	240		620	240	200		10	10	10	10	10	10	10	10

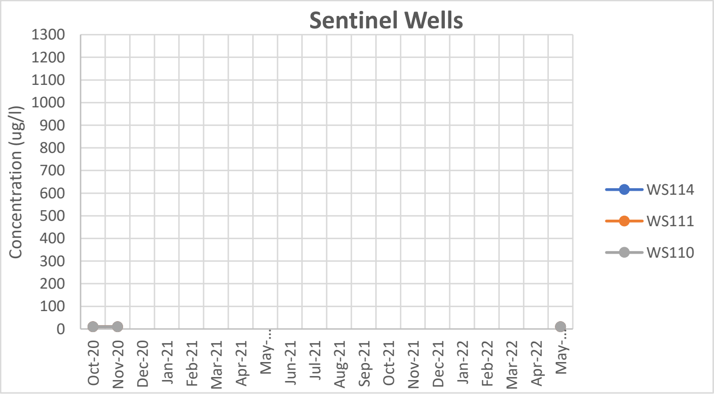
All data are in ug/l.
Limit of detection = 10 ug/l.
A blank cell indicates analysis was not undertaken during monitoring event.

Trend Graphs:







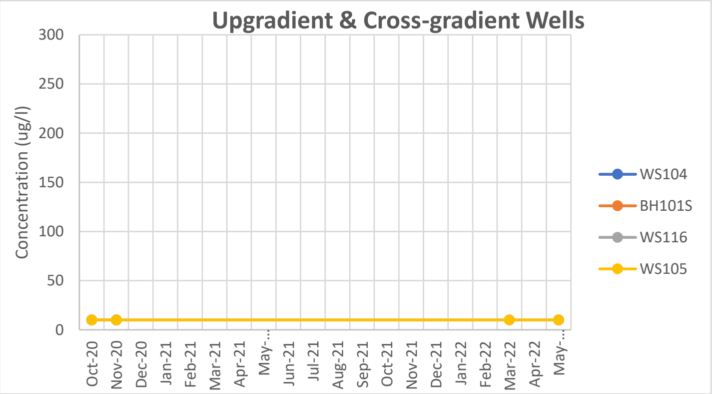


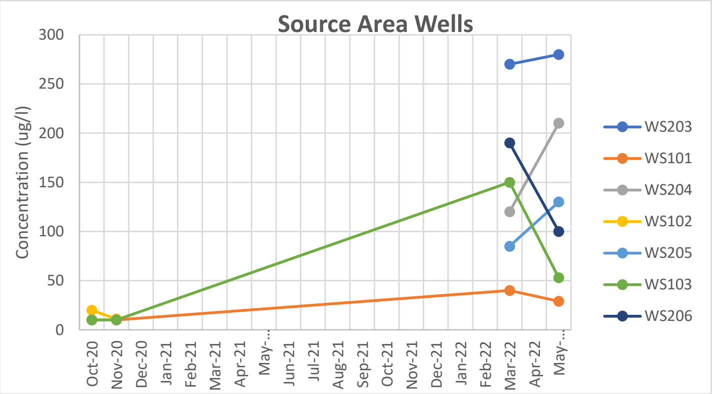
Aromatic >EC10-EC12

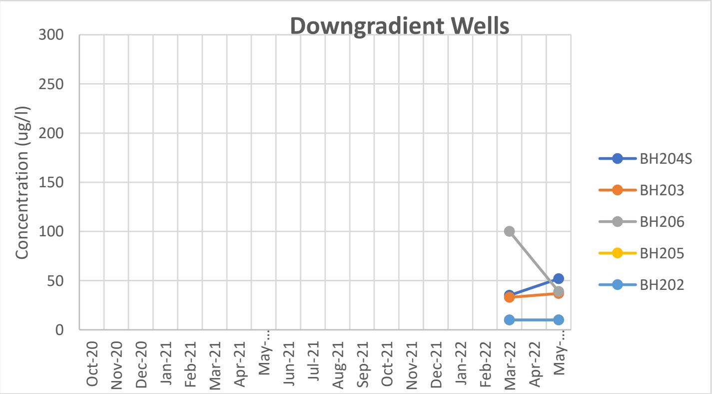
Date	Upgradient			Cross	Source Area								Downgradient					Sentinel		
	WS104	BH101S	WS116	WS105	WS203	WS101	WS204	WS102	WS205	WS103	WS206	WS115	BH204S	BH203	BH206	BH205	BH202	WS114	WS111	WS110
Oct-20	10	10	10	10		10		20		10								10	10	10
Nov-20	10	10	10	10		10		11		10								10	10	10
Mar-22			10	10	270	40	120		85	150	190		35	33	100	10	10			
May-22	10	10	10	10	280	29	210		130	53	100		52	37	39	10	10	10	10	10

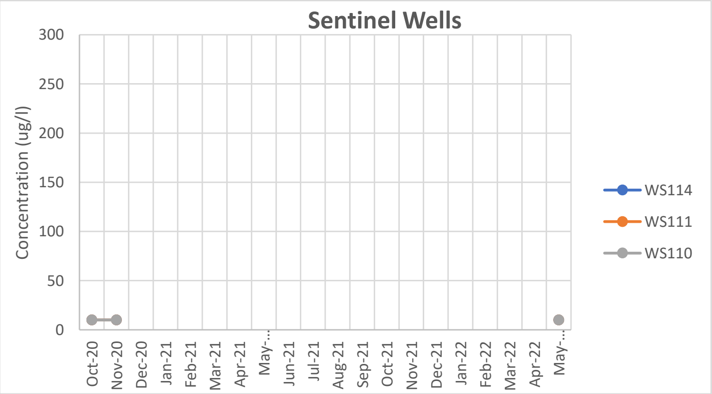
All data are in ug/l.
Limit of detection = 10 ug/l.
A blank cell indicates analysis was not undertaken during monitoring event.

Trend Graphs:









Aromatic >EC12-EC16

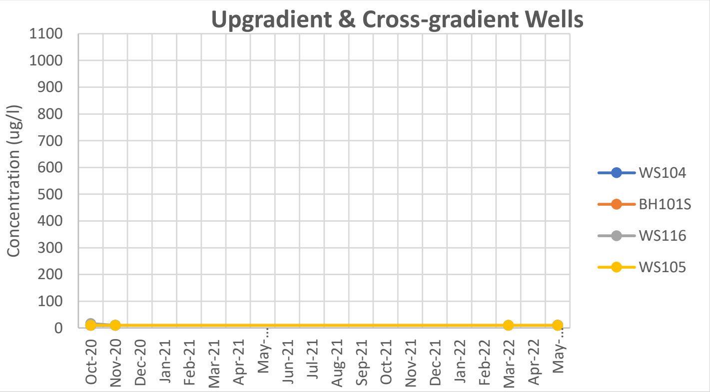
Date	Upgradient			Cross	Source Area								Downgradient					Sentinel		
	WS104	BH101S	WS116	WS105	WS203	WS101	WS204	WS102	WS205	WS103	WS206	WS115	BH204S	BH203	BH206	BH205	BH202	WS114	WS111	WS110
Oct-20	10	10	17	10		129		122		10								10	10	10
Nov-20	10	10	10	10		116		109		10								10	10	10
Mar-22			10	10	1100	130	590		800	970	870		320	240	270	10	10			
May-22	10	10	10	10	430	95	360		380	240	330		140	99	110	10	10	10	10	10

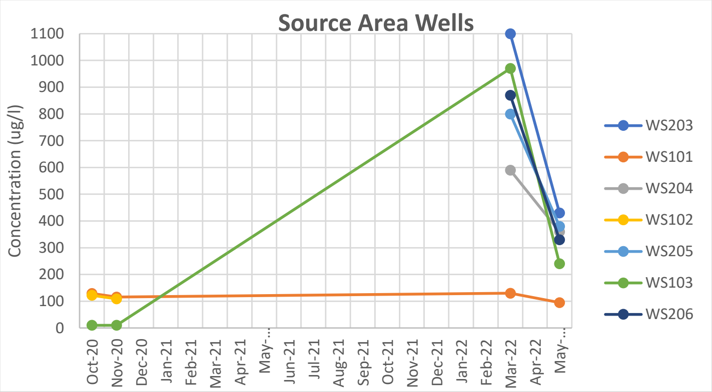
All data are in ug/l.

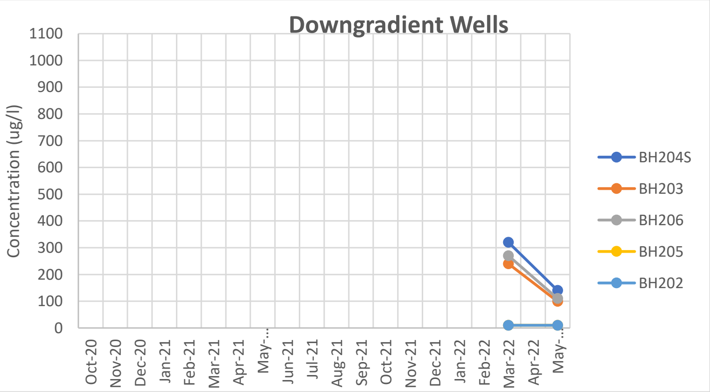
Limit of detection = 10 ug/l.

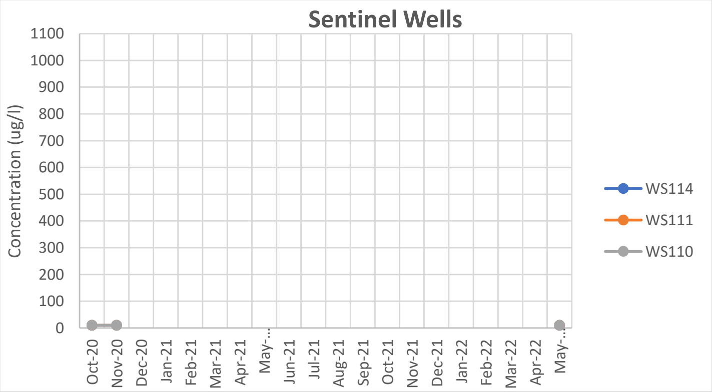
A blank cell indicates analysis was not undertaken during monitoring event.

Trend Graphs:







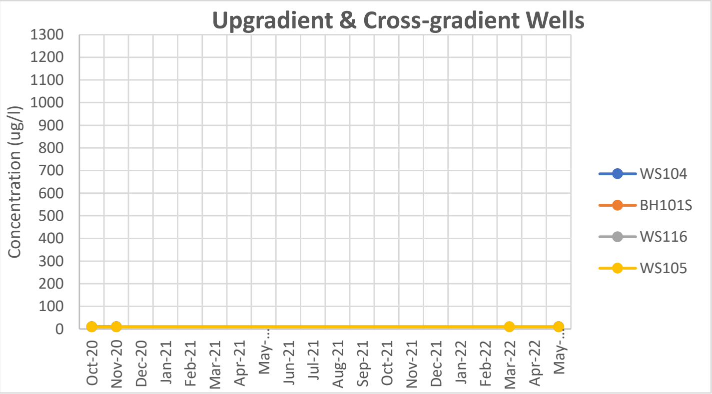


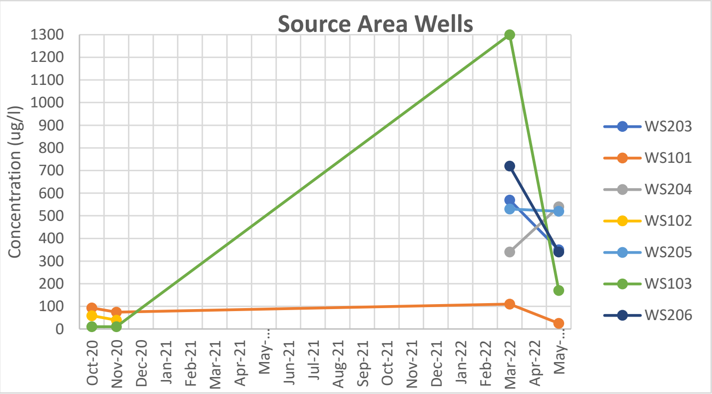
Aromatic >EC16-EC21

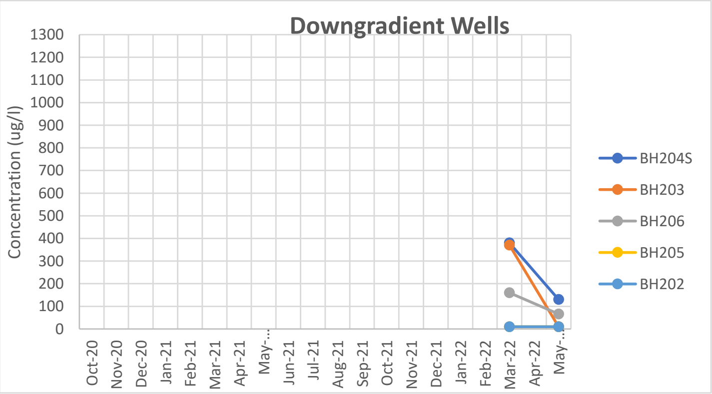
Date	Upgradient			Cross	Source Area								Downgradient					Sentinel		
	WS104	BH101S	WS116	WS105	WS203	WS101	WS204	WS102	WS205	WS103	WS206	WS115	BH204S	BH203	BH206	BH205	BH202	WS114	WS111	WS110
Oct-20	10	10	10	10		93		59		10								10	10	10
Nov-20	10	10	10	10		74		39		10								10	10	10
Mar-22			10	10	570	110	340		530	1300	720		380	370	160	10	10			
May-22	10	10	10	10	350	25	540		520	170	340		130	10	66	10	10	10	10	10

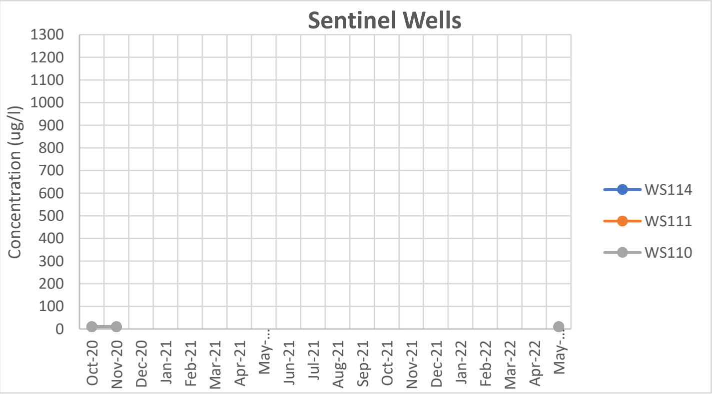
All data are in ug/l.
Limit of detection = 10 ug/l.
A blank cell indicates analysis was not undertaken during monitoring event.

Trend Graphs:







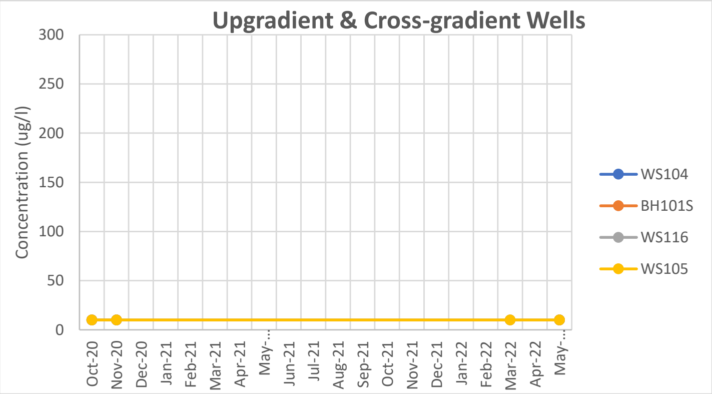


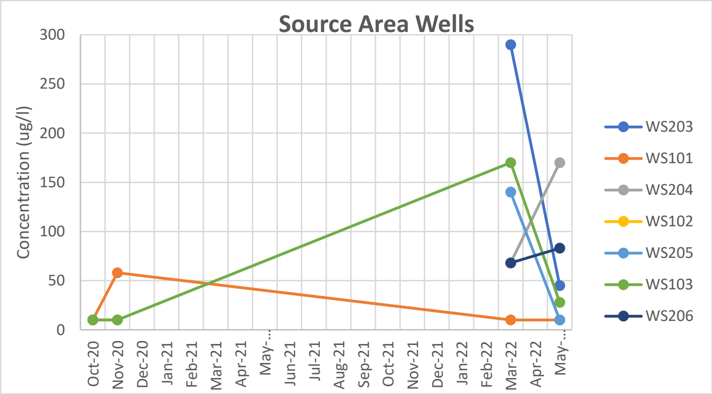
Aromatic >EC21-EC35

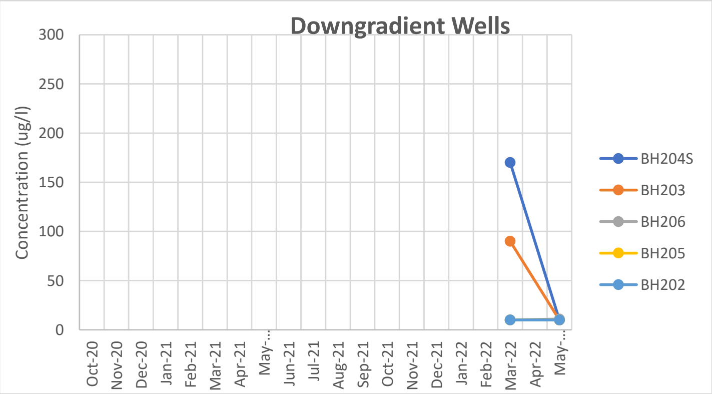
Date	Upgradient			Cross	Source Area								Downgradient					Sentinel		
	WS104	BH101S	WS116	WS105	WS203	WS101	WS204	WS102	WS205	WS103	WS206	WS115	BH204S	BH203	BH206	BH205	BH202	WS114	WS111	WS110
Oct-20	10	10	10	10		10		10		10								10	10	10
Nov-20	10	10	10	10		58		10		10								10	10	10
Mar-22			10	10	290	10	68		140	170	68		170	90	10	10	10			
May-22	10	10	10	10	45	10	170		10	28	83		10	10	11	10	10	10	10	10

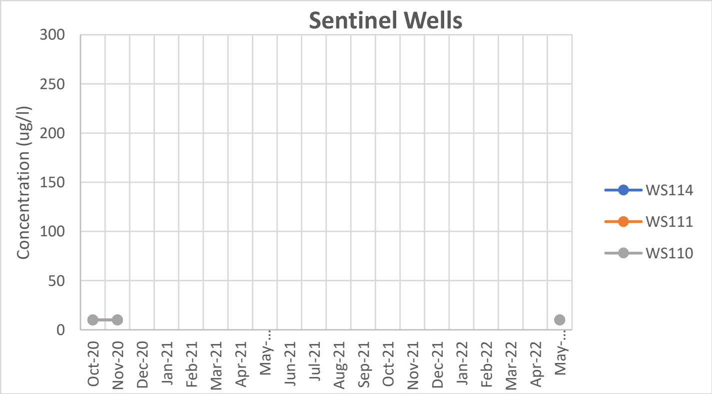
All data are in ug/l.
Limit of detection = 10 ug/l.
A blank cell indicates analysis was not undertaken during monitoring event.

Trend Graphs:









20775 GREAT WESTERN ROAD YARD, GLOUCESTER
GROUNDWATER BIODEGRADATION PARAMETERS SUMMARY

Relative Well Location	ID	Maximum TPH (C5-C44) (ug/L)	pH	Oxidaton-Reduction Potential (mV) (Field Measured)	Oxidaton-Reduction Potential (mV) (Corrected)	Biodegrdation Process -->											
						Aerobic	Nitrate Reduction		Manganese Reduction		Iron Reduction		Sulphate Reduction		Methanogenesis	
						Dissolved Oxygen (mg/L)	Nitrate NO_3 (mg/L)	Nitrite NO_2 (mg/L)	Manganese (IV) Mn^{+4} (mg/L)	Manganese (II) Mn^{-2} (mg/L)	Ferric Iron Fe^{+3} (mg/L)	Ferrous Iron Fe^{+2} (mg/L)	Sulphate SO_4^{-2} (mg/L)	Sulphide H_2S (mg/L)	Carbon Dioxide CO_2 (in well head) (%)	Methane CH_4 (in well head) (%)
Upgradient	**BH101S**	10	6.82	217.6	424.60	3.48	0.41	< 5.0	< 0.02	< 0.02	< 0.20	< 0.20	96.8	< 5.0	5.9	0.1
	WS116	17	6.91	0.1	207.10	0.54	1.76	28	0.69	0.07	< 0.20	< 0.20	32.6	< 5.0	4.4	0.1
Cross-gradient	**WS105**	11	7.10	84.1	291.10	2.15	4.35	< 5.0	< 0.02	< 0.02	< 0.20	< 0.20	37.7	< 5.0	3.9	0.2
Source Area	**WS203**	2,300	7.41	-138.1	68.90	0.60	0.52	< 5.0	0.35	0.72	< 0.20	< 0.20	118	< 5.0	7.8	0.1
	WS101	458	6.86	-36.5	170.50	0.31	0.57	52	0.85	0.16	< 0.20	0.23	101	< 5.0	1.4	0.8
	WS204	3,100	7.59	-156.8	50.20	0.01	0.52	6.5	0.64	0.14	< 0.20	< 0.20	22.9	< 5.0	3.3	0.2
	WS205	4,800	6.74	-66.0	141.00	0.47	0.78	< 5.0	0.09	0.17	< 0.20	< 0.20	35.8	< 5.0	4.5	0.1
	WS103	1200*	7.20	-145.8	61.20	1.07	0.36	< 5.0	0.64	0.15	< 0.20	< 0.20	21.5	< 5.0	2.9	0.1
	WS206	1,800	7.12	-104.0	103.00	0.72	0.78	< 5.0	0.51	0.13	< 0.20	< 0.20	6.38	< 5.0	1.1	0.1
Downgradient	**BH204S**	910	6.95	-110.6	96.40	0.65	0.83	6	0.57	0.27	< 0.20	< 0.20	20.2	< 5.0	0.8	0.1
	BH203	730	6.86	-61.7	145.30	0.33	0.47	< 5.0	0.67	0.13	< 0.20	< 0.20	44.4	< 5.0	NR	NR
	BH206	530	7.61	-175.6	31.40	0.43	0.26	< 5.0	0.24	0.06	< 0.20	< 0.20	5.29	< 5.0	3.1	1.8
	BH205	10	7.13	53.2	260.20	1.20	2.07	51	< 0.02	0.04	< 0.20	< 0.20	35.7	< 5.0	1.1	0.1
	BH202	10	7.40	167.0	374.00	6.34	0.26	< 5.0	< 0.02	< 0.02	< 0.20	< 0.20	21.5	< 5.0	0.3	0.1
Sentinel	**WS107**	301	6.83	15.7	222.70	0.66	0.41	40	0.38	0.07	< 0.20	< 0.20	31.9	< 5.0	8.2	0.1
	WS111	89	7.40	101.6	308.60	0.93	46.6	< 5.0	< 0.02	< 0.02	< 0.20	< 0.20	82.5	< 5.0	5.3	0.1

Notes:

TPH	Total petroelum hydrocarbons.
<	Below laboratory method detection limit.
*	Concentration from low-flow sampling during 4-6 May event as considered most representative. Sample with maximum of 11,000 ug/L collected using bailer.
NR	Not recorded.

ORP and DO data are from Hydrock monitoring events undertaken in March or May 2022.

ORP (corrected) readings are standardised to the standard hydrogen electrode. See reference In-Situ (2022) for further details.

Petroleum hydrocarbons are generally oxidised at dissolved oxygen concentrations in excess of 1 mg/L. Concentrations less than 1 mg/L generally indicate anaerobic conditions.

Appendix F RTM Modelling Outputs

Remedial Targets Worksheet , Release 3.2

Level 1 - Soil

Environment Agency

Select the method of calculating the soil water Partition Co-efficient by using the pull down menu below

Calculate for non-polar organic chemicals

Contaminant		**Aliphatic C10-12**	
Target concentration	C_T	**0.01**	**mg/l**

Input Parameters	**Variable**	**Value**	**Unit**	**Source of parameter value**
Standard entry				
Water filled soil porosity	θ_W	1.57E-01	fraction	RTM calc for CHSG (unsat.). Hydrock 2022 GI data.
Air filled soil porosity	θa	2.71E-01	fraction	RTM calc for CHSG (unsat.). Hydrock 2022 GI data.
Bulk density of soil zone material	ρ	1.59E+00	g/cm^3	Mid gravelly sand (Domenico & Schwartz, 1990).
Henry's Law constant	H	1.20E+02	dimensionless	*TPH CWG Series, Volume 3*
Entry if specify partition coefficient (option)				
Soil water partition coefficient	Kd		l/kg	-
Entry for non-polar organic chemicals (option)				
Fraction of organic carbon (in soil)	foc	7.00E-03	fraction	Mean CHSG free of vis./olf. (unsat.). Hydrock 2022 GI.
Organic carbon partition coefficient	Koc	2.51E+05	l/kg	*TPH CWG Series, Volume 3*
Entry for ionic organic chemicals (option)				
Sorption coefficient for neutral species	$K_{oc,n}$		l/kg	-
Sorption coefficient for ionised species	$K_{oc,i}$		l/kg	-
pH value	pH		pH units	*Analytical data from Hydrock 2022 GI.*
Acid dissociation constant	pKa			-
Fraction of organic carbon (in soil)	foc		fraction	*Mean CHSG free of vis./olf. (unsat.). Hydrock 2022 GI.*
Soil water partition coefficient used in Level Assessment	**Kd**	**1.76E+03**	**l/kg**	*Calculated value*

This sheet calculates the Level 1 remedial target for soils(mg/kg) based on a selected target concentration and theoretical calculation of soil water partitioning. Three options are included for determining the partition coefficient.

The measured soil concentration as mg/kg should be compared with the Level 1 remedial target to determine the need for further action.

Level 1 Remedial Target

Level 1 Remedial Target	**1.78E+01**	**mg/kg**	**(for comparison with soil analyses)**
	or		
	0.01	**mg/l**	**(for comparison with leachate test results)**

Site being assessed:	Great Western Road Yard
Completed by:	MK
Date:	13-Jun-22
Version:	1

Remedial Targets Worksheet , Release 3.2

Level 2 - Soil

Contaminant		**Aliphatic C10-12**		from Level 1
Target concentration	C_T	**0.01**	**mg/l**	from Level 1

This sheet calculates the Level 2 remedial target for soils (mg/kg) or for pore water (mg/l).

The measured soil concentration as mg/kg or pore water concentration should be compared with the Level 2 remedial target to determine the need for further action. Equations presented in 'Hydrogeological risk assessment for land contamiantion' (Environment Agency 2006)

Input Parameters	**Variable**	**Value**	**Unit**	**Source of parameter value**	
Standard entry					
Infiltration	Inf	4.75E-04	m/d	**20% of mean rainfall Cheltenham (Met Office).**	
Area of contaminant source	A	6.00E+03	m^2	**Consistent soil conc. (tank farm/refueling)**	Not used in calculation
Entry for groundwater flow below site					
Length of contaminant source in direction of groundwater flow	L	1.00E+02	m	**Consistent soil conc. (tank farm/refueling)**	
Saturated aquifer thickness	da	2.65E+00	m	**Max thickness in wells. Hydrock 2022 GI.**	
Hydraulic Conductivity of aquifer in which dilution occurs	K	2.61E+00	m/d	**Geometric mean slug testing. Hydrock 2022 GI.**	
Hydraulic gradient of water table	i	7.00E-03	fraction	**Mean across plume. Hydrock 2022 GI.**	
Width of contaminant source perpendicular to groundwater flow	w	6.00E+01	m	**Consistent soil conc. (tank farm/refueling)**	Not used in calculation
Background concentration of contaminant in groundwater beneath site	Cu	0.00E+00	mg/l	**No background concentrations assumed**	
Define mixing zone depth by specifying or calculating depth (using pull down list)		**Calculate**			
Enter mixing zone thickness	Mz		m	Only if selected	
Calculated mixing zone thickness	Mz	2.65E+00	m		

Calculated Parameters

Dilution Factor	**DF**	**2.02E+00**		
Level 2 Remedial Target		**2.02E-02**	**mg/l**	**For comparison with measured pore water concentration. This assumes Level 1 Remedial Target is based on Target Concentr**
		or		
		3.59E+01	**mg/kg**	**For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water**

Additional option

Calculation of impact on receptor

Concentration of contaminant in contaminated discharge (entering receptor)	Cc	0.00E+00	mg/l	
Calculated concentration within receptor (dilution only)		0.00E+00	mg/l	0

Site being assessed:	Great Western Road Yard
Completed by:	MK
Date:	13-Jun-22
Version:	1

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note

Input Parameters	Variable	Value	Unit	Source
Contaminant		**Aliphatic C10-12**		from Level 1
Target Concentration	C_T	**0.01**	mg/l	from Level 1
Dilution Factor	**DF**	**2.02E+00**		from Level 2

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks — **Equations in HRA publication**

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: **Apply degradation rate to pollutants in all phases (e.g. field derived value, l**

	Variable	Value	Unit	Source of parameter value
Enter source concentration	**Soil concentration as mg/kg**			
Enter soil concentration		**981**	mg/kg	
Half life for degradation of contaminant in water	$t_{1/2}$	1.83E+03	days	*Professional judgement - see Table 3.7.*
Calculated decay rate	λ	3.80E-04	$days^{-1}$	calculated
Width of plume in aquifer at source	Sz	6.00E+01	m	from Level 2
Plume thickness in aquifer at source	Sy	2.65E+00	m	from Level 2
Bulk density of aquifer materials	ρ	1.59E+00	g/cm^3	*Mid gravelly sand (Domenico & Schwartz, 1990).*
Effective porosity of aquifer	n	2.75E-01	fraction	*Mid gravelly sand (Domenico & Schwartz, 199*
Hydraulic gradient	i	1.39E-02	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	K	2.61E+00	m/d	from Level 2
Distance to compliance point	x	5.00E+01	m	*Default.*
Distance (lateral) to compliance point perpendicular to flow direction	z		m	
Distance (depth) to compliance point perpendicular to flow direction	y		m	
Time since pollutant entered groundwater	t	1.00E+99	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	7.53E+02	l/kg	*see options*
Longitudinal dispersivity	ax	5.000	m	*see options*
Transverse dispersivity	az	0.500	m	*see options*
Vertical dispersivity	ay	0.050	m	*see options*

Parameter values should be checked against Level 1 and 2

Calculated Parameters	Variable		
Groundwater flow velocity	v	1.32E-01	m/d
Retardation factor	Rf	4.35E+03	fraction
Decay rate used	λ	3.80E-04	d^{-1}
Hydraulic gradient used in aquifer flow down-gradient	i	1.39E-02	fraction
Rate of contaminant flow due to retardation	u	3.02E-05	m/d
Ratio of Compliance Point to Source Concentration	C_{ED}/C_0	3.64E-33	fraction
Attenuation factor (C_O/C_{ED})	**AF**	**2.75E+32**	**fraction**
Calculated soil leachate concentration	Co	5.52E-01	mg/l

Remedial Targets

Level 3 Remedial Target		**5.55E+30**	**mg/l**	For comparison with measured pore water concentration.
Ogata Banks		**or**		This assumes Level 1 Remedial Target is based on Target Concentration.
		9.86E+33	**mg/kg**	For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water partitioning equation.
Distance to compliance point		**50**	**m**	
Ratio of Compliance Point to Source Concentration	C_{ED}/C_0	**3.64E-33**	**fraction**	Ogata Banks

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target.
The recommended value for time when calculating the remedial target is 9.9E+99

Enter method of defining partition co-efficient (using pull down list)

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)			
Soil water partition coefficient	Kd		l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc	3.00E-03	fraction
Organic carbon partition coefficient	Koc	2.51E+05	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc.n}$		l/kg
Sorption coefficient for ionised species	$K_{oc.i}$		l/kg
pH value	pH		
Acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	7.53E+02	l/kg

Define dispersivity (click brown cell and use pull down list)

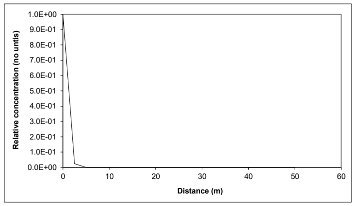
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	
Longitudinal dispersivity	**ax**	1.00E-04	5.00E+00	2.98E+00	m
Transverse dispersivity	**az**	1.00E-04	5.00E-01	2.98E-01	m
Vertical dispersivity	**ay**	1.00E-04	5.00E-02	2.98E-02	m

Note values of dispersivity must be > 0

Xu & Eckstein (1995) report $ax = 0.83(\log_{10}x)^{2.414}$; az = ax/10, ay = ax/100 are assumed

Note
This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best desribed by an electron limited degradation such as oxidation by O_2, NO_3, SO_4 etc than an alternative solution should be used



Note: 'Relative concentration' is the ratio of calculated concentation at a given position compared to the source concentration. The calculations assume plume disperses from the top of the aquifer. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

This sheet calculates the Level 3 remedial target for soils(mg/kg) or for pore water (mg/l), based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.By setting a long travel time (e.g. 9E99) it will give the steady state solution, which should always be used when calculating remedial targets.

The measured soil concentration as mg/kg or pore water concentration should be compared with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.9E+99.

Site being assessed:	Great Western Road Yard
Completed by:	MK
Date:	########
Version:	1

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	Relative concentration (No units)	Concentration mg/l
0	1.0E+00	2.73E-01
2.5	2.42E-02	6.62E-03
5.0	5.86E-04	1.60E-04
7.5	1.41E-05	3.87E-06
10.0	3.40E-07	9.31E-08
12.5	8.16E-09	2.23E-09
15.0	1.95E-10	5.33E-11
17.5	4.65E-12	1.27E-12
20.0	1.11E-13	3.02E-14
22.5	2.63E-15	7.19E-16
25.0	6.26E-17	1.71E-17
27.5	1.49E-18	4.06E-19
30.0	3.53E-20	9.66E-21
32.5	8.40E-22	2.30E-22
35.0	2.00E-23	5.46E-24
37.5	4.75E-25	1.30E-25
40.0	1.13E-26	3.09E-27
42.5	2.69E-28	7.36E-29
45.0	6.41E-30	1.75E-30
47.5	1.53E-31	4.17E-32
50.0	3.64E-33	9.95E-34

R&D Publication 20 Remedial Targets Worksheet, Release 3.2

Environment Agency

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)	Variable	Value	Unit	Source
Contaminant		Aliphatic C10-12		from Level 1
Target Concentration	C_T	1.00E-02	mg/l	from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks — **Equations in HRA publication**

Approach for simulating vertical dispersion: **Simulate vertical dispersion in 1 direction**

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: **Apply degradation rate to pollutants in all phases (e.g. field derived valu**

				Source of parameter value
Initial contaminant concentration in groundwater at plume core	C_0	3.10E-02	mg/l	*WS102 (Oct 2020).*
Half life for degradation of contaminant in water	$t_{1/2}$	1.83E+03	days	*Professional judgement - see Table 3.7.*
Calculated decay rate	λ	3.80E-04	$days^{-1}$	
Width of plume in aquifer at source (perpendicular to flow)	Sz	6.00E+01	m	*Consistent soil conc. (tank farm/refueling)*
Plume thickness at source	Sy	2.50E+00	m	*Max thickness. Hydrock 2022 GI.*
Saturated aquifer thickness	da	2.65E+00	m	*Max thickness in wells. Hydrock 2022 GI.*
Bulk density of aquifer materials	ρ	1.59E+00	g/cm^3	*Mid gravelly sand (Domenico & Schwartz, 1990).*
Effective porosity of aquifer	n	2.75E-01	fraction	*Mid gravelly sand (Domenico & Schwartz, 1990).*
Hydraulic gradient	i	7.00E-03	fraction	*Mean across plume. Hydrock 2022 GI.*
Hydraulic conductivity of aquifer	K	2.61E+00	m/d	*Geometric mean slug testing. Hydrock 202*
Distance to compliance point	x	5.00E+01	m	*Default.*
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	
Time since pollutant entered groundwater	t	1.00E+100	days	*time variant options only*

Parameters values determined from options

Partition coefficient	Kd	7.53E+02	l/kg	*see options*
Longitudinal dispersivity	ax	5.00E+00	m	*see options*
Transverse dispersivity	az	5.00E-01	m	*see options*
Vertical dispersivity	ay	5.00E-02	m	*see options*

Select Method for deriving Partition Co-efficient (using pull down menu)

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)			
Soil water partition coefficient	Kd		l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc	3.00E-03	fraction
Organic carbon partition coefficient	Koc	2.51E+05	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc.n}$		l/kg
Sorption coefficient for ionised species	$K_{oc.i}$		l/kg
pH value	pH		
acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	7.53E+02	l/kg

Define dispersivity (click brown cell and use pull down list)

Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	m
Longitudinal dispersivity	**ax**	1.00E-04	5.00E+00	2.98E+00	m
Transverse dispersivity	**az**	1.00E-04	5.00E-01	2.98E-01	m
Vertical dispersivity	**ay**	1.00E-04	5.00E-02	2.98E-02	

Note values of dispersivity must be > 0

For calculated value, assumes ax = 0.1 *x, az = 0.01 * x, ay = 0.001 * x

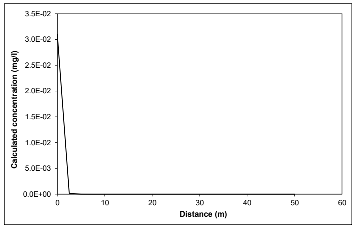
Xu & Eckstein (1995) report $ax = 0.83(\log_{10}x)^{2.414}$; az = ax/10, ay = ax/100 are assumed

Calculated Parameters	Variable		
Groundwater flow velocity	v	6.64E-02	m/d
Retardation factor	Rf	4.35E+03	fraction
Decay rate used	λ	3.80E-04	d^{-1}
Rate of contaminant flow due to retardation	u	1.53E-05	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C_{ED}	1.06E-48	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	**AF**	**2.92E+46**	

Remedial Targets

Remedial Target		**2.92E+44**	**mg/l**	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		**50**	**m**	
Concentration of contaminant at compliance point	C_{ED}/C_0	**1.06E-48**	**mg/l**	Ogata Banks
after		**1.0E+100**	**days**	

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target.
The recommended value for time when calculating the remedial target is 9.9E+99.



Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared
with the Level 3 remedial target to determine the need for further action.
Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best desribed by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	**Concentration**
	mg/l
0	**3.1E-02**
2.5	**1.50E-04**
5.0	**7.21E-07**
7.5	**3.47E-09**
10.0	**1.66E-11**
12.5	**7.89E-14**
15.0	**3.75E-16**
17.5	**1.77E-18**
20.0	**8.39E-21**
22.5	**3.97E-23**
25.0	**1.87E-25**
27.5	**8.86E-28**
30.0	**4.19E-30**
32.5	**1.98E-32**
35.0	**9.38E-35**
37.5	**4.44E-37**
40.0	**2.10E-39**
42.5	**9.96E-42**
45.0	**4.72E-44**
47.5	**2.24E-46**
50.0	**1.06E-48**

Site being assessed:	Great Western Road Yard
Completed by:	MK
Date:	########
Version:	1

Remedial Targets Worksheet , Release 3.2

Level 1 - Soil

Environment Agency

Select the method of calculating the soil water Partition Co-efficient by using the pull down menu below

Calculate for non-polar organic chemicals

Contaminant		**Aliphatic C12-16**		
Target concentration	**C_T**	**0.01**	**mg/l**	
Input Parameters	**Variable**	**Value**	**Unit**	**Source of parameter value**
Standard entry				
Water filled soil porosity	θ_W	1.57E-01	fraction	RTM calc for CHSG (unsat.). Hydrock 2022 GI data.
Air filled soil porosity	θa	2.71E-01	fraction	RTM calc for CHSG (unsat.). Hydrock 2022 GI data.
Bulk density of soil zone material	ρ	1.59E+00	g/cm^3	Mid gravelly sand (Domenico & Schwartz, 1990).
Henry's Law constant	H	5.20E+02	dimensionless	*TPH CWG Series, Volume 3*
Entry if specify partition coefficient (option)				
Soil water partition coefficient	Kd	[redacted]	l/kg	-
Entry for non-polar organic chemicals (option)				
Fraction of organic carbon (in soil)	foc	7.00E-03	fraction	Mean CHSG free of vis./olf. (unsat.). Hydrock 2022 GI.
Organic carbon partition coefficient	Koc	5.01E+06	l/kg	*TPH CWG Series, Volume 3*
Entry for ionic organic chemicals (option)				
Sorption coefficient for neutral species	$K_{oc,n}$	[redacted]	l/kg	-
Sorption coefficient for ionised species	$K_{oc,i}$	[redacted]	l/kg	-
pH value	pH	[redacted]	pH units	*Analytical data from Hydrock 2022 GI.*
Acid dissociation constant	pKa	[redacted]		-
Fraction of organic carbon (in soil)	foc	[redacted]	fraction	*Mean CHSG free of vis./olf. (unsat.). Hydrock 2022 GI.*
Soil water partition coefficient used in Level Assessment	**Kd**	**3.51E+04**	**l/kg**	*Calculated value*

This sheet calculates the Level 1 remedial target for soils(mg/kg) based on a selected target concentration and theoretical calculation of soil water partitioning. Three options are included for determining the partition coefficient.

The measured soil concentration as mg/kg should be compared with the Level 1 remedial target to determine the need for further action.

Level 1 Remedial Target

Level 1 Remedial Target	**3.52E+02**	**mg/kg**	**(for comparison with soil analyses)**
	or		
	0.01	**mg/l**	**(for comparison with leachate test results)**

Site being assessed:	Great Western Road Yard
Completed by:	MK
Date:	13-Jun-22
Version:	1

Remedial Targets Worksheet , Release 3.2

Level 2 - Soil

Contaminant		**Aliphatic C12-16**		from Level 1	
Target concentration	**C_T**	**0.01**	**mg/l**	from Level 1	

This sheet calculates the Level 2 remedial target for soils (mg/kg) or for pore water (mg/l).

The measured soil concentration as mg/kg or pore water concentration should be compared with the Level 2 remedial target to determine the need for further action. Equations presented in 'Hydrogeological risk assessment for land contamiantion' (Environment Agency 2006)

Input Parameters	**Variable**	**Value**	**Unit**	**Source of parameter value**	
Standard entry					
Infiltration	Inf	4.75E-04	m/d	**20% of mean rainfall Cheltenham (Met Office).**	
Area of contaminant source	A	0.00E+00	m^2		Not used in calculation
Entry for groundwater flow below site					
Length of contaminant source in direction of groundwater flow	L	1.00E+02	m	**Consistent soil conc. (tank farm/refueling)**	
Saturated aquifer thickness	da	2.65E+00	m	**Max thickness in wells. Hydrock 2022 GI.**	
Hydraulic Conductivity of aquifer in which dilution occurs	K	2.61E+00	m/d	**Geometric mean slug testing. Hydrock 2022 GI.**	
Hydraulic gradient of water table	i	7.00E-03	fraction	**Mean across plume. Hydrock 2022 GI.**	
Width of contaminant source perpendicular to groundwater flow	w	6.00E+01	m	**Consistent soil conc. (tank farm/refueling)**	Not used in calculation
Background concentration of contaminant in groundwater beneath site	Cu	0.00E+00	mg/l	**No background concentrations assumed**	
Define mixing zone depth by specifying or calculating depth (using pull down list)		**Calculate**			
Enter mixing zone thickness	Mz		m	Only if selected	
Calculated mixing zone thickness	Mz	2.65E+00	m		

Calculated Parameters

Dilution Factor	**DF**	**2.02E+00**		
Level 2 Remedial Target		**2.02E-02**	**mg/l**	**For comparison with measured pore water concentration. This assumes Level 1 Remedial Target is based on Target Concentra**
		or		
		7.10E+02	**mg/kg**	**For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water**

Additional option

Calculation of impact on receptor

Concentration of contaminant in contaminated discharge (entering receptor)	Cc	0.00E+00	mg/l	
Calculated concentration within receptor (dilution only)		0.00E+00	mg/l	0

Site being assessed:	Great Western Road Yard
Completed by:	MK
Date:	13-Jun-22
Version:	1

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note

Input Parameters

Input Parameters	Variable	Value	Unit	Source
Contaminant		**Aliphatic C12-16**		from Level 1
Target Concentration	C_T	**0.01**	mg/l	from Level 1
Dilution Factor	**DF**	**2.02E+00**		from Level 2

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks — **Equations in HRA publication**

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: **Apply degradation rate to pollutants in all phases (e.g. field derived value, l**

	Variable	Value	Unit	Source of parameter value
Enter source concentration		**Soil concentration as mg/kg**		
Enter soil concentration		**4970**	mg/kg	
Half life for degradation of contaminant in water	$t_{1/2}$	1.83E+03	days	*Professional judgement - see Table 3.7.*
Calculated decay rate	λ	3.80E-04	$days^{-1}$	calculated
Width of plume in aquifer at source	Sz	6.00E+01	m	from Level 2
Plume thickness in aquifer at source	Sy	2.65E+00	m	from Level 2
Bulk density of aquifer materials	ρ	1.59E+00	g/cm^3	*Mid gravelly sand (Domenico & Schwartz, 1990).*
Effective porosity of aquifer	n	2.75E-01	fraction	*Mid gravelly sand (Domenico & Schwartz, 199*
Hydraulic gradient	i	1.39E-02	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	K	2.61E+00	m/d	from Level 2
Distance to compliance point	x	5.00E+01	m	*Default.*
Distance (lateral) to compliance point perpendicular to flow direction	z		m	
Distance (depth) to compliance point perpendicular to flow direction	y		m	
Time since pollutant entered groundwater	t	1.00E+99	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	1.50E+04	l/kg	*see options*
Longitudinal dispersivity	ax	5.000	m	*see options*
Transverse dispersivity	az	0.500	m	*see options*
Vertical dispersivity	ay	0.050	m	*see options*

Parameter values should be checked against Level 1 and 2

Calculated Parameters

Calculated Parameters	Variable		
Groundwater flow velocity	v	1.32E-01	m/d
Retardation factor	Rf	8.69E+04	fraction
Decay rate used	λ	3.80E-04	d^{-1}
Hydraulic gradient used in aquifer flow down-gradient	i	1.39E-02	fraction
Rate of contaminant flow due to retardation	u	1.51E-06	m/d
Ratio of Compliance Point to Source Concentration	C_{ED}/C_0	1.80E-152	fraction
Attenuation factor (C_O/C_{ED})	**AF**	**5.55E+151**	**fraction**
Calculated soil leachate concentration	Co	1.41E-01	mg/l

Remedial Targets

Level 3 Remedial Target		**1.12E+150**	**mg/l**	For comparison with measured pore water concentration.
Ogata Banks		**or**		This assumes Level 1 Remedial Target is based on Target Concentration.
		3.94E+154	**mg/kg**	For comparison with measured soil concentration. This
Distance to compliance point		**50**	**m**	assumes Level 1 Remedial Target calculated from soil-water partitioning equation.
Ratio of Compliance Point to Source Concentration	C_{ED}/C_0	**1.80E-152**	**fraction**	Ogata Banks

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target.
The recommended value for time when calculating the remedial target is 9.9E+99

Enter method of defining partition co-efficient (using pull down list)

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)			
Soil water partition coefficient	Kd		l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc	3.00E-03	fraction
Organic carbon partition coefficient	Koc	5.01E+06	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc.n}$		l/kg
Sorption coefficient for ionised species	$K_{oc.i}$		l/kg
pH value	pH		
Acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	1.50E+04	l/kg

Define dispersivity (click brown cell and use pull down list)

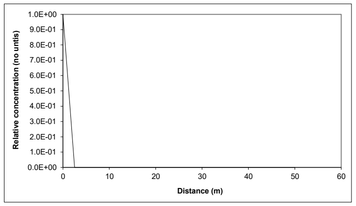
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	
Longitudinal dispersivity	**ax**	1.00E-04	5.00E+00	2.98E+00	m
Transverse dispersivity	**az**	1.00E-04	5.00E-01	2.98E-01	m
Vertical dispersivity	**ay**	1.00E-04	5.00E-02	2.98E-02	m

Note values of dispersivity must be > 0

Xu & Eckstein (1995) report $ax = 0.83(\log_{10}x)^{2.414}$; az = ax/10, ay = ax/100 are assumed

Note
This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best desribed by an electron limited degradation such as oxidation by O_2, NO_3, SO_4 etc than an alternative solution should be used



Note: 'Relative concentration' is the ratio of calculated concentation at a given position compared to the source concentration. The calculations assume plume disperses from the top of the aquifer. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

This sheet calculates the Level 3 remedial target for soils(mg/kg) or for pore water (mg/l), based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.By setting a long travel time (e.g. 9E99) it will give the steady state solution, which should always be used when calculating remedial targets.

The measured soil concentration as mg/kg or pore water concentration should be compared with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.9E+99.

Site being assessed: Great Western Road Yard
Completed by: MK
Date: ########
Version: 1

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	**Relative concentration**	**Concentration**
	(No units)	**mg/l**
0	**1.0E+00**	**7.00E-02**
2.5	**2.62E-08**	**1.84E-09**
5.0	**6.87E-16**	**4.81E-17**
7.5	**1.80E-23**	**1.26E-24**
10.0	**4.69E-31**	**3.28E-32**
12.5	**1.22E-38**	**8.52E-40**
15.0	**3.15E-46**	**2.21E-47**
17.5	**8.14E-54**	**5.70E-55**
20.0	**2.10E-61**	**1.47E-62**
22.5	**5.40E-69**	**3.78E-70**
25.0	**1.39E-76**	**9.74E-78**
27.5	**3.58E-84**	**2.51E-85**
30.0	**9.23E-92**	**6.46E-93**
32.5	**2.38E-99**	**1.66E-100**
35.0	**6.12E-107**	**4.29E-108**
37.5	**1.58E-114**	**1.10E-115**
40.0	**4.07E-122**	**2.85E-123**
42.5	**1.05E-129**	**7.34E-131**
45.0	**2.70E-137**	**1.89E-138**
47.5	**6.98E-145**	**4.89E-146**
50.0	**1.80E-152**	**1.26E-153**

R&D Publication 20 Remedial Targets Worksheet, Release 3.2

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

	Variable	Value	Unit	Source
Contaminant		**Aliphatic C12-16**		from Level 1
Target Concentration	C_T	**1.00E-02**	mg/l	from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks — **Equations in HRA publication**

Approach for simulating vertical dispersion: **Simulate vertical dispersion in 1 direction**

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: **Apply degradation rate to pollutants in all phases (e.g. field derived valu**

				Source of parameter value
Initial contaminant concentration in groundwater at plume core	C_0	1.30E+00	mg/l	*WS205 (May 2022).*
Half life for degradation of contaminant in water	$t_{1/2}$	1.83E+03	days	*Professional judgement - see Table 3.7.*
Calculated decay rate	λ	3.80E-04	$days^{-1}$	
Width of plume in aquifer at source (perpendicular to flow)	Sz	6.00E+01	m	*Consistent soil conc. (tank farm/refueling)*
Plume thickness at source	Sy	2.50E+00	m	*Max thickness. Hydrock 2022 GI.*
Saturated aquifer thickness	da	2.65E+00	m	*Max thickness in wells. Hydrock 2022 GI.*
Bulk density of aquifer materials	ρ	1.59E+00	g/cm^3	*Mid gravelly sand (Domenico & Schwartz, 1990).*
Effective porosity of aquifer	n	2.75E-01	fraction	*Mid gravelly sand (Domenico & Schwartz, 1990).*
Hydraulic gradient	i	7.00E-03	fraction	*Mean across plume. Hydrock 2022 GI.*
Hydraulic conductivity of aquifer	K	2.61E+00	m/d	*Geometric mean slug testing. Hydrock 202*
Distance to compliance point	x	5.00E+01	m	*Default.*
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	
Time since pollutant entered groundwater	t	1.00E+100	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	1.50E+04	l/kg	*see options*
Longitudinal dispersivity	ax	5.00E+00	m	*see options*
Transverse dispersivity	az	5.00E-01	m	*see options*
Vertical dispersivity	ay	5.00E-02	m	*see options*

Select Method for deriving Partition Co-efficient (using pull down menu)

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)			
Soil water partition coefficient	Kd		l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc	3.00E-03	fraction
Organic carbon partition coefficient	Koc	5.01E+06	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc.n}$		l/kg
Sorption coefficient for ionised species	$K_{oc.i}$		l/kg
pH value	pH		
acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	1.50E+04	l/kg

Define dispersivity (click brown cell and use pull down list)

Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	m
Longitudinal dispersivity	**ax**	1.00E-04	5.00E+00	2.98E+00	m
Transverse dispersivity	**az**	1.00E-04	5.00E-01	2.98E-01	m
Vertical dispersivity	**ay**	1.00E-04	5.00E-02	2.98E-02	

Note values of dispersivity must be > 0

For calculated value, assumes ax = 0.1 *x, az = 0.01 * x, ay = 0.001 * x

Xu & Eckstein (1995) report ax = $0.83(\log_{10}x)^{2.414}$; az = ax/10, ay = ax/100 are assumed

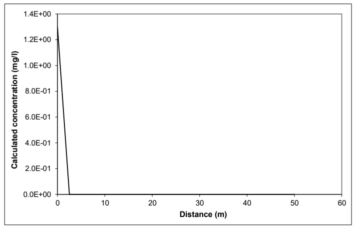
Calculated Parameters

	Variable		
Groundwater flow velocity	v	6.64E-02	m/d
Retardation factor	Rf	8.69E+04	fraction
Decay rate used	λ	3.80E-04	d^{-1}
Rate of contaminant flow due to retardation	u	7.64E-07	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C_{ED}	4.85E-215	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	**AF**	**2.68E+214**	

Remedial Targets

Remedial Target		**2.68E+212**	**mg/l**	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		**50**	**m**	
Concentration of contaminant at compliance point	**C_{ED}/C_0**	**4.85E-215**	**mg/l**	Ogata Banks
after		**1.0E+100**	**days**	

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target.
The recommended value for time when calculating the remedial target is 9.9E+99.



Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared
with the Level 3 remedial target to determine the need for further action.
Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best desribed by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed:	Great Western Road Yard
Completed by:	MK
Date:	########
Version:	1

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	**Concentration**
	mg/l
0	**1.3E+00**
2.5	**2.51E-11**
5.0	**4.83E-22**
7.5	**9.29E-33**
10.0	**1.78E-43**
12.5	**3.38E-54**
15.0	**6.41E-65**
17.5	**1.21E-75**
20.0	**2.30E-86**
22.5	**4.34E-97**
25.0	**8.20E-108**
27.5	**1.55E-118**
30.0	**2.93E-129**
32.5	**5.54E-140**
35.0	**1.05E-150**
37.5	**1.98E-161**
40.0	**3.75E-172**
42.5	**7.11E-183**
45.0	**1.35E-193**
47.5	**2.55E-204**
50.0	**4.85E-215**

Remedial Targets Worksheet , Release 3.2

Level 1 - Soil

Select the method of calculating the soil water Partition Co-efficient by using the pull down menu below

Calculate for non-polar organic chemicals

Contaminant		**Aliphatic C16-21**	
Target concentration	**C_T**	**0.01**	**mg/l**

Input Parameters	**Variable**	**Value**	**Unit**	**Source of parameter value**
Standard entry				
Water filled soil porosity	θ_W	1.57E-01	fraction	RTM calc for CHSG (unsat.). Hydrock 2022 GI data.
Air filled soil porosity	θa	2.71E-01	fraction	RTM calc for CHSG (unsat.). Hydrock 2022 GI data.
Bulk density of soil zone material	ρ	1.59E+00	g/cm^3	Mid gravelly sand (Domenico & Schwartz, 1990).
Henry's Law constant	H	4.90E+03	dimensionless	*TPH CWG Series, Volume 3*
Entry if specify partition coefficient (option)				
Soil water partition coefficient	Kd		l/kg	-
Entry for non-polar organic chemicals (option)				
Fraction of organic carbon (in soil)	foc	7.00E-03	fraction	Mean CHSG free of vis./olf. (unsat.). Hydrock 2022 GI.
Organic carbon partition coefficient	Koc	6.31E+08	l/kg	*TPH CWG Series, Volume 3*
Entry for ionic organic chemicals (option)				
Sorption coefficient for neutral species	$K_{oc,n}$		l/kg	-
Sorption coefficient for ionised species	$K_{oc,i}$		l/kg	-
pH value	pH		pH units	*Analytical data from Hydrock 2022 GI.*
Acid dissociation constant	pKa			-
Fraction of organic carbon (in soil)	foc		fraction	*Mean CHSG free of vis./olf. (unsat.). Hydrock 2022 GI.*
Soil water partition coefficient used in Level Assessment	**Kd**	**4.42E+06**	**l/kg**	*Calculated value*

This sheet calculates the Level 1 remedial target for soils(mg/kg) based on a selected target concentration and theoretical calculation of soil water partitioning. Three options are included for determining the partition coefficient.

The measured soil concentration as mg/kg should be compared with the Level 1 remedial target to determine the need for further action.

Level 1 Remedial Target

Level 1 Remedial Target	**4.42E+04**	**mg/kg**	**(for comparison with soil analyses)**
	or		
	0.01	**mg/l**	**(for comparison with leachate test results)**

Site being assessed:	Great Western Road Yard
Completed by:	MK
Date:	13-Jun-22
Version:	1

Remedial Targets Worksheet , Release 3.2

Level 2 - Soil

Contaminant		**Aliphatic C16-21**		from Level 1
Target concentration	C_T	**0.01**	**mg/l**	from Level 1

This sheet calculates the Level 2 remedial target for soils (mg/kg) or for pore water (mg/l).

The measured soil concentration as mg/kg or pore water concentration should be compared with the Level 2 remedial target to determine the need for further action. Equations presented in 'Hydrogeological risk assessment for land contamiantion' (Environment Agency 2006)

Input Parameters	**Variable**	**Value**	**Unit**	**Source of parameter value**	
Standard entry					
Infiltration	Inf	4.75E-04	m/d	**20% of mean rainfall Cheltenham (Met Office).**	
Area of contaminant source	A	0.00E+00	m^2		Not used in calculation
Entry for groundwater flow below site					
Length of contaminant source in direction of groundwater flow	L	1.00E+02	m	**Consistent soil conc. (tank farm/refueling)**	
Saturated aquifer thickness	da	2.65E+00	m	**Max thickness in wells. Hydrock 2022 GI.**	
Hydraulic Conductivity of aquifer in which dilution occurs	K	2.61E+00	m/d	**Geometric mean slug testing. Hydrock 2022 GI.**	
Hydraulic gradient of water table	i	7.00E-03	fraction	**Mean across plume. Hydrock 2022 GI.**	
Width of contaminant source perpendicular to groundwater flow	w	6.00E+01	m	**Consistent soil conc. (tank farm/refueling)**	Not used in calculation
Background concentration of contaminant in groundwater beneath site	Cu	0.00E+00	mg/l	**No background concentrations assumed**	
Define mixing zone depth by specifying or calculating depth (using pull down list)		**Calculate**			
Enter mixing zone thickness	Mz		m	Only if selected	
Calculated mixing zone thickness	Mz	2.65E+00	m		

Calculated Parameters

Dilution Factor	**DF**	**2.02E+00**		
Level 2 Remedial Target		**2.02E-02**	**mg/l**	**For comparison with measured pore water concentration. This assumes Level 1 Remedial Target is based on Target Concentra**
		or		
		8.92E+04	**mg/kg**	**For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water**

Additional option

Calculation of impact on receptor

Concentration of contaminant in contaminated discharge (entering receptor)	Cc	0.00E+00	mg/l	
Calculated concentration within receptor (dilution only)		0.00E+00	mg/l	0

Site being assessed:	Great Western Road Yard
Completed by:	MK
Date:	13-Jun-22
Version:	1

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note

Input Parameters	Variable	Value	Unit	Source
Contaminant		**Aliphatic C16-21**		from Level 1
Target Concentration	C_T	**0.01**	mg/l	from Level 1
Dilution Factor	DF	**2.02E+00**		from Level 2

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks — **Equations in HRA publication**

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: **Apply degradation rate to pollutants in all phases (e.g. field derived value, l**

	Variable	Value	Unit	Source of parameter value
Enter source concentration	**Soil concentration as mg/kg**			
Enter soil concentration		**6560**	mg/kg	
Half life for degradation of contaminant in water	$t_{1/2}$	3.65E+03	days	*Professional judgement - see Table 3.7.*
Calculated decay rate	λ	1.90E-04	$days^{-1}$	calculated
Width of plume in aquifer at source	Sz	6.00E+01	m	from Level 2
Plume thickness in aquifer at source	Sy	2.65E+00	m	from Level 2
Bulk density of aquifer materials	ρ	1.59E+00	g/cm^3	*Mid gravelly sand (Domenico & Schwartz, 1990).*
Effective porosity of aquifer	n	2.75E-01	fraction	*Mid gravelly sand (Domenico & Schwartz, 19*
Hydraulic gradient	i	1.39E-02	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	K	2.61E+00	m/d	from Level 2
Distance to compliance point	x	5.00E+01	m	*Default.*
Distance (lateral) to compliance point perpendicular to flow direction	z		m	
Distance (depth) to compliance point perpendicular to flow direction	y		m	
Time since pollutant entered groundwater	t	1.00E+99	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	1.89E+06	l/kg	*see options*
Longitudinal dispersivity	ax	5.000	m	*see options*
Transverse dispersivity	az	0.500	m	*see options*
Vertical dispersivity	ay	0.050	m	*see options*

Parameter values should be checked against Level 1 and 2

Calculated Parameters	Variable		
Groundwater flow velocity	v	1.32E-01	m/d
Retardation factor	Rf	1.09E+07	fraction
Decay rate used	λ	1.90E-04	d^{-1}
Hydraulic gradient used in aquifer flow down-gradient	i	1.39E-02	fraction
Rate of contaminant flow due to retardation	u	1.20E-08	m/d
Ratio of Compliance Point to Source Concentration	C_{ED}/C_0	0.00E+00	fraction
Attenuation factor (C_O/C_{ED})	**AF**	**ɔreakthrough at cc**	**fraction**
Calculated soil leachate concentration	Co	1.48E-03	mg/l

Remedial Targets

Level 3 Remedial Target		**No impact**	**mg/l**	For comparison with measured pore water concentration.
Ogata Banks		**or**		This assumes Level 1 Remedial Target is based on Target Concentration.
		No impact	**mg/kg**	For comparison with measured soil concentration. This
Distance to compliance point		**50**	**m**	assumes Level 1 Remedial Target calculated from soil-water partitioning equation.
Ratio of Compliance Point to Source Concentration	C_{ED}/C_0	**0.00E+00**	**fraction**	Ogata Banks

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target.
The recommended value for time when calculating the remedial target is 9.9E+99

Enter method of defining partition co-efficient (using pull down list)

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)			
Soil water partition coefficient	Kd		l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc	3.00E-03	fraction
Organic carbon partition coefficient	Koc	6.31E+08	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc.n}$		l/kg
Sorption coefficient for ionised species	$K_{oc.i}$		l/kg
pH value	pH		
Acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	1.89E+06	l/kg

Define dispersivity (click brown cell and use pull down list)

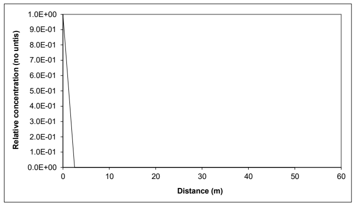
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	
Longitudinal dispersivity	**ax**	1.00E-04	5.00E+00	2.98E+00	m
Transverse dispersivity	**az**	1.00E-04	5.00E-01	2.98E-01	m
Vertical dispersivity	**ay**	1.00E-04	5.00E-02	2.98E-02	m

Note values of dispersivity must be > 0

Xu & Eckstein (1995) report $ax = 0.83(\log_{10}x)^{2.414}$; az = ax/10, ay = ax/100 are assumed

Note
This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best desribed by an electron limited degradation such as oxidation by O_2, NO_3, SO_4 etc than an alternative solution should be used



Note: 'Relative concentration' is the ratio of calculated concentation at a given position compared to the source concentration. The calculations assume plume disperses from the top of the aquifer. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

This sheet calculates the Level 3 remedial target for soils(mg/kg) or for pore water (mg/l), based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.By setting a long travel time (e.g. 9E99) it will give the steady state solution, which should always be used when calculating remedial targets.

The measured soil concentration as mg/kg or pore water concentration should be compared with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.9E+99.

Site being assessed:	Great Western Road Yard
Completed by:	MK
Date:	########
Version:	1

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	Relative concentration (No units)	Concentration mg/l
0	1.0E+00	7.35E-04
2.5	1.23E-61	9.06E-65
5.0	1.52E-122	1.12E-125
7.5	1.86E-183	1.37E-186
10.0	2.28E-244	1.68E-247
12.5	2.78E-305	0.00E+00
15.0	0.00E+00	0.00E+00
17.5	0.00E+00	0.00E+00
20.0	0.00E+00	0.00E+00
22.5	0.00E+00	0.00E+00
25.0	0.00E+00	0.00E+00
27.5	0.00E+00	0.00E+00
30.0	0.00E+00	0.00E+00
32.5	0.00E+00	0.00E+00
35.0	0.00E+00	0.00E+00
37.5	0.00E+00	0.00E+00
40.0	0.00E+00	0.00E+00
42.5	0.00E+00	0.00E+00
45.0	0.00E+00	0.00E+00
47.5	0.00E+00	0.00E+00
50.0	0.00E+00	0.00E+00

R&D Publication 20 Remedial Targets Worksheet, Release 3.2

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)	Variable	Value	Unit	Source
Contaminant		**Aliphatic C16-21**		from Level 1
Target Concentration	C_T	**1.00E-02**	mg/l	from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks — **Equations in HRA publication**

Approach for simulating vertical dispersion: **Simulate vertical dispersion in 1 direction**

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: **Apply degradation rate to pollutants in all phases (e.g. field derived valu**

				Source of parameter value
Initial contaminant concentration in groundwater at plume core	C_0	1.90E+00	mg/l	*WS205 (May 2022).*
Half life for degradation of contaminant in water	$t_{1/2}$	3.65E+03	days	*Professional judgement - see Table 3.7.*
Calculated decay rate	λ	1.90E-04	$days^{-1}$	
Width of plume in aquifer at source (perpendicular to flow)	Sz	6.00E+01	m	*Consistent soil conc. (tank farm/refueling)*
Plume thickness at source	Sy	2.50E+00	m	*Max thickness. Hydrock 2022 GI.*
Saturated aquifer thickness	da	2.65E+00	m	*Max thickness in wells. Hydrock 2022 GI.*
Bulk density of aquifer materials	ρ	1.59E+00	g/cm^3	*Mid gravelly sand (Domenico & Schwartz, 1990).*
Effective porosity of aquifer	n	2.75E-01	fraction	*Mid gravelly sand (Domenico & Schwartz, 1990).*
Hydraulic gradient	i	7.00E-03	fraction	*Mean across plume. Hydrock 2022 GI.*
Hydraulic conductivity of aquifer	K	2.61E+00	m/d	*Geometric mean slug testing. Hydrock 202*
Distance to compliance point	x	5.00E+01	m	*Default.*
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	
Time since pollutant entered groundwater	t	1.00E+100	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	1.89E+06	l/kg	*see options*
Longitudinal dispersivity	ax	5.00E+00	m	*see options*
Transverse dispersivity	az	5.00E-01	m	*see options*
Vertical dispersivity	ay	5.00E-02	m	*see options*

Calculated Parameters	Variable		
Groundwater flow velocity	v	6.64E-02	m/d
Retardation factor	Rf	1.09E+07	fraction
Decay rate used	λ	1.90E-04	d^{-1}
Rate of contaminant flow due to retardation	u	6.07E-09	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C_{ED}	0.00E+00	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	**AF**	breakthrough at compliance point	

Remedial Targets

Remedial Target	No impact	**mg/l**	For comparison with measured groundwater concentration.
Ogata Banks			
Distance to compliance point	**50**	**m**	
Concentration of contaminant at compliance point C_{ED}/C_0	**0.00E+00**	**mg/l**	Ogata Banks
after	**1.0E+100**	**days**	

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target.
The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)			
Soil water partition coefficient	Kd		l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc	3.00E-03	fraction
Organic carbon partition coefficient	Koc	6.31E+08	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc.n}$		l/kg
Sorption coefficient for ionised species	$K_{oc.i}$		l/kg
pH value	pH		
acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	1.89E+06	l/kg

Define dispersivity (click brown cell and use pull down list)

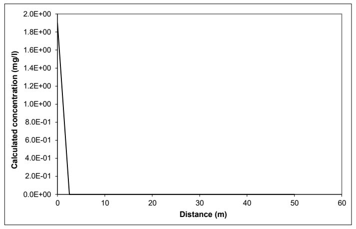
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	m
Longitudinal dispersivity	**ax**	1.00E-04	5.00E+00	2.98E+00	m
Transverse dispersivity	**az**	1.00E-04	5.00E-01	2.98E-01	m
Vertical dispersivity	**ay**	1.00E-04	5.00E-02	2.98E-02	

Note values of dispersivity must be > 0

For calculated value, assumes ax = 0.1 *x, az = 0.01 * x, ay = 0.001 * x

Xu & Eckstein (1995) report $ax = 0.83(\log_{10}x)^{2.414}$; az = ax/10, ay = ax/100 are assumed



Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared
with the Level 3 remedial target to determine the need for further action.
Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best desribed by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed:	Great Western Road Yard
Completed by:	MK
Date:	########
Version:	1

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	**Concentration**
	mg/l
0	**1.9E+00**
2.5	**3.18E-86**
5.0	**5.31E-172**
7.5	**8.85E-258**
10.0	**0.00E+00**
12.5	**0.00E+00**
15.0	**0.00E+00**
17.5	**0.00E+00**
20.0	**0.00E+00**
22.5	**0.00E+00**
25.0	**0.00E+00**
27.5	**0.00E+00**
30.0	**0.00E+00**
32.5	**0.00E+00**
35.0	**0.00E+00**
37.5	**0.00E+00**
40.0	**0.00E+00**
42.5	**0.00E+00**
45.0	**0.00E+00**
47.5	**0.00E+00**
50.0	**0.00E+00**

Remedial Targets Worksheet , Release 3.2

Level 1 - Soil

Select the method of calculating the soil water Partition Co-efficient by using the pull down menu below

Calculate for non-polar organic chemicals

Contaminant		**Aliphatic C21-35**	
Target concentration	**C_T**	**0.01**	**mg/l**

Input Parameters	**Variable**	**Value**	**Unit**	**Source of parameter value**
Standard entry				
Water filled soil porosity	θ_W	1.57E-01	fraction	RTM calc for CHSG (unsat.). Hydrock 2022 GI data.
Air filled soil porosity	θa	2.71E-01	fraction	RTM calc for CHSG (unsat.). Hydrock 2022 GI data.
Bulk density of soil zone material	ρ	1.59E+00	g/cm^3	Mid gravelly sand (Domenico & Schwartz, 1990).
Henry's Law constant	H	4.90E+03	dimensionless	*TPH CWG Series, Volume 3*
Entry if specify partition coefficient (option)				
Soil water partition coefficient	Kd		l/kg	-
Entry for non-polar organic chemicals (option)				
Fraction of organic carbon (in soil)	foc	7.00E-03	fraction	Mean CHSG free of vis./olf. (unsat.). Hydrock 2022 GI.
Organic carbon partition coefficient	Koc	6.31E+08	l/kg	*TPH CWG Series, Volume 3*
Entry for ionic organic chemicals (option)				
Sorption coefficient for neutral species	$K_{oc,n}$		l/kg	-
Sorption coefficient for ionised species	$K_{oc,i}$		l/kg	-
pH value	pH		pH units	*Analytical data from Hydrock 2022 GI.*
Acid dissociation constant	pKa			-
Fraction of organic carbon (in soil)	foc		fraction	*Mean CHSG free of vis./olf. (unsat.). Hydrock 2022 GI.*
Soil water partition coefficient used in Level Assessment	**Kd**	**4.42E+06**	**l/kg**	*Calculated value*

This sheet calculates the Level 1 remedial target for soils(mg/kg) based on a selected target concentration and theoretical calculation of soil water partitioning. Three options are included for determining the partition coefficient.

The measured soil concentration as mg/kg should be compared with the Level 1 remedial target to determine the need for further action.

Level 1 Remedial Target

Level 1 Remedial Target	**4.42E+04**	**mg/kg**	**(for comparison with soil analyses)**
	or		
	0.01	**mg/l**	**(for comparison with leachate test results)**

Site being assessed:	Great Western Road Yard
Completed by:	MK
Date:	13-Jun-22
Version:	1

Remedial Targets Worksheet , Release 3.2

Level 2 - Soil

Contaminant		**Aliphatic C21-35**		from Level 1	This sheet calculates the Level 2 remedial target for soils (mg/kg) or for pore water (mg/l).
Target concentration	**C_T**	**0.01**	**mg/l**	from Level 1	

The measured soil concentration as mg/kg or pore water concentration should be compared with the Level 2 remedial target to determine the need for further action. Equations presented in 'Hydrogeological risk assessment for land contamiantion' (Environment Agency 2006)

Input Parameters	**Variable**	**Value**	**Unit**	**Source of parameter value**	
Standard entry					
Infiltration	Inf	4.75E-04	m/d	**20% of mean rainfall Cheltenham (Met Office).**	
Area of contaminant source	A	0.00E+00	m^2		Not used in calculation
Entry for groundwater flow below site					
Length of contaminant source in direction of groundwater flow	L	1.00E+02	m	**Consistent soil conc. (tank farm/refueling)**	
Saturated aquifer thickness	da	2.65E+00	m	**Max thickness in wells. Hydrock 2022 GI.**	
Hydraulic Conductivity of aquifer in which dilution occurs	K	2.61E+00	m/d	**Geometric mean slug testing. Hydrock 2022 GI.**	
Hydraulic gradient of water table	i	7.00E-03	fraction	**Mean across plume. Hydrock 2022 GI.**	
Width of contaminant source perpendicular to groundwater flow	w	6.00E+01	m	**Consistent soil conc. (tank farm/refueling)**	Not used in calculation
Background concentration of contaminant in groundwater beneath site	Cu	0.00E+00	mg/l	**No background concentrations assumed**	
Define mixing zone depth by specifying or calculating depth (using pull down list)		**Calculate**			
Enter mixing zone thickness	Mz		m	Only if selected	
Calculated mixing zone thickness	Mz	2.65E+00	m		

Calculated Parameters

Dilution Factor	**DF**	**2.02E+00**		
Level 2 Remedial Target		**2.02E-02**	**mg/l**	**For comparison with measured pore water concentration. This assumes Level 1 Remedial Target is based on Target Concentra**
		or		
		8.92E+04	**mg/kg**	**For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water**

Additional option

Calculation of impact on receptor

Concentration of contaminant in contaminated discharge (entering receptor)	Cc	0.00E+00	mg/l	
Calculated concentration within receptor (dilution only)		0.00E+00	mg/l	0

Site being assessed:	Great Western Road Yard
Completed by:	MK
Date:	13-Jun-22
Version:	1

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note

Input Parameters	Variable	Value	Unit	Source
Contaminant		**Aliphatic C21-35**		from Level 1
Target Concentration	C_T	**0.01**	mg/l	from Level 1
Dilution Factor	DF	**2.02E+00**		from Level 2

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks — **Equations in HRA publication**

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: **Apply degradation rate to pollutants in all phases (e.g. field derived value, l**

	Variable	Value	Unit	Source of parameter value
Enter source concentration	**Soil concentration as mg/kg**			
Enter soil concentration		**2560**	mg/kg	
Half life for degradation of contaminant in water	$t_{1/2}$	5.00E+03	days	*Professional judgement - see Table 3.7.*
Calculated decay rate	λ	1.39E-04	$days^{-1}$	calculated
Width of plume in aquifer at source	Sz	6.00E+01	m	from Level 2
Plume thickness in aquifer at source	Sy	2.65E+00	m	from Level 2
Bulk density of aquifer materials	ρ	1.59E+00	g/cm^3	*Mid gravelly sand (Domenico & Schwartz, 1990).*
Effective porosity of aquifer	n	2.75E-01	fraction	*Mid gravelly sand (Domenico & Schwartz, 199*
Hydraulic gradient	i	1.39E-02	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	K	2.61E+00	m/d	from Level 2
Distance to compliance point	x	5.00E+01	m	*Default.*
Distance (lateral) to compliance point perpendicular to flow direction	z		m	
Distance (depth) to compliance point perpendicular to flow direction	y		m	
Time since pollutant entered groundwater	t	1.00E+99	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	1.89E+06	l/kg	*see options*
Longitudinal dispersivity	ax	5.000	m	*see options*
Transverse dispersivity	az	0.500	m	*see options*
Vertical dispersivity	ay	0.050	m	*see options*

Parameter values should be checked against Level 1 and 2

Calculated Parameters	Variable		
Groundwater flow velocity	v	1.32E-01	m/d
Retardation factor	Rf	1.09E+07	fraction
Decay rate used	λ	1.39E-04	d^{-1}
Hydraulic gradient used in aquifer flow down-gradient	i	1.39E-02	fraction
Rate of contaminant flow due to retardation	u	1.20E-08	m/d
Ratio of Compliance Point to Source Concentration	C_{ED}/C_0	0.00E+00	fraction
Attenuation factor (C_O/C_{ED})	**AF**	**preakthrough at c**	**fraction**
Calculated soil leachate concentration	Co	5.79E-04	mg/l

Remedial Targets

Level 3 Remedial Target		**No impact**	**mg/l**	For comparison with measured pore water concentration.
Ogata Banks		**or**		This assumes Level 1 Remedial Target is based on Target Concentration.
		No impact	**mg/kg**	For comparison with measured soil concentration. This
Distance to compliance point		**50**	**m**	assumes Level 1 Remedial Target calculated from soil-water partitioning equation.
Ratio of Compliance Point to Source Concentration	C_{ED}/C_0	**0.00E+00**	**fraction**	Ogata Banks

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target.
The recommended value for time when calculating the remedial target is 9.9E+99

Enter method of defining partition co-efficient (using pull down list)

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)			
Soil water partition coefficient	Kd		l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc	3.00E-03	fraction
Organic carbon partition coefficient	Koc	6.31E+08	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc.n}$		l/kg
Sorption coefficient for ionised species	$K_{oc.i}$		l/kg
pH value	pH		
Acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	1.89E+06	l/kg

Define dispersivity (click brown cell and use pull down list)

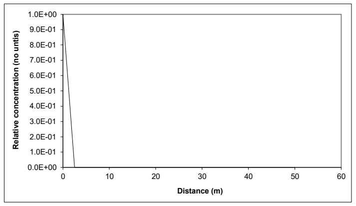
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	
Longitudinal dispersivity	**ax**	1.00E-04	5.00E+00	2.98E+00	m
Transverse dispersivity	**az**	1.00E-04	5.00E-01	2.98E-01	m
Vertical dispersivity	**ay**	1.00E-04	5.00E-02	2.98E-02	m

Note values of dispersivity must be > 0

Xu & Eckstein (1995) report ax = $0.83(\log_{10}x)^{2.414}$; az = ax/10, ay = ax/100 are assumed

Note
This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best desribed by an electron limited degradation such as oxidation by O_2, NO_3, SO_4 etc than an alternative solution should be used



Note: 'Relative concentration' is the ratio of calculated concentation at a given position compared to the source concentration. The calculations assume plume disperses from the top of the aquifer. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

This sheet calculates the Level 3 remedial target for soils(mg/kg) or for pore water (mg/l), based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.By setting a long travel time (e.g. 9E99) it will give the steady state solution, which should always be used when calculating remedial targets.

The measured soil concentration as mg/kg or pore water concentration should be compared with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.9E+99.

Site being assessed:	Great Western Road Yard
Completed by:	MK
Date:	########
Version:	1

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	Relative concentration	Concentration
	(No units)	mg/l
0	1.0E+00	2.87E-04
2.5	9.43E-53	2.71E-56
5.0	8.90E-105	2.55E-108
7.5	8.38E-157	2.40E-160
10.0	7.85E-209	2.25E-212
12.5	7.34E-261	2.11E-264
15.0	0.00E+00	0.00E+00
17.5	0.00E+00	0.00E+00
20.0	0.00E+00	0.00E+00
22.5	0.00E+00	0.00E+00
25.0	0.00E+00	0.00E+00
27.5	0.00E+00	0.00E+00
30.0	0.00E+00	0.00E+00
32.5	0.00E+00	0.00E+00
35.0	0.00E+00	0.00E+00
37.5	0.00E+00	0.00E+00
40.0	0.00E+00	0.00E+00
42.5	0.00E+00	0.00E+00
45.0	0.00E+00	0.00E+00
47.5	0.00E+00	0.00E+00
50.0	0.00E+00	0.00E+00

R&D Publication 20 Remedial Targets Worksheet, Release 3.2

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

Input Parameters (using pull down menu)	Variable	Value	Unit	Source
Contaminant		Aliphatic C21-35		from Level 1
Target Concentration	C_T	1.00E-02	mg/l	from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks — **Equations in HRA publication**

Approach for simulating vertical dispersion: **Simulate vertical dispersion in 1 direction**

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: **Apply degradation rate to pollutants in all phases (e.g. field derived valu**

	Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core	C_0	6.20E-01	mg/l	*WS205 (May 2022).*
Half life for degradation of contaminant in water	$t_{1/2}$	5.00E+03	days	*Professional judgement - see Table 3.7.*
Calculated decay rate	λ	1.39E-04	$days^{-1}$	
Width of plume in aquifer at source (perpendicular to flow)	Sz	6.00E+01	m	*Consistent soil conc. (tank farm/refueling)*
Plume thickness at source	Sy	2.50E+00	m	*Max thickness. Hydrock 2022 GI.*
Saturated aquifer thickness	da	2.65E+00	m	*Max thickness in wells. Hydrock 2022 GI.*
Bulk density of aquifer materials	ρ	1.59E+00	g/cm^3	*Mid gravelly sand (Domenico & Schwartz, 1990).*
Effective porosity of aquifer	n	2.75E-01	fraction	*Mid gravelly sand (Domenico & Schwartz, 1990).*
Hydraulic gradient	i	7.00E-03	fraction	*Mean across plume. Hydrock 2022 GI.*
Hydraulic conductivity of aquifer	K	2.61E+00	m/d	*Geometric mean slug testing. Hydrock 202*
Distance to compliance point	x	5.00E+01	m	*Default.*
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	
Time since pollutant entered groundwater	t	1.00E+100	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	1.89E+06	l/kg	*see options*
Longitudinal dispersivity	ax	5.00E+00	m	*see options*
Transverse dispersivity	az	5.00E-01	m	*see options*
Vertical dispersivity	ay	5.00E-02	m	*see options*

Calculated Parameters

Calculated Parameters	Variable		
Groundwater flow velocity	v	6.64E-02	m/d
Retardation factor	Rf	1.09E+07	fraction
Decay rate used	λ	1.39E-04	d^{-1}
Rate of contaminant flow due to retardation	u	6.07E-09	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C_{ED}	0.00E+00	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	**AF**	breakthrough at compliance point	

Remedial Targets

Remedial Target		No impact	**mg/l**	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		**50**	**m**	
Concentration of contaminant at compliance point	C_{ED}/C_0	**0.00E+00**	**mg/l**	Ogata Banks
after		**1.0E+100**	**days**	

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target.
The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)			
Soil water partition coefficient	Kd		l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc	3.00E-03	fraction
Organic carbon partition coefficient	Koc	6.31E+08	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc.n}$		l/kg
Sorption coefficient for ionised species	$K_{oc.i}$		l/kg
pH value	pH		
acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	1.89E+06	l/kg

Define dispersivity (click brown cell and use pull down list)

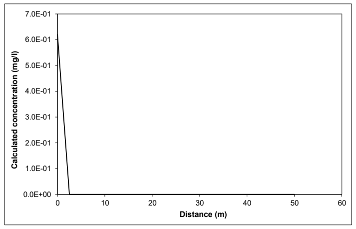
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	m
Longitudinal dispersivity	**ax**	1.00E-04	5.00E+00	2.98E+00	m
Transverse dispersivity	**az**	1.00E-04	5.00E-01	2.98E-01	m
Vertical dispersivity	**ay**	1.00E-04	5.00E-02	2.98E-02	

Note values of dispersivity must be > 0

For calculated value, assumes ax = 0.1 *x, az = 0.01 * x, ay = 0.001 * x

Xu & Eckstein (1995) report $ax = 0.83(\log_{10}x)^{2.414}$; az = ax/10, ay = ax/100 are assumed



Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared
with the Level 3 remedial target to determine the need for further action.
Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best desribed by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed: Great Western Road Yard
Completed by: MK
Date: #########
Version: 1

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	**Concentration**
	mg/l
0	**6.2E-01**
2.5	**3.32E-74**
5.0	**1.77E-147**
7.5	**9.44E-221**
10.0	**5.00E-294**
12.5	**0.00E+00**
15.0	**0.00E+00**
17.5	**0.00E+00**
20.0	**0.00E+00**
22.5	**0.00E+00**
25.0	**0.00E+00**
27.5	**0.00E+00**
30.0	**0.00E+00**
32.5	**0.00E+00**
35.0	**0.00E+00**
37.5	**0.00E+00**
40.0	**0.00E+00**
42.5	**0.00E+00**
45.0	**0.00E+00**
47.5	**0.00E+00**
50.0	**0.00E+00**

Remedial Targets Worksheet , Release 3.2

Level 1 - Soil

Select the method of calculating the soil water Partition Co-efficient by using the pull down menu below

Calculate for non-polar organic chemicals

Contaminant		**Aromatic C10-12**	
Target concentration	C_T	**0.01**	**mg/l**

Input Parameters	**Variable**	**Value**	**Unit**	**Source of parameter value**
Standard entry				
Water filled soil porosity	θ_W	1.57E-01	fraction	RTM calc for CHSG (unsat.). Hydrock 2022 GI data.
Air filled soil porosity	θa	2.71E-01	fraction	RTM calc for CHSG (unsat.). Hydrock 2022 GI data.
Bulk density of soil zone material	ρ	1.59E+00	g/cm^3	Mid gravelly sand (Domenico & Schwartz, 1990).
Henry's Law constant	H	1.40E-01	dimensionless	*TPH CWG Series, Volume 3*
Entry if specify partition coefficient (option)				
Soil water partition coefficient	Kd		l/kg	-
Entry for non-polar organic chemicals (option)				
Fraction of organic carbon (in soil)	foc	7.00E-03	fraction	Mean CHSG free of vis./olf. (unsat.). Hydrock 2022 GI.
Organic carbon partition coefficient	Koc	2.51E+03	l/kg	*TPH CWG Series, Volume 3*
Entry for ionic organic chemicals (option)				
Sorption coefficient for neutral species	$K_{oc,n}$		l/kg	-
Sorption coefficient for ionised species	$K_{oc,i}$		l/kg	-
pH value	pH		pH units	*Analytical data from Hydrock 2022 GI.*
Acid dissociation constant	pKa			-
Fraction of organic carbon (in soil)	foc		fraction	*Mean CHSG free of vis./olf. (unsat.). Hydrock 2022 GI.*
Soil water partition coefficient used in Level Assessment	**Kd**	**1.76E+01**	**l/kg**	*Calculated value*

This sheet calculates the Level 1 remedial target for soils(mg/kg) based on a selected target concentration and theoretical calculation of soil water partitioning. Three options are included for determining the partition coefficient.

The measured soil concentration as mg/kg should be compared with the Level 1 remedial target to determine the need for further action.

Level 1 Remedial Target

Level 1 Remedial Target	**1.77E-01**	**mg/kg**	**(for comparison with soil analyses)**
	or		
	0.01	**mg/l**	**(for comparison with leachate test results)**

Site being assessed:	Great Western Road Yard
Completed by:	MK
Date:	13-Jun-22
Version:	1

Remedial Targets Worksheet , Release 3.2

Level 2 - Soil

Contaminant		**Aromatic C10-12**		from Level 1
Target concentration	C_T	**0.01**	**mg/l**	from Level 1

This sheet calculates the Level 2 remedial target for soils (mg/kg) or for pore water (mg/l).

The measured soil concentration as mg/kg or pore water concentration should be compared with the Level 2 remedial target to determine the need for further action. Equations presented in 'Hydrogeological risk assessment for land contamiantion' (Environment Agency 2006)

Input Parameters	**Variable**	**Value**	**Unit**	**Source of parameter value**	
Standard entry					
Infiltration	Inf	4.75E-04	m/d	**20% of mean rainfall Cheltenham (Met Office).**	
Area of contaminant source	A	0.00E+00	m^2		Not used in calculation
Entry for groundwater flow below site					
Length of contaminant source in direction of groundwater flow	L	1.00E+02	m	**Consistent soil conc. (tank farm/refueling)**	
Saturated aquifer thickness	da	2.65E+00	m	**Max thickness in wells. Hydrock 2022 GI.**	
Hydraulic Conductivity of aquifer in which dilution occurs	K	2.61E+00	m/d	**Geometric mean slug testing. Hydrock 2022 GI.**	
Hydraulic gradient of water table	i	7.00E-03	fraction	**Mean across plume. Hydrock 2022 GI.**	
Width of contaminant source perpendicular to groundwater flow	w	6.00E+01	m	**Consistent soil conc. (tank farm/refueling)**	Not used in calculation
Background concentration of contaminant in groundwater beneath site	Cu	0.00E+00	mg/l	**No background concentrations assumed**	
Define mixing zone depth by specifying or calculating depth (using pull down list)		**Calculate**			
Enter mixing zone thickness	Mz		m	Only if selected	
Calculated mixing zone thickness	Mz	2.65E+00	m		

Calculated Parameters

Dilution Factor	**DF**	**2.02E+00**		
Level 2 Remedial Target		**2.02E-02**	**mg/l**	**For comparison with measured pore water concentration. This assumes Level 1 Remedial Target is based on Target Concentra**
		or		
		3.58E-01	**mg/kg**	**For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water**

Additional option

Calculation of impact on receptor

Concentration of contaminant in contaminated discharge (entering receptor)	Cc	0.00E+00	mg/l	
Calculated concentration within receptor (dilution only)		0.00E+00	mg/l	0

Site being assessed:	Great Western Road Yard
Completed by:	MK
Date:	13-Jun-22
Version:	1

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note

Input Parameters	Variable	Value	Unit	Source
Contaminant		Aromatic C10-12		from Level 1
Target Concentration	C_T	0.01	mg/l	from Level 1
Dilution Factor	DF	2.02E+00		from Level 2

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks — **Equations in HRA publication**

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: **Apply degradation rate to pollutants in all phases (e.g. field derived value, l**

	Variable	Value	Unit	Source of parameter value
Enter source concentration	**Soil concentration as mg/kg**			
Enter soil concentration		**360**	mg/kg	
Half life for degradation of contaminant in water	$t_{1/2}$	1.30E+02	days	*Midpoint Nahthalene Howard et al*
Calculated decay rate	λ	5.33E-03	$days^{-1}$	calculated
Width of plume in aquifer at source	Sz	6.00E+01	m	from Level 2
Plume thickness in aquifer at source	Sy	2.65E+00	m	from Level 2
Bulk density of aquifer materials	ρ	1.59E+00	g/cm^3	*Mid gravelly sand (Domenico & Schwartz, 1990).*
Effective porosity of aquifer	n	2.75E-01	fraction	*Mid gravelly sand (Domenico & Schwartz, 19*
Hydraulic gradient	i	1.39E-02	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	K	2.61E+00	m/d	from Level 2
Distance to compliance point	x	5.00E+01	m	*Default.*
Distance (lateral) to compliance point perpendicular to flow direction	z		m	
Distance (depth) to compliance point perpendicular to flow direction	y		m	
Time since pollutant entered groundwater	t	1.00E+99	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	7.54E+00	l/kg	*see options*
Longitudinal dispersivity	ax	5.000	m	*see options*
Transverse dispersivity	az	0.500	m	*see options*
Vertical dispersivity	ay	0.050	m	*see options*

Parameter values should be checked against Level 1 and 2

Calculated Parameters	Variable		
Groundwater flow velocity	v	1.32E-01	m/d
Retardation factor	Rf	4.46E+01	fraction
Decay rate used	λ	5.33E-03	d^{-1}
Hydraulic gradient used in aquifer flow down-gradient	i	1.39E-02	fraction
Rate of contaminant flow due to retardation	u	2.95E-03	m/d
Ratio of Compliance Point to Source Concentration	C_{ED}/C_0	6.70E-12	fraction
Attenuation factor (C_O/C_{ED})	**AF**	**1.49E+11**	**fraction**
Calculated soil leachate concentration	Co	2.03E+01	mg/l

Remedial Targets

Level 3 Remedial Target		**3.02E+09**	**mg/l**	For comparison with measured pore water concentration.
Ogata Banks		**or**		This assumes Level 1 Remedial Target is based on Target Concentration.
		5.34E+10	**mg/kg**	For comparison with measured soil concentration. This
Distance to compliance point		**50**	**m**	assumes Level 1 Remedial Target calculated from soil-water partitioning equation.
Ratio of Compliance Point to Source Concentration	**C_{ED}/C_0**	**6.70E-12**	**fraction**	Ogata Banks

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target.
The recommended value for time when calculating the remedial target is 9.9E+99

Enter method of defining partition co-efficient (using pull down list)

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)			
Soil water partition coefficient	Kd		l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc	3.00E-03	fraction
Organic carbon partition coefficient	Koc	2.51E+03	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc.n}$		l/kg
Sorption coefficient for ionised species	$K_{oc.i}$		l/kg
pH value	pH		
Acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	7.54E+00	l/kg

Define dispersivity (click brown cell and use pull down list)

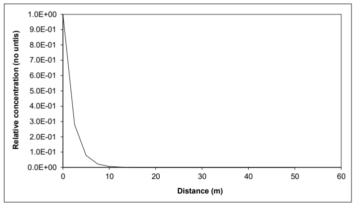
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	
Longitudinal dispersivity	**ax**	1.00E-04	5.00E+00	2.98E+00	m
Transverse dispersivity	**az**	1.00E-04	5.00E-01	2.98E-01	m
Vertical dispersivity	**ay**	1.00E-04	5.00E-02	2.98E-02	m

Note values of dispersivity must be > 0

Xu & Eckstein (1995) report $ax = 0.83(\log_{10}x)^{2.414}$; az = ax/10, ay = ax/100 are assumed

Note
This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best desribed by an electron limited degradation such as oxidation by O_2, NO_3, SO_4 etc than an alternative solution should be used



Note: 'Relative concentration' is the ratio of calculated concentation at a given position compared to the source concentration. The calculations assume plume disperses from the top of the aquifer. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

This sheet calculates the Level 3 remedial target for soils(mg/kg) or for pore water (mg/l), based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.By setting a long travel time (e.g. 9E99) it will give the steady state solution, which should always be used when calculating remedial targets.

The measured soil concentration as mg/kg or pore water concentration should be compared with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.9E+99.

Site being assessed:	Great Western Road Yard
Completed by:	MK
Date:	########
Version:	1

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	**Relative concentration (No units)**	**Concentration mg/l**
0	1.0E+00	1.01E+01
2.5	2.80E-01	2.82E+00
5.0	7.84E-02	7.89E-01
7.5	2.19E-02	2.21E-01
10.0	6.10E-03	6.14E-02
12.5	1.69E-03	1.70E-02
15.0	4.67E-04	4.70E-03
17.5	1.29E-04	1.30E-03
20.0	3.55E-05	3.57E-04
22.5	9.76E-06	9.82E-05
25.0	2.68E-06	2.70E-05
27.5	7.38E-07	7.43E-06
30.0	2.03E-07	2.04E-06
32.5	5.58E-08	5.62E-07
35.0	1.53E-08	1.55E-07
37.5	4.22E-09	4.25E-08
40.0	1.16E-09	1.17E-08
42.5	3.20E-10	3.22E-09
45.0	8.82E-11	8.88E-10
47.5	2.43E-11	2.45E-10
50.0	6.70E-12	6.74E-11

R&D Publication 20 Remedial Targets Worksheet, Release 3.2

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)	Variable	Value	Unit	Source
Contaminant		Aromatic C10-12		from Level 1
Target Concentration	C_T	1.00E-02	mg/l	from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks — **Equations in HRA publication**

Approach for simulating vertical dispersion: **Simulate vertical dispersion in 1 direction**

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: **Apply degradation rate to pollutants in all phases (e.g. field derived valu**

				Source of parameter value
Initial contaminant concentration in groundwater at plume core	C_0	2.80E-01	mg/l	*WS203 (May 2022).*
Half life for degradation of contaminant in water	$t_{1/2}$	1.30E+02	days	*Midpoint Nahthalene Howard et al*
Calculated decay rate	λ	5.33E-03	$days^{-1}$	
Width of plume in aquifer at source (perpendicular to flow)	Sz	6.00E+01	m	*Consistent soil conc. (tank farm/refueling)*
Plume thickness at source	Sy	2.50E+00	m	*Max thickness. Hydrock 2022 GI.*
Saturated aquifer thickness	da	2.65E+00	m	*Max thickness in wells. Hydrock 2022 GI.*
Bulk density of aquifer materials	ρ	1.59E+00	g/cm^3	*Mid gravelly sand (Domenico & Schwartz, 1990).*
Effective porosity of aquifer	n	2.75E-01	fraction	*Mid gravelly sand (Domenico & Schwartz, 1990).*
Hydraulic gradient	i	7.00E-03	fraction	*Mean across plume. Hydrock 2022 GI.*
Hydraulic conductivity of aquifer	K	2.61E+00	m/d	*Geometric mean slug testing. Hydrock 202*
Distance to compliance point	x	5.00E+01	m	*Default.*
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	
Time since pollutant entered groundwater	t	1.00E+100	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	7.54E+00	l/kg	*see options*
Longitudinal dispersivity	ax	5.00E+00	m	*see options*
Transverse dispersivity	az	5.00E-01	m	*see options*
Vertical dispersivity	ay	5.00E-02	m	*see options*

Calculated Parameters	Variable		
Groundwater flow velocity	v	6.64E-02	m/d
Retardation factor	Rf	4.46E+01	fraction
Decay rate used	λ	5.33E-03	d^{-1}
Rate of contaminant flow due to retardation	u	1.49E-03	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C_{ED}	9.78E-18	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	**AF**	**2.86E+16**	

Remedial Targets

Remedial Target		**2.86E+14**	**mg/l**	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		**50**	**m**	
Concentration of contaminant at compliance point	C_{ED}/C_0	**9.78E-18**	**mg/l**	Ogata Banks
after		**1.0E+100**	**days**	

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target.
The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)			
Soil water partition coefficient	Kd		l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc	3.00E-03	fraction
Organic carbon partition coefficient	Koc	2.51E+03	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc.n}$		l/kg
Sorption coefficient for ionised species	$K_{oc.i}$		l/kg
pH value	pH		
acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	7.54E+00	l/kg

Define dispersivity (click brown cell and use pull down list)

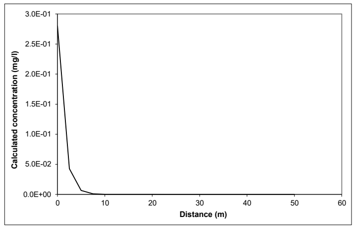
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	m
Longitudinal dispersivity	**ax**	1.00E-04	5.00E+00	2.98E+00	m
Transverse dispersivity	**az**	1.00E-04	5.00E-01	2.98E-01	m
Vertical dispersivity	**ay**	1.00E-04	5.00E-02	2.98E-02	

Note values of dispersivity must be > 0

For calculated value, assumes ax = 0.1 *x, az = 0.01 * x, ay = 0.001 * x

Xu & Eckstein (1995) report ax = $0.83(\log_{10}x)^{2.414}$; az = ax/10, ay = ax/100 are assumed



Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared
with the Level 3 remedial target to determine the need for further action.
Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best desribed by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed:	Great Western Road Yard
Completed by:	MK
Date:	########
Version:	1

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	Concentration
	mg/l
0	2.8E-01
2.5	4.28E-02
5.0	6.53E-03
7.5	9.93E-04
10.0	1.50E-04
12.5	2.26E-05
15.0	3.40E-06
17.5	5.10E-07
20.0	7.63E-08
22.5	1.14E-08
25.0	1.71E-09
27.5	2.56E-10
30.0	3.83E-11
32.5	5.73E-12
35.0	8.58E-13
37.5	1.29E-13
40.0	1.93E-14
42.5	2.89E-15
45.0	4.34E-16
47.5	6.51E-17
50.0	9.78E-18

Remedial Targets Worksheet , Release 3.2

Level 1 - Soil

Select the method of calculating the soil water Partition Co-efficient by using the pull down menu below

Calculate for non-polar organic chemicals

Contaminant		**Aromatic C12-16**		
Target concentration	**C_T**	**0.01**	**mg/l**	
Input Parameters	**Variable**	**Value**	**Unit**	**Source of parameter value**
Standard entry				
Water filled soil porosity	θ_W	1.57E-01	fraction	RTM calc for CHSG (unsat.). Hydrock 2022 GI data.
Air filled soil porosity	θa	2.71E-01	fraction	RTM calc for CHSG (unsat.). Hydrock 2022 GI data.
Bulk density of soil zone material	ρ	1.59E+00	g/cm^3	Mid gravelly sand (Domenico & Schwartz, 1990).
Henry's Law constant	H	5.30E-02	dimensionless	*TPH CWG Series, Volume 3*
Entry if specify partition coefficient (option)				
Soil water partition coefficient	Kd		l/kg	-
Entry for non-polar organic chemicals (option)				
Fraction of organic carbon (in soil)	foc	7.00E-03	fraction	Mean CHSG free of vis./olf. (unsat.). Hydrock 2022 GI.
Organic carbon partition coefficient	Koc	5.01E+03	l/kg	*TPH CWG Series, Volume 3*
Entry for ionic organic chemicals (option)				
Sorption coefficient for neutral species	$K_{oc,n}$		l/kg	-
Sorption coefficient for ionised species	$K_{oc,i}$		l/kg	-
pH value	pH		pH units	*Analytical data from Hydrock 2022 GI.*
Acid dissociation constant	pKa			-
Fraction of organic carbon (in soil)	foc		fraction	*Mean CHSG free of vis./olf. (unsat.). Hydrock 2022 GI.*
Soil water partition coefficient used in Level Assessment	**Kd**	**3.51E+01**	**l/kg**	*Calculated value*

This sheet calculates the Level 1 remedial target for soils(mg/kg) based on a selected target concentration and theoretical calculation of soil water partitioning. Three options are included for determining the partition coefficient.

The measured soil concentration as mg/kg should be compared with the Level 1 remedial target to determine the need for further action.

Level 1 Remedial Target

Level 1 Remedial Target	**3.52E-01**	**mg/kg**	**(for comparison with soil analyses)**
	or		
	0.01	**mg/l**	**(for comparison with leachate test results)**

Site being assessed:	Great Western Road Yard
Completed by:	MK
Date:	13-Jun-22
Version:	1

Remedial Targets Worksheet , Release 3.2

Level 2 - Soil

Contaminant		**Aromatic C12-16**		from Level 1	This sheet calculates the Level 2 remedial target for soils (mg/kg) or for pore water (mg/l).
Target concentration	**C_T**	**0.01**	**mg/l**	from Level 1	

The measured soil concentration as mg/kg or pore water concentration should be compared with the Level 2 remedial target to determine the need for further action. Equations presented in 'Hydrogeological risk assessment for land contamiantion' (Environment Agency 2006)

Input Parameters	**Variable**	**Value**	**Unit**	**Source of parameter value**	
Standard entry					
Infiltration	Inf	4.75E-04	m/d	**20% of mean rainfall Cheltenham (Met Office).**	
Area of contaminant source	A	0.00E+00	m^2		Not used in calculation
Entry for groundwater flow below site					
Length of contaminant source in direction of groundwater flow	L	1.00E+02	m	**Consistent soil conc. (tank farm/refueling)**	
Saturated aquifer thickness	da	2.65E+00	m	**Max thickness in wells. Hydrock 2022 GI.**	
Hydraulic Conductivity of aquifer in which dilution occurs	K	2.61E+00	m/d	**Geometric mean slug testing. Hydrock 2022 GI.**	
Hydraulic gradient of water table	i	7.00E-03	fraction	**Mean across plume. Hydrock 2022 GI.**	
Width of contaminant source perpendicular to groundwater flow	w	6.00E+01	m	**Consistent soil conc. (tank farm/refueling)**	Not used in calculation
Background concentration of contaminant in groundwater beneath site	Cu	0.00E+00	mg/l	**No background concentrations assumed**	
Define mixing zone depth by specifying or calculating depth (using pull down list)		**Calculate**			
Enter mixing zone thickness	Mz		m	Only if selected	
Calculated mixing zone thickness	Mz	2.65E+00	m		

Calculated Parameters

Dilution Factor	**DF**	**2.02E+00**		
Level 2 Remedial Target		**2.02E-02**	**mg/l**	**For comparison with measured pore water concentration. This assumes Level 1 Remedial Target is based on Target Concentra**
		or		
		7.11E-01	**mg/kg**	**For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water**

Additional option

Calculation of impact on receptor

Concentration of contaminant in contaminated discharge (entering receptor)	Cc	0.00E+00	mg/l	
Calculated concentration within receptor (dilution only)		0.00E+00	mg/l	0

Site being assessed:	Great Western Road Yard
Completed by:	MK
Date:	13-Jun-22
Version:	1

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note

Input Parameters	Variable	Value	Unit	Source
Contaminant		**Aromatic C12-16**		from Level 1
Target Concentration	C_T	**0.01**	mg/l	from Level 1
Dilution Factor	**DF**	**2.02E+00**		from Level 2

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks — **Equations in HRA publication**

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: **Apply degradation rate to pollutants in all phases (e.g. field derived value, l**

	Variable	Value	Unit	Source of parameter value
Enter source concentration	**Soil concentration as mg/kg**			
Enter soil concentration		**3000**	mg/kg	
Half life for degradation of contaminant in water	$t_{1/2}$	1.15E+02	days	*Midpoint of range for acenapthylene,acenapth*
Calculated decay rate	λ	6.03E-03	$days^{-1}$	calculated
Width of plume in aquifer at source	Sz	6.00E+01	m	from Level 2
Plume thickness in aquifer at source	Sy	2.65E+00	m	from Level 2
Bulk density of aquifer materials	ρ	1.59E+00	g/cm^3	*Mid gravelly sand (Domenico & Schwartz, 1990).*
Effective porosity of aquifer	n	2.75E-01	fraction	*Mid gravelly sand (Domenico & Schwartz, 199*
Hydraulic gradient	i	1.39E-02	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	K	2.61E+00	m/d	from Level 2
Distance to compliance point	x	5.00E+01	m	*Default.*
Distance (lateral) to compliance point perpendicular to flow direction	z		m	
Distance (depth) to compliance point perpendicular to flow direction	y		m	
Time since pollutant entered groundwater	t	1.00E+99	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	1.50E+01	l/kg	*see options*
Longitudinal dispersivity	ax	5.000	m	*see options*
Transverse dispersivity	az	0.500	m	*see options*
Vertical dispersivity	ay	0.050	m	*see options*

Parameter values should be checked against Level 1 and 2

Calculated Parameters	Variable		
Groundwater flow velocity	v	1.32E-01	m/d
Retardation factor	Rf	8.79E+01	fraction
Decay rate used	λ	6.03E-03	d^{-1}
Hydraulic gradient used in aquifer flow down-gradient	i	1.39E-02	fraction
Rate of contaminant flow due to retardation	u	1.50E-03	m/d
Ratio of Compliance Point to Source Concentration	C_{ED}/C_0	2.79E-18	fraction
Attenuation factor (C_O/C_{ED})	**AF**	**3.58E+17**	**fraction**
Calculated soil leachate concentration	Co	8.52E+01	mg/l

Remedial Targets

Level 3 Remedial Target		**7.23E+15**	**mg/l**	For comparison with measured pore water concentration.
Ogata Banks		**or**		This assumes Level 1 Remedial Target is based on Target Concentration.
		2.54E+17	**mg/kg**	For comparison with measured soil concentration. This
Distance to compliance point		**50**	**m**	assumes Level 1 Remedial Target calculated from soil-water partitioning equation.
Ratio of Compliance Point to Source Concentration	C_{ED}/C_0	**2.79E-18**	**fraction**	Ogata Banks

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target.
The recommended value for time when calculating the remedial target is 9.9E+99

Enter method of defining partition co-efficient (using pull down list)

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)			
Soil water partition coefficient	Kd		l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc	3.00E-03	fraction
Organic carbon partition coefficient	Koc	5.01E+03	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc.n}$		l/kg
Sorption coefficient for ionised species	$K_{oc.i}$		l/kg
pH value	pH		
Acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	1.50E+01	l/kg

Define dispersivity (click brown cell and use pull down list)

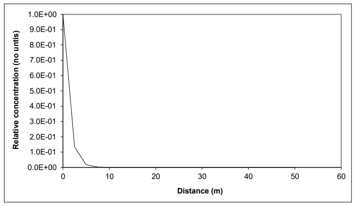
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	
Longitudinal dispersivity	**ax**	1.00E-04	5.00E+00	2.98E+00	m
Transverse dispersivity	**az**	1.00E-04	5.00E-01	2.98E-01	m
Vertical dispersivity	**ay**	1.00E-04	5.00E-02	2.98E-02	m

Note values of dispersivity must be > 0

Xu & Eckstein (1995) report $ax = 0.83(\log_{10}x)^{2.414}$; az = ax/10, ay = ax/100 are assumed

Note
This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best desribed by an electron limited degradation such as oxidation by O_2, NO_3, SO_4 etc than an alternative solution should be used



Note: 'Relative concentration' is the ratio of calculated concentation at a given position compared to the source concentration. The calculations assume plume disperses from the top of the aquifer. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

This sheet calculates the Level 3 remedial target for soils(mg/kg) or for pore water (mg/l), based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.By setting a long travel time (e.g. 9E99) it will give the steady state solution, which should always be used when calculating remedial targets.

The measured soil concentration as mg/kg or pore water concentration should be compared with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.9E+99.

Site being assessed:	Great Western Road Yard
Completed by:	MK
Date:	########
Version:	1

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	Relative concentration (No units)	Concentration mg/l
0	1.0E+00	4.22E+01
2.5	1.34E-01	5.67E+00
5.0	1.80E-02	7.62E-01
7.5	2.42E-03	1.02E-01
10.0	3.23E-04	1.36E-02
12.5	4.30E-05	1.81E-03
15.0	5.70E-06	2.40E-04
17.5	7.53E-07	3.18E-05
20.0	9.95E-08	4.20E-06
22.5	1.31E-08	5.55E-07
25.0	1.73E-09	7.32E-08
27.5	2.29E-10	9.65E-09
30.0	3.02E-11	1.27E-09
32.5	3.98E-12	1.68E-10
35.0	5.25E-13	2.22E-11
37.5	6.93E-14	2.93E-12
40.0	9.15E-15	3.86E-13
42.5	1.21E-15	5.11E-14
45.0	1.60E-16	6.75E-15
47.5	2.11E-17	8.92E-16
50.0	2.79E-18	1.18E-16

R&D Publication 20 Remedial Targets Worksheet, Release 3.2

Level 3 - Groundwater

See Note

Environment Agency

Input Parameters (using pull down menu)

Input Parameters	Variable	Value	Unit	Source
Contaminant		Aromatic C12-16		from Level 1
Target Concentration	C_T	1.00E-02	mg/l	from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks — **Equations in HRA publication**

Approach for simulating vertical dispersion: **Simulate vertical dispersion in 1 direction**

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: **Apply degradation rate to pollutants in all phases (e.g. field derived valu**

	Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core	C_0	1.10E+00	mg/l	*WS203 (March 2022).*
Half life for degradation of contaminant in water	$t_{1/2}$	1.15E+02	days	*Midpoint of range for acenapthylene,acena*
Calculated decay rate	λ	6.03E-03	$days^{-1}$	
Width of plume in aquifer at source (perpendicular to flow)	Sz	6.00E+01	m	*Consistent soil conc. (tank farm/refueling)*
Plume thickness at source	Sy	2.50E+00	m	*Max thickness. Hydrock 2022 GI.*
Saturated aquifer thickness	da	2.65E+00	m	*Max thickness in wells. Hydrock 2022 GI.*
Bulk density of aquifer materials	ρ	1.59E+00	g/cm^3	*Mid gravelly sand (Domenico & Schwartz, 1990).*
Effective porosity of aquifer	n	2.75E-01	fraction	*Mid gravelly sand (Domenico & Schwartz, 1990).*
Hydraulic gradient	i	7.00E-03	fraction	*Mean across plume. Hydrock 2022 GI.*
Hydraulic conductivity of aquifer	K	2.61E+00	m/d	*Geometric mean slug testing. Hydrock 202*
Distance to compliance point	x	5.00E+01	m	*Default.*
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	
Time since pollutant entered groundwater	t	1.00E+100	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	1.50E+01	l/kg	*see options*
Longitudinal dispersivity	ax	5.00E+00	m	*see options*
Transverse dispersivity	az	5.00E-01	m	*see options*
Vertical dispersivity	ay	5.00E-02	m	*see options*

Calculated Parameters

Calculated Parameters	Variable	Value	Unit
Groundwater flow velocity	v	6.64E-02	m/d
Retardation factor	Rf	8.79E+01	fraction
Decay rate used	λ	6.03E-03	d^{-1}
Rate of contaminant flow due to retardation	u	7.56E-04	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C_{ED}	3.67E-26	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	**AF**	**3.00E+25**	

Remedial Targets

Remedial Target		**3.00E+23**	**mg/l**	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		**50**	**m**	
Concentration of contaminant at compliance point	C_{ED}/C_0	**3.67E-26**	**mg/l**	Ogata Banks
after		**1.0E+100**	**days**	

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target.
The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)			
Soil water partition coefficient	Kd		l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc	3.00E-03	fraction
Organic carbon partition coefficient	Koc	5.01E+03	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc.n}$		l/kg
Sorption coefficient for ionised species	$K_{oc.i}$		l/kg
pH value	pH		
acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	1.50E+01	l/kg

Define dispersivity (click brown cell and use pull down list)

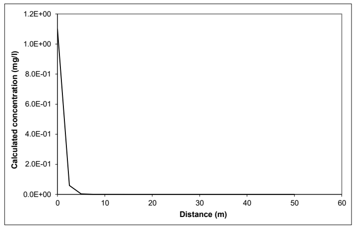
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	m
Longitudinal dispersivity	**ax**	1.00E-04	5.00E+00	2.98E+00	m
Transverse dispersivity	**az**	1.00E-04	5.00E-01	2.98E-01	m
Vertical dispersivity	**ay**	1.00E-04	5.00E-02	2.98E-02	

Note values of dispersivity must be > 0

For calculated value, assumes ax = 0.1 *x, az = 0.01 * x, ay = 0.001 * x

Xu & Eckstein (1995) report ax = $0.83(\log_{10}x)^{2.414}$; az = ax/10, ay = ax/100 are assumed



Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared
with the Level 3 remedial target to determine the need for further action.
Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best desribed by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed:	Great Western Road Yard
Completed by:	MK
Date:	########
Version:	1

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	**Concentration**
	mg/l
0	1.1E+00
2.5	5.95E-02
5.0	3.21E-03
7.5	1.73E-04
10.0	9.27E-06
12.5	4.95E-07
15.0	2.63E-08
17.5	1.40E-09
20.0	7.40E-11
22.5	3.92E-12
25.0	2.07E-13
27.5	1.10E-14
30.0	5.82E-16
32.5	3.08E-17
35.0	1.64E-18
37.5	8.67E-20
40.0	4.60E-21
42.5	2.44E-22
45.0	1.30E-23
47.5	6.90E-25
50.0	3.67E-26

Remedial Targets Worksheet , Release 3.2

Level 1 - Soil

Environment Agency

Select the method of calculating the soil water Partition Co-efficient by using the pull down menu below

Calculate for non-polar organic chemicals

Contaminant		**Aromatic C16-21**		
Target concentration	C_T	**0.01**	**mg/l**	
Input Parameters	**Variable**	**Value**	**Unit**	**Source of parameter value**
Standard entry				
Water filled soil porosity	θ_W	1.57E-01	fraction	RTM calc for CHSG (unsat.). Hydrock 2022 GI data.
Air filled soil porosity	θa	2.71E-01	fraction	RTM calc for CHSG (unsat.). Hydrock 2022 GI data.
Bulk density of soil zone material	ρ	1.59E+00	g/cm^3	Mid gravelly sand (Domenico & Schwartz, 1990).
Henry's Law constant	H	1.30E-02	dimensionless	*TPH CWG Series, Volume 3*
Entry if specify partition coefficient (option)				
Soil water partition coefficient	Kd	[redacted]	l/kg	-
Entry for non-polar organic chemicals (option)				
Fraction of organic carbon (in soil)	foc	7.00E-03	fraction	Mean CHSG free of vis./olf. (unsat.). Hydrock 2022 GI.
Organic carbon partition coefficient	Koc	1.58E+04	l/kg	*TPH CWG Series, Volume 3*
Entry for ionic organic chemicals (option)				
Sorption coefficient for neutral species	$K_{oc,n}$	[redacted]	l/kg	-
Sorption coefficient for ionised species	$K_{oc,i}$	[redacted]	l/kg	-
pH value	pH	[redacted]	pH units	*Analytical data from Hydrock 2022 GI.*
Acid dissociation constant	pKa	[redacted]		-
Fraction of organic carbon (in soil)	foc	[redacted]	fraction	*Mean CHSG free of vis./olf. (unsat.). Hydrock 2022 GI.*
Soil water partition coefficient used in Level Assessment	**Kd**	**1.11E+02**	**l/kg**	*Calculated value*

This sheet calculates the Level 1 remedial target for soils(mg/kg) based on a selected target concentration and theoretical calculation of soil water partitioning. Three options are included for determining the partition coefficient.

The measured soil concentration as mg/kg should be compared with the Level 1 remedial target to determine the need for further action.

Level 1 Remedial Target

Level 1 Remedial Target	**1.11E+00**	**mg/kg**	**(for comparison with soil analyses)**
	or		
	0.01	**mg/l**	**(for comparison with leachate test results)**

Site being assessed:	Great Western Road Yard
Completed by:	MK
Date:	13-Jun-22
Version:	1

Remedial Targets Worksheet , Release 3.2

Level 2 - Soil

Contaminant		**Aromatic C16-21**		from Level 1
Target concentration	**C_T**	**0.01**	**mg/l**	from Level 1

This sheet calculates the Level 2 remedial target for soils (mg/kg) or for pore water (mg/l).

The measured soil concentration as mg/kg or pore water concentration should be compared with the Level 2 remedial target to determine the need for further action. Equations presented in 'Hydrogeological risk assessment for land contamiantion' (Environment Agency 2006)

Input Parameters	**Variable**	**Value**	**Unit**	**Source of parameter value**	
Standard entry					
Infiltration	Inf	4.75E-04	m/d	**20% of mean rainfall Cheltenham (Met Office).**	
Area of contaminant source	A	0.00E+00	m^2		Not used in calculation
Entry for groundwater flow below site					
Length of contaminant source in direction of groundwater flow	L	1.00E+02	m	**Consistent soil conc. (tank farm/refueling)**	
Saturated aquifer thickness	da	2.65E+00	m	**Max thickness in wells. Hydrock 2022 GI.**	
Hydraulic Conductivity of aquifer in which dilution occurs	K	2.61E+00	m/d	**Geometric mean slug testing. Hydrock 2022 GI.**	
Hydraulic gradient of water table	i	7.00E-03	fraction	**Mean across plume. Hydrock 2022 GI.**	
Width of contaminant source perpendicular to groundwater flow	w	6.00E+01	m	**Consistent soil conc. (tank farm/refueling)**	Not used in calculation
Background concentration of contaminant in groundwater beneath site	Cu	0.00E+00	mg/l	**No background concentrations assumed**	
Define mixing zone depth by specifying or calculating depth (using pull down list)		**Calculate**			
Enter mixing zone thickness	Mz		m	Only if selected	
Calculated mixing zone thickness	Mz	2.65E+00	m		

Calculated Parameters

Dilution Factor	**DF**	**2.02E+00**		
Level 2 Remedial Target		**2.02E-02**	**mg/l**	**For comparison with measured pore water concentration. This assumes Level 1 Remedial Target is based on Target Concentr**
		or		
		2.24E+00	**mg/kg**	**For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water**

Additional option

Calculation of impact on receptor

Concentration of contaminant in contaminated discharge (entering receptor)	Cc	0.00E+00	mg/l	
Calculated concentration within receptor (dilution only)		0.00E+00	mg/l	0

Site being assessed:	Great Western Road Yard
Completed by:	MK
Date:	13-Jun-22
Version:	1

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note

Input Parameters	Variable	Value	Unit	Source
Contaminant		Aromatic C16-21		from Level 1
Target Concentration	C_T	**0.01**	mg/l	from Level 1
Dilution Factor	DF	**2.02E+00**		from Level 2

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks — **Equations in HRA publication**

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: **Apply degradation rate to pollutants in all phases (e.g. field derived value, l**

	Variable	Value	Unit	Source of parameter value
Enter source concentration		**Soil concentration as mg/kg**		
Enter soil concentration		**3800**	mg/kg	
Half life for degradation of contaminant in water	$t_{1/2}$	4.76E+02	days	*Midpoint of range for fluorene, anthracene, ph*
Calculated decay rate	λ	1.46E-03	$days^{-1}$	calculated
Width of plume in aquifer at source	Sz	6.00E+01	m	from Level 2
Plume thickness in aquifer at source	Sy	2.65E+00	m	from Level 2
Bulk density of aquifer materials	ρ	1.59E+00	g/cm^3	*Mid gravelly sand (Domenico & Schwartz, 1990).*
Effective porosity of aquifer	n	2.75E-01	fraction	*Mid gravelly sand (Domenico & Schwartz, 19*
Hydraulic gradient	i	1.39E-02	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	K	2.61E+00	m/d	from Level 2
Distance to compliance point	x	5.00E+01	m	*Default.*
Distance (lateral) to compliance point perpendicular to flow direction	z		m	
Distance (depth) to compliance point perpendicular to flow direction	y		m	
Time since pollutant entered groundwater	t	1.00E+99	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	4.75E+01	l/kg	*see options*
Longitudinal dispersivity	ax	5.000	m	*see options*
Transverse dispersivity	az	0.500	m	*see options*
Vertical dispersivity	ay	0.050	m	*see options*

Parameter values should be checked against Level 1 and 2

Calculated Parameters	Variable		
Groundwater flow velocity	v	1.32E-01	m/d
Retardation factor	Rf	2.75E+02	fraction
Decay rate used	λ	1.46E-03	d^{-1}
Hydraulic gradient used in aquifer flow down-gradient	i	1.39E-02	fraction
Rate of contaminant flow due to retardation	u	4.78E-04	m/d
Ratio of Compliance Point to Source Concentration	C_{ED}/C_0	9.23E-16	fraction
Attenuation factor (C_O/C_{ED})	**AF**	**1.08E+15**	**fraction**
Calculated soil leachate concentration	Co	3.43E+01	mg/l

Remedial Targets

Level 3 Remedial Target		**2.19E+13**	**mg/l**	For comparison with measured pore water concentration.
Ogata Banks		**or**		This assumes Level 1 Remedial Target is based on Target Concentration.
		2.43E+15	**mg/kg**	For comparison with measured soil concentration. This
Distance to compliance point		**50**	**m**	assumes Level 1 Remedial Target calculated from soil-water partitioning equation.
Ratio of Compliance Point to Source Concentration	C_{ED}/C_0	**9.23E-16**	**fraction**	Ogata Banks

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target.
The recommended value for time when calculating the remedial target is 9.9E+99

Enter method of defining partition co-efficient (using pull down list)

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)			
Soil water partition coefficient	Kd		l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc	3.00E-03	fraction
Organic carbon partition coefficient	Koc	1.58E+04	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc.n}$		l/kg
Sorption coefficient for ionised species	$K_{oc.i}$		l/kg
pH value	pH		
Acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	4.75E+01	l/kg

Define dispersivity (click brown cell and use pull down list)

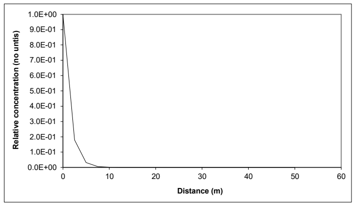
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	
Longitudinal dispersivity	**ax**	1.00E-04	5.00E+00	2.98E+00	m
Transverse dispersivity	**az**	1.00E-04	5.00E-01	2.98E-01	m
Vertical dispersivity	**ay**	1.00E-04	5.00E-02	2.98E-02	m

Note values of dispersivity must be > 0

Xu & Eckstein (1995) report ax = $0.83(\log_{10}x)^{2.414}$; az = ax/10, ay = ax/100 are assumed

Note
This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best desribed by an electron limited degradation such as oxidation by O_2, NO_3, SO_4 etc than an alternative solution should be used



Note: 'Relative concentration' is the ratio of calculated concentation at a given position compared to the source concentration. The calculations assume plume disperses from the top of the aquifer. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

This sheet calculates the Level 3 remedial target for soils(mg/kg) or for pore water (mg/l), based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.By setting a long travel time (e.g. 9E99) it will give the steady state solution, which should always be used when calculating remedial targets.

The measured soil concentration as mg/kg or pore water concentration should be compared with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.9E+99.

Site being assessed:	Great Western Road Yard
Completed by:	MK
Date:	########
Version:	1

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	Relative concentration	Concentration
	(No units)	mg/l
0	1.0E+00	1.70E+01
2.5	1.80E-01	3.05E+00
5.0	3.22E-02	5.47E-01
7.5	5.77E-03	9.80E-02
10.0	1.03E-03	1.75E-02
12.5	1.83E-04	3.11E-03
15.0	3.24E-05	5.51E-04
17.5	5.74E-06	9.74E-05
20.0	1.01E-06	1.72E-05
22.5	1.79E-07	3.03E-06
25.0	3.15E-08	5.35E-07
27.5	5.55E-09	9.43E-08
30.0	9.79E-10	1.66E-08
32.5	1.73E-10	2.93E-09
35.0	3.04E-11	5.17E-10
37.5	5.37E-12	9.12E-11
40.0	9.48E-13	1.61E-11
42.5	1.67E-13	2.84E-12
45.0	2.95E-14	5.02E-13
47.5	5.22E-15	8.86E-14
50.0	9.23E-16	1.57E-14

R&D Publication 20 Remedial Targets Worksheet, Release 3.2

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

	Variable	Value	Unit	Source
Contaminant		**Aromatic C16-21**		from Level 1
Target Concentration	C_T	**1.00E-02**	mg/l	from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks **Equations in HRA publication**

Approach for simulating vertical dispersion: **Simulate vertical dispersion in 1 direction**

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: **Apply degradation rate to pollutants in all phases (e.g. field derived valu**

				Source of parameter value
Initial contaminant concentration in groundwater at plume core	C_0	5.70E-01	mg/l	*WS203 (March 2022).*
Half life for degradation of contaminant in water	$t_{1/2}$	4.76E+02	days	*Midpoint of range for fluorene, anthracene,*
Calculated decay rate	λ	1.46E-03	$days^{-1}$	
Width of plume in aquifer at source (perpendicular to flow)	Sz	6.00E+01	m	*Consistent soil conc. (tank farm/refueling)*
Plume thickness at source	Sy	2.50E+00	m	*Max thickness. Hydrock 2022 GI.*
Saturated aquifer thickness	da	2.65E+00	m	*Max thickness in wells. Hydrock 2022 GI.*
Bulk density of aquifer materials	ρ	1.59E+00	g/cm^3	*Mid gravelly sand (Domenico & Schwartz, 1990).*
Effective porosity of aquifer	n	2.75E-01	fraction	*Mid gravelly sand (Domenico & Schwartz, 1990).*
Hydraulic gradient	i	7.00E-03	fraction	*Mean across plume. Hydrock 2022 GI.*
Hydraulic conductivity of aquifer	K	2.61E+00	m/d	*Geometric mean slug testing. Hydrock 202*
Distance to compliance point	x	5.00E+01	m	*Default.*
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	
Time since pollutant entered groundwater	t	1.00E+100	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	4.75E+01	l/kg	*see options*
Longitudinal dispersivity	ax	5.00E+00	m	*see options*
Transverse dispersivity	az	5.00E-01	m	*see options*
Vertical dispersivity	ay	5.00E-02	m	*see options*

Calculated Parameters

	Variable		
Groundwater flow velocity	v	6.64E-02	m/d
Retardation factor	Rf	2.75E+02	fraction
Decay rate used	λ	1.46E-03	d^{-1}
Rate of contaminant flow due to retardation	u	2.41E-04	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C_{ED}	6.87E-23	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	**AF**	**8.30E+21**	

Remedial Targets

Remedial Target		**8.30E+19**	**mg/l**	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		**50**	**m**	
Concentration of contaminant at compliance point	C_{ED}/C_0	**6.87E-23**	**mg/l**	Ogata Banks
after		**1.0E+100**	**days**	

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target.
The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)			
Soil water partition coefficient	Kd		l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc	3.00E-03	fraction
Organic carbon partition coefficient	Koc	1.58E+04	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc.n}$		l/kg
Sorption coefficient for ionised species	$K_{oc.i}$		l/kg
pH value	pH		
acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	4.75E+01	l/kg

Define dispersivity (click brown cell and use pull down list)

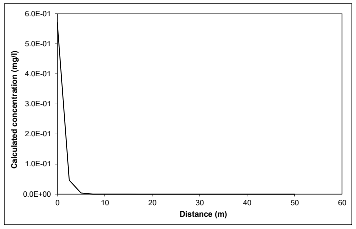
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	m
Longitudinal dispersivity	**ax**	1.00E-04	5.00E+00	2.98E+00	m
Transverse dispersivity	**az**	1.00E-04	5.00E-01	2.98E-01	m
Vertical dispersivity	**ay**	1.00E-04	5.00E-02	2.98E-02	

Note values of dispersivity must be > 0

For calculated value, assumes ax = 0.1 *x, az = 0.01 * x, ay = 0.001 * x

Xu & Eckstein (1995) report $ax = 0.83(\log_{10}x)^{2.414}$; az = ax/10, ay = ax/100 are assumed



Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared
with the Level 3 remedial target to determine the need for further action.
Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best desribed by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed:	Great Western Road Yard
Completed by:	MK
Date:	########
Version:	1

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	**Concentration**
	mg/l
0	**5.7E-01**
2.5	**4.64E-02**
5.0	**3.78E-03**
7.5	**3.06E-04**
10.0	**2.47E-05**
12.5	**1.99E-06**
15.0	**1.59E-07**
17.5	**1.27E-08**
20.0	**1.02E-09**
22.5	**8.10E-11**
25.0	**6.46E-12**
27.5	**5.15E-13**
30.0	**4.11E-14**
32.5	**3.28E-15**
35.0	**2.62E-16**
37.5	**2.09E-17**
40.0	**1.67E-18**
42.5	**1.34E-19**
45.0	**1.07E-20**
47.5	**8.57E-22**
50.0	**6.87E-23**

Remedial Targets Worksheet , Release 3.2

Level 1 - Soil

Select the method of calculating the soil water Partition Co-efficient by using the pull down menu below

Calculate for non-polar organic chemicals

Contaminant		**Aromatic C21-35**	
Target concentration	**C_T**	**0.01**	**mg/l**

Input Parameters	**Variable**	**Value**	**Unit**	**Source of parameter value**
Standard entry				
Water filled soil porosity	θ_W	1.57E-01	fraction	RTM calc for CHSG (unsat.). Hydrock 2022 GI data.
Air filled soil porosity	θa	2.71E-01	fraction	RTM calc for CHSG (unsat.). Hydrock 2022 GI data.
Bulk density of soil zone material	ρ	1.59E+00	g/cm^3	Mid gravelly sand (Domenico & Schwartz, 1990).
Henry's Law constant	H	6.70E-04	dimensionless	*TPH CWG Series, Volume 3*
Entry if specify partition coefficient (option)				
Soil water partition coefficient	Kd	[redacted]	l/kg	-
Entry for non-polar organic chemicals (option)				
Fraction of organic carbon (in soil)	foc	7.00E-03	fraction	Mean CHSG free of vis./olf. (unsat.). Hydrock 2022 GI.
Organic carbon partition coefficient	Koc	1.26E+05	l/kg	*TPH CWG Series, Volume 3*
Entry for ionic organic chemicals (option)				
Sorption coefficient for neutral species	$K_{oc,n}$	[redacted]	l/kg	-
Sorption coefficient for ionised species	$K_{oc,i}$	[redacted]	l/kg	-
pH value	pH	[redacted]	pH units	*Analytical data from Hydrock 2022 GI.*
Acid dissociation constant	pKa	[redacted]		-
Fraction of organic carbon (in soil)	foc	[redacted]	fraction	*Mean CHSG free of vis./olf. (unsat.). Hydrock 2022 GI.*
Soil water partition coefficient used in Level Assessment	**Kd**	**8.81E+02**	**l/kg**	*Calculated value*

This sheet calculates the Level 1 remedial target for soils(mg/kg) based on a selected target concentration and theoretical calculation of soil water partitioning. Three options are included for determining the partition coefficient.

The measured soil concentration as mg/kg should be compared with the Level 1 remedial target to determine the need for further action.

Level 1 Remedial Target

Level 1 Remedial Target	**8.81E+00**	**mg/kg**	**(for comparison with soil analyses)**
	or		
	0.01	**mg/l**	**(for comparison with leachate test results)**

Site being assessed:	Great Western Road Yard
Completed by:	MK
Date:	13-Jun-22
Version:	1

Remedial Targets Worksheet , Release 3.2

Level 2 - Soil

Contaminant		**Aromatic C21-35**		from Level 1
Target concentration	**C_T**	**0.01**	**mg/l**	from Level 1

This sheet calculates the Level 2 remedial target for soils (mg/kg) or for pore water (mg/l).

The measured soil concentration as mg/kg or pore water concentration should be compared with the Level 2 remedial target to determine the need for further action. Equations presented in 'Hydrogeological risk assessment for land contamiantion' (Environment Agency 2006)

Input Parameters	**Variable**	**Value**	**Unit**	**Source of parameter value**	
Standard entry					
Infiltration	Inf	4.75E-04	m/d	**20% of mean rainfall Cheltenham (Met Office).**	
Area of contaminant source	A	0.00E+00	m^2		Not used in calculation
Entry for groundwater flow below site					
Length of contaminant source in direction of groundwater flow	L	1.00E+02	m	**Consistent soil conc. (tank farm/refueling)**	
Saturated aquifer thickness	da	2.65E+00	m	**Max thickness in wells. Hydrock 2022 GI.**	
Hydraulic Conductivity of aquifer in which dilution occurs	K	2.61E+00	m/d	**Geometric mean slug testing. Hydrock 2022 GI.**	
Hydraulic gradient of water table	i	7.00E-03	fraction	**Mean across plume. Hydrock 2022 GI.**	
Width of contaminant source perpendicular to groundwater flow	w	6.00E+01	m	**Consistent soil conc. (tank farm/refueling)**	Not used in calculation
Background concentration of contaminant in groundwater beneath site	Cu	0.00E+00	mg/l	**No background concentrations assumed**	
Define mixing zone depth by specifying or calculating depth (using pull down list)		**Calculate**			
Enter mixing zone thickness	Mz		m	Only if selected	
Calculated mixing zone thickness	Mz	2.65E+00	m		

Calculated Parameters				
Dilution Factor	**DF**	**2.02E+00**		
Level 2 Remedial Target		**2.02E-02**	**mg/l**	**For comparison with measured pore water concentration. This assumes Level 1 Remedial Target is based on Target Concentra**
		or		
		1.78E+01	**mg/kg**	**For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water**

Additional option

Calculation of impact on receptor

Concentration of contaminant in contaminated discharge (entering receptor)	Cc	0.00E+00	mg/l	
Calculated concentration within receptor (dilution only)		0.00E+00	mg/l	0

Site being assessed:	Great Western Road Yard
Completed by:	MK
Date:	13-Jun-22
Version:	1

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note

Input Parameters	Variable	Value	Unit	Source
Contaminant		**Aromatic C21-35**		from Level 1
Target Concentration	C_T	**0.01**	mg/l	from Level 1
Dilution Factor	DF	**2.02E+00**		from Level 2

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks — **Equations in HRA publication**

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: **Apply degradation rate to pollutants in all phases (e.g. field derived value, l**

	Variable	Value	Unit	Source of parameter value
Enter source concentration		**Soil concentration as mg/kg**		
Enter soil concentration		**1200**	mg/kg	
Half life for degradation of contaminant in water	$t_{1/2}$	1.95E+03	days	*Midpoint of range for pyrene, benzo(a)pyrene*
Calculated decay rate	λ	3.55E-04	$days^{-1}$	calculated
Width of plume in aquifer at source	Sz	6.00E+01	m	from Level 2
Plume thickness in aquifer at source	Sy	2.65E+00	m	from Level 2
Bulk density of aquifer materials	ρ	1.59E+00	g/cm^3	*Mid gravelly sand (Domenico & Schwartz, 1990).*
Effective porosity of aquifer	n	2.75E-01	fraction	*Mid gravelly sand (Domenico & Schwartz, 19*
Hydraulic gradient	i	1.39E-02	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	K	2.61E+00	m/d	from Level 2
Distance to compliance point	x	5.00E+01	m	*Default.*
Distance (lateral) to compliance point perpendicular to flow direction	z		m	
Distance (depth) to compliance point perpendicular to flow direction	y		m	
Time since pollutant entered groundwater	t	1.00E+99	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	3.78E+02	l/kg	*see options*
Longitudinal dispersivity	ax	5.000	m	*see options*
Transverse dispersivity	az	0.500	m	*see options*
Vertical dispersivity	ay	0.050	m	*see options*

Parameter values should be checked against Level 1 and 2

Calculated Parameters	Variable		
Groundwater flow velocity	v	1.32E-01	m/d
Retardation factor	Rf	2.18E+03	fraction
Decay rate used	λ	3.55E-04	d^{-1}
Hydraulic gradient used in aquifer flow down-gradient	i	1.39E-02	fraction
Rate of contaminant flow due to retardation	u	6.02E-05	m/d
Ratio of Compliance Point to Source Concentration	C_{ED}/C_0	2.42E-22	fraction
Attenuation factor (C_O/C_{ED})	**AF**	**4.13E+21**	**fraction**
Calculated soil leachate concentration	Co	1.36E+00	mg/l

Remedial Targets

Level 3 Remedial Target		**8.34E+19**	**mg/l**	For comparison with measured pore water concentration.
Ogata Banks		**or**		This assumes Level 1 Remedial Target is based on Target Concentration.
		7.35E+22	**mg/kg**	For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water partitioning equation.
Distance to compliance point		**50**	**m**	
Ratio of Compliance Point to Source Concentration	C_{ED}/C_0	**2.42E-22**	**fraction**	Ogata Banks

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target.
The recommended value for time when calculating the remedial target is 9.9E+99

Enter method of defining partition co-efficient (using pull down list)

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)			
Soil water partition coefficient	Kd		l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc	3.00E-03	fraction
Organic carbon partition coefficient	Koc	1.26E+05	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc.n}$		l/kg
Sorption coefficient for ionised species	$K_{oc.i}$		l/kg
pH value	pH		
Acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	3.78E+02	l/kg

Define dispersivity (click brown cell and use pull down list)

Dispersivities 10%, 1%, 0.1% of pathway length

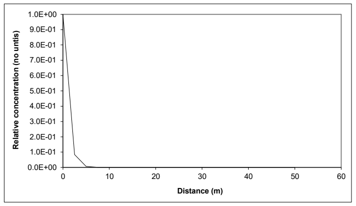
		Enter value	Calc value	Xu & Eckstein	
Longitudinal dispersivity	**ax**	1.00E-04	5.00E+00	2.98E+00	m
Transverse dispersivity	**az**	1.00E-04	5.00E-01	2.98E-01	m
Vertical dispersivity	**ay**	1.00E-04	5.00E-02	2.98E-02	m

Note values of dispersivity must be > 0

Xu & Eckstein (1995) report ax = $0.83(\log_{10}x)^{2.414}$; az = ax/10, ay = ax/100 are assumed

Note
This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best desribed by an electron limited degradation such as oxidation by O_2, NO_3, SO_4 etc than an alternative solution should be used

Environment Agency



Note: 'Relative concentration' is the ratio of calculated concentation at a given position compared to the source concentration. The calculations assume plume disperses from the top of the aquifer. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

This sheet calculates the Level 3 remedial target for soils(mg/kg) or for pore water (mg/l), based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.By setting a long travel time (e.g. 9E99) it will give the steady state solution, which should always be used when calculating remedial targets.

The measured soil concentration as mg/kg or pore water concentration should be compared with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.9E+99.

Site being assessed:	Great Western Road Yard
Completed by:	MK
Date:	########
Version:	1

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	Relative concentration (No units)	Concentration mg/l
0	1.0E+00	6.74E-01
2.5	8.42E-02	5.67E-02
5.0	7.08E-03	4.77E-03
7.5	5.95E-04	4.01E-04
10.0	4.97E-05	3.35E-05
12.5	4.14E-06	2.79E-06
15.0	3.44E-07	2.32E-07
17.5	2.85E-08	1.92E-08
20.0	2.36E-09	1.59E-09
22.5	1.95E-10	1.32E-10
25.0	1.61E-11	1.09E-11
27.5	1.33E-12	8.99E-13
30.0	1.10E-13	7.43E-14
32.5	9.11E-15	6.14E-15
35.0	7.53E-16	5.08E-16
37.5	6.23E-17	4.20E-17
40.0	5.15E-18	3.47E-18
42.5	4.26E-19	2.88E-19
45.0	3.53E-20	2.38E-20
47.5	2.92E-21	1.97E-21
50.0	2.42E-22	1.63E-22

R&D Publication 20 Remedial Targets Worksheet, Release 3.2

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)	Variable	Value	Unit	Source
Contaminant		Aromatic C21-35		from Level 1
Target Concentration	C_T	**1.00E-02**	mg/l	from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks — **Equations in HRA publication**

Approach for simulating vertical dispersion: **Simulate vertical dispersion in 1 direction**

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: **Apply degradation rate to pollutants in all phases (e.g. field derived valu**

				Source of parameter value
Initial contaminant concentration in groundwater at plume core	C_0	2.90E-01	mg/l	*WS203 (March 2022).*
Half life for degradation of contaminant in water	$t_{1/2}$	1.95E+03	days	*Midpoint of range for pyrene, benzo(a)pyre*
Calculated decay rate	λ	3.55E-04	$days^{-1}$	
Width of plume in aquifer at source (perpendicular to flow)	Sz	6.00E+01	m	*Consistent soil conc. (tank farm/refueling)*
Plume thickness at source	Sy	2.50E+00	m	*Max thickness. Hydrock 2022 GI.*
Saturated aquifer thickness	da	2.65E+00	m	*Max thickness in wells. Hydrock 2022 GI.*
Bulk density of aquifer materials	ρ	1.59E+00	g/cm^3	*Mid gravelly sand (Domenico & Schwartz, 1990).*
Effective porosity of aquifer	n	2.75E-01	fraction	*Mid gravelly sand (Domenico & Schwartz, 1990).*
Hydraulic gradient	i	7.00E-03	fraction	*Mean across plume. Hydrock 2022 GI.*
Hydraulic conductivity of aquifer	K	2.61E+00	m/d	*Geometric mean slug testing. Hydrock 202*
Distance to compliance point	x	5.00E+01	m	*Default.*
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	
Time since pollutant entered groundwater	t	1.00E+100	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	3.78E+02	l/kg	*see options*
Longitudinal dispersivity	ax	5.00E+00	m	*see options*
Transverse dispersivity	az	5.00E-01	m	*see options*
Vertical dispersivity	ay	5.00E-02	m	*see options*

Calculated Parameters	Variable		
Groundwater flow velocity	v	6.64E-02	m/d
Retardation factor	Rf	2.18E+03	fraction
Decay rate used	λ	3.55E-04	d^{-1}
Rate of contaminant flow due to retardation	u	3.04E-05	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C_{ED}	1.79E-32	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	**AF**	**1.62E+31**	

Remedial Targets

Remedial Target	**1.62E+29**	**mg/l**	For comparison with measured groundwater concentration.
Ogata Banks			
Distance to compliance point	**50**	**m**	
Concentration of contaminant at compliance point (C_{ED}/C_0)	**1.79E-32**	**mg/l**	Ogata Banks
after	**1.0E+100**	**days**	

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target.
The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)			
Soil water partition coefficient	Kd		l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc	3.00E-03	fraction
Organic carbon partition coefficient	Koc	1.26E+05	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc.n}$		l/kg
Sorption coefficient for ionised species	$K_{oc.i}$		l/kg
pH value	pH		
acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	3.78E+02	l/kg

Define dispersivity (click brown cell and use pull down list)

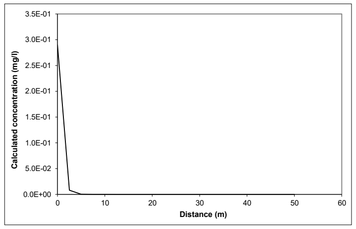
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	m
Longitudinal dispersivity	**ax**	1.00E-04	5.00E+00	2.98E+00	m
Transverse dispersivity	**az**	1.00E-04	5.00E-01	2.98E-01	m
Vertical dispersivity	**ay**	1.00E-04	5.00E-02	2.98E-02	

Note values of dispersivity must be > 0

For calculated value, assumes ax = 0.1 *x, az = 0.01 * x, ay = 0.001 * x

Xu & Eckstein (1995) report $ax = 0.83(\log_{10}x)^{2.414}$; az = ax/10, ay = ax/100 are assumed



Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared
with the Level 3 remedial target to determine the need for further action.
Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best desribed by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed: Great Western Road Yard
Completed by: MK
Date: ########
Version: 1

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	**Concentration**
	mg/l
0	**2.9E-01**
2.5	**8.10E-03**
5.0	**2.26E-04**
7.5	**6.30E-06**
10.0	**1.74E-07**
12.5	**4.81E-09**
15.0	**1.32E-10**
17.5	**3.63E-12**
20.0	**9.94E-14**
22.5	**2.72E-15**
25.0	**7.45E-17**
27.5	**2.04E-18**
30.0	**5.58E-20**
32.5	**1.53E-21**
35.0	**4.19E-23**
37.5	**1.15E-24**
40.0	**3.15E-26**
42.5	**8.65E-28**
45.0	**2.38E-29**
47.5	**6.52E-31**
50.0	**1.79E-32**

Appendix G CLEA Model Settings & Results

CLEA Software Version 1.071

Report generated 23/06/2022

Report title Detailed Quantitative Risk Assessment, Great Western Road, Gloucester

Created by Matthew Keehn at Hydrock

BASIC SETTINGS

Land Use Residential with produce (C4SL)

Building Medium/large terraced house
Receptor Female (res C4SL) Start age class 1 End age class 6 Exposure Duration 6 years
Soil Sand

Exposure Pathways

Direct soil and dust ingestion ☒
Consumption of homegrown produce ☒
Soil attached to homegrown produce ☒

Dermal contact with indoor dust ☒
Dermal contact with soil ☒

Inhalation of indoor dust ☒
Inhalation of soil dust ☒
Inhalation of indoor vapour ☑
Inhalation of outdoor vapour ☑

Land Use Residential with produce (C4SL)

Receptor Female (res C4SL)

Age Class	Exposure Frequencies (days yr^{-1})						Occupation Periods (hr day^{-1})		Soil to skin adherence factors (mg cm^{2})						Max exposed skin factor		
	Direct soil ingestion	Consumption of homegrown produce	Dermal contact with indoor dust	Dermal contact with soil	Inhalation of dust and vapour, indoor	Inhalation of dust and vapour, outdoor	Indoors	Outdoors	Indoor	Outdoor	Direct soil ingestion rate (g day^{-1})	Body weight (kg)	Body height (m)	Inhalation rate (m^{3} day^{-1})	Indoor (m^{2} m^{-2})	Outdoor (m^{2} m^{-2})	Total skin area (m^{2})
1	180	180	180	170	365	365	23.0	1.0	0.06	0.10	0.10	5.60	0.7	5.4	0.32	0.26	3.43E-01
2	365	365	365	170	365	365	23.0	1.0	0.06	0.10	0.10	9.80	0.8	8.0	0.33	0.26	4.84E-01
3	365	365	365	170	365	365	23.0	1.0	0.06	0.10	0.10	12.70	0.9	8.9	0.32	0.25	5.82E-01
4	365	365	365	170	365	365	23.0	1.0	0.06	0.10	0.10	15.10	0.9	10.1	0.35	0.28	6.36E-01
5	365	365	365	170	365	365	19.0	1.0	0.06	0.10	0.10	16.90	1.0	10.1	0.35	0.28	7.04E-01
6	365	365	365	170	365	365	19.0	1.0	0.06	0.10	0.10	19.70	1.1	10.1	0.33	0.26	7.94E-01
7	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	22.10	1.2	12.0	0.22	0.15	8.73E-01
8	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	25.30	1.2	12.0	0.22	0.15	9.36E-01
9	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	27.50	1.3	12.0	0.22	0.15	1.01E+00
10	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	31.40	1.3	12.0	0.22	0.15	1.08E+00
11	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	35.70	1.4	12.0	0.22	0.14	1.19E+00
12	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	41.30	1.4	15.2	0.22	0.14	1.29E+00
13	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	47.20	1.5	15.2	0.22	0.14	1.42E+00
14	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	51.20	1.6	15.2	0.22	0.14	1.52E+00
15	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	56.70	1.6	15.2	0.21	0.14	1.60E+00
16	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	59.00	1.6	15.2	0.21	0.14	1.63E+00
17	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	70.00	1.6	15.7	0.33	0.27	1.78E+00
18	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	70.90	1.6	13.6	0.33	0.27	1.80E+00

Consumption Rates

Consumption rates (g FW kg^{-1} bodyweight day^{-1}) by Produce Group

Age Class	MEAN RATES						90TH PERCENTILE RATES					
	Green veg	Root veg	Tuber veg	Herb. Fruit	Shrub fruit	Tree fruit	Green veg	Root veg	Tuber veg	Herb. Fruit	Shrub fruit	Tree fruit
1	3.47E+00	5.22E+00	9.22E+00	8.90E-01	1.07E+00	1.87E+00	7.12E+00	1.07E+01	1.60E+01	1.83E+00	2.23E+00	3.82E+00
2	3.34E+00	1.61E+00	3.14E+00	1.93E+00	2.60E-01	5.84E+00	5.87E+00	2.83E+00	6.60E+00	3.39E+00	4.60E-01	1.03E+01
3	3.34E+00	1.61E+00	3.14E+00	1.93E+00	2.60E-01	5.84E+00	5.87E+00	2.83E+00	6.60E+00	3.39E+00	4.60E-01	1.03E+01
4	3.34E+00	1.61E+00	3.14E+00	1.93E+00	2.60E-01	5.84E+00	5.87E+00	2.83E+00	6.60E+00	3.39E+00	4.60E-01	1.03E+01
5	2.54E+00	1.20E+00	2.65E+00	1.25E+00	1.10E-01	2.89E+00	4.53E+00	2.14E+00	4.95E+00	2.24E+00	1.90E-01	5.16E+00
6	2.54E+00	1.20E+00	2.65E+00	1.25E+00	1.10E-01	2.89E+00	4.53E+00	2.14E+00	4.95E+00	2.24E+00	1.90E-01	5.16E+00
7	2.54E+00	1.20E+00	2.65E+00	1.25E+00	1.10E-01	2.89E+00	4.53E+00	2.14E+00	4.95E+00	2.24E+00	1.90E-01	5.16E+00
8	2.54E+00	1.20E+00	2.65E+00	1.25E+00	1.10E-01	2.89E+00	4.53E+00	2.14E+00	4.95E+00	2.24E+00	1.90E-01	5.16E+00
9	2.54E+00	1.20E+00	2.65E+00	1.25E+00	1.10E-01	2.89E+00	4.53E+00	2.14E+00	4.95E+00	2.24E+00	1.90E-01	5.16E+00
10	2.54E+00	1.20E+00	2.65E+00	1.25E+00	1.10E-01	2.89E+00	4.53E+00	2.14E+00	4.95E+00	2.24E+00	1.90E-01	5.16E+00
11	2.54E+00	1.20E+00	2.65E+00	1.25E+00	1.10E-01	2.89E+00	4.53E+00	2.14E+00	4.95E+00	2.24E+00	1.90E-01	5.16E+00
12	1.03E+00	4.90E-01	1.60E+00	5.10E-01	4.00E-02	1.18E+00	1.87E+00	8.90E-01	3.05E+00	9.30E-01	8.00E-02	2.13E+00
13	1.03E+00	4.90E-01	1.60E+00	5.10E-01	4.00E-02	1.18E+00	1.87E+00	8.90E-01	3.05E+00	9.30E-01	8.00E-02	2.13E+00
14	1.03E+00	4.90E-01	1.60E+00	5.10E-01	4.00E-02	1.18E+00	1.87E+00	8.90E-01	3.05E+00	9.30E-01	8.00E-02	2.13E+00
15	1.03E+00	4.90E-01	1.60E+00	5.10E-01	4.00E-02	1.18E+00	1.87E+00	8.90E-01	3.05E+00	9.30E-01	8.00E-02	2.13E+00
16	1.03E+00	4.90E-01	1.60E+00	5.10E-01	4.00E-02	1.18E+00	1.87E+00	8.90E-01	3.05E+00	9.30E-01	8.00E-02	2.13E+00
17	1.26E+00	6.00E-01	1.18E+00	6.90E-01	9.00E-02	1.27E+00	2.36E+00	1.12E+00	2.35E+00	1.29E+00	1.80E-01	2.38E+00
18	1.35E+00	6.40E-01	1.25E+00	7.40E-01	1.00E-01	1.36E+00	2.34E+00	1.12E+00	2.36E+00	1.28E+00	1.80E-01	2.37E+00

Top 2 applied? Yes

Where top 2 method is applied, two produce categories use 90th percentile rates, while the remainder use the mean. Produce categories vary on a chemical-by-chemical basis. Where top 2 method is not used, all produce categories for all chemicals assume 90th percentile rates.

Building Medium/large terraced house

Soil Sand

Building footprint (m^2)	4.40E+01
Living space air exchange rate (hr^{-1})	5.00E-01
Living space height (above ground, m)	4.80E+00
Living space height (below ground, m)	0.00E+00
Pressure difference (soil to enclosed space, Pa)	3.10E+00
Foundation thickness (m)	1.50E-01
Floor crack area (cm^2)	5.31E+02
Dust loading factor (μg m^{-3})	5.00E+01

Porosity, Total (cm^3 cm^{-3})	5.40E-01
Porosity, Air-Filled (cm^3 cm^{-3})	3.00E-01
Porosity, Water-Filled (cm^3 cm^{-3})	2.40E-01
Residual soil water content (cm^3 cm^{-3})	7.00E-02
Saturated hydraulic conductivity (cm s^{-1})	7.36E-03
van Genuchten shape parameter *m* (dimensionless)	3.51E-01
Bulk density (g cm^{-3})	1.18E+00
Threshold value of wind speed at 10m (m s^{-1})	7.20E+00
Empirical function (F$_x$) for dust model (dimensionless)	1.22E+00
Ambient soil temperature (K)	2.83E+02

Soil pH	8.50E+00
Soil Organic Matter content (%)	1.00E+00
Fraction of organic carbon (g g^{-1})	5.80E-03

Effective total fluid saturation (unitless)	3.62E-01
Intrinsic soil permeability (cm^2)	9.83E-08
Relative soil air permeability (unitless)	7.68E-01
Effective air permeability (cm^2)	7.54E-08

Soil - Vapour Model

Depth to top of source (no building) (cm)	**110**
Depth to top of source (beneath building) (cm)	**110**
Default soil gas ingress rate?	**No**
Soil gas ingress rate (cm^3 s^{-1})	4.44E+01
Building ventilation rate (cm^3 s^{-1})	2.93E+04
Averaging time surface emissions (yr)	6
Finite vapour source model?	**Yes**
Thickness of contaminated layer (cm)	**250**

Air Dispersion Model

Mean annual windspeed at 10m (m s^{-1})		5.00
Air dispersion factor at height of 0.8m *		2400.00
Air dispersion factor at height of 1.6m *		0.00
Fraction of site cover (m^2 m^{-2})		0.75

* Air dispersion factor in g m^{-2} s^{-1} per kg m^{-3}

Soil - Plant Model

	Dry weight conversion factor	Homegrown fraction Average	Homegrown fraction High	Soil loading factor	Preparation correction factor
	g DW g^{-1} FW	dimensionless		g g^{-1} DW	dimensionless
Green vegetables	0.096	0.05	0.33	1.00E-03	2.00E-01
Root vegetables	0.103	0.06	0.40	1.00E-03	1.00E+00
Tuber vegetables	0.210	0.02	0.13	1.00E-03	1.00E+00
Herbaceous fruit	0.058	0.06	0.40	1.00E-03	6.00E-01
Shrub fruit	0.166	0.09	0.60	1.00E-03	6.00E-01
Tree fruit	0.157	0.04	0.27	1.00E-03	6.00E-01

Gardener type Average

CLEA Software Version 1.071

Report generated	23-Jun-22
Report title	Detailed Quantitative Risk Assessment, Great Western Road, Gloucester
Created by	Matthew Keehn at Hydrock

RESULTS

Environment Agency

		Assessment Criterion (mg kg^{-1})			Ratio of ADE to HCV			Saturation Limit (mg kg^{-1})	50% rule?		Top Two applied?	Apply Top 2 Approach to Produce Group					
		oral	inhalation	combined	oral	inhalation	combined		Oral	Inhal		Green vegetables	Root vegetables	Tuber vegetables	Herbaceous fruit	Shrub fruit	Tree fruit
1	TPH ali >EC10-EC12	NR	1.30E+02	1.30E+02	0.00	1.00	1.00	4.77E+01 (vap)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2	TPH ali >EC12-EC16	NR	7.52E+02	7.52E+02	0.00	1.00	1.00	2.37E+01 (sol)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3	TPH ali >EC16-EC35	8.11E+04	NR	NR	1.00	NR	NR	8.48E+00 (sol)	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4	TPH aro >EC10-EC12	NR	1.73E+02	1.73E+02	0.00	1.00	1.00	3.62E+02 (sol)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
5	TPH aro >EC12-EC16	NR	1.81E+03	1.81E+03	0.00	1.00	1.00	1.68E+02 (sol)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
6	TPH aro >EC16-EC21	4.40E+04	NR	NR	1.00	NR	NR	5.36E+01 (vap)	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
7	TPH aro >EC21-EC35	6.87E+06	NR	NR	1.00	NR	NR	4.83E+00 (sol)	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
8																	
9																	
10																	
11																	
12																	
13																	
14																	
15																	
16																	
17																	
18																	
19																	
20																	

	Assessment Criterion (mg kg^{-1})			Ratio of ADE to HCV			Saturation Limit (mg kg^{-1})	50% rule?		Top Two applied?	Apply Top 2 Approach to Produce Group					
	oral	inhalation	combined	oral	inhalation	combined		Oral	Inhal		Green vegetables	Root vegetables	Tuber vegetables	Herbaceous fruit	Shrub fruit	Tree fruit
21																
22																
23																
24																
25																
26																
27																
28																
29																
30																

		Soil Distribution				Media Concentrations															
		Sorbed	Dissolved	Vapour	Total	Soil	Soil gas	Indoor Dust	Outdoor dust at 0.8m	Outdoor dust at 1.6m	Indoor Vapour	Outdoor vapour at 0.8m	Outdoor vapour at 1.6m	Green vegetables	Root vegetables	Tuber vegetables	Herbaceous fruit	Shrub fruit	Tree fruit
		%	%	%	%	mg kg^{-1}	mg m^{-3}	mg kg^{-1}	mg m^{-3}	mg m^{-3}	mg m^{-3}	mg m^{-3}	mg m^{-3}	mg kg^{-1} FW	mg kg^{-1} FW	mg kg^{-1} FW	mg kg^{-1} FW	mg kg^{-1} FW	mg kg^{-1} FW
1	TPH ali >EC10-EC12	98.8	0.0	1.2	100.0	1.30E+02	5.94E+03	NA	NA	NA	2.23E-01	8.43E-04	0.00E+00	NA	NA	NA	NA	NA	NA
2	TPH ali >EC12-EC16	99.9	0.0	0.1	100.0	7.52E+02	4.12E+03	NA	NA	NA	2.23E-01	9.72E-04	0.00E+00	NA	NA	NA	NA	NA	NA
3	TPH ali >EC16-EC35	100.0	0.0	0.0	100.0	8.11E+04	2.60E+04	NA	NA	NA	1.54E+00	6.13E-03	0.00E+00	NA	NA	NA	NA	NA	NA
4	TPH aro >EC10-EC12	98.5	1.4	0.1	100.0	1.73E+02	8.45E+02	NA	NA	NA	4.62E-02	1.99E-04	0.00E+00	NA	NA	NA	NA	NA	NA
5	TPH aro >EC12-EC16	99.3	0.7	0.0	100.0	1.81E+03	7.80E+02	NA	NA	NA	4.62E-02	1.85E-04	0.00E+00	NA	NA	NA	NA	NA	NA
6	TPH aro >EC16-EC21	99.8	0.2	0.0	100.0	4.40E+04	3.73E+02	NA	NA	NA	2.31E-02	9.38E-05	0.00E+00	NA	NA	NA	NA	NA	NA
7	TPH aro >EC21-EC35	100.0	0.0	0.0	100.0	6.87E+06	2.33E+02	NA	NA	NA	2.31E-02	1.60E-04	0.00E+00	NA	NA	NA	NA	NA	NA
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Environment Agency

	Soil Distribution				Media Concentrations															
	Sorbed	Dissolved	Vapour	Total	Soil	Soil gas	Indoor Dust	Outdoor dust at 0.8m	Outdoor dust at 1.6m	Indoor Vapour	Outdoor vapour at 0.8m	Outdoor vapour at 1.6m	Green vegetables	Root vegetables	Tuber vegetables	Herbaceous fruit	Shrub fruit	Tree fruit
	%	%	%	%	mg kg^{-1}	mg m^{-3}	mg kg^{-1}	mg m^{-3}	mg m^{-3}	mg m^{-3}	mg m^{-3}	mg m^{-3}	mg kg^{-1} FW	mg kg^{-1} FW	mg kg^{-1} FW	mg kg^{-1} FW	mg kg^{-1} FW	mg kg^{-1} FW
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		Average Daily Exposure (mg kg^{-1} bw day^{-1})							Distribution by Pathway (%)							
		Direct soil ingestion	Consumption of homegrown produce and attached soil	Dermal contact with soil and dust	Inhalation of dust	Inhalation of vapour	Background (oral)	Background (inhalation)	Direct soil ingestion	Consumption of homegrown produce and attached soil	Dermal contact with soil and dust	Inhalation of dust	Inhalation of vapour (indoor)	Inhalation of vapour (outdoor)	Background (oral)	Background (inhalation)
1	TPH ali >EC10-EC12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.45E-01	5.62E+95	6.06E+95	0.00	0.00	0.00	0.00	49.99	0.01	0.00	50.00
2	TPH ali >EC12-EC16	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.45E-01	5.62E+95	6.06E+95	0.00	0.00	0.00	0.00	49.99	0.01	0.00	50.00
3	TPH ali >EC16-EC35	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.00E+00	5.62E+95	0.00E+00	0.00	0.00	0.00	0.00	49.99	0.01	50.00	0.00
4	TPH aro >EC10-EC12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.00E-02	5.62E+95	6.06E+95	0.00	0.00	0.00	0.00	49.99	0.01	0.00	50.00
5	TPH aro >EC12-EC16	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.00E-02	5.62E+95	6.06E+95	0.00	0.00	0.00	0.00	49.99	0.01	0.00	50.00
6	TPH aro >EC16-EC21	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.50E-02	5.62E+95	0.00E+00	0.00	0.00	0.00	0.00	49.99	0.01	50.00	0.00
7	TPH aro >EC21-EC35	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.50E-02	5.62E+95	0.00E+00	0.00	0.00	0.00	0.00	49.98	0.02	50.00	0.00
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	Average Daily Exposure (mg kg^{-1} bw day^{-1})							Distribution by Pathway (%)							
	Direct soil ingestion	Consumption of homegrown produce and attached soil	Dermal contact with soil and dust	Inhalation of dust	Inhalation of vapour	Background (oral)	Background (inhalation)	Direct soil ingestion	Consumption of homegrown produce	Dermal contact with soil and dust	Inhalation of dust	Inhalation of vapour (indoor)	Inhalation of vapour (outdoor)	Background (oral)	Background (inhalation)
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		Oral Health Criteria Value (µg kg^{-1} BW day^{-1})		Inhalation Health Criteria Value (µg kg^{-1} BW day^{-1})		(µg day^{-1})	(µg day^{-1})	Air-water partition coefficient (K_{aw}) (cm^3 cm^{-3})	Coefficient of Diffusion in Air (m^2 s^{-1})	Coefficient of Diffusion in Water (m^2 s^{-1})	log K_{oc} (cm^3 g^{-1})	log K_{ow} (dimensionless)	Dermal Absorption Fraction (dimensionless)	Soil-to-dust transport factor (g g^{-1} DW)	Sub-surface soil to indoor air correction factor (dimensionless)	Relative bioavailability via soil ingestion (unitless)	Relative bioavailability via dust inhalation (unitless)
1	TPH ali >EC10-EC12	TDI	100	TDI	290	1E+100	1E+100	6.44E+01	1.00E-05	1.00E-09	5.38	6.3	0.1	0.5	10	1	1
2	TPH ali >EC12-EC16	TDI	100	TDI	290	1E+100	1E+100	1.71E+02	1.00E-05	1.00E-09	6.73	7.94	0.1	0.5	10	1	1
3	TPH ali >EC16-EC35	TDI	2000	NR	0	1E+100	NR	1.07E+03	1.00E-05	1.00E-09	8.76	10.39	0.1	0.5	10	1	1
4	TPH aro >EC10-EC12	TDI	40	TDI	60	1E+100	1E+100	7.22E-02	1.00E-05	1.00E-09	3.4	3.93	0.1	0.5	10	1	1
5	TPH aro >EC12-EC16	TDI	40	TDI	60	1E+100	1E+100	1.26E-02	1.00E-05	1.00E-09	3.7	4.29	0.1	0.5	10	1	1
6	TPH aro >EC16-EC21	TDI	30	NR	0	1E+100	NR	6.95E-04	1.00E-05	1.00E-09	4.15	4.82	0.1	0.5	10	1	1
7	TPH aro >EC21-EC35	TDI	30	NR	0	1E+100	NR	2.48E-05	1.00E-05	1.00E-09	5.1	5.95	0.1	0.5	10	1	1
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		Oral Health Criteria Value (µg kg^{-1} BW day^{-1})		Inhalation Health Criteria Value (µg kg^{-1} BW day^{-1})	(µg day^{-1})	(µg day^{-1})	Air-water partition coefficient (K_{aw}) (cm^3 cm^{-3})	Coefficient of Diffusion in Air (m^2 s^{-1})	Coefficient of Diffusion in Water (m^2 s^{-1})	log K_{oc} (cm^3 g^{-1})	log K_{ow} (dimensionless)	Dermal Absorption Fraction (dimensionless)	Soil-to-dust transport factor (g g^{-1} DW)	Sub-surface soil to indoor air correction factor (dimensionless)	Relative bioavailability via soil ingestion (unitless)	Relative bioavailability via dust inhalation (unitless)
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		Soil-to-water partition coefficient (cm ^{3} g $^{-1}$)	Vapour pressure (Pa)	Water solubility (mg L $^{-1}$)	Soil-to-plant concentration factor for green vegetables (mg g $^{-1}$ plant DW or FW basis over mg g $^{-1}$ DW soil)	Soil-to-plant concentration factor for root vegetables (mg g $^{-1}$ plant DW or FW basis over mg g $^{-1}$ DW soil)	Soil-to-plant concentration factor for tuber vegetables (mg g $^{-1}$ plant DW or FW basis over mg g $^{-1}$ DW soil)	Soil-to-plant concentration factor for herbaceous fruit (mg g $^{-1}$ plant DW or FW basis over mg g $^{-1}$ DW soil)	Soil-to-plant concentration factor for shrub fruit (mg g $^{-1}$ plant DW or FW basis over mg g $^{-1}$ DW soil)	Soil-to-plant concentration factor for tree fruit (mg g $^{-1}$ plant DW or FW basis over mg g $^{-1}$ DW soil)
1	TPH ali >EC10-EC12	1.39E+03	3.21E+01	3.39E-02	model	model	model	model	model	model
2	TPH ali >EC12-EC16	3.11E+04	1.53E+00	7.59E-04	model	model	model	model	model	model
3	TPH ali >EC16-EC35	3.34E+06	2.38E-02	2.54E-06	model	model	model	model	model	model
4	TPH aro >EC10-EC12	1.46E+01	3.21E+01	2.45E+01	model	model	model	model	model	model
5	TPH aro >EC12-EC16	2.91E+01	1.14E+00	5.75E+00	model	model	model	model	model	model
6	TPH aro >EC16-EC21	8.19E+01	5.62E-03	6.53E-01	model	model	model	model	model	model
7	TPH aro >EC21-EC35	7.30E+02	1.61E-06	6.61E-03	model	model	model	model	model	model
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	Soil-to-water partition coefficient (cm ^{3} g^{-1})	Vapour pressure (Pa)	Water solubility (mg L $^{-1}$)	Soil-to-plant concentration factor for green vegetables (mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)	Soil-to-plant concentration factor for root vegetables (mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)	Soil-to-plant concentration factor for tuber vegetables (mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)	Soil-to-plant concentration factor for herbaceous fruit (mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)	Soil-to-plant concentration factor for shrub fruit (mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)	Soil-to-plant concentration factor for tree fruit (mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)
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CLEA Software Version 1.071

Report generated	23/06/2022
Report title	Detailed Quantitative Risk Assessment, Great Western Road, Gloucester
Created by	Matthew Keehn at Hydrock

BASIC SETTINGS

Land Use Residential with produce (C4SL)

Building Medium/large terraced house
Receptor Female (res C4SL) Start age class 1 End age class 6 Exposure Duration 6 years
Soil Sand

Exposure Pathways

Direct soil and dust ingestion	☒	Dermal contact with indoor dust	☒	Inhalation of indoor dust	☒
Consumption of homegrown produce	☒	Dermal contact with soil	☒	Inhalation of soil dust	☒
Soil attached to homegrown produce	☒			Inhalation of indoor vapour	☑
				Inhalation of outdoor vapour	☑

Land Use Residential with produce (C4SL)

Receptor Female (res C4SL)

	Exposure Frequencies (days yr^{-1})						Occupation Periods (hr day^{-1})		Soil to skin adherence factors (mg cm^{2})						Max exposed skin factor		
Age Class	Direct soil ingestion	Consumption of homegrown produce	Dermal contact with indoor dust	Dermal contact with soil	Inhalation of dust and vapour, indoor	Inhalation of dust and vapour, outdoor	Indoors	Outdoors	Indoor	Outdoor	Direct soil ingestion rate (g day^{-1})	Body weight (kg)	Body height (m)	Inhalation rate (m^{3} day^{-1})	Indoor (m^{2} m^{-2})	Outdoor (m^{2} m^{-2})	Total skin area (m^{2})
1	180	180	180	170	365	365	23.0	1.0	0.06	0.10	0.10	5.60	0.7	5.4	0.32	0.26	3.43E-01
2	365	365	365	170	365	365	23.0	1.0	0.06	0.10	0.10	9.80	0.8	8.0	0.33	0.26	4.84E-01
3	365	365	365	170	365	365	23.0	1.0	0.06	0.10	0.10	12.70	0.9	8.9	0.32	0.25	5.82E-01
4	365	365	365	170	365	365	23.0	1.0	0.06	0.10	0.10	15.10	0.9	10.1	0.35	0.28	6.36E-01
5	365	365	365	170	365	365	19.0	1.0	0.06	0.10	0.10	16.90	1.0	10.1	0.35	0.28	7.04E-01
6	365	365	365	170	365	365	19.0	1.0	0.06	0.10	0.10	19.70	1.1	10.1	0.33	0.26	7.94E-01
7	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	22.10	1.2	12.0	0.22	0.15	8.73E-01
8	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	25.30	1.2	12.0	0.22	0.15	9.36E-01
9	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	27.50	1.3	12.0	0.22	0.15	1.01E+00
10	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	31.40	1.3	12.0	0.22	0.15	1.08E+00
11	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	35.70	1.4	12.0	0.22	0.14	1.19E+00
12	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	41.30	1.4	15.2	0.22	0.14	1.29E+00
13	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	47.20	1.5	15.2	0.22	0.14	1.42E+00
14	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	51.20	1.6	15.2	0.22	0.14	1.52E+00
15	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	56.70	1.6	15.2	0.21	0.14	1.60E+00
16	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	59.00	1.6	15.2	0.21	0.14	1.63E+00
17	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	70.00	1.6	15.7	0.33	0.27	1.78E+00
18	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	70.90	1.6	13.6	0.33	0.27	1.80E+00

Consumption Rates

	Consumption rates (g FW kg^{-1} bodyweight day^{-1}) by Produce Group											
	MEAN RATES						90TH PERCENTILE RATES					
Age Class	Green veg	Root veg	Tuber veg	Herb. Fruit	Shrub fruit	Tree fruit	Green veg	Root veg	Tuber veg	Herb. Fruit	Shrub fruit	Tree fruit
1	3.47E+00	5.22E+00	9.22E+00	8.90E-01	1.07E+00	1.87E+00	7.12E+00	1.07E+01	1.60E+01	1.83E+00	2.23E+00	3.82E+00
2	3.34E+00	1.61E+00	3.14E+00	1.93E+00	2.60E-01	5.84E+00	5.87E+00	2.83E+00	6.60E+00	3.39E+00	4.60E-01	1.03E+01
3	3.34E+00	1.61E+00	3.14E+00	1.93E+00	2.60E-01	5.84E+00	5.87E+00	2.83E+00	6.60E+00	3.39E+00	4.60E-01	1.03E+01
4	3.34E+00	1.61E+00	3.14E+00	1.93E+00	2.60E-01	5.84E+00	5.87E+00	2.83E+00	6.60E+00	3.39E+00	4.60E-01	1.03E+01
5	2.54E+00	1.20E+00	2.65E+00	1.25E+00	1.10E-01	2.89E+00	4.53E+00	2.14E+00	4.95E+00	2.24E+00	1.90E-01	5.16E+00
6	2.54E+00	1.20E+00	2.65E+00	1.25E+00	1.10E-01	2.89E+00	4.53E+00	2.14E+00	4.95E+00	2.24E+00	1.90E-01	5.16E+00
7	2.54E+00	1.20E+00	2.65E+00	1.25E+00	1.10E-01	2.89E+00	4.53E+00	2.14E+00	4.95E+00	2.24E+00	1.90E-01	5.16E+00
8	2.54E+00	1.20E+00	2.65E+00	1.25E+00	1.10E-01	2.89E+00	4.53E+00	2.14E+00	4.95E+00	2.24E+00	1.90E-01	5.16E+00
9	2.54E+00	1.20E+00	2.65E+00	1.25E+00	1.10E-01	2.89E+00	4.53E+00	2.14E+00	4.95E+00	2.24E+00	1.90E-01	5.16E+00
10	2.54E+00	1.20E+00	2.65E+00	1.25E+00	1.10E-01	2.89E+00	4.53E+00	2.14E+00	4.95E+00	2.24E+00	1.90E-01	5.16E+00
11	2.54E+00	1.20E+00	2.65E+00	1.25E+00	1.10E-01	2.89E+00	4.53E+00	2.14E+00	4.95E+00	2.24E+00	1.90E-01	5.16E+00
12	1.03E+00	4.90E-01	1.60E+00	5.10E-01	4.00E-02	1.18E+00	1.87E+00	8.90E-01	3.05E+00	9.30E-01	8.00E-02	2.13E+00
13	1.03E+00	4.90E-01	1.60E+00	5.10E-01	4.00E-02	1.18E+00	1.87E+00	8.90E-01	3.05E+00	9.30E-01	8.00E-02	2.13E+00
14	1.03E+00	4.90E-01	1.60E+00	5.10E-01	4.00E-02	1.18E+00	1.87E+00	8.90E-01	3.05E+00	9.30E-01	8.00E-02	2.13E+00
15	1.03E+00	4.90E-01	1.60E+00	5.10E-01	4.00E-02	1.18E+00	1.87E+00	8.90E-01	3.05E+00	9.30E-01	8.00E-02	2.13E+00
16	1.03E+00	4.90E-01	1.60E+00	5.10E-01	4.00E-02	1.18E+00	1.87E+00	8.90E-01	3.05E+00	9.30E-01	8.00E-02	2.13E+00
17	1.26E+00	6.00E-01	1.18E+00	6.90E-01	9.00E-02	1.27E+00	2.36E+00	1.12E+00	2.35E+00	1.29E+00	1.80E-01	2.38E+00
18	1.35E+00	6.40E-01	1.25E+00	7.40E-01	1.00E-01	1.36E+00	2.34E+00	1.12E+00	2.36E+00	1.28E+00	1.80E-01	2.37E+00

Top 2 applied? Yes

Where top 2 method is applied, two produce categories use 90th percentile rates, while the remainder use the mean. Produce categories vary on a chemical-by-chemical basis. Where top 2 method is not used, all produce categories for all chemicals assume 90th percentile rates.

Building Medium/large terraced house

Soil Sand

Environment Agency

Building footprint (m^2)	4.40E+01
Living space air exchange rate (hr^{-1})	5.00E-01
Living space height (above ground, m)	4.80E+00
Living space height (below ground, m)	0.00E+00
Pressure difference (soil to enclosed space, Pa)	3.10E+00
Foundation thickness (m)	1.50E-01
Floor crack area (cm^2)	5.31E+02
Dust loading factor ($\mu g\ m^{-3}$)	5.00E+01

Porosity, Total ($cm^3\ cm^{-3}$)	5.40E-01
Porosity, Air-Filled ($cm^3\ cm^{-3}$)	3.00E-01
Porosity, Water-Filled ($cm^3\ cm^{-3}$)	2.40E-01
Residual soil water content ($cm^3\ cm^{-3}$)	7.00E-02
Saturated hydraulic conductivity ($cm\ s^{-1}$)	7.36E-03
van Genuchten shape parameter *m* (dimensionless)	3.51E-01
Bulk density ($g\ cm^{-3}$)	1.18E+00
Threshold value of wind speed at 10m ($m\ s^{-1}$)	7.20E+00
Empirical function (F_x) for dust model (dimensionless)	1.22E+00
Ambient soil temperature (K)	2.83E+02

Soil pH	8.50E+00
Soil Organic Matter content (%)	1.00E+00
Fraction of organic carbon ($g\ g^{-1}$)	5.80E-03

Effective total fluid saturation (unitless)	3.62E-01
Intrinsic soil permeability (cm^2)	9.83E-08
Relative soil air permeability (unitless)	7.68E-01
Effective air permeability (cm^2)	7.54E-08

Soil - Vapour Model

Depth to top of source (no building) (cm)	**110**
Depth to top of source (beneath building) (cm)	**110**
Default soil gas ingress rate?	**No**
Soil gas ingress rate ($cm^3\ s^{-1}$)	4.44E+01
Building ventilation rate ($cm^3\ s^{-1}$)	2.93E+04
Averaging time surface emissions (yr)	6
Finite vapour source model?	**Yes**
Thickness of contaminated layer (cm)	**250**

Air Dispersion Model

Mean annual windspeed at 10m ($m\ s^{-1}$)	5.00
Air dispersion factor at height of 0.8m *	2400.00
Air dispersion factor at height of 1.6m *	0.00
Fraction of site cover ($m^2\ m^{-2}$)	0.75

* Air dispersion factor in g $m^{-2}\ s^{-1}$ per kg m^{-3}

Soil - Plant Model

	Dry weight conversion factor	Homegrown fraction Average	Homegrown fraction High	Soil loading factor	Preparation correction factor
	g DW g^{-1} FW	dimensionless		g g^{-1} DW	dimensionless
Green vegetables	0.096	0.05	0.33	1.00E-03	2.00E-01
Root vegetables	0.103	0.06	0.40	1.00E-03	1.00E+00
Tuber vegetables	0.210	0.02	0.13	1.00E-03	1.00E+00
Herbaceous fruit	0.058	0.06	0.40	1.00E-03	6.00E-01
Shrub fruit	0.166	0.09	0.60	1.00E-03	6.00E-01
Tree fruit	0.157	0.04	0.27	1.00E-03	6.00E-01

Gardener type Average

CLEA Software Version 1.071

Report generated 23-Jun-22

Report title Detailed Quantitative Risk Assessment, Great Western Road, Gloucester

Created by Matthew Keehn at Hydrock

RESULTS

		Assessment Criterion (mg kg^{-1})			Ratio of ADE to HCV			Saturation Limit (mg kg^{-1})	50% rule?			Apply Top 2 Approach to Produce Group					
		oral	inhalation	combined	oral	inhalation	combined		Oral	Inhal	Top Two applied?	Green vegetables	Root vegetables	Tuber vegetables	Herbaceous fruit	Shrub fruit	Tree fruit
1	TPH ali >EC10-EC12	0.00E+00	0.00E+00	0.00E+00	0.00	0.37	0.37	4.77E+01 (vap)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2	TPH ali >EC12-EC16	0.00E+00	0.00E+00	0.00E+00	0.00	0.03	0.03	2.37E+01 (sol)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3	TPH ali >EC16-EC35	0.00E+00	0.00E+00	0.00E+00	0.00	NR	NR	8.48E+00 (sol)	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4	TPH aro >EC10-EC12	0.00E+00	0.00E+00	0.00E+00	0.00	2.10	2.10	3.62E+02 (sol)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
5	TPH aro >EC12-EC16	0.00E+00	0.00E+00	0.00E+00	0.00	0.09	0.09	1.68E+02 (sol)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
6	TPH aro >EC16-EC21	0.00E+00	0.00E+00	0.00E+00	0.00	NR	NR	5.36E+01 (vap)	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
7	TPH aro >EC21-EC35	0.00E+00	0.00E+00	0.00E+00	0.00	NR	NR	4.83E+00 (sol)	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
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	Assessment Criterion (mg kg^{-1})			Ratio of ADE to HCV			Saturation Limit (mg kg^{-1})	50% rule?		Top Two applied?	Apply Top 2 Approach to Produce Group					
	oral	inhalation	combined	oral	inhalation	combined		Oral	Inhal		Green vegetables	Root vegetables	Tuber vegetables	Herbaceous fruit	Shrub fruit	Tree fruit
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		Soil Distribution				Media Concentrations															
		Sorbed	Dissolved	Vapour	Total	Soil	Soil gas	Indoor Dust	Outdoor dust at 0.8m	Outdoor dust at 1.6m	Indoor Vapour	Outdoor vapour at 0.8m	Outdoor vapour at 1.6m	Green vegetables	Root vegetables	Tuber vegetables	Herbaceous fruit	Shrub fruit	Tree fruit
		%	%	%	%	mg kg^{-1}	mg m^{-3}	mg kg^{-1}	mg m^{-3}	mg m^{-3}	mg m^{-3}	mg m^{-3}	mg m^{-3}	mg kg^{-1} FW	mg kg^{-1} FW	mg kg^{-1} FW	mg kg^{-1} FW	mg kg^{-1} FW	mg kg^{-1} FW
1	TPH ali >EC10-EC12	98.8	0.0	1.2	100.0	4.77E+01	2.18E+03	NA	NA	NA	8.20E-02	3.10E-04	0.00E+00	NA	NA	NA	NA	NA	NA
2	TPH ali >EC12-EC16	99.9	0.0	0.1	100.0	2.37E+01	1.30E+02	NA	NA	NA	7.03E-03	3.07E-05	0.00E+00	NA	NA	NA	NA	NA	NA
3	TPH ali >EC16-EC35	100.0	0.0	0.0	100.0	8.52E+00	2.73E+00	NA	NA	NA	1.62E-04	6.44E-07	0.00E+00	NA	NA	NA	NA	NA	NA
4	TPH aro >EC10-EC12	98.5	1.4	0.1	100.0	3.63E+02	1.77E+03	NA	NA	NA	9.69E-02	4.18E-04	0.00E+00	NA	NA	NA	NA	NA	NA
5	TPH aro >EC12-EC16	99.3	0.7	0.0	100.0	1.69E+02	7.27E+01	NA	NA	NA	4.30E-03	1.72E-05	0.00E+00	NA	NA	NA	NA	NA	NA
6	TPH aro >EC16-EC21	99.8	0.2	0.0	100.0	5.36E+01	4.54E-01	NA	NA	NA	2.81E-05	1.14E-07	0.00E+00	NA	NA	NA	NA	NA	NA
7	TPH aro >EC21-EC35	100.0	0.0	0.0	100.0	4.84E+00	1.64E-04	NA	NA	NA	1.63E-08	1.13E-10	0.00E+00	NA	NA	NA	NA	NA	NA
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	Soil Distribution				Media Concentrations													
	Sorbed	Dissolved	Vapour	Total	Soil	Soil gas	Indoor Dust	Outdoor dust at 0.8m	Outdoor dust at 1.6m	Indoor Vapour	Outdoor vapour at 0.8m	Outdoor vapour at 1.6m	Green vegetables	Root vegetables	Tuber vegetables	Herbaceous fruit	Shrub fruit	Tree fruit
	%	%	%	%	mg kg^{-1}	mg m^{-3}	mg kg^{-1}	mg m^{-3}	mg m^{-3}	mg m^{-3}	mg m^{-3}	mg m^{-3}	mg kg^{-1} FW	mg kg^{-1} FW	mg kg^{-1} FW	mg kg^{-1} FW	mg kg^{-1} FW	mg kg^{-1} FW
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		Average Daily Exposure (mg kg^{-1} bw day^{-1})							Distribution by Pathway (%)							
		Direct soil ingestion	Consumption of homegrown produce and attached soil	Dermal contact with soil and dust	Inhalation of dust	Inhalation of vapour	Background (oral)	Background (inhalation)	Direct soil ingestion	Consumption of homegrown produce and attached soil	Dermal contact with soil and dust	Inhalation of dust	Inhalation of vapour (indoor)	Inhalation of vapour (outdoor)	Background (oral)	Background (inhalation)
1	TPH ali >EC10-EC12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.33E-02	5.62E+95	6.06E+95	0.00	0.00	0.00	0.00	0.00	0.00	48.14	51.86
2	TPH ali >EC12-EC16	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.57E-03	5.62E+95	6.06E+95	0.00	0.00	0.00	0.00	0.00	0.00	48.14	51.86
3	TPH ali >EC16-EC35	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.05E-04	5.62E+95	0.00E+00	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
4	TPH aro >EC10-EC12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.29E-02	5.62E+95	6.06E+95	0.00	0.00	0.00	0.00	0.00	0.00	48.14	51.86
5	TPH aro >EC12-EC16	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.80E-03	5.62E+95	6.06E+95	0.00	0.00	0.00	0.00	0.00	0.00	48.14	51.86
6	TPH aro >EC16-EC21	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.83E-05	5.62E+95	0.00E+00	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
7	TPH aro >EC21-EC35	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.06E-08	5.62E+95	0.00E+00	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
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	Average Daily Exposure (mg kg^{-1} bw day^{-1})							Distribution by Pathway (%)							
	Direct soil ingestion	Consumption of homegrown produce and attached soil	Dermal contact with soil and dust	Inhalation of dust	Inhalation of vapour	Background (oral)	Background (inhalation)	Direct soil ingestion	Consumption of homegrown produce	Dermal contact with soil and dust	Inhalation of dust	Inhalation of vapour (indoor)	Inhalation of vapour (outdoor)	Background (oral)	Background (inhalation)
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			Oral Health Criteria Value $(\mu g\ kg^{-1}\ BW\ day^{-1})$		Inhalation Health Criteria Value $(\mu g\ kg^{-1}\ BW\ day^{-1})$	$(\mu g\ day^{-1})$	$(\mu g\ day^{-1})$	Air-water partition coefficient (K_{aw}) $(cm^3\ cm^{-3})$	Coefficient of Diffusion in Air $(m^2\ s^{-1})$	Coefficient of Diffusion in Water $(m^2\ s^{-1})$	log K_{oc} $(cm^3\ g^{-1})$	log K_{ow} (dimensionless)	Dermal Absorption Fraction (dimensionless)	Soil-to-dust transport factor $(g\ g^{-1}\ DW)$	Sub-surface soil to indoor air correction factor (dimensionless)	Relative bioavailability via soil ingestion (unitless)	Relative bioavailability via dust inhalation (unitless)
1	TPH ali >EC10-EC12	TDI	100	TDI	290	1E+100	1E+100	6.44E+01	1.00E-05	1.00E-09	5.38	6.3	0.1	0.5	10	1	1
2	TPH ali >EC12-EC16	TDI	100	TDI	290	1E+100	1E+100	1.71E+02	1.00E-05	1.00E-09	6.73	7.94	0.1	0.5	10	1	1
3	TPH ali >EC16-EC35	TDI	2000	NR	0	1E+100	NR	1.07E+03	1.00E-05	1.00E-09	8.76	10.39	0.1	0.5	10	1	1
4	TPH aro >EC10-EC12	TDI	40	TDI	60	1E+100	1E+100	7.22E-02	1.00E-05	1.00E-09	3.4	3.93	0.1	0.5	10	1	1
5	TPH aro >EC12-EC16	TDI	40	TDI	60	1E+100	1E+100	1.26E-02	1.00E-05	1.00E-09	3.7	4.29	0.1	0.5	10	1	1
6	TPH aro >EC16-EC21	TDI	30	NR	0	1E+100	NR	6.95E-04	1.00E-05	1.00E-09	4.15	4.82	0.1	0.5	10	1	1
7	TPH aro >EC21-EC35	TDI	30	NR	0	1E+100	NR	2.48E-05	1.00E-05	1.00E-09	5.1	5.95	0.1	0.5	10	1	1
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		Oral Health Criteria Value ($\mu g\ kg^{-1}$ BW day^{-1})		Inhalation Health Criteria Value ($\mu g\ kg^{-1}$ BW day^{-1})	($\mu g\ day^{-1}$)	($\mu g\ day^{-1}$)	Air-water partition coefficient (K_{aw}) ($cm^3\ cm^{-3}$)	Coefficient of Diffusion in Air ($m^2\ s^{-1}$)	Coefficient of Diffusion in Water ($m^2\ s^{-1}$)	log K_{oc} ($cm^3\ g^{-1}$)	log K_{ow} (dimensionless)	Dermal Absorption Fraction (dimensionless)	Soil-to-dust transport factor ($g\ g^{-1}$ DW)	Sub-surface soil to indoor air correction factor (dimensionless)	Relative bioavailability via soil ingestion (unitless)	Relative bioavailability via dust inhalation (unitless)
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		Soil-to-water partition coefficient ($cm^3 g^{-1}$)	Vapour pressure (Pa)	Water solubility ($mg L^{-1}$)	Soil-to-plant concentration factor for green vegetables ($mg g^{-1}$ plant DW or FW basis over $mg g^{-1}$ DW soil)	Soil-to-plant concentration factor for root vegetables ($mg g^{-1}$ plant DW or FW basis over $mg g^{-1}$ DW soil)	Soil-to-plant concentration factor for tuber vegetables ($mg g^{-1}$ plant DW or FW basis over $mg g^{-1}$ DW soil)	Soil-to-plant concentration factor for herbaceous fruit ($mg g^{-1}$ plant DW or FW basis over $mg g^{-1}$ DW soil)	Soil-to-plant concentration factor for shrub fruit ($mg g^{-1}$ plant DW or FW basis over $mg g^{-1}$ DW soil)	Soil-to-plant concentration factor for tree fruit ($mg g^{-1}$ plant DW or FW basis over $mg g^{-1}$ DW soil)
1	TPH ali >EC10-EC12	1.39E+03	3.21E+01	3.39E-02	model	model	model	model	model	model
2	TPH ali >EC12-EC16	3.11E+04	1.53E+00	7.59E-04	model	model	model	model	model	model
3	TPH ali >EC16-EC35	3.34E+06	2.38E-02	2.54E-06	model	model	model	model	model	model
4	TPH aro >EC10-EC12	1.46E+01	3.21E+01	2.45E+01	model	model	model	model	model	model
5	TPH aro >EC12-EC16	2.91E+01	1.14E+00	5.75E+00	model	model	model	model	model	model
6	TPH aro >EC16-EC21	8.19E+01	5.62E-03	6.53E-01	model	model	model	model	model	model
7	TPH aro >EC21-EC35	7.30E+02	1.61E-06	6.61E-03	model	model	model	model	model	model
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	Soil-to-water partition coefficient (cm ^{3} g^{-1})	Vapour pressure (Pa)	Water solubility (mg L $^{-1}$)	Soil-to-plant concentration factor for green vegetables (mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)	Soil-to-plant concentration factor for root vegetables (mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)	Soil-to-plant concentration factor for tuber vegetables (mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)	Soil-to-plant concentration factor for herbaceous fruit (mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)	Soil-to-plant concentration factor for shrub fruit (mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)	Soil-to-plant concentration factor for tree fruit (mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)
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EUTOPIA
HOMES

EUTOPIA
HOMES

Ecological Impact Assessment

Great Western Yard

Burton Reid Associates

EUTOPIA

HOMES

COMPANY PHILOSOPHY

Burton Reid Associates are a multi-disciplinary consultancy specialising in providing high quality ecological and landscape design and advice related to the provision of embedded green and blue infrastructure and biodiversity net gains. We have a simple philosophy, designing with nature in mind supports the long-term health and wellbeing of us all. We work with clients who share this philosophy.

We can help you to achieve biodiversity net gains and deliver high-quality green infrastructure at a local and strategic level. We provide expert ecological services, undertaking surveys for protected species and habitats and supporting you to create on and off-site mitigation with our dedicated habitat management team. Our services include landscape architecture and production of high quality graphics that clearly communicate information and data.

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DOCUMENT CONTROL

Site name:	Great Western Yard, Gloucester
Project No:	BR0478
Document Title:	Ecological Impact Assessment
Document No:	BR0478/ECIA/B
Client:	Eutopia Homes Ltd.
Date of survey:	September 2020 – August 2021

☐ Original Document

☒ Revision

B Revision Code

Prepared by:	Tamsyn Bridger MSc ACIEEM	Senior Ecologist	[redacted]	30/06/2022
	Ella Dangerfield BSc (Hons) Qualifying Member of CIEEM	Graduate Ecologist	[redacted]	
Checked by:	Jenni Reid CEnv MCIEEM	Founder	[redacted]	30/06/2022
Approved by:	Jenni Reid CEnv MCIEEM	Founder	[redacted]	30/06/2022

Revision Record

Rev Code	Date Prepared	Prepared By	Checker/Approved	Description of Changes
B	11/07/2022	TB	JR	Changes to description of landscape proposals

BURTON REID
ASSOCIATES

"As we rekindle our imagination, we discover our power to act. And that is the point at which we become unstoppable."

George Monbiot, journalist and author

BURTON REID
ASSOCIATES

DECLARATIONS OF COMPLIANCE

The report which we have prepared and provided is in accordance with the Chartered Institute for Ecology and Environmental Management's Code of Professional Conduct. We confirm that the opinions expressed are our true and professional bona fide opinions.

This report has been produced in accordance with British Standard 42020:2013 "Biodiversity, Code of practice for planning and development" and the Chartered Institute of Ecology and Environmental Management's Guidelines for Ecological Report Writing (CIEEM, 2017).

DATA VALIDITY

Please note that unless otherwise stated, the contents of this report will remain valid for a maximum period of 12 months from date of issue. Beyond this updated survey work may be required to establish any changes in baseline conditions.

DISCLAIMER

Burton Reid Associates has exercised all reasonable skill and due care in preparing this report. Burton Reid Associates has not, unless specifically stated, independently verified information provided by others. No other warranty, express or implied, is made in relation to the content of this report and Burton Reid Associates assumes no liability for any loss resulting from errors, omissions or misrepresentation made by others.

Any recommendation, opinion or finding stated in this report is based on circumstances and facts as they existed at the time that Burton Reid Associates performed the work (including based on the information provided by the client). Professional judgement and opinion has been utilised where required. All opinion is provided in good faith.

Nothing in this report constitutes legal advice or opinion. If legal opinion is required a qualified legal professional should be contacted for advice.

NON-TECHNICAL SUMMARY

Burton Reid Associates was instructed by Eutopia Homes Ltd to undertake an ecological assessment in relation to a proposed planning application for a housing development and associated green spaces at Great Western Yard, Gloucester,

Baseline ecological information was collated for the proposed development site between September 2020 to August 2021. This included a desk study and Preliminary Ecological Appraisal (PEA) including UK Habitat Classification survey and targeted protected species surveys for bats (roosting) in line with relevant best practice guidance.

The results of the surveys are summarised as follows:

- The site is largely composed of hardstanding and railway ballast/gravel with significant scrub and ruderal encroachment and early successional vegetation emerging.
- Schedule 9 invasive plant species are present at the site, namely Japanese Knotweed and Virginia Creeper.
- No evidence of roosting bats was found within buildings on site, although several buildings were deemed to have Low bat roosting potential (as per BCT guideline criteria (Collins et al, 2016)).
- Nocturnal bat emergence surveys of buildings with Low bat potential did not record any bats emerging.
- Very low levels of bat activity were recorded during the emergence surveys, limited to a small number of passes by an individual Common Pipistrelle.
- The buildings, scrub and trees on site provide breeding habitat for relatively common and widespread species of birds.
- The site is considered to have low potential for self-sustaining populations of reptiles. However, presence of small numbers of individuals is assumed.

The Ecological Impact Assessment concludes that with proposed avoidance, mitigation and compensation measures in place, it is considered that there will be no likely significant effects or adverse impacts on biodiversity at the site. Biodiversity net gain requirements will be achieved in accordance with emerging national and local planning policy, the NPPF 2021 and NERC Act 2006 through proposed habitat creation as demonstrated using Natural England's Biodiversity Metric 3.1 calculation tool (see Burton Reid Associates, 2022).

STAGE	RECOMMENDATIONS
GENERAL	• Scrub and tree clearance works should be timed to avoid the bird breeding season (which is generally considered to be from March to August inclusive). Failure to time works accordingly may result in significant delays should active nests be found.
POST-PLANNING/ PRE-CONSTRUCTION	• Production of Construction Environmental Management Plan (CEMP), incorporating the ecological protection and mitigation measures detailed within this report. • Production of landscape proposals and detailed Landscape and Ecology Management Plan (LEMP) to guide future management of the site.
CONSTRUCTION STAGE – ENABLING WORKS	• Eradication programme in relation to Japanese Knotweed. • Pre-demolition bat inspections of buildings for evidence of roosting bats by licenced bat ecologist immediately prior to start of works. To include nesting bird survey immediately prior to start of works if undertaken during the nesting period (i.e. March to August). • If scrub clearance to be undertaken during nesting bird season, pre-commencement checks for active nests to be undertaken by experienced ornithologist. • Precautionary working measures implemented during vegetation clearance to avoid risk of harm to reptiles and nesting birds. • Protection of retained tree during clearance / construction, in accordance with BS5837:2012.
CONSTRUCTION STAGE – MAIN WORKS	• Removal of roof coverings on former railway sidings buildings with "low" potential to support roosting bats under a precautionary working method statement. • Precautionary working measures implemented during vegetation clearance to avoid risk of harm to reptiles and nesting birds. • Implement habitat creation proposals in accordance with Sections 5 & 6 of this report and the detailed Landscape Ecological Management Plan (LEMP).
POST-DEVELOPMENT	• Long-term management of habitats and ecological features on site in line with the detailed Landscape Ecological Management Plan (LEMP).

CONTENTS

1 INTRODUCTION

1.1 SITE BACKGROUND

Burton Reid Associates was commissioned by Eutopia Homes Ltd. to undertake an Ecological Impact Assessment of Great Western Yard, hereinafter referred to as 'the Site', in relation to a planning application being put forward for the creation of a housing development.

The Site centre is located at National Grid Reference SO 8414 1836 between Great Western Road to the north, Horton Road to the east and the railway to the south. The Site is composed of a former railway sidings and diesel depot, with associated buildings.

The need to carry out an ecological assessment was identified in order to highlight any potential ecological constraints / opportunities associated with the proposals and to help inform the design of the development. Work to establish baseline ecological information was therefore undertaken between September 2020 and August 2021. This included a desk-based study and Preliminary Ecological Appraisal (PEA), detailed UK Habitat Classification Survey and specialist surveys for bats (roosting, commuting/foraging) within the disused buildings.

The following are detailed within this Ecological Impact Assessment (EcIA) report:

- Details of survey methods;
- Description of Site ecological baseline including habitat descriptions and results of protected species surveys;
- An assessment of the anticipated impacts of the development on habitats/species present;
- Avoidance, mitigation and biodiversity enhancement measures required.

1.2 PROPOSED DEVELOPMENT

The proposals for the Site include a residential development of up to 315no. dwellings with associated landscaping, parking, open space and ancillary works. Site clearance work will include the demolition of all existing buildings.

1.3 WILDLIFE LEGISLATION AND PLANNING POLICY

This report has been written with reference to the following wildlife legislation, links to the full text of which can be found in Appendix I:

- Environment Act 2021;

- Conservation of Habitats and Species Regulations 2017 (as amended);
- Wildlife and Countryside Act 1981 (as amended);
- Countryside Rights of Way Act 2000;
- Natural Environment and Rural Communities Act 2006.

A summary of relevant specific species legal protections derived from the above legislation is also given in Appendix I for ease of reference.

Furthermore, the following planning policies, guidance and local plans have been taken into account and referred to where appropriate:

- Gloucester, Cheltenham and Tewkesbury Joint Core Strategy 2011 – 2031;
- Gloucester City Plan 2011-2031;
- Gloucester City Plan 2011-2031 Habitats Regulations Assessment, Revised Screening & Appropriate Assessment Report July 2019;
- ODPM Circular 06/2005: Biodiversity and Geological Conservation;
- UK Post-2010 Biodiversity Framework;
- National Planning Policy Framework (NPPF).

2 METHODS

2.1 SCOPE OF ECIA ASSESSMENT

The impact assessment has been undertaken following the Chartered Institute of Ecology and Environmental Management's Guidelines for Ecological Impact Assessment Version 1.2 (CIEEM, 2018). These guidelines represent current best practice when assessing the impacts of development on biodiversity.

In summary, the guidelines provide a framework for describing the potentially significant effects of a proposed development on ecology and for setting out mitigation and enhancement measures to avoid/minimise impacts and create positive outcomes for biodiversity.

In the first instance, ecological features of importance are identified. Some features can already be recognised as having ecological value through their designation e.g. statutory/non-statutory designated sites whilst others may require an evaluation based on professional judgement using available guidance and information. Key considerations taken into account include legal protection, local and national conservation status, population trends, range and distribution, diversity, connectivity and rarity.

The importance of each ecological feature has been further given a geographic frame of reference within the relevant headings in Section 3 as per the CIEEM (2018) guidelines for EcIA: International, National, Regional, County, District/local authority area, Local or Site level.

An assessment has then been made of the scale and significance of anticipated impacts on any ecological features of importance. For the purposes of this report, this impact assessment takes into consideration mitigation and enhancement measures which have been developed and incorporated into the scheme design (i.e. embedded mitigation).

Additional mitigation and enhancement measures to avoid/minimise impacts during the construction and post-construction phases of the development are also included and are typically secured through the planning process via the use of planning conditions/obligations.

2.2 SURVEY APPROACH

2.2.1 Desk Study

A data search was requested from the Gloucestershire Centre for Environmental Records (GCER) in April 2022 for information on designated nature conservation sites and records of protected and notable species within 2km of the Site. The search was to obtain background data on the presence and distribution of sensitive ecological receptors within the area surrounding the Site. This scale of search was considered appropriate for the nature and scale of proposals.

The presence of nearby designated sites and priority habitats was established using the Defra MAGIC map tool (www.magic.gov.uk). Statutory designated sites are those which are protected under current UK/European legislation and include Sites of Special Scientific Interest (SSSI), National Nature Reserves (NNR), Special Areas of Conservation (SAC), Special Protection Areas (SPA), Ramsar sites and Local Nature Reserves (LNR). Non-statutory designated sites include Local Wildlife Sites (LWSs) and Unconfirmed Wildlife Sites (UWSs). They are designated on account of the habitats, flora and fauna they support and are considered of county wildlife importance. UWSs are sites identified as having probable ecological interest but which have not been fully surveyed to confirm their value.

Protected species are those which are afforded legal protection. Priority habitats and species are those which have some level of nature conservation importance due to factors such as rarity, vulnerability or declining population/ status and are considered as priorities for nature conservation. They may be of importance at a national scale, or at a more local level and include 'Habitats/Species of Principal Importance' as listed under the under Section 41 of the NERC Act (2006).

2.2.2 Field surveys

A Preliminary Ecological Appraisal (PEA) walkover survey of the Site was undertaken on 2nd September 2020 by Burton Reid Associates. This survey included a scoping survey for potential presence of protected species and impacts on notable or protected habitats. The survey was undertaken in accordance with guidance by the Chartered Institute of Ecology and Environmental Management (2017) and UK Habitat Classification guidelines (Butcher et al., 2020) for assessment of habitats. The results of the PEA survey in turn informed the targeted 'Phase 2' surveys of habitats and protected species undertaken in September 2020 and August 2021 required to inform the Ecological Impact Assessment (EcIA). Details of these Phase 2 surveys are provided in Table 1 below. For full details of methods, dates/ times and weather conditions for each survey please see the relevant appendices.

Habitats at the Site were assessed using the UK Habitat Classification System (UKHAB) on the 2nd of September 2020. This system for habitat classification allows for clear interpretation of data as it takes into account important habitat types such as Priority and Annex I habitats. The system also allows for translation between existing classifications including the Phase I Habitat methodology (JNCC 2010) and the National Vegetation Classification (Rodwell et al. 1991-2000). It comprises a Principal hierarchy (Primary habitats) which include ecosystems, broad habitats, priority habitats and Annex I Habitats together with a suite of more detailed secondary codes which can be used to record further information on habitat features, land use, landscape context and management practices (Butcher et al, 2020). Lists of species within each distinct habitat were recorded and representative photographs of habitats were also taken as part of the assessment.

Table 1: Details of Phase 2 ecological surveys

SURVEY TYPE	DATE OF SURVEY	SURVEY EFFORT
Preliminary Bat Roost Assessment (buildings)	02/09/2020	Inspection of buildings within the development area by bat licenced ecologist in line with survey guidelines by BCT (Collins et al, 2016). Details of methods are provided in Appendix IV.
Bat roost surveys (nocturnal emergence)	02/09/2020 and 13/08/2021	Nocturnal bat surveys of buildings B1, B6, B9 and B10 identified as having low bat roosting potential undertaken in accordance with BCT guidelines (Collins et al, 2016). See Appendix V for detailed methods.

2.2.3 Limitations

Details of limitations and constraints encountered during the desk study and field surveys are set out in Table 2 below.

Table 2: Survey and assessment limitations

SURVEY / ASSESSMENT	LIMITATIONS
Desk study	No significant constraints encountered.
Preliminary Ecological Appraisal	No significant constraints encountered.
UK Habitat Classification Assessment	No significant constraints encountered.
Preliminary Bat Roost Assessment (buildings)	Not all internal areas of buildings were accessible, including the roof void of B6 (no formal attic hatch), the internal area of B9 (unsafe structure) and B2 & B3 (boarded up). However, detailed external inspections of these structures were carried out as well as nocturnal emergence surveys of buildings B6 & B9. This level of survey is considered to provide an appropriately robust assessment of the suitability of buildings for roosting bats, and to confirm likely absence.
Nocturnal bat roost emergence surveys	Access along the northern elevation of building B9 was not possible during the first emergence survey in 2020 due to a gate that could not be unlocked at this time. The nocturnal survey in 2021 included this side of the building to provide comprehensive coverage of all structures of 'low' suitability over the survey effort.

3 ECOLOGICAL BASELINE

3.1 DESIGNATED SITES

3.1.1 Statutory designated sites

3no. statutory designated sites are located within 2km of the Site, namely Alney Island Local Nature Reserve (LNR), Saintbridge Balancing Pool LNR and Barnwood Arboretum LNR. Alney Island LNR lies c.1.6km to the west of the Site and is designated for its coastal and floodplain grazing marsh, ponds, ditch, lowland meadows, wet woodland, and reedbed habitats, as well as for its plant and dragonfly interest. Saintbridge Balancing Pool LNR, c.1.8km to the southeast, is designated for its ponds and aquatic wildlife, while Barnwood Arboretum LNR is designated for its species-rich woodland and rough grassland habitats and lies c.1.8km to the east of the Site.

The Site falls within the SSSI Impact Risk Zone for Innsworth Meadow Site of Special Scientific Interest (SSSI), with the development proposals meeting the criteria for Natural England consultation (i.e. any residential developments with a total net gain in residential units).

Innsworth Meadow SSSI is located c.3.1km north of the Site and is designated for its unimproved neutral grasslands.

Other Important designated sites outside the desk study area include Cotswold Beechwoods SSSI c.6km to the southeast, Walmore Common SSSI c.9km to the west, and the Severn Estuary SAC c.14km to the southwest of the Site.

3.1.2 Non-statutory designated sites

3no. Local Wildlife Sites (LWS) are located within 2km of the Site. These included Alney Island LWS and Barnwood Arboretum LWS, both of which are described above (also designated as LNRs), and Sandhurst Lane Meadows LWS, c1.9km to the northeast, comprising semi-natural grassland.

3no. Unconfirmed Wildlife Sites (potential LWS or toad patrol locations, as yet unnamed) were also located at c.1.7km from the Site.

No areas of woodland listed on Natural England's Inventory of Ancient Woodlands are present within or adjacent to the Site.

3.1.3 Habitat Networks

The Site is not located within a National Habitat Network area (Edwards et al., 2020).

3.1.4 Priority habitats

No Habitats of Principle Importance (HPIs) were identified within or adjacent to the Site during a review of the MAGIC online database. 3no. HPIs were identified further afield but within 2km of the Site, namely Deciduous Woodland (closest area 450m to the north), Coastal and Floodplain Grazing Marsh (1.3km to the east), Good Quality Semi-improved Grassland (c1.3km to the east), and Wood Pasture and Parkland (750m to the south west and also forming part of the National Habitat Network).

Each of the habitat types recorded within the Site itself are described below, with more comprehensive species lists are provided in Appendix III. The distribution of the main habitats present is shown in the habitat survey map in Appendix II.

3.2 HABITATS

3.2.1 Broad habitat: Urban (u)

u1 – urban

The Site was dominated by hardstanding, railway track ballast, areas of gravel or compacted aggregate. Buildings were also present across the Site, including vacant structures associated with the disused railway sidings, and a set of larger structures in the northwest of the Site which were occupied for commercial use.

A classification of "u1a Open Mosaic Habitats on Previously Developed Land" was considered for areas in the south and east of the Site. While these areas showed some characteristics of u1a, the poor plant diversity, maturity of early successional vegetation and levels of bare substrate were judged on balance to be insufficient to classify as such. It was concluded that the typical species composition indicated for u1a provided in the UK Habitat Classification Habitat Descriptions v1.1 (Butcher et al, 2020) did not accurately reflect the vegetation communities present in these areas, which are decidedly species-poor. It is therefore considered likely that the habitats present around the buildings and railway sidings in the south and east of the Site are in the process of transitioning towards a u1a habitat, however have not yet reached the threshold for this classification. Should the Site lay unmanaged for several years more, this classification may indeed become more representative. For the time being, these areas have been classified as either "u1b Developed land / sealed surface" (where concrete hardstanding is the underlying substrate), or "u1c Artificial unvegetated / unsealed surface" (where gravel, compacted aggregate or railway ballast are the predominant underlying substrate). Encroaching vegetation in these areas has been accounted for through the use of appropriate secondary codes. An area to the south of building B1 has been separately classified as "u1b6 Other developed land" due to not neatly fitting into either category (alternating rows of hardstanding and ballast with significant scrub (Butterfly-bush) encroachment.

Scattered, and largely low-lying / young Butterfly-bush *Buddleja davidii*. and creeping Bramble *Rubus fruticosus agg.* growth were present. Where more established, dense stands had formed these are covered under section 3.2.2 below. Ephemeral and ruderal species recorded scattered within u1b and u1c habitats included mosses (*Bryophyta)*, Common Ragwort *Senecio jacobaea,* Yarrow *Achillea millefolium,* Black Medick *Medicago lupulina,* and Great

Willowherb *Epilobium hirsutum.*

Areas of bare, unvegetated loose gravel were also present, most notably in the builder's yard in the centre of the Site.

Many areas of the Site were fenced, including boundary fencing and internal fencing. These consisted of metal wire and palisade fencing, and were frequently encroached by Bramble and Butterfly-bush.

UKHAB Primary Code	Description and UKHAB Secondary Codes
u1b – developed land; sealed surface	
	*Example of hardstanding with scrub encroachment* *Secondary codes:* *10 – Scattered scrub* *46 – Railside* *48 – Non-native* *89 – Car park* *351 – Vacant/derelict land*
	*Example of hardstanding with ephemeral encroachment* *Secondary codes:* *17 – Ruderal/ephemeral* *46 – Railside* *351 – Vacant/derelict land*

UKHAB Primary Code	Description and UKHAB Secondary Codes
u1b5 – buildings	
	*Example of disused railway buildings: B1 – large brick tram shed* *Secondary codes:* *46 – Railside* *78 – Abandoned* *351 – Vacant/derelict land*
	*Example of commercial building complex: B4 – complex of sheds* *Secondary codes:* *90 – Commercial Building*
u1c – artificial unvegetated, unsealed surface	
	*Builder's yard in the central area of the Site*

UKHAB Primary Code	Description and UKHAB Secondary Codes
	*Vegetation encroachment around gravel/bare ground track in the south of the Site* *Secondary codes:* *17 – Ruderal/ephemeral* *46 – Railside* *351 – Vacant/derelict land*
u1b6 – other developed land	
	*Area of alternating hardstanding and gravel / ballast with vegetation encroachment and debris piles.* *10 – Scattered scrub* *17 – Ruderal / ephemeral* *48 – Non-native* *351 – Vacant / derelict land* *1301 – Rubble pile*

3.2.2 Broad habitat: Heathland and scrub (h)

h3h – Mixed scrub

Areas of dense and scattered scrub occurred throughout the Site. Species diversity was generally poor and non-native Butterfly-bush was dominant in many areas with frequent Birch *Betula sp.*, as well as a few locally dominant areas of Bramble. Other species occasionally or rarely present included Common Dogwood *Cornus sanguinea*, Field Maple *Acer campestre*, Dog-rose *Rosa canina*, Hawthorn *Crataegus monogyna*, and Blackthorn *Prunus spinosa.* These stands of dense scrub were encroaching on hardstanding around the railway buildings, some of the railway buildings themselves, areas adjacent to the tracks and in the car park in the west of the Site.

UKHAB Primary Code	Description and UKHAB Secondary Codes
h3h – Mixed scrub	
	*Example of Butterfly-bush encroachment in an area north of the disused railway buildings.* *Secondary codes:* *46 – Railside* *48 – Non-native* *351 – Vacant/derelict land*

h2b – Other hedgerows

Short stretches of boundary vegetation forming a hedge-like feature were present along parts of the north-eastern boundary with Great Western Road. The feature was gappy in its northern extent and largely comprised of Butterfly-bush and Bramble.

UKHAB Primary Code	Description and UKHAB Secondary Codes
h2b – Other hedgerows	
	*Species-poor hedgerow forming boundary feature with Great Western Road along north-eastern boundary with builder's yard.* *Secondary codes:* *69 – Fence* *111 - Road*

Trees

The Site contains a number of semi-mature trees, namely 1no. Ash *Fraxinus excelsior* (TN1), 1no. Sycamore *Acer pseudoplatanus* (TN2) and a row of 5no. Balsam Poplar *Populus balsamifera* (G1, Appendix II). All other trees are young / sub-mature and have not been individually mapped within scrub habitats.

3.3 BATS

3.3.1 Desk study

The GCER data search returned 25no. bat records within 2km of the Site. Species identified included unidentified bat species, Common Pipistrelle *Pipistrellus pipistrellus*, Soprano Pipistrelle *Pipistrellus pygmaeus*, Pipistrelle species *Pipistrellus sp.,* Brown Long-eared *Plecotus auritus*, Daubenton's bat *Myotis daubentonii*, *Myotis* sp., Serotine *Eptesicus serotinus*, and Noctule *Nyctalus noctula*.

No records appear to directly coincide with the Site itself. The closest records to the Site are 2no. records pertaining to the Railway Triangle (Triangle Retail Park) approximately 500m southeast of the Site relating to a Common Pipistrelle and a Soprano Pipistrelle dating from 2005. The nature of these records (i.e. roost, flying or other) is not specified.

A search of the MAGIC online database returned 3no. granted European Protected Species Licences. These were for Common Pipistrelle and Brown Long-eared bats at properties c.1km and c.1.7km to the west of the Site.

3.3.2 Habitat Assessment – foraging / commuting

The Site offers a an area of dark space within an otherwise heavily artificially lit urban environment and therefore has the potential to be attractive to local populations of light-adverse bat species. However, the prevalence of poor quality habitat for foraging such as hardstanding and bare ground within the Site limits its suitability for bats, providing only sub-optimal foraging.

The nocturnal bat emergence surveys of buildings (see Section 3.3.4 below) only recorded very low / negligible levels of bat activity within the Site (with only a single commuting/foraging Common Pipistrelle bat recorded across all surveyor locations during both the 2020 and 2021 surveys).

Overall the Site is therefore not considered to be of significant importance to local foraging and commuting bat populations.

3.3.3 Habitat Assessment - Preliminary Bat Roost Assessment (PBRA) of buildings

All vacant structures within the Site underwent a Preliminary Bat Roost Assessment by a licenced bat ecologist as part of the initial survey scope. Some buildings were not accessible for internal inspection as they were structurally unsafe with some small brick outbuildings closely boarded up. Structures that were previously inaccessible during the 2020 survey in the north-west of the Site in commercial use, including the timber yard, builders yard office and vehicle repair workshops were also inspected internally and externally during the 2021 survey. These internal inspections did not record any presence of bats in the structures and features present were considered to have only low or negligible potential to support roosting bats. Full details of the PBRA survey results are provided in Appendix VI at the end of this report.

3.3.4 Nocturnal bat emergence surveys

In line with Bat Conservation Trust guidelines (Collins et al, 2016) for buildings with low potential to support roosting bats, a single dusk emergence survey was undertaken of buildings B1, B6 and B9 on 2nd September 2020, with an update survey undertaken on 13th August 2021.

The nocturnal bat surveys of these buildings did not record any bats emerging from or entering the structures, nor any bats interacting with the buildings on Site. Only very low / negligible levels of bat activity were recorded around the Site.

3.4 HAZEL DORMOUSE

3.4.1 Desk study

No records of Hazel Dormouse *Muscardinus avellanarius* were returned for within 2km of the Site.

3.4.2 Habitat assessment

The habitats within the Site were assessed as having negligible suitability for Hazel Dormouse due to the structure and species composition of the scrub present, along with poor connectivity to adjacent suitable habitat, and the species is therefore considered unlikely to be impacted by the proposed development. Hazel Dormouse is therefore not considered further in this report.

3.5 BADGERS

3.5.1 Desk study

7no. records of Badger *Meles meles* were returned for within 2km of the Site. The closet relates to a sighting within the Railway Triangle c.500m southeast of the Site. The record lists one count of Badger dung.

3.5.2 Habitat assessment

No setts were recorded within the Site during any of the survey visits. No evidence of Badger presence (such as dung or signs of foraging) were recorded within the survey area. Badger are therefore considered unlikely to be impacted by the development on the Site, and are not considered further in this report.

3.6 BIRDS

3.6.1 Desk study

The GCER data search returned 668no. records of notable bird species within 2km of the Site. 1no. record pertained to the Site itself and related to a Sparrowhawk *Accipiter nisus* sighting dating from 2016. Records included species listed on Schedule 1 of the 1981 Wildlife and Countryside Act (WCA) (as amended), species listed on Section 41 of the 2006 NERC Act (Species of Principal Importance) and species on the Amber and Red lists of BoCC (Stanbury et al, 2021), such as:

- Schedule 1 listed birds: Barn Owl *Tyto alba,* Black Redstart *Pheonicurus ochruros,* Cetti's Warbler *Cettia cetti*, and Fieldfare *Turdus pilaris*
- Species of Principal Importance - Common Bullfinch *Pyrrhula*, Cuckoo *Cuculus canorus*, Dunnock *Prunella modularis*, House Sparrow *Passer domesticus*, Linnet *Linaria cannabina*, and Hawfinch *Coccothraustes coccothraustes*.
- Red listed species (2021 BoCC) – House Sparrow, Hawfinch, Fieldfare, Cuckoo, Mistle Thrush *Turdus viscivorus*, Skylark *Alauda arvensis,* Greenfinch *Chloris chloris* and House Martin *Delichon urbicum*.
- Amber listed species (2021 BoCC) – Grey Wagtail *Motacilla cinerea,* Meadow Pipit *Anthus Pretensis*, Sedge Warbler *Acrocephalus schoenobaerus,* Black Redstart, Saprrowhawk, Common Bullfinch and Dunnock.

3.6.2 Habitat Assessment

The buildings and scrub and trees on Site provide suitable habitat for nesting birds common to urban settings. There was evidence of nesting bird activity across the Site including Feral Pigeon *Columba livia domestica* and Blackbird *Turdus merula* within buildings and within trees and scrub vegetation.

The Site provides suitable nesting and foraging habitat for Black Redstart, which show a preference for nesting in derelict buildings (often on disused industrial sites) and often foraging on or near wastelands/brownfield with early successional vegetation. The nearest data search record of Black Redstart originates from December 2016 at Gloucester Hospital immediately to the north of Great Western Road.

Black Redstart are a rare breeder in the UK, with the current UK breeding population of this species estimated to be in the region of 58no. pairs (Woodward et al, 2020), with their distribution largely concentrated in London and Birmingham. It should be noted that all but one of the 7no. records of the species returned within the GCER data search are from winter months when nesting would not occur. Furthermore no documentation could be identified relating to breeding activity by the species within the city of Gloucester.

The Site is unlikely to offer suitable habitat for the other Schedule 1 bird species returned within the data search.

3.7 REPTILES

3.7.1 Desk study

30no. reptile records were returned for within 2km of the Site as part of the GCER data search, of which 25no. related to Slow-worm *Anguis fragilis* and a further 5no. related to Barred Grass Snake *Natrix helvetica*. The closest record pertained to a property in urban development c.1.6km southeast of the Site.

3.7.2 Habitat assessment

The habitats on the Site were noted to have a poorly established ground layer which generally provides insufficient cover for reptile species likely present in the wider area. The ground layer mostly comprised of hardstanding, stones and/or gravel with a sparse covering of mosses, ephemeral species with frequent stands of Bramble and woody scrub. Although some areas of edge habitats with denser grasses may offer greater suitability, these were limited in extent. Habitats on site were therefore considered to be of low potential for reptiles, offering only limited opportunities and unlikely to support any self-sustaining populations. Nevertheless there remains a low risk of individuals of common species (such as Common Lizard or Slow-worm) being present throughout the Site in low numbers on occasion, including sheltering within brash and debris piles and therefore presence is assumed. It is considered that further reptile survey work is not required however, given the isolated and fragmented nature of suitable habitat present and an assumption that low numbers are present.

3.8 AMPHIBIANS, INCL. GREAT CRESTED NEWTS

3.8.1 Desk study

The GCER data search returned 95no. records of amphibian species within 2km of the Site. These included 3no. records of Great Crested Newt *Triturus cristatus,* 9no. records of Smooth Newt *Lissotriton vulgaris*, 7no. records of Palmate Newt *Lissotriton helveticus,* 50no. records of Common Frog *Rana temporania*, and 24no. records of Common Toad *Bufo bufo*, There are no ponds within 500m of the Site. The closest bodies of water are a stream running through a park c.500m to the east and a stream or drain connecting the back gardens of a row of houses c.300m to the south of the Site.

3.8.2 Habitat Assessment

The Site does not contain any bodies of water and is composed of large areas of hardstanding. Vegetation on Site could provide cover for amphibians but connectivity to the closest water bodies is poor and fragmented by roads and railway. The Site is therefore considered reasonably unlikely to support amphibians and they are not considered further in this report.

3.9 INVERTEBRATES

3.9.1 Desk study

87no. records of notable invertebrate species within 2km of the Site were returned by GCER. These included 2no. records of Stag Beetle *Lucanus servus,* 1no. record of Northern Damselfly *Coenagrium hastulatum*, and 84no. records of moth species including Brindled Beauty *Lycia hirtaria,* Large Nutmeg *Apamea anceps*, and Spindle Knot-horn *Nephopterix angustella.* These records were largely associated with the Local Nature Reserves and the riverside areas to the west of Gloucester City centre.

3.9.2 Habitat Assessment

As part of the PEA survey the site was scoped for its potential to support notable invertebrate assemblages. The Site provides a variety of habitats established on previously developed / disturbed ground, although due to the poor floral diversity, large expanses of hardstanding and dominance of non-native species (e.g. Butterfly-bush) is not considered of Priority Habitat quality (Butcher et al., 2020). Open Mosaic Habitat with high suitability for invertebrates is characterised by a diverse range of habitats and high abundance of flowering plants which are required for all invertebrates to feed on. The Site is not considered to support a high diversity or abundance of flowering plants, with the exception of Butterfly-bush which is likely to provide a food source for more common and widespread species of butterfly but at the expense of the diversity of other flowering species as it becomes more dominant across the Site. This is considered likely to limit the potential for the Site to support diverse invertebrate assemblages of note.

Whilst the presence of notable invertebrate species at the Site cannot be ruled out entirely, it is considered on balance, considering the heavily urbanised nature of the surroundings and predominance of bare ground/ hardstanding substrates that the presence of self-sustaining populations of notable invertebrate species is reasonably unlikely. Invertebrates are therefore not considered further within this report.

3.10 PLANTS

3.10.1 Desk study

14no. records of notable plant species were provided by GCER for the desk study area. However, these records are largely associated with Alney Island LNR and an area of grassland to the north of Gloucester City centre. None of the records corresponded to the Site itself.

Twenty-six records of invasive plant species listed on Schedule 9 of the Wildlife and Countryside Act (WCA) 1981 (as amended) were returned as part of the GCER data search. These included records of Himalayan Balsam *Impatiens glandulifera*, Nuttall's Waterweed *Elodea nuttallii*, Canadian Waterweed *Elodea canadensis*, Few-flowered Garlic *Allium paradoxum*, Japanese Knotweed *Fallopia japonica*, New Zealand Pigmyweed *Crassula helmsii* and Duck-potato *Sagittaria latifolia* within 2km of the Site. The nearest record was of New Zealand Pigmyweed approximately 1km south-west of the Site.

3.10.2 Survey results

No protected or notable plant species were recorded at or adjacent to the Site, and are therefore not considered further in this report.

A stand of Japanese Knotweed, a non-native invasive plant species listed on Schedule 9 of the Wildlife and Countryside Act 1981 (as amended), was recorded within the Site. This was located along the edge of a grassy area in the northeast of the Site (target note TN1, Appendix II). A further invasive plant species listed on WCA Schedule 9, Virginia Creeper *Parthenocissus quinquefolia, was* found to be present along the boundary between the builder's yard and the residential gardens along the northern central boundary of the Site (target note TN2, Appendix II).

3.11 OTHER SPECIES

Potential for other protected/ priority species to occur within habitats at the Site has been assessed as follows.

3.11.1 Hedgehog

116no. records of Hedgehog *Erinaceus europaeus* were provided for the desk study area by GCER for within 2km of the Site. The large extent of hardstanding on Site is considered sub-optimal habitat for Hedgehogs. However, the successional vegetation provides some foraging and refuge habitats for this widespread but declining species which is listed as a Species of Principal Importance. It is therefore considered possible that Hedgehog could use the Site as part of wider habitat networks.

3.12 ECOLOGICAL EVALUATION

Table 3 below provides an analysis of the value of potential ecological receptors described in Sections 3.1-3.11. The valuation of the receptor takes into account factors such as legal protection, local and national conservation status, population trends, range and distribution, diversity, connectivity and rarity (CIEEM, 2018).

Table 3: Evaluation of ecological receptors at Site

ECOLOGICAL RECEPTOR	VALUE	REASON
Habitats		
Mixed scrub (h3h)	Site	This habitat is widespread throughout the Site and if left unmanaged will continue to encroach on areas currently free of scrub. The scrub consists mainly of a non-native species, Butterfly-bush, along with Bramble.
Sealed surfaces / artificially unvegetated surfaces / vacant or derelict land (u1b, u1c, u1b6)	Site	Early successional ephemeral / ruderal vegetation beginning to form. Potential to develop towards an Open Mosaic Habitat on Previously Developed Land (Priority Habitat under the NERC Act 2006) if left unmanaged.
Protected and notable species		
Bats (roosts)	Negligible	Buildings with low roosting potential present. No evidence of presence of roosting bats recorded during internal inspection or nocturnal emergence surveys.
Bats (commuting/ foraging)	Site	The Site offers sub-optimal bat foraging habitat and recorded activity levels at the Site were low/negligible. The Site has the potential to offer a dark corridor for commuting within a heavily urbanized environment but no evidence of this was recorded.
Hazel Dormouse	Negligible	No suitable habitat present. Poor connectivity to nearby habitats.
Badger	Negligible	Limited foraging or sett building opportunities. No evidence of presence noted.
Breeding birds	Site	Denser areas of scrub and the vacant buildings offer opportunities for nesting bird species associated with urban and semi-urban environments.
Reptiles	Site	Habitats unlikely to support any significant self-sustaining populations, although low numbers of more mobile common species such as Common Lizard may be present on occasion.

ECOLOGICAL RECEPTOR	VALUE	REASON
Great Crested Newt	Negligible	No suitable aquatic habitat present within 500m. Presence therefore considered unlikely.
Invertebrates	Site	Habitats unlikely to support notable assemblages or self-sustaining populations of notable or scarce invertebrate species.
Plants	Site	Species-poor vegetation communities. Presence of Schedule 9 invasive non-native plant species.
Hedgehog	Site	Sub-optimal habitat, some limited foraging and refuge potential.

4 ASSESSMENT OF ECOLOGICAL IMPACTS

Please note that, for the purposes of this report, the impact assessment takes into consideration mitigation that has been incorporated into the scheme design (e.g. embedded mitigation) as well as proposed habitat enhancement.

Measures required to avoid/minimise impacts on ecological receptors during the construction phase (e.g. those that need to be adhered to for legal reasons, to minimise/avoid impacts not of ecological significance or simply as environmental good practice) are detailed in Section 5. In addition, measures required to facilitate enhancement and management of ecological features post-construction are included. Such measures are typically secured through the planning process via the use of planning conditions/obligations.

4.1 DESIGNATED SITES

4.1.1 Innsworth Meadow SSSI

The Site falls within the SSSI Impact Risk Zone set up by Natural England around Innsworth Meadow SSSI. Furthermore, by providing an overall gain in the number of residential units, the development meets the stated criteria requiring the Local Planning Authority to consult with Natural England on likely risks to the SSSI as a result of development. Risks considered during this consultation may be direct (i.e. habitat loss or damage), or indirect (such as increases in recreational pressures on publicly accessible sites).

4.1.2 Other sites

No other statutory or non-statutory designated sites are expected to be affected by the proposed development in view of the distance of these from the Site.

4.2 HABITATS

Potential impacts

Approximate areas of baseline habitats at the Site along with descriptions of anticipated impacts as a result of the development proposals are given in the table below. All existing habitats within the Site boundary are anticipated to be lost during Site clearance, with the exception of a semi-mature Ash tree in the north of the Site.

Table 4: Impacts on pre-development habitats

HABITAT TYPE	AREA (ha)	NOTES
Mixed scrub	0.75	To be lost as a result of the development proposals. Species-poor, largely comprising Butterfly-bush and Bramble.
Artificially unvegetated / unsealed surface	1.28	To be lost as a result of the development proposals. 0.45ha of this falls within the existing builder's yard (unvegetated). Remaining 0.82ha showing signs of early successional vegetation encroachment, but does not meet standard to qualify as Open Mosaic Habitat. Potential to develop to OMH over time.
Developed land/ sealed surface	1.09	To be lost as a result of the development proposals. Includes buildings and hardstanding.
Vacant / derelict land	0.14	To be lost as a result of the development proposals. Showing signs of early successional vegetation encroachment, but does not meet standard to qualify as Open Mosaic Habitat. Potential to develop to OMH over time.
Urban trees	n/a	1no. semi-mature Sycamore and 5no. Balsam Poplar to be lost as a result of the development. 1no. semi-mature Ash in the north of the Site to be retained.

Embedded mitigation

The landscape scheme for the development includes areas of biodiverse roofs on the apartment blocks, native mixed scrub planting along some boundaries, extensive planting of trees within parkland, public open spaces and along streets, areas of wildflower meadow in public open space, and SUDs/rain garden shrub borders. The biodiverse roofs will aim to mitigate the loss of brownfield habitat through provision of similar, higher quality habitats. Detailed design of these roofs has yet to be undertaken, however recommendations in relation to provisions are provided in Section 6. Tree, shrub and scrub planting will act towards mitigating the loss of the existing poor quality scrub habitats.

Further information on proposed habitat creation and enhancement is provided in Section 6 of this report.

Significance of residual effects

Whilst existing habitats at the Site have the potential to develop into habitats of high ecological value over time or Priority habitats, they are largely currently considered to be of relatively low ecological value. The most significant impact on habitat at the Site is therefore considered to be the loss of significant areas of species-poor scrub within an urban setting, and the value this may have for nesting birds and pollinating insects. Establishment and long-term management of the proposed biodiverse roofs, wildflower planting and tree and shrub planting will add to the overall diversity of habitats and provide opportunity for a variety of urban-centric species.

It is concluded that, although the proposals may result in short- to medium- term loss of interest of particular broad habitats present, it is, considered that no significant adverse impacts on the ecological value of the Site's habitats will result from development in the long-term. Habitat creation proposals have the potential to result in a beneficial impact on the ecological value of the habitats present at the local level, as demonstrated by the accompanying Biodiversity Net Gain report for the Site (Burton Reid Associates, 2022).

4.3 INVASIVE PLANTS

Construction

In the absence of adequate biosecurity measures, site clearance and construction works could cause the spread of non-native invasive species around the Site or from the Site to other areas. This could result in detrimental impacts on habitats and native species within the Site and surrounding areas. Biosecurity measures to avoid/ minimise the likelihood of this happening are outlined in Section 5 and further detail should be contained in the CEMP and advised in detail by a specialist contractor.

Operation

New development can increase the risk of colonisation of invasive non-native species through increasing human movement around habitats and tipping of garden waste. Management measures to minimise the spread of invasive species within the Site during the operational phase of development will be provided in the LEMP.

4.4 BATS

Potential impacts

Roosting bats:

All existing buildings within the Site will be demolished during initial Site clearance. No evidence of bats was recorded within the buildings on Site during the ecological survey work. Notwithstanding this, bats are highly mobile species and therefore the presence of bats during demolition works cannot be entirely ruled out. As a result, it is recommended that a precautionary approach to demolition should be followed in order to ensure compliance with nature conservation legislation. Details of recommendations in relation to this are provided in Section 5.

Foraging / commuting bats:

Given the low to negligible levels of bat activity recorded at the Site and prevalence of sub-optimal habitats for foraging, impacts on foraging / commuting bats are not considered likely to be significant. Measures to avoid and minimise impacts on foraging / commuting bats by way of sensitive construction phase lighting have been detailed in Section 5 of this report.

Significance of residual effects

No significant adverse impacts on roosting, foraging and commuting bats using the Site are expected.

4.5 BREEDING BIRDS

Potential impacts

Black Redstart:

Overall, the risk of impacts on breeding Black Redstart as a result of the development of the Site are considered to be low given their presence within Gloucester is largely limited to the winter months, however the species has been recorded within the city during summer months on at least one occasion. Therefore their potential presence during summer months along with the availability of suitable habitat at the Site infers that potential nesting activity should not be completely ruled out. Measures to avoid and minimise these impacts on breeding birds have been detailed in Section 5 of this report.

General:

In the absence of appropriate mitigation, the proposed habitat clearance to facilitate the housing development could result in impacts on species of relatively common and widespread breeding birds through loss of nest sites and foraging areas.

The Site will be cleared of buildings and species-poor scrub habitat to facilitate construction. This loss of nesting habitat is unlikely to have significant impacts in the context of the wider landscape, as similar nesting habitat is relatively common in the wider area. Proposed habitat creation including hedgerow planting, tree planting, provision of nest boxes, biodiverse roofs and creation of parks as public open spaces will maintain, and may in the long-term improve opportunities for a range of breeding bird species at the Site.

Breeding birds and their young could be harmed during clearance of scrub habitats and buildings within the proposed development areas. Measures to avoid and minimise these impacts on breeding birds have been detailed in Section 5 of this report.

Significance of residual effects

No significant adverse impacts on local breeding bird populations from loss of breeding or foraging habitat is expected.

4.6 REPTILES

Potential impacts

There is a minor risk that during vegetation clearance works individual reptiles present on Site could be harmed and so a precautionary approach is recommended for these works, which is detailed in Section 5.

Significance of residual effects

On the basis that the above mitigation measures will be implemented, significant impacts on reptiles are not anticipated during construction.

4.7 HEDGEHOGS

Loss of suitable hedgehog habitat proposed is considered unlikely to be significant in the context of the wider surroundings and therefore, no significant adverse impacts from habitat loss on this species is expected. Precautionary working methods during Site clearance proposed in relation to reptiles at the Site should act to further minimise risk of harm during removal of suitable habitat. The possible presence of Hedgehog at the Site has been further considered in the proposed ecological mitigation and enhancement features in Section 5, with Hedgehog holes (13x13cm) to be created in residential garden fences to allow for continued permeability for Hedgehogs and other small mammals and amphibians / reptiles.

5 ECOLOGICAL MITIGATION AND AVOIDANCE MEASURES

5.1 HABITATS

RECOMMENDATIONS		
• Tree T1 (which is to be retained within the scheme) will be protected in accordance with BS 5837:2012 (Trees in relation to design, demolition and construction) or the recommendations of an appropriately qualified arboriculturist. • Implement habitat compensation and enhancements (i.e. habitat creation) as proposed during the design phase.		
Requires additional work pre-planning:		NO
Requires action post-planning/ pre-construction:	YES	
Requires action during construction:	YES	
Requires action post-development:		NO

5.1.1 Trees

Construction

Tree T1 (as shown on Appendix II) is set to be retained within the post-development landscape design. Measures should therefore be taken to ensure this feature is not damaged during site clearance and construction. Protection measures utilised should be in accordance with BS5837:2012 (Trees in relation to design, demolition and construction) or the recommendations of a Suitably Qualified Arboriculturist (SQA). This will include use of suitable tree protection fencing (e.g. Heras fencing), where appropriate, to prevent accidental damage to stems and roots of trees and shrubs during the construction phase.

5.1.2 Other/ general

Construction

A sensitive lighting strategy will be implemented during the construction phase including measures such as night-time curfews to minimise potential for indirect adverse effects of artificial lighting on wildlife.

Operation

To ensure the long-term success of the proposed post-development habitats as part of the Biodiversity Net Gain strategy for the development, a Landscape and Ecological Management Plan (LEMP) should be produced that provides prescriptions for the establishment and long-term management of proposed new habitats within the Site. This LEMP should be in place prior to the start of Site clearance works.

5.2 INVASIVE PLANTS

RECOMMENDATIONS

- Eradication programme in relation to Japanese Knotweed to be undertaken by specialist contractor in advance of the start of Site clearance works.
- Details of working practices in relation to invasive plant species to be included within the contractor's CEMP.

Requires additional work pre-planning:		NO
Requires action post-planning/ pre-construction:	YES	
Requires action during construction:	YES	
Requires action post-development:		NO

Construction

Two invasive plant species listed on Schedule 9 of the Wildlife and Countryside Act 1981 (as amended) have been recorded within the Site during the surveys; Japanese Knotweed (location: T1, Appendix II) and Virginia Creeper (location:TN2, Appendix II). The legislation makes it an offence to allow or cause Schedule 9 listed plant species to spread into the wild, and material containing these plant species (including seeds) is classified as controlled waste.

Clearance works within the Site need to consider the above legislation and employ appropriate measures to prevent the possible spread of these species where works affect areas where they grow. Each species recorded has a different method of spread and, therefore, advice should be sought in relation to works affecting habitats containing these species and methods for controlling these species in the long-term through consultation with an appropriate contractor or suitably qualified ecologist. Details of working practices in relation to invasive plant species to be included within the contractor's CEMP.

It is strongly recommended that a specialist contractor is instructed as soon as practicable to undertake an eradication programme for the Japanese Knotweed at the Site, so that this is completed ahead of commencement of works to minimise the risk of spread.

Operation

A LEMP will be produced and will provide detail on how habitats should be managed to avoid spread or colonisation of invasive plant species in the future.

5.3 BATS

- Minimise potential effects on nocturnal wildlife through the sensitive use of lighting within the scheme.
- Demolition of the existing buildings should be preceded by a building inspection by a licensed ecologist to confirm the continued absence of bat roosts.
- Provision of new roosting opportunities on new buildings following demolition works.
- Contractors to remain vigilant for presence of bats during demolition works. If evidence of bats is found works should cease immediately and the advice of a licensed bat ecologist sought. A licence from Natural England may be required before works can resume.

Requires additional work pre-planning:		NO
Requires action post-planning/ pre-construction:	YES	
Requires action during construction:	YES	
Requires action post-development:		NO

Many UK bat species are adversely affected by artificial lighting during dark hours. Night working as part of the construction process will therefore be avoided where possible. However, should night working be required, lighting restrictions will be in place to minimise negative effects on Site biodiversity.

Public realm lighting proposals for the Site will seek to avoid potential indirect effects on bats and other nocturnal wildlife. This will be achieved by following the guidance below in relation to lighting design and more detailed technical guidance provided by the Institute of Lighting Professional (ILP, 2018):

- Only the minimum amount of external light needed for safety should be used.
- Light trespass (spillage) onto vegetated boundaries and proposed bat roosting features will be avoided through use of directional lighting at the appropriate height and positioning to light only the intended area.
- Use of narrow spectrum bulbs (as this will lower the range of species affected by the lighting). These should have a warm white spectrum (ideally <2700Kelvin) with minimal blue light component and should lack a UV component when manufactured. The peak wavelength of the luminaires should be higher than 550nm. LED luminaires are usually best due to their sharp cut-off, lower intensity, good colour rendition and dimming capability.

No evidence of roosting bats was recorded in association with any of the buildings present within the Site. Notwithstanding this, bats are highly mobile species and it is recommended that a precautionary approach to demolition should be followed in order to ensure compliance with nature conservation legislation. This should take the form of either:

- A single bat re-entry survey carried out immediately prior to demolition at the appropriate time of year

(May to September inclusive) in suitable weather conditions for detecting bat roosting activity to confirm the continued absence of roosting bats; or

- All potential roosting features to be affected by the works should be subject to a detailed inspection by a licenced ecologist to confirm the absence of bats prior to works commencing. Where features identified as being suitable for roosting bats cannot be exhaustively searched, works to these features should be carried out using a soft-demolition approach under an ecological watching brief (i.e. in the presence of a licenced bat ecologist). Once affected areas of the building has been declared free of bats by the licenced ecologist, works will be allowed to proceed without supervision.

Please note that in the event that bats are discovered during the works, destructive works to any similar potential roosting features at the Site will have to cease until advice can be sought regarding the requirement for a licence from Natural England for the works to continue lawfully. This may involve significant delays to the works for additional surveys, preparation of licence application documents and the standard Natural England application processing period (normally in excess of 30 working days from submission).

Contractors should be informed of how to identify signs of bats and how to respond should bats be uncovered:

- Bat droppings crumble when rubbed between thumb and forefinger, mouse and rat droppings do not.
- Bats do not build nests;
- Bats can be found tucked into very small cracks and crevices within the roof structure and surrounding features (e.g. soffit box);
- If bats (or signs of bats) are found works should stop immediately and a licenced bat worker should be consulted; works should not resume until advice has been sought and acted upon. A licence from Natural England may need to be obtained.
- If a bat is injured, it should be carefully placed in a small box with air holes and a licenced bat worker should be consulted.
- Bats should always be handled with gloves as very rarely they can carry the rabies virus.

Bat boxes provided as part of the development proposals will offer mitigation for loss of potential roosting features in the derelict buildings. Details of recommendations are provided in Section 6 below in relation to habitat creation.

5.4 BREEDING BIRDS

RECOMMENDATIONS

- Vegetation clearance works required as part of the proposals should either be undertaken between the months of October and February inclusive to avoid the nesting bird season or be preceded by a nesting bird check if undertaken between March and September inclusive.
- If building demolition undertaken during the breeding bird season, this should be immediately preceded by a nesting bird survey of the structures to determine the presence of any active nests.

Requires additional work pre-planning:		NO
Requires action post-planning/ pre-construction:		NO
Requires action during construction:	YES	
Requires action post-development:		NO

All birds, their nests and eggs are protected under the Wildlife and Countryside Act 1981 (as amended). Bird species listed on Schedule 1 of this legislation (such as Black Redstart) are further protected from disturbance whilst nesting.

It is possible that trees and shrubs within the development area could be used by low numbers of common and widespread species of breeding bird. It is recommended that removal of vegetation with the potential to support nesting birds should be timed to avoid the main bird nesting period, which falls between March and September inclusive.

Where this is not possible, an ecologist should be present to check for any nests prior to demolition/ vegetation removal works being carried out. Should a nest be discovered, an appropriate buffer zone (minimum of 5m for vegetation, but possibly larger depending on the species) will need to be put in place around the nest where works can only proceed once it has been determined by an ecologist that the young have fledged.

Please note that undertaking vegetation removal during the nesting bird season can result in significant project delays should active bird nests be recorded and works be required to cease in the vicinity. It is therefore strongly advised that vegetation removal is undertaken outside of the breeding bird season (i.e. removed September-February inclusive).

Similarly, where building demolition is scheduled to be undertaken during the months of March and August inclusive, this should be immediately preceded by a nesting check by an experienced ornithologist to identify the presence of any active nests within the structures. In the unlikely event that Black Redstart are identified within the structure any works that may cause disturbance (such as noise or vibration) will be required to cease until the nesting activity has completed.

Provision of biodiverse roofs on the apartment blocks post-development will provide mitigation for loss of potential Black Redstart foraging habitat (although it should be noted that the species has not been confirmed to utilise the Site). Habitat creation requirements in relation to the brown roofs are outlined in Section 6 below.

5.5 REPTILES

RECOMMENDATIONS		
• Precautionary methodology to be employed during Site clearance to avoid risk of harm to reptiles.		
Requires additional work pre-planning:		NO
Requires action post-planning/ pre-construction:		NO
Requires action during construction:	YES	
Requires action post-development:		NO

Whilst the Site is considered unlikely to support any significant resident populations of reptiles, presence of low numbers of commonly occurring species such as Common Lizard and/or Slow-worm cannot be ruled out. Therefore, a precautionary approach is recommended to Site clearance whereby areas of ground cover including ground-level scrub and ruderal vegetation should be cut-back and strimmed using hand tools. Removal of ground-level vegetation and stripping of soil from areas supporting suitable reptile habitat should then be carried out under guidance from an experienced ecologist.

Shrubs and trees should be cleared outside of the bird breeding season (i.e. cleared between September and February) to a height of no lower than 15cm to avoid harming reptiles. Vegetation should then be cleared to a ground level in phases from the eastern, northern and southern edges, moving westwards towards the railway line, thereby giving any reptiles present within the working area the opportunity to move themselves out of the way. All arisings should be removed from the zone of works to discourage reptiles from taking refuge within remaining material.
At the same time as the vegetation clearance, any features suitable for hibernating reptiles such as brash/ log and stone piles within the impact area should be dismantled by hand by or under the supervision of the ecologist. Following clearance, the working area should be maintained as a smooth bare surface to discourage reptiles from venturing into the construction zone. Scrub roots should be grubbed up when day time temperatures are consistently above 10°C and in the presence of an ecologist.

Any reptiles found during the habitat removal should be moved to a place of safety away from the area of works to areas of retained vegetation. Should more than 5no. reptiles be recorded at the Site during clearance, works should be temporarily halted whilst the requirement for additional or alternative mitigation measures is determined.

6 BIODIVERSITY ENHANCEMENTS

6.1 BIODIVERSITY NET GAIN

6.1.1 Planning policy and legislation

Biodiversity Net Gain (BNG) is an approach to development that aims to "leave the natural environment in a measurably better state than before". The recently enacted Environment Act 2021 now makes Biodiversity Net Gain a mandatory part of the development process. Local Planning Authorities (LPAs) have been given 18 months (as of November 2021) to fully implement this legislation, however many have already made BNG a requirement of new planning applications through local planning policy.

In respect of development proposals, national planning policy now states that planning applications need to demonstrate measurable net gains for biodiversity. The National Planning Policy Framework (NPPF 2021) states that the planning system should:

'contribute to and enhance the natural and local environment by …minimising impacts on and providing net gains for biodiversity…". NPPF 2021 Paragraph 180 (d) states 'opportunities to improve biodiversity in and around developments should be integrated as part of their design especially where this can secure measurable net gains for biodiversity'.

Recent guidance on Biodiversity Net Gain (Baker et al., 2019) states the following:

'*When designing Biodiversity Net Gains (BNG), good practice is achieving net gains in features of the same or higher biodiversity value of those affected by the development. It is also to achieve at least equivalent or better levels of ecological functionality and, overall, to improve the extent or condition of biodiversity affected by a project (or the biodiversity within or surrounding a project footprint if no negative impacts are incurred)*'.

6.1.2 Biodiversity Net Gain requirements

Under the Environment Act 2021 and planning policy, planning proposals must demonstrate that a measurable net gain in biodiversity of at least 10% will be achieved. The biodiversity units gains are measured through the use of the DEFRA Biodiversity Metric calculation tool. The Metric calculations should be accompanied by the production of a Landscape Ecological Management Plan (LEMP), proportional to the scheme, detailing the implementation and management of enhanced and newly created habitats to maximise their long-term value to wildlife and ensure the calculated BNG will be achieved.

Biodiversity Net Gain calculations for the development and landscaping and habitat enhancement proposals have been undertaken using the Defra Metric 3.1 in line with guidance. Baseline habitat units have been based on the results of the UK Habitat Classification using the Metric 3.1 tool guidelines.

6.1.3 Defra Biodiversity Net Gain Metric calculations

The DEFRA Metric 3.1 calculations suggest that a net gain in biodiversity of over 10% will be achieved within the Site. This is based on the inclusion of the following key habitat compensation and enhancements:

- Provision of biodiverse roofs on apartment blocks.
- Inclusion of species-rich wildflower meadow seeding in public open space.
- Planting of Hornbeam *Carpinus betulus* hedgerows around apartment blocks and residential frontages.
- Significant levels of tree planting in parkland, public open spaces and along access roads

The DEFRA Biodiversity Metric calculation tool will be provided as part of the application with the accompanying Biodiversity Net Gain report (Burton Reid Associates, 2022).

6.2 LOCAL PLANNING POLICY AND BIODIVERSITY

The Gloucester, Cheltenham and Tewkesbury Joint Core Strategy 2011-2031 (adopted by Gloucester City Council in December 2017) policies relating to ecology which are relevant include:

- Policy SD9: Biodiversity and Geodiversity.

Although there is no current local policy referring specifically to the provision of biodiversity net gain and use of the metric, Policy SD9 states that "the biodiversity and geological resource of the JCS area will be protected and enhanced in order to establish and reinforce ecological networks that are resilient to current and future pressures".

Paragraph 4.9.2 of the local plan states that "all development should, wherever possible, make a positive contribution to biodiversity and geodiversity in the JCS area, helping to establish and reinforce networks for wildlife".

6.3 HABITAT CREATION AND ENHANCEMENT

The following enhancements are proposed for inclusion at the Site post-development. Further details of proposed habitat creation and long-term management should be detailed in a Landscape and Ecological Management Plan prior to commencement of works.

Table 5: Proposed habitat creation and ecological features

Biodiverse roofs	
Habitat creation proposals include approximately 680m² of biodiverse roofs spread across Blocks A, B, C and D. Detailed design for these should be undertaken to inform the LEMP, and will include the following habitat features: • Species-rich plug planting and seeding, including wildflowers and sedums; • Aggregate of varying sizes and types to create a variety of microclimates (e.g. stone gravel, stone piles and sand); • Mosaic of vegetated and unvegetated areas; and • Organic matter (e.g. dead wood and site harvested topsoil). Invertebrate habitat opportunities may be further enhanced through provision of invertebrate boxes on these roofs, such as the Schwegler “Insect Nesting Aid” or Green & Blue “Bees Block”.	
Native boundary scrub planting	
New strips of native scrub will be created along some boundaries as buffer planting / screening. Plant species for inclusion within these include Bramble, Blackthorn, Hawthorn, Stinking Hellebore, Ivy and Bluebell. This will provide habitats for nesting birds, small mammals, foraging/ commuting bats and invertebrates. This will also enhance habitat connectivity around the Site and contribute towards ecological network enhancement objectives for the area.	

Introduced shrub borders / rain garden planting / tree planting

Development proposals should include areas of wildlife-friendly planting using nectar-/pollen-rich species of flowers and shrubs within the planting scheme for the development in order to maximise its value for a range of species. These areas will provide enhanced opportunities for pollinating insects which in turn can benefit local bird and bat populations.

In addition to this, extensive planting of urban trees will be undertaken which

Species-rich wildflower seeding

Wildflower grassland will be created within areas of public open space using a native species-rich seed mix appropriate for the soil type. This will provide a food source for pollinating insects and birds as well as provide habitat for small mammals and invertebrates.

Establishment and management will include preparation of the ground for sowing of a wildflower/ species-rich grassland seed mix. Management cutting regimes will control weed growth on prepared bare soils to allow wildflowers and grasses to become established.

Habitat piles

Arisings from habitat management should be used to create habitat piles including logs, brash and some grass cuttings. These will be located in areas of public open space or boundary planting to provide foraging and refuge opportunities for reptiles, amphibians, invertebrates, and a range of other species.

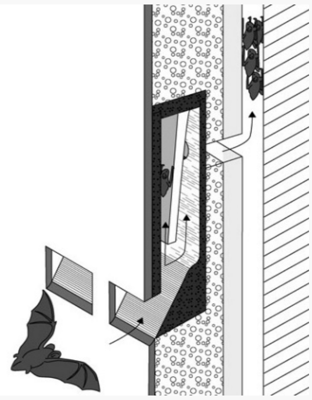
Hedgehog passes

130mm x 130 mm gaps will be created at the base of residential garden fencing to provide hedgehog access and easier passage across the Site. Information on the purpose of these passes, or signage as shown opposite, should be provided to residents to help ensure they are kept open and free of obstructions.

Bat roosting provisions

Provision of new roosting provisions for bats in new dwellings. This should comprise a minimum of 10no. integrated bat boxes or tubes including pre-fabricated bat roosting features suitable for the proposed construction type (e.g. Schwegler 2FR/ Ibstock Enclosed Bat Box) or bespoke features (e.g. soffit box features).

Roosting features should be located on the elevations of buildings away from direct lighting, ideally in south- or west-facing positions.



(Source: schwegler-natur.de)

Bird nesting provisions

Integrated features providing opportunities for nesting birds within buildings should be provided as part of the development scheme, comprising a minimum of 10no. House Sparrow nesting features (e.g. Schwegler 1SP or similar integrated boxes) installed on the north- or eastern aspects of buildings near eaves level (ideally close to vegetation).

General bird nesting boxes (e.g. Schwegler 1B/ Vivara Pro Seville Nest Box) suitable for woodland and garden birds may also be provided on suitable larger tree planting specimens or on the retained tree (T1) in the north of the Site. These should be sited ideally at least 3m off the ground and north- to east- facing.

7 MANAGEMENT PLANS

7.1 CONSTRUCTION ENVIRONMENT MANAGEMENT PLAN (CEMP)

A CEMP should be produced to ensure that mitigation measures as described within this report are delivered during the construction phase.

The CEMP should include details of measures to be implemented in advance of (or at the immediate commencement of) the main construction period (such as works associated with any advanced vegetation clearance) and measures which must be implemented throughout the main construction phase.

The following should also be included within the CEMP:

- Identification of ecological protection zones where works are to be restricted;
- Areas where protective fencing is to be installed and maintained;
- Procedures to avoid pollution incidents;
- Ecological working methodologies to avoid/minimise impacts on sensitive ecological receptors;
- Timing of works to avoid/minimise impacts on sensitive ecological receptors;
- Where and when ecological supervision and/or toolbox talks to Site personnel are required;
- Method statements for installation of enhancement features (e.g. bat and bird boxes);
- Responsible persons.

7.2 LANDSCAPE AND ECOLOGY MANAGEMENT PLAN (LEMP)

Once operational, the long-term management of ecological resources across the Site should be implemented through a Landscape and Ecology Management Plan (LEMP). The following should be included within the LEMP:

- Description of features to be managed;
- Management aims and objectives;
- Management prescriptions taking into account any legal requirements associated with protected species on Site;
- Work schedules and annual work plans;
- Body or personnel responsible for implementation of the plan;
- Monitoring and remedial measures;
- Funding resources and mechanisms for long term delivery.

8 CONCLUSIONS

Based on the findings and recommendations of this assessment, with proposed biodiversity avoidance, mitigation and compensation measures in place, it is concluded that the development as proposed would have no likely significant effects or adverse impacts on biodiversity.

With recommended habitat creation and management measures in place it is demonstrated that the proposals for the Site would achieve a 24.96% biodiversity net gain as measured by Natural England's Biodiversity Metric 3.1 calculation tool (Burton Reid Associates, 2022).

It can therefore be concluded that the development as proposed meets the relevant legislation and policy requirements in accordance with the Gloucester, Cheltenham and Tewkesbury Joint Local Strategy, the NPPF 2021 and NERC Act 2006.

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10 APPENDICES

APPENDIX I: LEGISLATION AND PLANNING POLICY

This report has been produced with reference to the following relevant wildlife and environmental legislation and planning policy.

LEGISLATION/ PLANNING POLICY	LINK
The Environment Act 2021. Part 6: Nature and Biodiversity	https://www.legislation.gov.uk/ukpga/2021/30/pdfs/ukpga_20210030_en.pdf
The Conservation of Habitats and Species Regulations 2017 (as amended)	https://www.legislation.gov.uk/uksi/2017/1012/contents/made
The Wildlife and Countryside Act (W&CA) 1981 (as amended)	http://www.legislation.gov.uk/ukpga/1981/69/contents_
Countryside and Rights of Way (CRoW) Act 2000	http://www.legislation.gov.uk/ukpga/2000/37/contents
Natural Environment and Rural Communities (NERC) Act 2006	http://www.legislation.gov.uk/ukpga/2006/16/contents
ODPM Circular 06/2005: Biodiversity and Geological Conservation	https://www.gov.uk/government/publications/biodiversity-and-geological-conservation-circular-06-2005
Gloucester, Cheltenham and Tewkesbury Joint Core Strategy 2011-2031	https://www.gloucester.gov.uk/media/5441/jcs.pdf
UK Post 2010 Biodiversity Framework	http://jncc.defra.gov.uk/pdf/UK_Post2010_Bio-Fwork.pdf
National Planning Policy Framework (2021 update)	https://www.gov.uk/government/publications/national-planning-policy-framework--2

The most relevant legislation pertaining to each of the protected species described within this document is given in the table below.

SPECIES	LEGISLATION	PROTECTION
Bats (all species)	Sch.5 of The Wildlife and Countryside Act 1981 (as amended) Conservation of Habitats and Species Regulations 2017 (as amended)	It is an offence to: • Intentionally or deliberately take, kill or injure a bat; • Damage, destroy or obstruct access to bat roosts; • Deliberately disturb bats in a resting place or roost.
Hazel Dormouse	Sch.5 of The Wildlife and Countryside Act 1981 (as amended) Conservation of Habitats and Species Regulations 2017 (as amended)	It is an offence to: • Intentionally or deliberately take, kill or injure; • Damage, destroy or obstruct access to any structure or place used for shelter or protection; • Disturb an animal occupying such a structure or place.
Great Crested Newt	Sch.5 of The Wildlife and Countryside Act 1981 (as amended) Conservation of Habitats and Species Regulations 2017 (as amended)	It is an offence to: • Intentionally or deliberately take, kill or injure; • Damage, destroy or obstruct access to any structure or place used for shelter or protection; • Disturb an animal occupying such a structure or place.
Reptiles*	Sch.5 of The Wildlife and Countryside Act 1981 (as amended)	Part of sub-section 9(1) and all of sub-section 9(5) apply; • Prohibits the intentional killing and injuring of reptile species
Badgers	The Protection of Badgers Act 1992	It is an offence to: • intentionally or recklessly damage, destroy or obstruct access to a sett; and • to disturb a Badger whilst it is occupying a sett.

Nesting birds (all species)	The Wildlife and Countryside Act 1981 (as amended)	It is an offence to: • Kill, injure, or take any wild bird; • Take, damage or destroy the nest of any wild bird while that nest is in use or being built; • Take or destroy an egg of any wild bird.
Non-native invasive plants	Sch.9 of The Wildlife and Countryside Act 1981 (as amended)	It is an offence to: • Plant, or otherwise cause to grow, in the wild any plant species listed on Schedule 9.

[*] Excludes Sand Lizard and Smooth Snake for which a higher level of protection is granted. These species were not considered here, as no suitable habitat was available for them and the Site falls outside of their recorded range.

Great Western Yard, Gloucester

Eutopia Homes Ltd

UK Habitat Classification Map

June 2022

BY TB | **DOC REF** BR0696/EcIA/A | **REV.** A

BURTON REID
ASSOCIATES

Project No:	BR0478	**Date:**	July 2022
Client:	Eutopia Homes Ltd.	**Project:**	Great Western Yard, Gloucester
Status:	Survey	**Figure:**	APPENDIX II: UK HABITAT CLASSIFICATION SURVEY MAP

APPENDIX III: UK HABITAT CLASSIFICATION PLANT SPECIES LISTS

* DAFOR scale of relative abundance: Dominant (D), Abundant (A), Frequent (F), Occasional (O) or Rare (R). "L" prefix denotes localised distribution pattern.

u1b – Developed land; sealed surface (encroaching vegetation in and around cervices)

COMMON NAME	LATIN NAME	ABUNDANCE (DAFOR*)
Sedum sp.	*Various*	LA
Field Horsetail	*Equisetum arvense*	LF
Canadian Fleabane	*Conyza canadensis*	LF
Rosebay Willowherb	*Chamerion angustifolium*	LF
Red Valerian	*Centranthus ruber*	O
Common Michaelmas-daisy	*Aster novi-belgii x lanceolatus = A. x salignus*	O
Lesser Trefoil	*Trifolium dubium*	O
Common Bird's-foot-trefoil	*Lotus corniculatus*	O
Petty Spurge	*Euphorbia peplus*	O
Bristly Oxtongue	*Picris echioides*	O
Bramble	*Rubus fruticosus agg.*	O
Wild Teasel	*Dipsacus fullonum*	R

u1b6 – Other developed land

COMMON NAME	LATIN NAME	ABUNDANCE (DAFOR*)
Butterfly-bush	*Buddleja davidii*	LA
Common Ragwort	*Senecio jacobaea*	LF
Bramble (prostrate habit)	*Rubus fruticosus agg.*	O
Common Bird's-foot-trefoil	*Lotus corniculatus*	O
Common Centaury	*Centaurium erythraea*	R
Canadian Fleabane	*Conyza canadensis*	R

u1c – Artificial unvegetated, unsealed surface (scattered encroaching vegetation)

COMMON NAME	LATIN NAME	ABUNDANCE (DAFOR*)
Sedum sp.	*Various*	LA
Broad-leaved Willowherb	*Epilobium montanum*	LA
Russian-vine	*Fallopia baldschuanica*	LF
Oxeye Daisy	*Leucanthemum vulgare*	LF

Canadian Fleabane	*Conyza canadensis*	LF
American Willowherb	*Epilobium ciliatum*	O
Common Ragwort	*Senecio jacobaea*	O
Black Medick	*Medicago lupulina*	O
Yarrow	*Achillea millefolium*	O
Butterfly-bush	*Buddleja davidii*	O
Great Willowherb	*Epilobium hirsutum*	O
Hoary Willowherb	*Epilobium parviflorum*	O
Lesser Trefoil	*Trifolium dubium*	O
Rosebay Willowherb	*Chamerion angustifolium*	O
Curled Dock	*Rumex crispus*	O
Wild Teasel	*Dipsacus fullonum*	O
Spear Thistle	*Cirsium vulgare*	O
Herb Robert	*Geranium robertianum*	O
Ribwort Plantain	*Plantago lanceolata*	O
Perforate St John's-wort	*Hypericum perforatum*	R
Common Vetch	*Vicia sativa subsp. segetalis*	R
Wild Carrot	*Daucus carota subsp. carota*	R
Cat's-ear	*Hypochaeris radicata*	R

h3h – Mixed scrub

COMMON NAME	LATIN NAME	ABUNDANCE (DAFOR*)
Butterfly-bush	Buddleja davidii	LD / A
Bramble	Rubus fruticosus agg.	LA / F
Silver Birch	*Betula pendula*	LF
Ash	Fraxinus excelsior	R
Hawthorn	Crataegus monogyna	R
Dogwood	Cornus sanguinea	R
Field Maple	Acer campestre	R

APPENDIX IV: PRELIMINARY BAT ROOST ASSESSMENT OF BUILDINGS – METHODOLOGY

The buildings on Site were inspected both externally and internally (where access was possible) in accordance with best practice guidance (Collins, 2016) to search for bats, signs of their presence (including droppings, staining, urine stains and feeding remains) and potential roosting features and access points. All suitable roosting features and any evidence of bats were recorded onto a base plan.

The suitability of the buildings for roosting bats was classified in line with best practice guidance as detailed in Table 1 below (adapted from Collins, 2016):

Table 6: Bat roost suitability assessment criteria (from Collins, 2016)

SUITABILITY	DESCRIPTION OF ROOSTING HABITATS
Negligible	Negligible habitat features on site likely to be used by roosting bats.
Low	A structure with one or more potential roost sites that could be used by individual bats opportunistically. However, these potential roost sites do not provide enough space, shelter, protection, appropriate conditions and/or suitable surrounding habitat to be used on a regular basis or by larger numbers of bats (i.e. unlikely to be suitable for maternity or hibernation).
Moderate	A structure with one or more potential roost sites that could be used by bats due to their size, shelter, protection, conditions and surrounding habitat but unlikely to support a roost of high conservation status (with respect to roost type only).
High	A structure with one or more potential roost sites that are obviously suitable for use by larger numbers of bats on a more regular basis and potentially for longer periods of time sue to their size, shelter, protection, conditions and surrounding habitats.

The inspection was undertaken using an endoscope, high-powered torch, headtorch, camera, binoculars, and ladder.

The Preliminary Bat Roost Assessment of buildings was carried out on 2nd September 2020 and 13th August 2021 by Alex Leishman MCIEEM of Burton Reid Associates (Level 2 Bat Survey Class Licence No. 2017-29436-CLS-CLS and Chrissy Mason MCIEEM (Level 2 Bat Survey Class Licence CL18 2016-22069-CLS-CLS). Where access allowed, buildings were inspected both externally and internally (including the roof voids) in accordance with best practice guidance (Collins, 2016) to search for bats, signs of their presence (including droppings, staining, urine stains and feeding remains) and potential roosting features and access points.

APPENDIX V: NOCTURNAL BAT EMERGENCE SURVEYS – METHODOLOGY

Nocturnal surveys were carried out of all buildings assessed as having 'low' suitability for roosting bats during the Preliminary Bat Roost Assessment. Some other buildings assessed as having very low/negligible suitability were also covered incidentally due to their proximity to other surveyed buildings. Dusk emergence surveys were carried out on 2nd September 2020 (Buildings B1, B6 and B9) and 13th August 2021 (Buildings B1, B6 and B9) by up to four experienced bat surveyors in suitable weather conditions.

Table 7: Details of nocturnal bat activity surveys

SURVEY	DATE & TIMES	PERSONNEL	WEATHER
Buildings B1, B6 and B9 Sunset: 19:53	02/09/20 19:35 – 21.23	Tamsyn Bridger ACIEEM; Chrissy Mason MCIEEM (Level 2 Bat Survey Class Licence CL18 2016-22069-CLS-CLS); Alex Leishman MCIEEM (Level 2 Bat Survey Class Licence No. 2017-29436-CLS-CLS); Ella Dangerfield (CIEEM Qualifying Member).	Temp : 17˚C Wind: 1-2 Cloud: 0 Rain: None
Buildings B1, B6 and B9 (& B10) Sunset: 20.33	13/08/21 20:15 – 22:03	Chrissy Mason MCIEEM (Level 2 Bat Survey Class Licence CL18 2016-22069-CLS-CLS); Alex Leishman MCIEEM (Level 2 Bat Survey Class Licence No. 2017-29436-CLS-CLS)	Temp: 17.5˚C Wind: 1 Cloud: 3 Rain: None

The dusk emergence surveys were undertaken in accordance with current best practice guidelines by the Bat Conservation Trust (Collins, 2016), commencing 15 minutes before sunset and continuing until 1.5 hours after sunset. The surveyors used Wildlife Acoustic EM3+ or EM touch bat detectors. All calls were recorded and bats identified to species level (where possible) in the field and later confirmed using bat call analysis software (Titley Scientific AnalookW).

APPENDIX VI: PRELIMINARY BAT ROOST ASSESSMENT OF BUILDINGS – RESULTS

All vacant structures within the former sidings area and former diesel depot underwent a Preliminary Bat Roost Assessment by a licenced bat ecologist as part of the initial survey scope. Some buildings were not accessible for internal inspection as they were structurally unsafe with some small brick outbuildings closely boarded up.

Structures in commercial use in the north-west of the wider Survey Area that were previously inaccessible during the 2020 survey, including the timber yard, builders yard office and vehicle repair workshops were inspected internally and externally during the 2021 survey.

The internal inspections did not record any presence of bats in any of the surveyed structures, and features present were considered to have only low or negligible potential to support roosting bats.

Building reference numbers are provided on the UK Habitat Classification plan in Appendix II.

Table 4: Results - Preliminary Bat Roost Assessment (Buildings)

BUILDING	DESCRIPTION & FEATURES	PHOTO
B1 - **Low** suitability	Large disused brick train shed with solid brick walls, and parapets on the tops of side walls. The internal area was light and many Feral Pigeons were present. The roof had a steel frame covered with corrugated bitumen/asbestos cement sheets with small areas also boarded on the inside. The areas of greatest suitability for bats in the structure were cracks in external brickwork and gaps under roof edging on the gable ends. These features were likely to be suitable for individual crevice-dwelling bats, but most likely on a sporadic or occasional basis due to the level of disrepair. The building has not been in use for a long time and is light, drafty and damp internally, which provides unfavorable conditions for day roosting bats.	 

B2 and B3 - **Negligible/very low** suitability	Small single-room brick buildings with solid concrete roofs and boarded up doors and windows. Holes present at broken vents at top of walls. Buildings did not appear to provide suitable cavities for roosting bats due to solid roof construction.	
B4 – **Negligible/ very low** suitability	Complex of warehouses/ sheds currently used by a car dealership and as a workshop. The construction is mainly of wood and corrugated metal. A few gaps are assumed present in the wooden section at the rear.	 

B5 – **Negligible/ very low** suitability	Asbestos-roofed Dutch barn. A few gaps present between asbestos and metal sheeting on roof though mostly single skinned roof. Only suitable for opportunistic or occasional use by pipistrelles *Pipistrellus sp.*	 
B6 – **Low** suitability	Small brick-built bungalow used as offices, with concrete tile roof and wooden soffits. Gaps present under ridge top tiles and ridge, as well as along underside of soffit at tops of walls. Assumed presence of roof void, which may be accessible to bats (not accessible internally).	
B7 – **Negligible** suitability	Domed-roof open-sided shelter. No features suitable for roosting bats were present.	

B8 – **Negligible** suitability	Rusted metal shed, with metal frame and corrugated metal roof and side cladding. Whilst the inside of the building could not be accessed and searched due to health and safety concerns, no evidence of bats, droppings or favourable features for bats were evident within areas of the building that could be viewed. Bat potential considered negligible.	 
B9 –**Very low** suitability	Derelict brick shed with slate roof over wooden sarking. Half of roof collapsed and considered unfavourable for roosting bats. Some crevices and gaps within external brick wall. These features are likely to be suitable for individual crevice-dwelling bats, but most likely on a sporadic or occasional basis due to the level of disrepair.	
B10 – **Negligible/very low** potential	Small brick single room building with solid concrete roof, similar to B2 and B3. Holes at top of walls where vents are broken. Buildings do not appear to provide suitable cavities for roosting bats due to solid roof construction.	

No trees on Site held any potential for roosting bats.

Several Feral pigeons were found within Building B1 including evidence of nesting. No other evidence of active nesting by other bird species was recorded although individual nesting remains were found in one of the outbuildings of the car repair commercial units (B4).

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Building with Nature

CIEEM
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PRACTICE 2021-2022

Landscape Institute
Registered Practice

EUTOPIA
HOMES

Energy Strategy

Great Western Yard

ESD

EUTOPIA
HOMES

Environmental Services Design

GREAT WESTERN YARD, GLOUCESTER

ENERGY STATEMENT

FOR

EUTOPIA HOMES

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[redacted] [redacted]
[redacted] [redacted]

Project No:	EJ1646
Date:	July 2022
Rev:	P03 Final

TABLE OF CONTENTS

1.0 EXECUTIVE SUMMARY

This report assesses the predicted energy performance for the proposed development by Eutopia Homes at the site of Great Western Yard, Gloucester. The land is bordered by Great Western Road to the north, Horton Road to the east, and the retained railway line to the south.

The proposal is for residential development of up to 315 dwellings with associated landscaping, parking, open space, and ancillary works including demolition of existing buildings

The scheme has considered the issue of energy from an early stage. The client and architect have been decisive in their brief and design intentions.

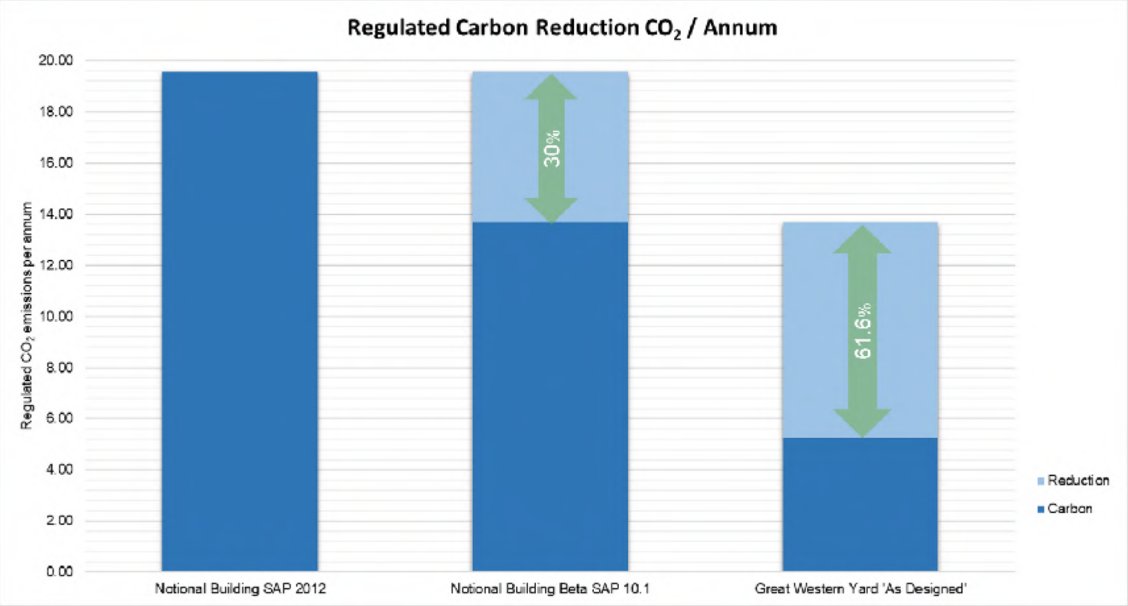
Where more than one dwelling is physically attached to another, for example a block of flats or a terrace of houses, the average emission rate can be used to demonstrate compliance with the regulations of all included flats and houses (Block Compliance). This is instead of requiring each flat and house to meet the requirements in its stand-alone form.

The Block Compliance method has been used in this report, providing average DER / TER results. Compliance is reached when the overall averaged DER is less than that of the equivalent TER.

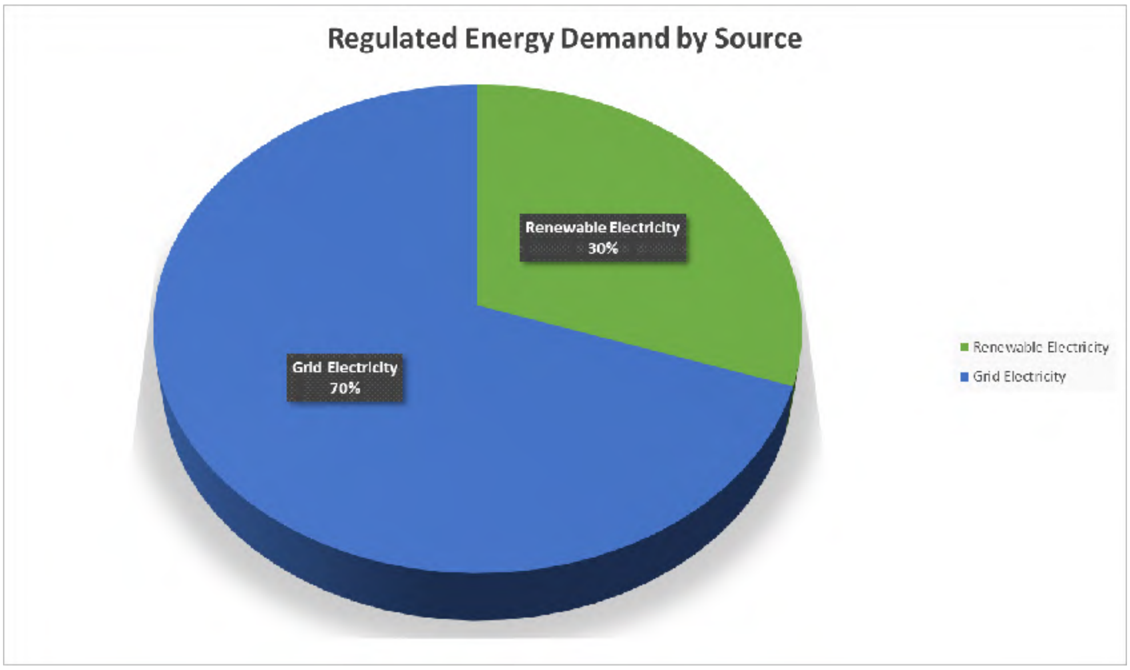
Updates to Part L of the Building Regulations were published in December 2021, replacing the previous 2013 edition. A Government press release on the 15th of December 2021 stated that CO_2 emissions from new build homes must be around 30% lower than current standards [2013 edition]. The updates to Part L have now taken affect from 15th June 2022. The methodology used to determine the CO_2 emissions for the proposed development is in accordance with the 2021 edition of Building Regulations Part L as the regulation in force at the time of this application.

Energy calculations were carried out using the beta version of Stroma FSAP 10.1 for the residential units.

The overall CO_2 emissions reduction for the proposed development is 61.6% against Part L 2021 edition as shown in the graph below.



The proposed development has a total of 607.8 kWp of solar photovoltaic panels producing 30.2% of the developments regulated energy demand as shown below, maximising the opportunity to utilise renewable energy.

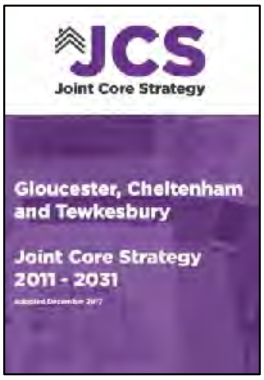

Regulated Energy Demand by Source
Renewable Electricity 30%
Grid Electricity 70%
Renewable Electricity
Grid Electricity

2.0 INTRODUCTION

This report assesses the predicted energy performance for the proposed development by Eutopia Homes at the site of Great Western Yard, Gloucester. The land is bordered by Great Western Road to the north, Horton Road to the east, and the retained railway line to the south.

The proposal is for residential development of up to 315 dwellings with associated landscaping, parking, open space, and ancillary works including demolition of existing buildings

This report demonstrates how the development addresses the relevant policies of the Gloucester, Cheltenham, and Tewkesbury Joint Core Strategy 2011 - 2031 (2017).



JCS
Joint Core Strategy

Gloucester, Cheltenham
and Tewkesbury

Joint Core Strategy
2011 - 2031

Adopted December 2017

Moreover, this report responds to the energy policies of the Gloucester, Cheltenham, and Tewkesbury Joint Core Strategy, including:

- Policy SD3: Sustainable Design and Construction

This report also takes cognisance of the emerging Gloucester City Plan 2011 – 2031 (April 2022).

Gloucester City Plan 2011 - 2031
With Modifications

April 2022

Deleted text is struck through
~~Example~~

New text is bold and underlined
Example

1

In line with the Joint Core Strategy, this energy statement shall incorporate the following.

Policy SD3

1. Development proposals will demonstrate how they contribute to the aims of sustainability by increasing energy efficiency, minimising waste, and avoiding unnecessary pollution of air, harm to the water environment, and contamination of land or interference in other natural systems. In doing so, proposals (including changes to existing buildings) will be expected to achieve national standards.

5. Major planning applications must be submitted with an Energy Statement that clearly indicates the methods used to calculate predicted annual energy demand and associated annual Carbon Dioxide (CO_2) emissions.

Section G of the emerging Gloucester City Plan includes further commentary on Policy SD3

4.7.6 *In order to address the climate emergency, and in compliance with JCS Policy SD3 Sustainable Design and Construction, all applications for new buildings will be expected to demonstrate that all reasonable techniques have been utilised to adapt to and mitigate the effects of climate change.*

4.7.7 *JCS Policy SD3 requires the submission of an Energy Statement as well as a Waste Minimisation Statement for all major development. The GCP strongly encourages all applications for new buildings to supply an Energy statement and a Waste Minimisation Statement.*

4.7.8 *The GCP strongly encourages energy efficiency measures allied with the appropriate use of renewable energy in new buildings and the retrofitting of existing buildings. It is considered that, as technologies and energy markets evolve, there are increasing opportunities to utilise renewables in sustainable design and construction without excessive costs.*

This report should be read in conjunction with the Design and Access Statement, prepared by Darling Associates Architects, and the other supporting application documents.

3.0 ENERGY EFFICIENCY

Policy SD3 requires development proposals to demonstrate how they contribute to the aims of sustainability by increasing energy efficiency.

Section G of the emerging Gloucester City Plan includes further commentary on Policy SD3 and strongly encourages energy efficiency measures.

Enhanced Building Fabric

The external envelope of a building acts as an important climatic modifier, with a well-designed façade significantly reducing the building's heating demand.

The façade system will be designed to minimise energy requirements and improve thermal comfort.

Due to the proposed building height above 18m, careful consideration has been given to the combustibility of insulation products as well as their thermal performance.

The characteristics for u-values and air permeability for the proposed development will be significantly better than the limiting values set out by Part L 2021 edition and listed below.

The applied building values for the development are set out against the Part L1 2021 edition notional building parameters in table below.

Proposed Building Thermal Envelope

Element / System	Part L 2021 Limiting Values	Part L 2021 Notional Values	Proposed Great Western Yard
Walls	0.26 W/m²K	0.18 W/m²K	0.18 W/m²K
Party Walls	0.20 W/m²K	0.00 W/m²K	0.00 W/m²K
Floor	0.18 W/m²K	0.13 W/m²K	0.13 W/m²K
Roof	0.16 W/m²K	0.11 W/m²K	0.11 W/m²K
Doors (incl. frame)	1.6 W/m²K (Solid)	1.0 W/m²K (Solid)	1.0 W/m²K (Solid)
Windows (incl. frame)	1.6 W/m²K	1.2 W/m²K (g-value 0.63)	1.2 W/m²K (g-value 0.63)
Air Tightness @ 50Pa	8.0 m³/h.m²	5.0 m³/h.m²	3.0 m³/h.m²
Thermal Bridging	y = 0.20 W/m²K	y = 0.05 W/m²K	y = 0.04 W/m²K

Note – The psi-value in the above table has been based on the LETI Climate Emergency Design Guide (2020)[1]. Specialist consultants will be required to design thermal bridging details and calculate psi-values to improve upon the default y-value indicated at planning stage. By

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[1] https://www.leti.london/cedg

calculating thermal bridging, the notional psi-values are also calculated by using Approved Construction Details.

Air Permeability

Heat loss may also occur due to air infiltration. Although this cannot be eliminated altogether, good construction details and the use of best practice construction techniques can minimise the amount of air infiltration into a building.

Current Part L Building Regulations (2021 edition) sets a maximum air permeability rate of 8m^3/h.m^2 at 50Pa. The proposed development is likely to improve upon this to achieve at least 3m^3/h.m^2 at 50Pa through the application of best practice construction techniques.

Ventilation Heat Recovery

The energy required to heat or cool the incoming fresh air supply to the buildings will be significantly reduced by using an efficient heat recovery system. The Mechanical Ventilation Heat Recovery (MVHR) system will utilise the thermal properties of the return air to transfer ‘free’ heat/cooling to the incoming fresh air supply. These will be controlled to minimise the demand for any heating and cooling of the fresh air supply.

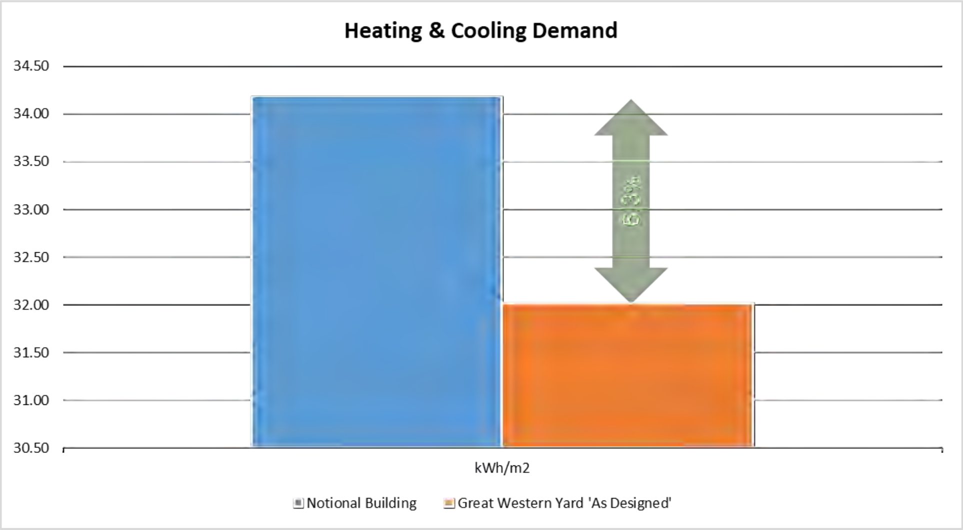
Overheating

During the summer months, due to the noise constraints within the vicinity of the site as reported in the Noise Impact Assessment Report produced by Hann Tucker Associates, the reliance upon openable windows as a means of mitigating overheating risk is unlikely. The MVHR unit will be supplied with a cooling module to reduce the temperature of the incoming fresh air and mitigate the risk of overheating within the units.

Heating and Cooling Demand

The Fabric Energy Efficiency Standard of dwellings is assessed using the beta version of Stroma FSAP 10.1, the FEES is a measure of the primary energy associated with heating and cooling within dwellings.

The above energy efficiency measures have reduced the heating and cooling demand by 6.3%.



4.0 RENEWABLE ENERGY

Policy SD3 of the Joint Core Strategy requires development proposals for major planning applications to clearly indicate the methods used to calculate predicted annual energy demand.

Energy calculations were carried out using the beta version of Stroma FSAP 10.1 for the residential units. SAP calculates the energy demand for heating, domestic hot water, lighting, pumps, and fans (regulated energy) for the building ‘as designed’.

Section G of the emerging Gloucester City Plan includes further commentary on Policy SD3 and strongly encourages the appropriate use of renewable energy in new buildings.

The proposed development will install arrays of photovoltaic (PV) panels to generate renewable electricity. The table below shows the number of panels and total output for each block of flats and terrace of houses.

Block / Terrace	No. of Panels	Power kWp
Block A	132.00	49.50
Block B	374.00	140.25
Block C	132.00	49.50
Block D	106.00	39.75
Terrace 2B3P Type 1	266.00	81.80
Terrace 2B3P Type 2	174.00	52.20
Terrace 3B4P Type 1	88.00	30.80
Terrace 3B4P Type 2	225.00	78.80
Terrace 3B5P	284.00	85.20

The table below shows the total annual energy demand and annual electricity generated by the PV arrays for each block of flats and terrace of houses. As can be seen from the table below, each block of flats and terrace of houses generates 30% of its regulated energy demand from the PV arrays, maximising the opportunity to utilise renewable energy.

Block / Terrace	Heating kWh / yr.	DHW kWh / yr.	Pumps / Fans kWh / yr.	Lighting kWh / yr.	Total kWh / yr.	PV kWh / yr.	PV %
Block A	28,040.33	35,752.00	3,015.69	1,851.28	68,659.30	- 17,494.30	25%
Block B	76,452.91	95,922.26	9,109.79	5,327.48	186,812.44	- 54,722.42	29%
Block C	29,319.65	35,748.76	3,057.40	1,843.06	69,968.87	- 16,756.56	24%
Block D	18,494.52	23,944.67	1,904.16	1,269.85	45,613.20	- 11,116.42	24%
Terrace 2B3P Type 1	3,529.26	3,788.73	353.98	271.25	7,943.22	- 4,189.55	53%
Terrace 2B3P Type 2	3,677.04	3,160.24	344.98	262.25	7,444.51	- 4,335.65	58%
Terrace 3B4P Type 1	4,142.82	3,424.68	408.74	293.84	8,270.08	- 5,249.44	63%
Terrace 3B4P Type 2	4,430.12	3,436.68	420.74	305.84	8,593.38	- 5,249.44	61%
Terrace 3B5P	4,737.87	3,504.56	475.74	324.01	9,042.18	- 5,714.51	63%
Total	**172,824.52**	**208,682.58**	**19,091.22**	**11,748.86**	**412,347.18**	**-124,828.29**	**30%**

5.0 PART L COMPLIANCE

Updates to Part L of the Building Regulations were published in December 2021, replacing the previous 2013 edition. A Government press release on the 15th of December 2021 stated that CO_2 emissions from new build homes must be around 30% lower than current standards [2013 edition]. The updates to Part L have now taken affect from 15th June 2022. The methodology used to determine the CO_2 emissions for the proposed development is in accordance with the 2021 edition of Building Regulations Part L as the regulation in force at the time of this application.

Policy SD3 of the Joint Core Strategy requires development proposals for major planning applications to clearly indicate the methods used to calculate predicted annual energy demand and associated annual Carbon Dioxide (CO_2) emissions.

Energy calculations were carried out using the beta version of Stroma FSAP 10.1 for the residential units. SAP calculates the energy demand for heating, domestic hot water, lighting, pumps, and fans (regulated energy) for the building 'as designed' and the associated annual Carbon Dioxide (CO_2) emissions.

Where more than one dwelling is physically attached to another, for example a block of flats or a terrace of houses, the average primary energy rate, emission rate and fabric energy efficiency rate can be used to demonstrate compliance with the regulations of all included flats and houses (Block Compliance). This is instead of requiring each flat and house to meet the requirements in its stand-alone form.

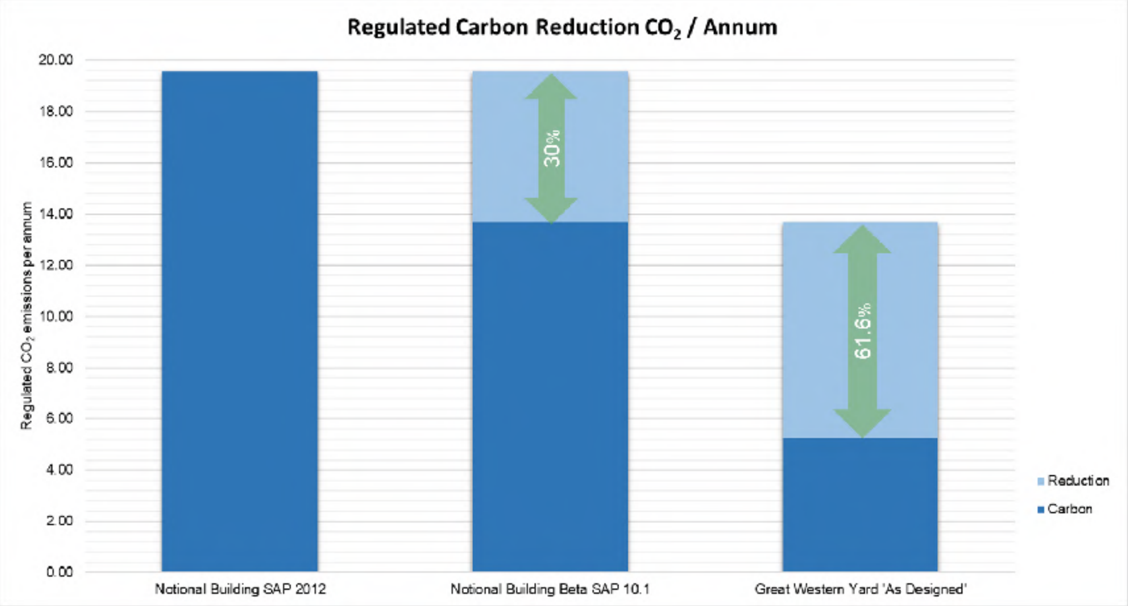
The Block Compliance method has been used in this report, providing average DER / TER, DPER / TPER and DFEE / TFEE results. Compliance is reached when the overall averaged DER / DPER / DFEE is less than that of the equivalent TER / TPER / TFEE.

The details used to produce the 'as designed' beta Stroma SAP 10.1 Part L compliance model are shown in the table below.

Element / System	**Flats**	**Townhouses**
Walls	0.18 W/m²K	0.18 W/m²K
Party Walls	0.00 W/m²K	0.00 W/m²K
Floor	0.13 W/m²K	0.13 W/m²K
Roof	0.11 W/m²K	0.11 W/m²K
Windows (incl. frame)	1.0 W/m²K (Solid)	1.0 W/m²K (Solid)
Doors (incl. frame)	1.2 W/m²K (g-value 0.63)	1.2 W/m²K (g-value 0.63)
Air Tightness @ 50Pa	3.0 m³/h.m²	3.0 m³/h.m²
Thermal Bridging	y = 0.04 W/m²K	y = 0.04 W/m²K
Heating	Electric Panel Heaters (Lot 20)	Electric Panel Heaters (Lot 20)
Hetaing Controls	- Integrated appliance thermostat - Integrated appliance 24/7 programmer - Adaptive heating start - Open window detection	- Integrated appliance thermostat - Integrated appliance 24/7 programmer - Adaptive heating start - Open window detection
Hot Water	Direct electric hot water cylinder. 1 bed 120L, 2 bed 150L, 3 bed 180L Heat Loss = 1.03 / 1.27 / 1.42 kWh/day	Direct electric hot water cylinder. 1 bed 120L, 2 bed 150L, 3 bed 180L Heat Loss = 1.03 / 1.27 / 1.42 kWh/day
Hot Water Controls	Integrated smart control adaptive thermostat	Integrated smart control adaptive thermostat
Ventilation	MVHR Nuaire MRXBOXAB-ECO3. All ductwork insulated	MVHR Nuaire MRXBOXAB-ECO3. All ductwork insulated
Water usage	105.5 litres/person/day	105.5 litres/person/day
PV	Average 1.22 kWp per flat	Average 3.78 kWp per flat
Lighting	Downlight (7.6W 912lm) -Kitchens -Bathrooms -Ensuites Pendant (8W 800lm) -Bedrooms -Living room/dining room -Hallway	Downlight (7.6W 912lm) -Kitchens -Bathrooms -Ensuites Pendant (8W 800lm) -Bedrooms -Living room/dining room -Hallway

CO_2 Emissions

The results of the Block Compliance method demonstrating compliance with Part L (2021 edition) of the Building Regulations are shown below, with the proposed development achieving a reduction in carbon (CO_2) emissions of 61.6%, compared with the Building Regulations notional dwelling.



Block Compliance

A breakdown showing the Part L (2021 edition) Block Compliance for the individual blocks and terraces is shown in the table below

Block / Terrace	Ave. DER	Ave. TER	% Improvement	Ave. DFEE	Ave. TFEE	% Improvement	Ave. DPER	Ave. TPER	% Improvement
Block A	5.19	14.83	65.0%	30.63	33.58	8.8%	74.65	73.95	0.9%
Block B	5.81	14.54	60.0%	32.17	34.88	7.8%	64.16	73.26	12.4%
Block C	6.52	14.95	56.4%	33.51	36.24	7.5%	71.94	73.59	2.2%
Block D	6.63	14.89	55.5%	34.55	36.09	4.3%	73.15	73.86	1.0%
Terrace 2B3P Type 1	3.75	11.14	66.4%	30.66	31.89	3.9%	42.69	42.87	0.4%
Terrace 2B3P Type 2	3.13	11.25	72.2%	31.59	32.50	2.8%	43.05	43.50	1.0%
Terrace 3B4P Type 1	3.34	10.09	67.0%	29.63	31.20	5.0%	36.82	37.12	0.8%
Terrace 3B4P Type 2	3.44	10.31	66.7%	31.26	32.24	3.0%	37.91	38.26	0.9%
Terrace 3B5P	3.23	9.84	67.2%	31.48	32.28	2.5%	35.58	35.76	0.5%

6.0 CONCLUSION

This report has demonstrated the commitment for the proposed development at Great Western Yard, Gloucester to the policies relating to energy within the Gloucester, Cheltenham, and Tewkesbury Joint Core Strategy 2011 - 2031 (2017), specifically:

- Policy SD3: Sustainable Design and Construction

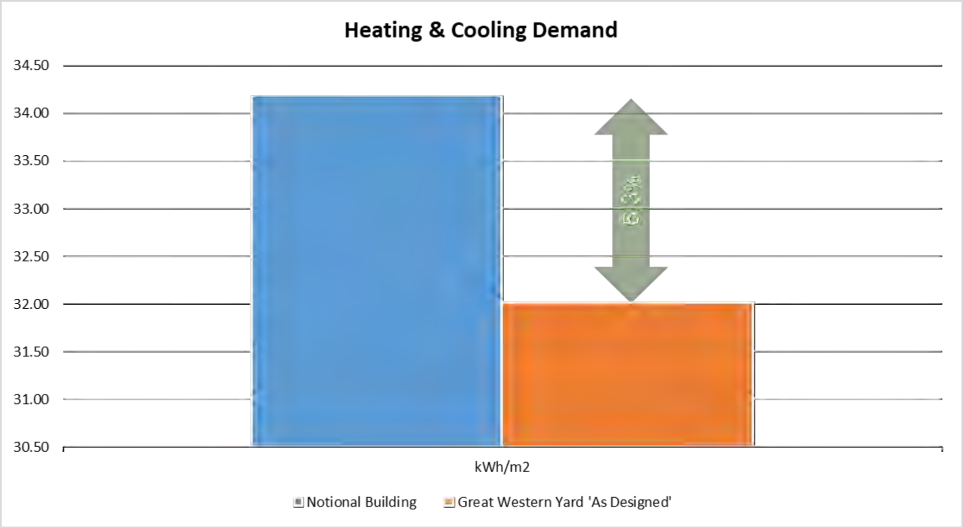
This report has also taken cognisance of the emerging Section G of the Gloucester City Plan 2011 – 2031 (April 2022), specifically.

4.7.9 In order to address the climate emergency, and in compliance with JCS Policy SD3 Sustainable Design and Construction, all applications for new buildings will be expected to demonstrate that all reasonable techniques have been utilised to adapt to and mitigate the effects of climate change.

4.7.10 JCS Policy SD3 requires the submission of an Energy Statement as well as a Waste Minimisation Statement for all major development. The GCP strongly encourages all applications for new buildings to supply an Energy statement and a Waste Minimisation Statement.

4.7.11 The GCP strongly encourages energy efficiency measures allied with the appropriate use of renewable energy in new buildings and the retrofitting of existing buildings. It is considered that, as technologies and energy markets evolve, there are increasing opportunities to utilise renewables in sustainable design and construction without excessive costs.

Using a range of energy efficient measures has reduced heating and cooling demand by 6.3%.



The proposed development will install arrays of photovoltaic (PV) panels to generate renewable electricity. The table below shows the number of panels and total output for each block of flats and terrace of houses.

Block / Terrace	No. of Panels	Power kWp
Block A	132.00	49.50
Block B	374.00	140.25
Block C	132.00	49.50
Block D	106.00	39.75
Terrace 2B3P Type 1	266.00	81.80
Terrace 2B3P Type 2	174.00	52.20
Terrace 3B4P Type 1	88.00	30.80
Terrace 3B4P Type 2	225.00	78.80
Terrace 3B5P	284.00	85.20

30% of regulated energy demand for each block of flats and terrace of houses will be generated through PV arrays, maximising the opportunity to utilise renewable energy.

Block / Terrace	Heating kWh / yr.	DHW kWh / yr.	Pumps / Fans kWh / yr.	Lighting kWh / yr.	Total kWh / yr.	PV kWh / yr.	PV %
Block A	28,040.33	35,752.00	3,015.69	1,851.28	68,659.30	- 17,494.30	25%
Block B	76,452.91	95,922.26	9,109.79	5,327.48	186,812.44	- 54,722.42	29%
Block C	29,319.65	35,748.76	3,057.40	1,843.06	69,968.87	- 16,756.56	24%
Block D	18,494.52	23,944.67	1,904.16	1,269.85	45,613.20	- 11,116.42	24%
Terrace 2B3P Type 1	3,529.26	3,788.73	353.98	271.25	7,943.22	- 4,189.55	53%
Terrace 2B3P Type 2	3,677.04	3,160.24	344.98	262.25	7,444.51	- 4,335.65	58%
Terrace 3B4P Type 1	4,142.82	3,424.68	408.74	293.84	8,270.08	- 5,249.44	63%
Terrace 3B4P Type 2	4,430.12	3,436.68	420.74	305.84	8,593.38	- 5,249.44	61%
Terrace 3B5P	4,737.87	3,504.56	475.74	324.01	9,042.18	- 5,714.51	63%
Total	**172,824.52**	**208,682.58**	**19,091.22**	**11,748.86**	**412,347.18**	**-124,828.29**	**30%**

Block compliance will be achieved with Part L (2021 edition) of the Building Regulations with the proposed development achieving an overall carbon (CO2) emission reduction of 61.6%, compared with the Building Regulations notional dwelling.

Block / Terrace	Ave. DER	Ave. TER	% Improvement	Ave. DFEE	Ave. TFEE	% Improvement	Ave. DPER	Ave. TPER	% Improvement
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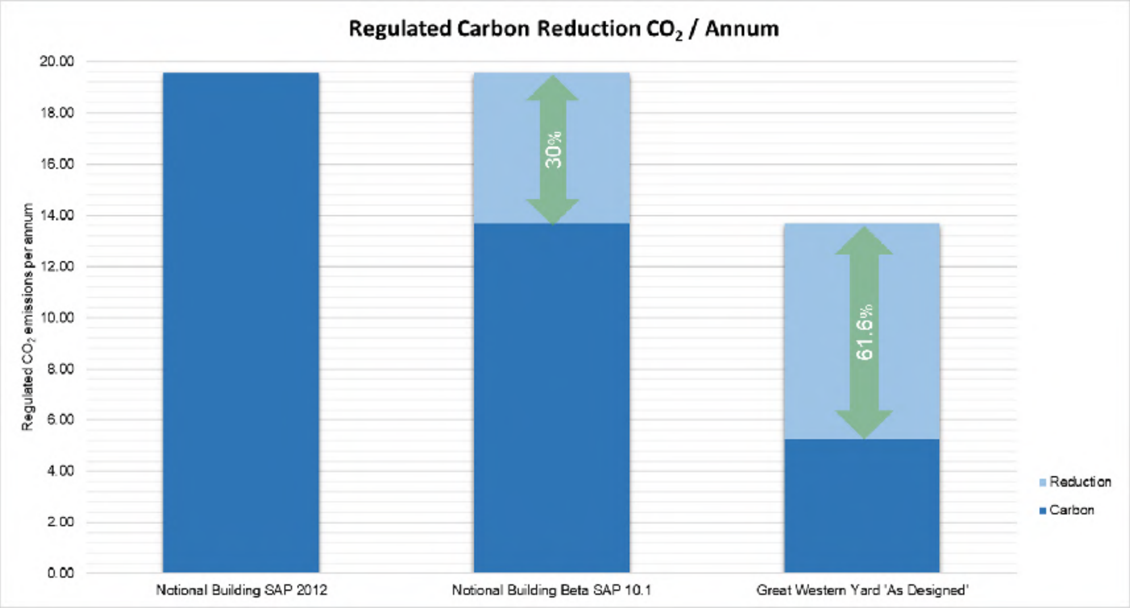
Regulated Carbon Reduction CO₂ / Annum
Regulated CO₂ emissions per annum
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
30%
61.6%
Reduction
Carbon
Notional Building SAP 2012
Notional Building Beta SAP 10.1
Great Western Yard 'As Designed'

Artisan

Estate Management Limited

Report

Engine Shed, Rail Yard, Horton Rd, Gloucester, GL1 3AN

Development Assessment

An evaluation of potential building re-use

Date: 17 May 2022

Contents

Introduction

Eutopia Homes (Gloucester) Limited has instructed Artisan Estate Management Limited to assess the potential for retention and re-use of the Engine Shed at the Rail Yard, Horton Road, Gloucester, GL1 3AN.

The building is located on a site designated as an emerging allocation in the Gloucester City Plan, which is currently subject to a main modification public consultation (16th May – 4th July 2022) to increase the number of dwelling units at the wider site from 200-300 dwellings.

It is understood that the primary driver for retention and re-use is to keep the building in its current form as a non-designated heritage asset.

Eutopia have provided a Heritage Appraisal prepared by Pegasus Group dated 31st January 2022 and advice from Hydrock, the Geo-Environmental Consultant for the wider redevelopment project.

Artisan undertook an inspection of the property on Friday 22nd April 2022.The weather conditions were dry, overcast, and breezy with temperatures of around 15°C.

Aerial View

Description

The Engine Shed is a single-story industrial building, purpose built for servicing railway vehicles.

The Pegasus Group Heritage Appraisal notes that the building was *‘never intended to be a standalone structure being built off the adjoining, earlier building’*. Consequently, it is noted that the building incorporates brickwork from a previous partially demolished building but with the bulk of the building added in the 20th century post war period.

The shed includes deep inspection pits and large access apertures to the east and west elevations with rail tracks laid through the building to allow railway vehicles to enter and exit for servicing and inspection.

The building is rectangular in shape with gross external measurements of circa 34m x 14m.

The walls are of solid brick construction with the roof a pitched light weight steel structure supporting corrugated metal panels and glazing. It is assumed that the floor and foundation are of reinforced concrete with no damp proof membrane.

A window and pedestrian entrance door are included within the east elevation. Five large windows are included in the southern elevation and a further seven small windows are included within the northern elevation.

The east and west elevations include large double doors of circa 3.9m wide x 7.9m high fabricated using corrugated metal panels and steel bars. They are not weatherproof.

Internal eves height is circa 3.9m above finished ground level.

There is no evidence of connected utility supplies and no existing sanitary installation.

Condition

The building is in very poor derelict condition. Photographs, together with a detailed commentary, are included within Appendix 1.

No fixtures or fittings of any description were identified as salvageable, and a general summary of condition is set out below: -

Roof
The roof covering is a mixture of glazed and corrugated metal panels in extremely poor and dangerous condition. None are salvageable.

The roof structure is of light weight steel. The steel was painted many years ago but what paint is left is flaking off and has provided little protection in recent years. An expert survey would be required to confirm the future load bearing capability, but it is anticipated that a good part of the structure is in poor condition and will require at least partial replacement.

Walls
The walls are all in extremely poor and dangerous condition.

The concrete lintels above the vehicle access doors of the east and west elevations are both degraded with exposed reinforcing bars. The lintels are beyond repair and require replacement.

Heavy brick spalling is evident throughout and at was once painted to protect against brick degradation, although it has all now flaked away with only traces remaining.

There is significant structural movement evident throughout south, east and west elevations with pointing washed away and both low and high-level slippage of brickwork and cracking. Perhaps the most significant elements are the circa 6m long opening underneath two of the central windows of the southern elevation; the brick parapet above the southern elevation is separating and showing signs of instability, most likely as a result of the significant quantity of vegetation growing from the brickwork; and all corners of the building are in a dangerous condition and considered irreparable.

Very little of the existing wall along the southern, eastern and western elevations could be reused. Furthermore, the unstable nature of the east and west concrete lintels would require the further demolition of the unstable brickwork above and around them.

The northern elevation was too covered by undergrowth to be able to determine its condition, but it is unlikely to have fared more favourably.

Foundation & Floor
The obvious concerns are the deep and flooded inspection pits, railway tracks, lack of damp proofing and land contamination. While substantial in terms of structure the floor make up does not meet modern building regulation standards.

We understand from Hydrock, the Geo-environmental consultant that: -

"*Significant visual and olfactory evidence of petroleum hydrocarbons, including light non-aqueous phase liquid (LNAPL), grey staining, and hydrocarbon odours have been identified in the former railway sidings area of the site, notably adjacent to the existing engine shed where relic tank holders, refuelling pumps, inspection pits, and relic floor slabs of demolished buildings surround the structure.*

In addition, significant concentrations of petroleum hydrocarbons have also been recorded in soil and groundwater in this area of the site by laboratory analysis. Intrusive ground investigation has not been possible within the footprint of the existing engine shed, however, based on the evidence recorded within the surrounding soils and downgradient groundwater, It is reasonable to assume that the identified petroleum hydrocarbon impacts also extend beneath the engine shed, which will historically have been used for the servicing and maintenance of locomotives, and has a further inspection pit recessed into the ground within the structure.

If this structure were to be retained, any impacted Made Ground and natural soils beneath the footprint will largely be inaccessible, and it will also not be considered practical to remove impacted soils within close proximity to the existing structure, if it were to remain. This will make remediation significantly more difficult and may also significantly reduce the volume of material that can be remediated across the central portion of the former railway sidings area, thus reducing the betterment to the natural environment that may be achieved elsewhere across the site."

Considerations for Re-use

Condition

- It will not be possible to retain the existing walls of the building because of their poor condition;
- As a result of losing the walls, the existing roof structure cannot be retained;
- It will not be possible to retain the foundation and flooring of the building if the site's land contamination is to be properly remediated.
- In effect, the whole structure would require demolition and reconstruction;
- The building will require upgrading to meet energy performance criteria;
- The building will require upgrading to meet current building regulations;
- As a result of these upgrades, the roof structure will require upgrading to carry the anticipated additional load, changing its appearance; and
- WCs and underground drainage will need to be introduced.

Demand

- The constraint of keeping the building in its current form severely limits the use to which it can ultimately be put.

- The internal height, limited access points, existing window apertures, roof structure and dimensions make it virtually impossible to meaningfully subdivide the current form without significantly altering its form and appearance: -

    - The building has an approximate floor area of 430 m^2 (4,630 ft^2);

    - The building has an approximate eves height of 3.9m.;

    - The building has limited access points;

    - The building has an irregular pattern of windows and depends upon natural light from its glazed roof for approximately 30% of its volume; and

    - The eves height is too high for conventional commercial office type applications.

- As a result of the above the current built form is unsuitable for conversion to residential use;

- The building will be located within a new housing development, meaning that any commercial occupier must be non-residential but also not anti-social;

- The built form lacks the box like security of an industrial building and has an eves height that is too low for industrial occupation.

- As a result of the above the current built form is unsuitable for conversion to industrial use.

- The volume of the built form is unappealing to office occupiers because: -

    - Its glazed roof, hard surfaces, and eaves height will create acoustic issues;

    - The eaves height of the building is abnormally high for office use and will create: -

        - Hygiene and cleaning constraints;

        - Energy performance constraints;

  - Seasonal heating and cooling control management issues; and
  - Abnormally high occupational costs.

- As a result of the above the current built form is unsuitable for conversion to office use.

- With no ability to deliver residential uses, and exceptionally limited appeal to industrial and office occupiers, it is extremely difficult to identify any ready market for an isolated building of this form within a residential setting.

Conclusions

- The existing building has come to the end of its life.

- The land beneath and around the building is contaminated and should be remediated.

- If it's built form is to be maintained the building would need to be demolished, redesigned to meet modern standards and then rebuilt with the ground under it decontaminated. It would not be the same building although the construction cost of replicating non-standard design details will be above construction costs for a comparably sized building of standard modern design.

- Once rebuilt the building would remain unoccupied as there is no identifiable commercial demand for a building of this form and location, particularly within a completed residential development.

- Artisan's instructions were to assess the potential for retention and reuse of the Engine House. The conclusion is that the Engine House cannot realistically be retained without demolition and reconstruction, and its form and residential location mean that it is highly unlikely ever to be reused.

Appendix 1 - Photographs

Photograph 1

Western Elevation

Showing the lack of fenestration, the steel door and rail tracks entering the building. Vegetation is growing from the brickwork and the poor structural condition of the reinforced concrete lintel and structural issues with the southwest corner brickwork.

Photograph 2

Eastern Elevation

Showing the steel door, part of the inspection pit that extends inside and outside the building and rail tracks entering the building. Vegetation is growing from the brickwork and the poor structural condition of the reinforced concrete lintel and structural issues with the southeast corner brickwork.

Photograph 3

Northern Elevation
Showing the rear of the building with vegetation growing from some brickwork, the corrugated steel roofing panels, the roof glazing panels and the roof ventilators at roof ridge level.

Photograph 4

Showing the lack of fenestration throughout the Southern elevation, evidence of flaking paint that has all but peeled away from the brickwork, the parapet wall and roof.

Photograph 5

Northwest Corner

Showing detail of roof timber degradation, washed out pointing and badly degraded reinforced concrete lintel with exposed and rusted reinforcing bars.

Photograph 6

West Elevation Reinforced Concrete Lintel

Detail of a very badly degraded reinforced concrete lintel with exposed and rusted reinforcing bars. Shows detail of the steel doors and poor weatherproofing

Photograph 7

Southwest Corner

Showing detail of roof timber degradation, washed out pointing and badly degraded reinforced concrete lintel with exposed and rusted reinforcing bars. There is significant critical movement at a number of mortar joints. There is vegetation growing from some of the brickwork. Although difficult to identify a historic ‘tell=tale’ indicator is evident suggesting a history of structural movement that has not been addressed.

Photograph 8

Southern Elevation Parapet Wall Cracking

Showing significant brick spalling, cracking , movement along mortar lines, missing capping and generally a very poorly degraded and dangerous parapet wall.

Photograph 9

Evidence of solid wall construction

Photograph 10

Examples of Brick Spalling

Photograph 11

Examples of Brick Spalling

Also showing vegetation growing from brickwork and fractured rainwater goods.

Photograph 12

Southern Elevation low level movement

Showing significant settlement and slippage of brickwork at a low level undermining the structure of the wall, the movement extends several meters underneath the windows of the southern elevation.

Photograph 13

Examples of Brick Spalling

Photograph 14

Southern Elevation low level movement

Another view of the cracking and movement along the low-level brickwork of the southern elevation.

Photograph 15

Southern Elevation high level movement

Showing movement, cracking, vegetation and washed away pointing with a brief view of the timber window frame.

Photograph 16

Southeast Corner

Brick degradation, significant cracking to the parapet wall indicates significant settlement that has undermined the parapet..

Photograph 17

Southeast Corner

Further brick degradation cracking and washed away pointing. Degradation of roof timbers is also evident.

Photograph 18

Pit extending from 3m in front of the east elevation into the Engine Shed

Partially filled with debris

Photograph 19

Pit inside the shed and roof construction

Filled with water and debris. Pigeon droppings and lightweight roof structure.

Photograph 20

Interior

Evidence of a small window and pedestrian door to the eastern elevation. Small windows evident along the northern elevation.

Photograph 21

Flooded interior pit

Central pit appears to be flooded by groundwater rather than surface water. Evidence of dilapidated and rotten timber window frames

Photograph 22

Interior

Evidence of the roof structure, single corrugated steel panel finishing panels and single glazed rooflight panels.

Photograph 23

Roof & roof glazing

External view of the roof and glazed panels. Both in dilapidated condition.

Photograph 24

Roof & roof glazing

Photograph 25

Roof ventilator

Artisan

Estate Management Limited

Submission Date: 17 May 2022

[redacted]

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Robert Whiting

Robert started his real estate career in 1993 and has since gained broad asset management, property development and valuation experience across most real estate sectors.

After completing his professional training Robert spent six years as Head of Property at Brook Henderson Group, then a Sunday Times Top Track 250 company, setting and leading their real estate strategy including the creation of asset and construction management companies and establishing an income producing development portfolio.

He spent a further seven years with the institutionally backed Evergreen Fund as Asset Director of the ground-breaking build to rent developer and operator Essential Living, and also as Property Director at M3 Capital Partners leading the incubation of a retail focused investment platform.

Robert holds an MBA, a BSc (Hons) degree in Urban Estate Management, a PGDip in Project Management and is a Fellow of the Royal Institution of Chartered Surveyors, an Associate of the Chartered Institute of Arbitrators and an Incorporate member of the Charted Institute of Building.

EUTOPIA
HOMES

Flood Risk & Drainage Strategy

Great Western Yard

IDOM

FLOOD RISK ASSESSMENT & DRAINAGE STRATEGY
GREAT WESTERN YARD, GLOUCESTER
EUTOPIA HOMES (GLOUCESTER) LTD
FRA&DS-22471-22-228

Authors

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Document Revisions

Rev	Date	Author	Checked	Approved
A	24/06/22	JB	JR	MB
B	**07/07/22**	**JR**	**JR**	**MB**

Report issued from

DERBYSHIRE   Cromford Mills, Mill Lane, Matlock, Derbyshire. DE4 3RQ [redacted]

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Location	Great Western Road, Gloucester GL1 3ND
Current Use	Brownfield – formerly railway services, timber merchants and vehicle repair shop
Flood Zone	Flood Zone 1
Nearest Watercourse	River Twyver (approx. 470 m west)
Proposal	315 residential units (flat blocks and townhouses)
Vulnerability	'More vulnerable'
Design Life	60 years
Sequential Test	Not Required
Climate Change	25% increase in rainfall intensities
Potential Sources of Flooding	Introduction of impermeable areas. Surface water flooding.
Probability of Flooding	The probability is 'Low' risk. 0.1% and 1% annual (surface water only)
Design Flood	N/A
Surface Water Management	Filter drains and soak-away (infiltration tests would be required)
Surface Water Maintenance	Management Company (Private)
Risk to Occupants	None
Exception Test	N/A
Residual Risk	The possibility of blockage or failure of the drainage system resulting in exceedance flows.

PREAMBLE

Eutopia Homes (Gloucester) Ltd appointed Idom Merebrook Limited to undertake a Flood Risk Assessment to support the planning application for a proposed development of 315 no. of flat blocks and townhouses on land south of Great Western Road, the site is also referred to as Great Western Yard, Gloucester.

This Flood Risk Assessment has been prepared in accordance with the guidelines set out in the Ministry of Housing, Communities & Local Government publication, ‘Flood Risk and Coastal Change’. This document is web based and can be found at the following link:

https://www.gov.uk/guidance/flood-risk-and-coastal-change

This Flood Risk Assessment includes consideration of flood risk from all sources and considers the effects of climatic change. The risks to the site and its occupant are identified along with any risk that the development imposes on the surrounding area.

Gloucestershire County Council’s Local Flood Risk Management Strategy Annual Progress and Implementation Plan 2021/22 and Gloucester City Council Strategic Flood Risk Assessment for Local Development Framework Level 1 Volume 1 – FINAL September 2008, have been used as a reference and has guided some of the assessment criteria.

These can all be found at the following link:

https://www.gloucestershire.gov.uk/planning-and-environment/flood-risk-management/flood-planning-information/

https://www.gloucestershire.gov.uk/planning-and-environment/flood-risk-management/flood-planning-information/gloucestershire-county-councils-local-flood-risk-management-strategy-lfrms/

This report has been prepared for the sole purpose described above and no extended duty of care to any third party is implied or offered. Third parties referring to this report should consult the applicant, Eutopia Homes (Gloucester) Ltd and Idom Merebrook Limited as to the extent to which findings may be appropriate for their use.

SECTION 1 DEVELOPMENT SITE AND LOCATION

1.1 LOCATION

1.1.1 The site occupies a parcel of land located to the south of Great Western Road within the County of Gloucestershire. The approximate OS Grid Reference SO 84091 18413 and the nearest post code is GL1 3ND.

1.1.2 The area defined by the site boundary is approximately 3.2 ha.

1.1.3 The site is bound to the south and south-west by Network Rail railway lines, the north by Great Western Road and the east boundary by Horton Road.

1.1.4 The site will be accessed from an existing entrance from Great Western Road which currently allows access to the timber merchants and 2 no. proposed accesses from the northwest of the site off Great Western Road.

1.1.5 A location plan has been provided for reference within **Appendix 1**.

1.2 CURRENT USE

1.2.1 The site is a Brownfield site formerly used as railway sidings, timber merchants and a vehicle repair shop. There is also an existing car park to the the north west of the site.

1.2.2 A topographical survey of the site is included in **Appendix 1**.

1.3 FLOOD ZONE

1.3.1 The site is located within Flood Zone 1. **Appendix 1** contains the Flood Zone mapping obtained from https://flood-map-for-planning.service.gov.uk/.

1.4 PROXIMITY TO MAIN RIVERS

1.4.1 Approximately 470 m to the west of the site is a main river called the River Twyver which flows to the River Severn northwest to the southeast of the site.

1.5 GEOLOGY

1.5.1 A Site Investigation report is available under separate cover ref: 20775-HYD-XX-XX-RP-GE-1001 DATED 26/4/22.

1.5.2 Geological mapping has been studied with reference to the British Geological Survey mapping (via the Geology of Britain Viewer) which can be acquired from https://mapapps.bgs.ac.uk/geologyofbritain/home.html?&_ga=2.212620828.983110538.1627572080-1688802548.1593791022.

1.5.3 The west of the site has superficial deposits of Cheltenham Sand and Gravel – Sand and Gravel, the east has no recorded superficial deposits. The development site is underlain with bedrock geology comprises of the Blue Lias Formation and Charmouth Mudstone Formation (undifferentiated) - Mudstone.

1.5.4 The site has shallow groundwater reported as being within 0.7 m of the surface.

1.5.5 The site has made ground ranging between 0.1 m and 2.1 m deep. The made ground contains significant hydrocarbon contamination.

SECTION 2 DEVELOPMENT PROPOSALS

2.1 OUTLINE OF THE PROPOSALS

2.1.1 The proposal is to redevelop the site into 315 no. flat blocks and townhouses.

2.1.2 An illustrative site layout is provided within **Appendix 1**.

2.2 VULNERABILITY TO FLOODING.

2.2.1 The vulnerability of the development is assessed by reference to Table 2 Flood risk vulnerability classification of the Ministry of Housing, Communities & Local Government publication, Flood Risk and Coastal Change (https://www.gov.uk/guidance/flood-risk-and-coastal-change#Table-2-Flood-Risk-Vulnerability-Classification).

2.2.2 The flood risk vulnerability of the proposed residential development is classified as ‘More vulnerable’.

2.2.3 In accordance with the information provided within Table 3 Flood risk vulnerability and flood zone compatibility of the Ministry of Housing, Communities & Local Government publication, Flood Risk and Coastal Change (https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/575184/Table_3_-_Flood_risk_vulnerability_and_flood_zone__compatibility_.pdf), ‘More vulnerable’ developments are compatible with Flood Zones 1 and 2. ‘More vulnerable’ developments are compatible with Flood Zone 3a but an Exception Test is required. ‘More vulnerable’ developments are not permitted in Flood Zone 3b.

2.3 LIFETIME OF THE DEVELOPMENT

2.3.1 The design life of the proposed development is assumed to be 60 years.

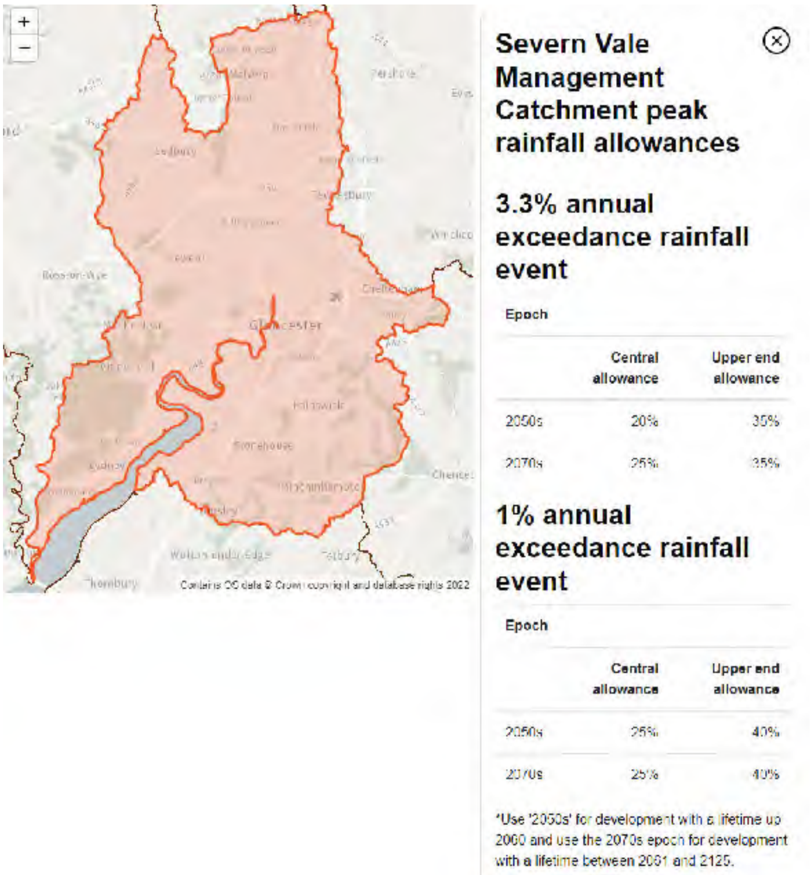
SECTION 3 SEQUENTIAL TEST.

3.1 In accordance with Ministry of Housing, Communities & Local Government publication, Flood Risk and Coastal Change https://www.gov.uk/guidance/flood-risk-and-coastal-change#Site-Specific-Flood-Risk-Assessment-checklist-section, developments that are outside Flood Zones 2 or 3 do not require a Sequential Test.

3.2 The vulnerability of the development is compatible with the Flood Zone.

SECTION 4 CLIMATE CHANGE

4.1 PEAK RAINFALL INTENSITY ALLOWANCE



Severn Vale Management Catchment peak rainfall allowances

3.3% annual exceedance rainfall event

Epoch	Central allowance	Upper end allowance
2050s	20%	35%
2070s	25%	35%

1% annual exceedance rainfall event

Epoch	Central allowance	Upper end allowance
2050s	25%	40%
2070s	25%	40%

'Use '2050s' for development with a lifetime up 2060 and use the 2070s epoch for development with a lifetime between 2061 and 2125.

Figure 1: Severn Vale Management Catchment peak rainfall allowances (https://environment.data.gov.uk/hydrology/climate-change-allowances/rainfall?mgmtcatid=3077)

4.1.1 In accordance with the EA 2021 guidance publication on Flood Risk Assessments: Climate Change Allowances https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances, and assuming the design life for the proposed development is from 2061 and 2100, a central allowance of 25% is required to be applied to the 3.3% and 1% annual exceedance rainfall events.

4.1.2 The current flood risk is explored further in **Section 5**.

SECTION 5 SITE SPECIFIC FLOOD RISK ASSESMENT

5.1 POTENTIAL SOURCES OF FLOODING

5.1.1 Watercourse flooding. Environment Agency (EA) flood mapping is provided in **Appendix 1**. This demonstrates that the site is shown to be at low risk of flooding. Consultation with the EA (**Appendix 2**) has confirmed this to be the case. Gloucestershire County Council's Local Flood Risk Management Strategy and Gloucester City Council's Strategic Flood Risk Assessment do not refer to the site as being at risk of flooding from watercourses.

5.1.2 Overland surface water flows. EA mapping demonstrates that there are some small areas of 'Low risk' surface water flooding on the site and a small narrow area of 'Medium risk' surface water flooding to the south of the site. Consultation with the EA (**Appendix 2**) has confirmed this to be the case. Gloucestershire County Council's Local Flood Risk Management Strategy and Gloucester City Council's Strategic Flood Risk Assessment make no reference to the site.

5.1.3 Groundwater. Gloucestershire County Council's Local Flood Risk Management Strategy and Gloucester City Council's Strategic Flood Risk Assessment have been reviewed but do not make any specific reference to the site.

5.1.4 Infrastructure flooding (from reservoirs/ponds/canals). The are no man-made water retaining structures within the vicinity of the development site. Environment Agency (EA) flood mapping demonstrates that the site is not shown to be at-risk from flooding. Consultation with the EA (**Appendix 2**) has confirmed this to be the case. Gloucestershire County Council's Local Flood Risk Management Strategy and Gloucester City Council's Strategic Flood Risk Assessment do not make reference to the site.

5.1.5 Sewer flooding. Foul and surface water sewers are absent on the site, the nearest combined water sewer is located north of the site in Great Western Road. The location of the combined sewer has been identified on Severn Trent Water Sewer Records (**Appendix 1**). Gloucestershire County Council's Local Flood Risk Management Strategy (LFRMS) has been reviewed and reference to the general post code area has been made. Table 4.5 (LFRMS): Flooding from Sewers as recorded in the Severn Trent Water DG5 Register indicates that the postcode area GL1 3 has been highlighted as an area at high risk of flooding from sewers. Gloucestershire County Council's Local Flood Risk Management Strategy however makes no specific reference to the site being affected by this risk.

5.1.6 EA flood mapping. The site is shown as being in Flood Zone 1 and is therefore in the lowest possible risk category. Consultation with the EA (**Appendix 2**) has confirmed this to be the case.

5.1.7 Strategic Flood Risk Assessment. Gloucester City Council's Strategic Flood Risk Assessment makes no specific reference to the development site as being at risk of flooding.

5.1.8 Local Flood Risk Management Strategy. Gloucestershire County Council's Local Flood Risk Management Strategy makes no specific reference to the development site as being at risk of flooding.

5.1.9 Historic records. Gloucester City Council's Strategic Flood Risk Assessment and Gloucestershire County Council's Local Flood Risk Management Strategy but do not make reference to the site. The EA have confirmed (**Appendix 2**) that they have no records of any historical flooding for this site.

5.1.10 The risk posed by the proposed development. Without mitigation the introduction of impermeable areas will increase the flood risk both within the site and to surrounding areas.

5.2 PROBABILITY OF FLOODING

5.2.1 The identified risks of flooding on the site are from the introduction of impermeable areas within the development and surface water flooding.

5.2.2 This risk posed by the introduction of impermeable areas needs to be mitigated by the provision of an adequate surface water drainage strategy. Flooding should be mitigated for all storms up to and including 1 in 100-year storm event (with an allowance for climate change). Therefore, with mitigation the probability is ‘Low’ risk.

5.2.3 The risk of surface water flooding is contained within the site and is identified in **Appendix 1** as being some small areas of ‘Low risk’ surface water flooding on the site and a small narrow area of ‘Medium risk’ surface water flooding to the south of the site.

5.2.4 In this context ‘Low risk’ is stated by the EA as having between 0.1% and 1% annual risk. ‘Medium risk’ is stated by the EA as having between 1% and 3.3% annual risk. The measures proposed to mitigate against the introduction of impermeable areas, in managing the SW drainage from the site as a whole, will also mitigate against the risk posed by the existing impermeable areas. Therefore, with mitigation the probability is ‘Low’ risk.

5.3 DESIGN FLOOD

5.3.1 The design flood is normally stated, along with expected level and depth of flooding with reference to Ministry of Housing, Communities & Local Government publication, Flood Risk and Coastal Change Paragraph 55, https://www.gov.uk/guidance/flood-risk-and-coastal-change#design-flood

5.3.2 For the external areas the annual risk is between 0.1% and 1%, as such there is no definable Design Flood level.

5.4 INTERNAL FLOODING

5.4.1 No internal flooding is expected.

5.5 FLOOD RESILIENCE AND RESISTANCE MEASURES

5.5.1 None required

SECTION 6 SURFACE WATER MANAGEMENT

6.1.1 Adequate surface water management is required for the proposed development to control the risk of flooding associated with the increase of surface water runoff through the construction of areas of impermeable hardstanding.

6.1 EXISTING RUNOFF RATES

6.1.1 In the absence of any evidence of existing positive drainage it is assumed that the existing site runoff drains to the combined sewers in Great Western Road.

6.1.2 Pending a survey of the existing drainage, a Brownfield runoff assessment was completed for the site including the provision for 50% betterment over the existing runoff rates, using the MRM method. Outputs from hydraulic modelling software are included in **Appendix 3** and the results are summarised in **Table 1**.

Design Event	Runoff (l/s)
100% (1 in 1) annual event probability (Q_{1yr})	149.8
33.3% annual event probability (Q_{30yr})	349.5
1% annual event probability (Q_{100yr})	440.4

Table 1 Brownfield Runoff Assessment

6.1.3 Should a drainage survey conclude that there is no existing offsite drainage, then the Greenfield runoff rate will apply. A greenfield runoff assessment was completed for the site, using the IH124 method. Outputs from hydraulic modelling software are included in **Appendix 3** and the results are summarised in **Table 2**.

Design Event	Runoff (l/s)
Development mean annual peak flow (Q_{BAR})	8.4
100% (1 in 1) annual event probability (Q_{1yr})	6.9
33.3% annual event probability (Q_{30yr})	16.6
1% annual event probability (Q_{100yr})	21.5

Table 2 Greenfield Runoff Assessment

6.2 SUDS HIERARCHY

6.2.1 The SuDS hierarchy defines the most appropriate method of disposal of surface water.

6.2.2 The favoured disposal method is by infiltration. For this development infiltration is not possible due to the following reasons:

i. Presence of hydrocarbon containing made ground

ii. High water table

iii. Underlying impermeable strata (mudstone).

6.2.3 Where infiltration is not possible, disposal to an offsite watercourse is preferred. This method of disposal is not possible for this development as there is no available watercourse within the proximity of the site.

6.2.4 Where disposal to an offsite watercourse is not possible, disposal to a public sewer is preferred. This method of disposal is possible for this development. The pre-development runoff route has been assessed and 2 no. combined sewers have been identified to the north of the site in Great Western Road.

6.3 SUDS APPRAISAL

6.3.1 A SuDS approach is required, and **Table 3** provides a comprehensive assessment of which SuDS techniques are viable for this development.

SuDS Feature	Evaluation	Suitability
Rainwater Harvesting	Low demand for re-use within the proposed usage	Not suitable
Green Roofs	Viable to provide surface water treatment but NOT storage.	Possible, subject to roof space.
Infiltration Systems	Not possible.	Not recommended.
Proprietary Treatment Systems	No reason to preclude the use of a proprietary treatment system if other components are not available; however, the preference should be towards SuDS components. Becomes a requirement in high-pollution risk areas.	Possible if required; however, not first choice. Will be required for high-pollution risk areas.
Filter Strips	Viable to provide surface water treatment and collection.	Possible.
Filter Drains	Viable to provide surface water treatment and collection.	Possible.
Swales	Subject to space/level constraints.	Possible.
Bioretention Systems	May be possible to include – should be considered alongside landscaping plan. Landscaping is limited and any volumetric benefit is likely to be minimal.	Possible, but landscaping is limited.
Trees	Landscaping opportunities are limited.	Likely to be insufficient quantity to be beneficial for drainage.
Pervious Surfaces	Viable to provide surface water treatment and collection.	Possible.
Attenuation Storage Tanks	Viable to provide surface water attenuation.	Possible. Not recognised as a SuDS feature.
Detention Basins	Subject to space/level constraints.	Possible if space is available
Ponds and Wetlands	Space constraints preclude the use of full wetlands	Not recommended

Table 3 SuDS Evaluation

6.3.2 Following the SuDS evaluation, there are a number of SuDS options available for use around the development that can be used in combination, however water quality benefits also require consideration.

6.4 WATER QUALITY

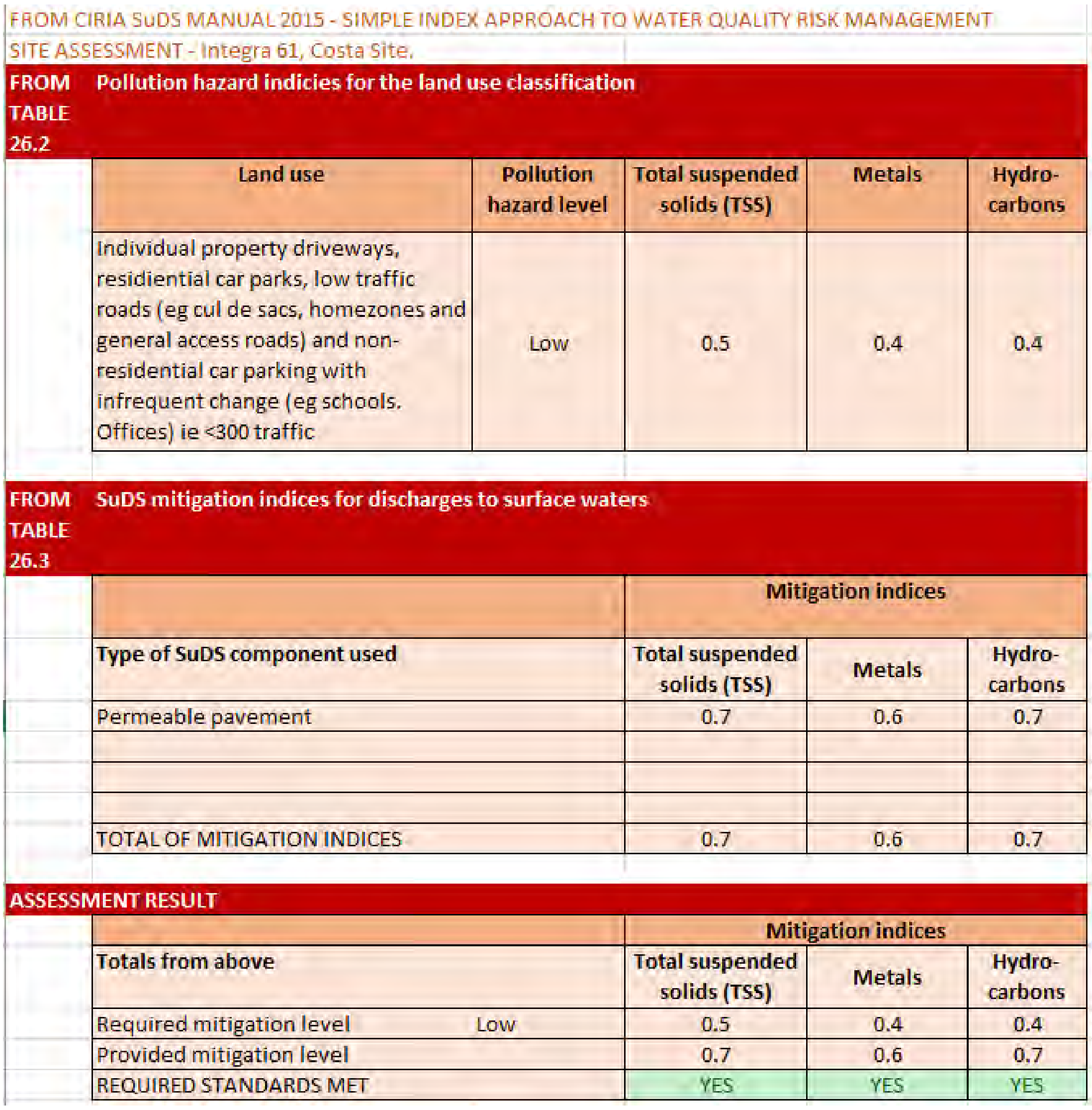
6.4.1 With the nature of the site and the preferred method of surface water disposal to a combined public sewer, there is a requirement to provide adequate treatment to ensure appropriate water quality management. The following possible options are available:

i. Filtration using pervious surfaces including permeable paving or ‘grasscrete’ and filter strips.

ii. Detention by storing surface water runoff volumes and by using outflow controls to meet hydraulic design criteria this also allows sedimentation to take place, which contributes to water quality improvements.

6.4.2 Given the scale and nature of the development it is proposed that treatment stages *i.* and *ii.* will be incorporated within a SuDS based surface water management strategy.

6.4.3 CIRIA 753 (SuDS Manual) has been used to assess the water quality measures required to minimise the impact of the scheme refer to **Figure 2**.



FROM CIRIA SuDS MANUAL 2015 - SIMPLE INDEX APPROACH TO WATER QUALITY RISK MANAGEMENT

SITE ASSESSMENT - Integra 61, Costa Site.

FROM TABLE 26.2 **Pollution hazard indicies for the land use classification**

Land use	Pollution hazard level	Total suspended solids (TSS)	Metals	Hydro-carbons
Individual property driveways, residiential car parks, low traffic roads (eg cul de sacs, homezones and general access roads) and non-residential car parking with infrequent change (eg schools. Offices) ie <300 traffic	Low	0.5	0.4	0.4

FROM TABLE 26.3 **SuDS mitigation indices for discharges to surface waters**

	Mitigation indices		
Type of SuDS component used	**Total suspended solids (TSS)**	**Metals**	**Hydro-carbons**
Permeable pavement	0.7	0.6	0.7
TOTAL OF MITIGATION INDICES	0.7	0.6	0.7

ASSESSMENT RESULT

		Mitigation indices		
Totals from above		**Total suspended solids (TSS)**	**Metals**	**Hydro-carbons**
Required mitigation level	Low	0.5	0.4	0.4
Provided mitigation level		0.7	0.6	0.7
REQUIRED STANDARDS MET		YES	YES	YES

Figure 2 SuDS Mitigation Indices

6.5 SURFACE WATER DRAINAGE PROPOSALS

6.5.1 The indicative surface water drainage strategy drawing provided in **Appendix 3** shows how a sustainable drainage system may be used to mitigate surface water runoff on the development site. Consultation with Severn Trent Water **Appendix 2** has confirmed that a flow rate of 5 l/s per hectare can be used if it is proved that infiltration and disposal to an offsite watercourse are not possible. Following the SuDS hierarchy assessment in section 6.2, the rate of 5 l/s/ha has been used for the remainder of this assessment.

6.5.2 The site has been split into 3 drainage catchment areas A, B and C. The surface water drainage proposals for each area are highlighted below and on the Drainage GA plan in **Appendix 3**.

Methods	Use
Permeable Paving (parking areas)	Provides water treatment, a method of collection and 7 to 12 m^3 of storage.
Hydro brake/Flow Control	Restricting flow to 2 l/s

Table 4 Area A Surface Water Drainage Proposals

Methods	Use
Permeable Paving (parking areas)	Provides water treatment, a method of collection and storage.
Cellular Attenuation Tank	Provides 206 to 280 m^3 of surface water attenuation.
Hydro brake/Flow Control	Restricting flow to 2 l/s

Table 5 Area B Surface Water Drainage Proposals

Methods	Use
Permeable Paving (parking areas & driveways)	Provides water treatment, a method of collection and 360 m^3 of storage.
Cellular Attenuation Tanks	Provides 435 m^3 of surface water attenuation.
1200 mm dia Oversized Pipes	Provides 660 m^3 of surface water attenuation.
Hydro brake/Flow Control	Restricting flow to 11.4 l/s

Table 6 Area C Surface Water Drainage Proposals

6.6 ONGOING OPERATION & MAINTENANCE

6.6.1 It is assumed that the majority of below ground drainage will be offered to the water authority for adoption, the developer is to set up a management company who will retain overall responsibility for the remaining assets using the maintenance schedule prepared in accordance with CIRIA 735, provided in **Appendix 4.**

6.6.2 During the first year, inspections should be carried out monthly and after significant storm events to ensure the system is functioning as designed and that no damage is evident. As a minimum, an annual maintenance inspection and report should be undertaken by a competent contractor.

6.6.3 Routine inspections will indicate when occasional or remedial maintenance is required. A routine inspection checklist is included within **Appendix 4**. Records of all inspections and maintenance should be kept by the building manager.

SECTION 7 OCCUPANTS AND USERS OF THE DEVELOPMENT

7.1 NUMBER OF OCCUPANTS & USERS

7.1.1 Exact figures of occupancy are not yet available; however, we know the development will provide 315 no of residential units (flat blocks and townhouses), this is assumed to be an increase over the existing.

7.2 NATURE OF USE

7.2.1 The change from an industrial site to a residential site will affect the pattern of occupancy. However, there is no change to the degree of flood risk to occupants.

7.3 VULNERABLE OCCUPANTS

7.3.1 The site is at the lowest possible risk of flooding and no further mitigation to protect occupants and residents is required.

SECTION 8 EXCEPTION TEST

8.1 The requirement for undertaking an Exception Test is defined in Table 3 of Ministry of Housing, Communities & Local Government publication, Flood Risk and Coastal Change (https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/575184/Table_3_-_Flood_risk_vulnerability_and_flood_zone__compatibility_.pdf), The Vulnerability Classification of this site is compatible with the flood zone and so the exception test is not required.

SECTION 9 RESIDUAL RISK

9.1 The residual risk for this site includes the possibility of blockage or failure of the drainage system resulting in exceedance flows as such there remains minimal risk to persons or property.

9.2 As an additional precautionary measure, finished floor levels should be raised above the road level by a minimum of 300mm.

9.3 The measures described in the report demonstrate that the land can be developed in compliance with the requirements set out in **Section 1**, in compliance with the NPPF and in accordance with the requirements of the LLFA.

SECTION 10 OTHER CONSIDERATIONS

10.1 FOUL DRAINAGE

10.2 The proposed development means that there will be foul flows generated from the 315 dwellings. It has been highlighted in **Section 5.1.5**, that the nearest foul sewers are 2 combined sewers which are located within Great Western Road. The Drainage GA plan in **Appendix 3** shows this arrangement.

10.3 Severn Trent Water have confirmed that a connection can be made to the existing 300 mm diameter combined sewer but would prefer a connection to the 600 mm diameter combined sewer. They have also confirmed that 322 properties would generate approximately 5 l/s. The confirmation letter from Severn Trent Water can be found in **Appendix 2**.

APPENDIX 1

- Site Location Plan
- Topographic Survey
- Proposed Site Layout
- EA Flood Zone Plan
- Sewer Records

FIRST ISSUE	01-06-2022		P0
	JB	JR	MB
ISSUE DETAILS	DWN	CHD	APP'D

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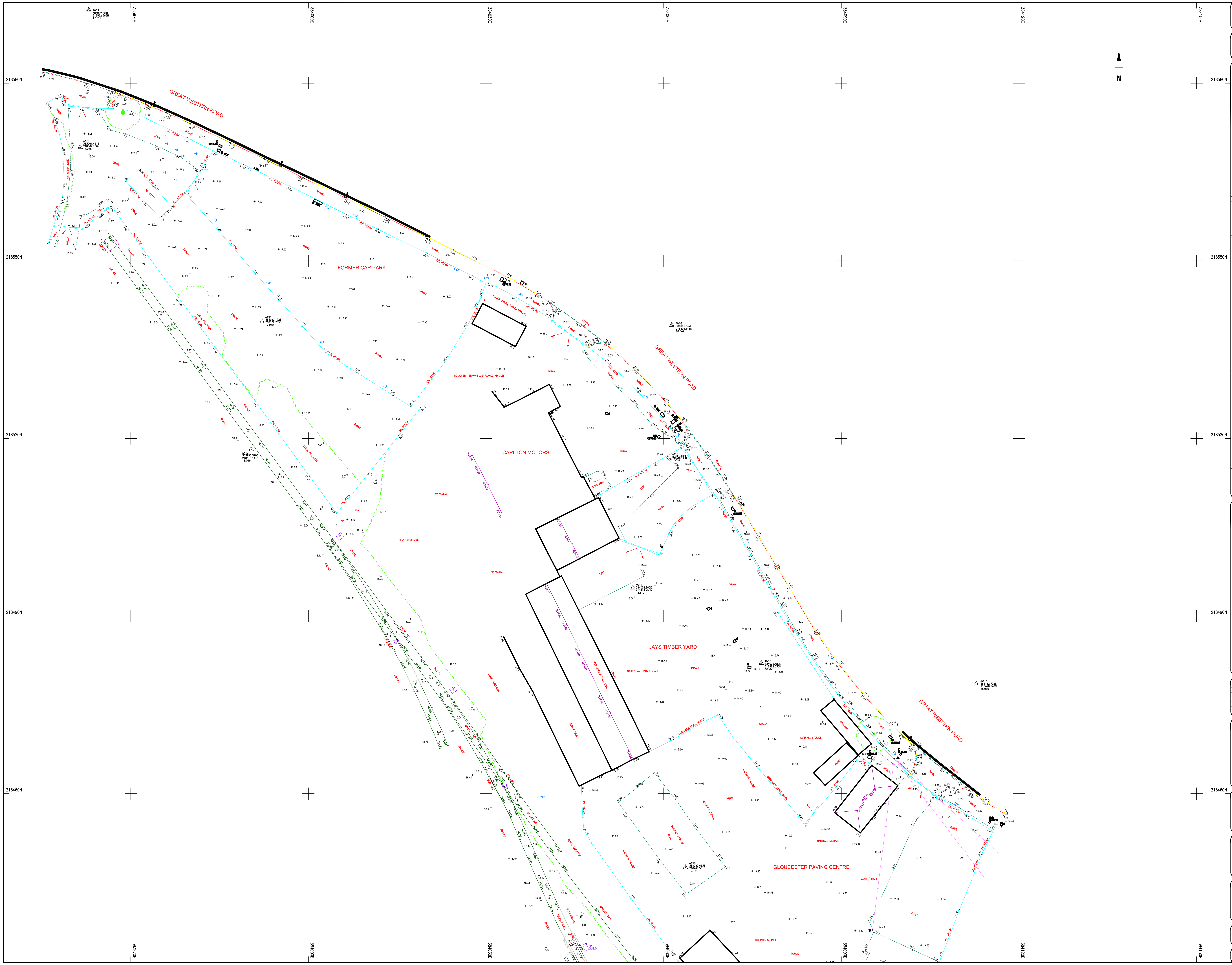
EUTOPIA HOMES
GREAT WESTERN YARD
SITE LOCATION PLAN

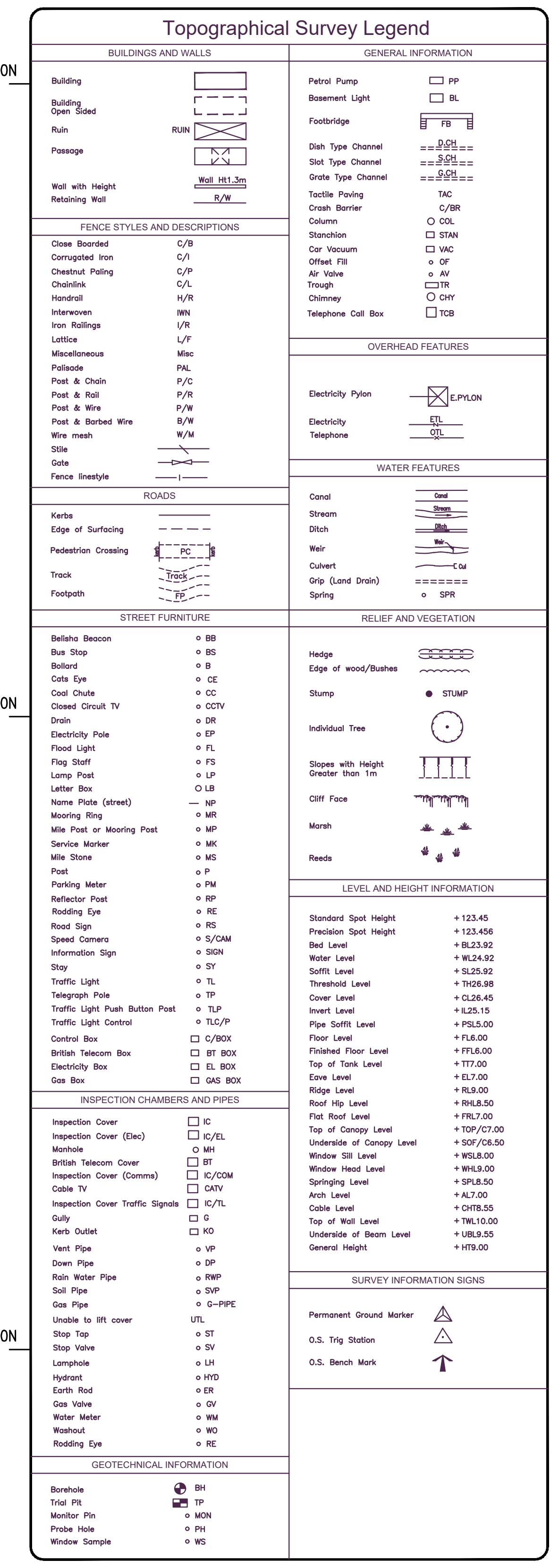
DWG NO. 22471-IDM-XXDR-D-0100
REVISION P0
SCALE 1:2000
DATE JUNE 2022
FRAME DIMS (mm) (A4) 250x181
DRAWN JB
CHECKED JR
APPROVED MB



Survey Notes
Grid: Local plane metric related to National Grid fixed at Stn AW02
Levels: OS Datum from GNSS positioning converted using the National GEOID model OSM15

Notes

Topographical Survey Legend



Sheet Index

Rev.	Date	Description

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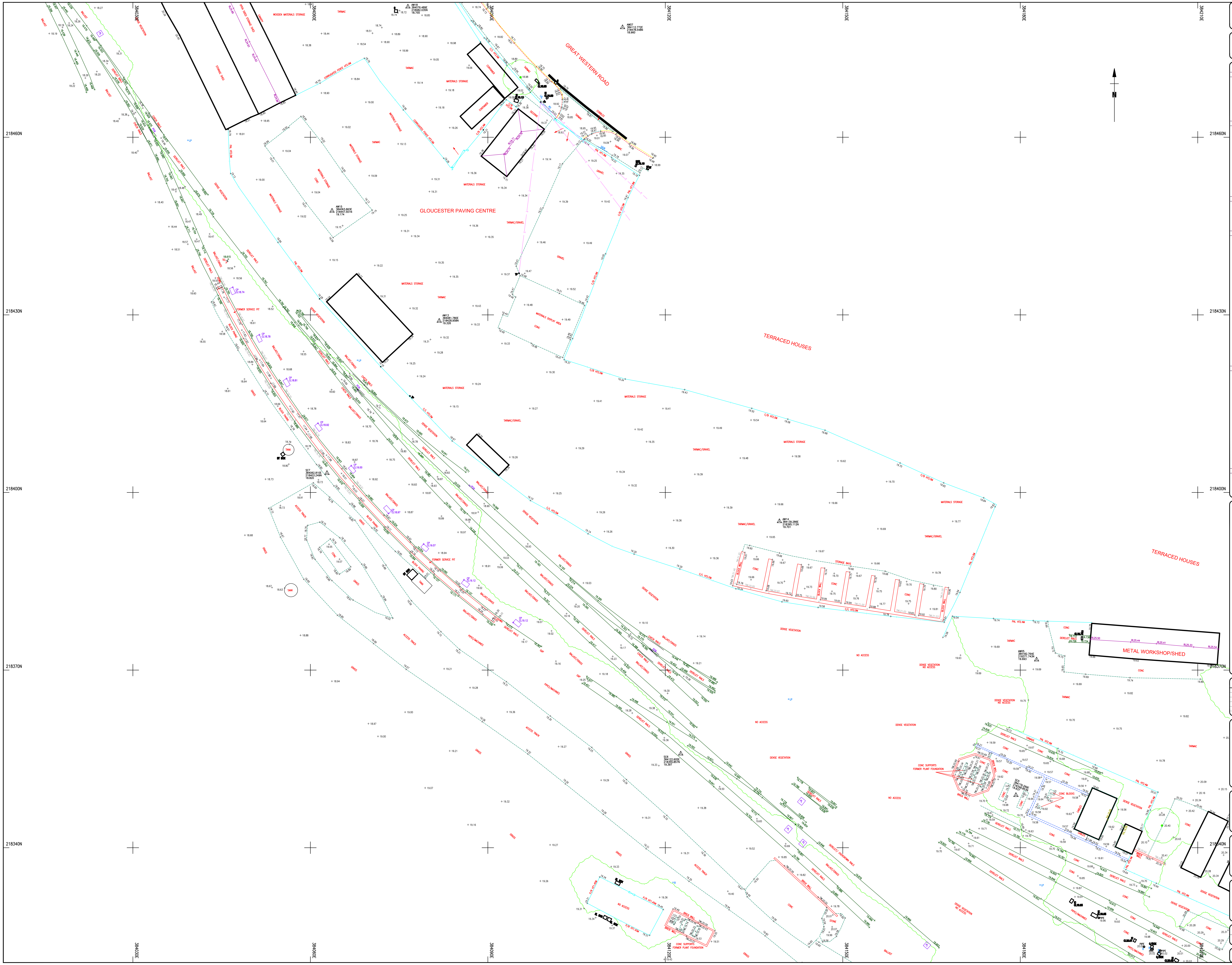
Project
GREAT WESTERN ROAD
GLOUCESTER

Drawing Title
TOPOGRAPHICAL SURVEY

Drawn By ZS 11/02/19
Checked by CT 11/02/19
Survey Date JANUARY 2019
Scale A0@1:200

Drawing No 53083/TOPO-1
Revision



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Notes

Topographical Survey Legend

BUILDINGS AND WALLS

Building	▭
Building Open Sided	⬚
Ruin	RUIN ☒
Passage	☒
Wall with Height	Wall Ht1.3m
Retaining Wall	R/W

FENCE STYLES AND DESCRIPTIONS

Close Boarded	C/B
Corrugated Iron	C/I
Chestnut Paling	C/P
Chainlink	C/L
Handrail	H/R
Interwoven	IWN
Iron Railings	I/R
Lattice	L/F
Miscellaneous	Misc
Palisade	PAL
Post & Chain	P/C
Post & Rail	P/R
Post & Wire	P/W
Post & Barbed Wire	B/W
Wire mesh	W/M
Stile	
Gate	
Fence linestyle	

ROADS

Kerbs	
Edge of Surfacing	
Pedestrian Crossing	kerb PC kerb
Track	Track
Footpath	FP

STREET FURNITURE

Belisha Beacon	○ BB
Bus Stop	○ BS
Bollard	○ B
Cats Eye	○ CE
Coal Chute	○ CC
Closed Circuit TV	○ CCTV
Drain	○ DR
Electricity Pole	○ EP
Flood Light	○ FL
Flag Staff	○ FS
Lamp Post	○ LP
Letter Box	○ LB
Name Plate (street)	— NP
Mooring Ring	○ MR
Mile Post or Mooring Post	○ MP
Service Marker	○ MK
Mile Stone	○ MS
Post	○ P
Parking Meter	○ PM
Reflector Post	○ RP
Rodding Eye	○ RE
Road Sign	○ RS
Speed Camera	○ S/CAM
Information Sign	○ SIGN
Stay	○ SY
Traffic Light	○ TL
Telegraph Pole	○ TP
Traffic Light Push Button Post	○ TLP
Traffic Light Control	○ TLC/P
Control Box	☐ C/BOX
British Telecom Box	☐ BT BOX
Electricity Box	☐ EL BOX
Gas Box	☐ GAS BOX

INSPECTION CHAMBERS AND PIPES

Inspection Cover	☐ IC
Inspection Cover (Elec)	☐ IC/EL
Manhole	○ MH
British Telecom Cover	☐ BT
Inspection Cover (Comms)	☐ IC/COM
Cable TV	☐ CATV
Inspection Cover Traffic Signals	☐ IC/TL
Gully	☐ G
Kerb Outlet	☐ KO
Vent Pipe	○ VP
Down Pipe	○ DP
Rain Water Pipe	○ RWP
Soil Pipe	○ SVP
Gas Pipe	○ G–PIPE
Unable to lift cover	UTL
Stop Tap	○ ST
Stop Valve	○ SV
Lamphole	○ LH
Hydrant	○ HYD
Earth Rod	○ ER
Gas Valve	○ GV
Water Meter	○ WM
Washout	○ WO
Rodding Eye	○ RE

GEOTECHNICAL INFORMATION

Borehole	◕ BH
Trial Pit	▨ TP
Monitor Pin	○ MON
Probe Hole	○ PH
Window Sample	○ WS

GENERAL INFORMATION

Petrol Pump	▭ PP
Basement Light	▭ BL
Footbridge	FB
Dish Type Channel	D.CH
Slot Type Channel	S.CH
Grate Type Channel	G.CH
Tactile Paving	TAC
Crash Barrier	C/BR
Column	○ COL
Stanchion	☐ STAN
Car Vacuum	☐ VAC
Offset Fill	○ OF
Air Valve	○ AV
Trough	▭ TR
Chimney	○ CHY
Telephone Call Box	☐ TCB

OVERHEAD FEATURES

Electricity Pylon	☒ E.PYLON
Electricity	ETL
Telephone	OTL

WATER FEATURES

Canal	Canal
Stream	Stream
Ditch	Ditch
Weir	Weir
Culvert	Cul
Grip (Land Drain)	=======
Spring	○ SPR

RELIEF AND VEGETATION

Hedge	
Edge of wood/Bushes	
Stump	● STUMP
Individual Tree	
Slopes with Height Greater than 1m	
Cliff Face	
Marsh	
Reeds	

LEVEL AND HEIGHT INFORMATION

Standard Spot Height	+ 123.45
Precision Spot Height	+ 123.456
Bed Level	+ BL23.92
Water Level	+ WL24.92
Soffit Level	+ SL25.92
Threshold Level	+ TH26.98
Cover Level	+ CL26.45
Invert Level	+ IL25.15
Pipe Soffit Level	+ PSL5.00
Floor Level	+ FL6.00
Finished Floor Level	+ FFL6.00
Top of Tank Level	+ TT7.00
Eave Level	+ EL7.00
Ridge Level	+ RL9.00
Roof Hip Level	+ RHL8.50
Flat Roof Level	+ FRL7.00
Top of Canopy Level	+ TOP/C7.00
Underside of Canopy Level	+ SOF/C6.50
Window Sill Level	+ WSL8.00
Window Head Level	+ WHL9.00
Springing Level	+ SPL8.50
Arch Level	+ AL7.00
Cable Level	+ CHT8.55
Top of Wall Level	+ TWL10.00
Underside of Beam Level	+ UBL9.55
General Height	+ HT9.00

SURVEY INFORMATION SIGNS

Permanent Ground Marker	△
O.S. Trig Station	△
O.S. Bench Mark	↑

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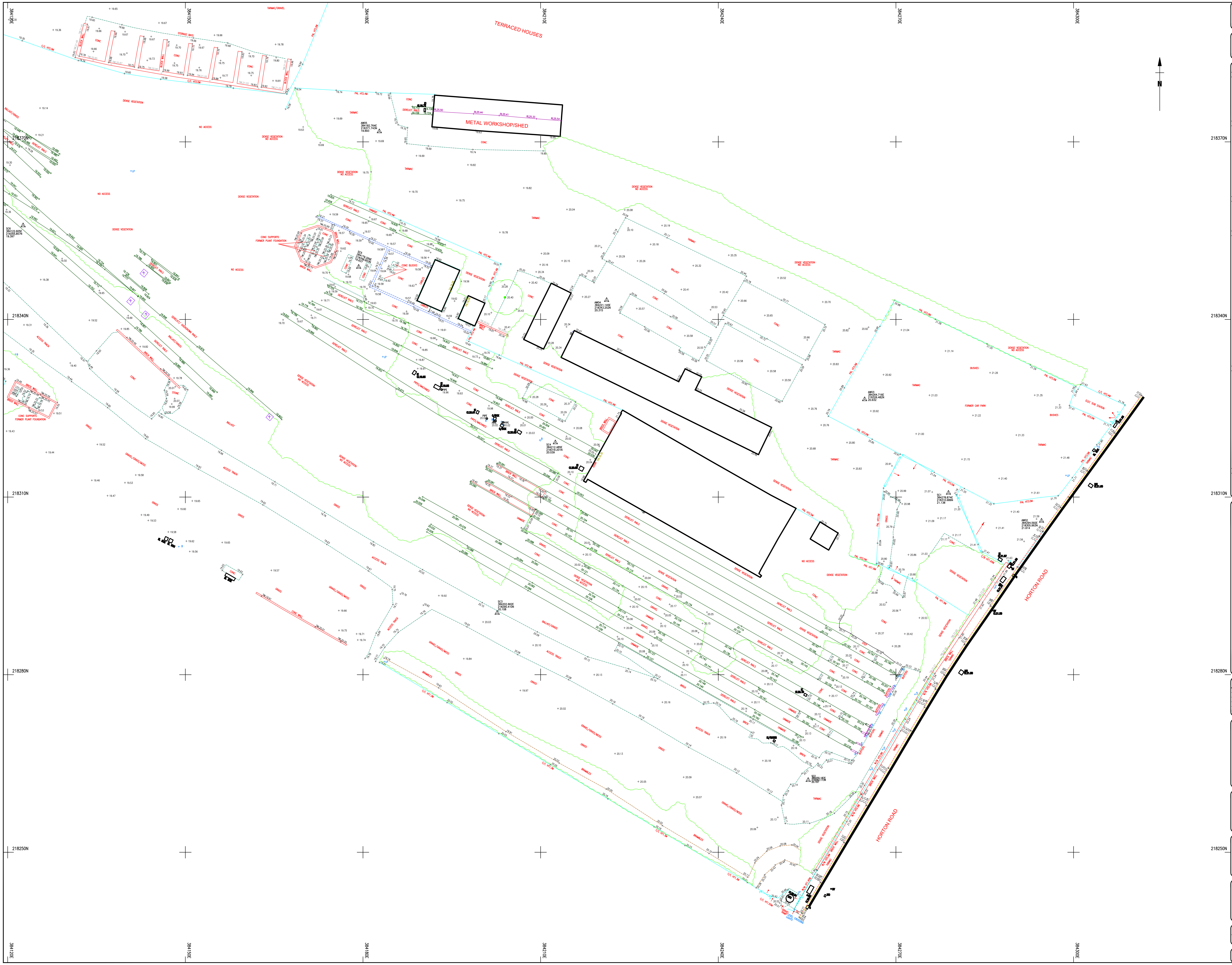

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Retaining Wall	R/W

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Close Boarded	C/B
Corrugated Iron	C/I
Chestnut Paling	C/P
Chainlink	C/L
Handrail	H/R
Interwoven	IWN
Iron Railings	I/R
Lattice	L/F
Miscellaneous	Misc
Palisade	PAL
Post & Chain	P/C
Post & Rail	P/R
Post & Wire	P/W
Post & Barbed Wire	B/W
Wire mesh	W/M
Stile	
Gate	
Fence linestyle	

ROADS

Kerbs	
Edge of Surfacing	
Pedestrian Crossing	PC
Track	Track
Footpath	FP

STREET FURNITURE

Belisha Beacon	o BB
Bus Stop	o BS
Bollard	o B
Cats Eye	o CE
Coal Chute	o CC
Closed Circuit TV	o CCTV
Drain	o DR
Electricity Pole	o EP
Flood Light	o FL
Flag Staff	o FS
Lamp Post	o LP
Letter Box	O LB
Name Plate (street)	— NP
Mooring Ring	o MR
Mile Post or Mooring Post	o MP
Service Marker	o MK
Mile Stone	o MS
Post	o P
Parking Meter	o PM
Reflector Post	o RP
Rodding Eye	o RE
Road Sign	o RS
Speed Camera	o S/CAM
Information Sign	o SIGN
Stay	o SY
Traffic Light	o TL
Telegraph Pole	o TP
Traffic Light Push Button Post	o TLP
Traffic Light Control	o TLC/P
Control Box	☐ C/BOX
British Telecom Box	☐ BT BOX
Electricity Box	☐ EL BOX
Gas Box	☐ GAS BOX

INSPECTION CHAMBERS AND PIPES

Inspection Cover	☐ IC
Inspection Cover (Elec)	☐ IC/EL
Manhole	O MH
British Telecom Cover	☐ BT
Inspection Cover (Comms)	☐ IC/COM
Cable TV	☐ CATV
Inspection Cover Traffic Signals	☐ IC/TL
Gully	☐ G
Kerb Outlet	☐ KO
Vent Pipe	o VP
Down Pipe	o DP
Rain Water Pipe	o RWP
Soil Pipe	o SVP
Gas Pipe	o G–PIPE
Unable to lift cover	UTL
Stop Tap	o ST
Stop Valve	o SV
Lamphole	o LH
Hydrant	o HYD
Earth Rod	o ER
Gas Valve	o GV
Water Meter	o WM
Washout	o WO
Rodding Eye	o RE

GEOTECHNICAL INFORMATION

Borehole	BH
Trial Pit	TP
Monitor Pin	o MON
Probe Hole	o PH
Window Sample	o WS

GENERAL INFORMATION

Petrol Pump	☐ PP
Basement Light	☐ BL
Footbridge	FB
Dish Type Channel	D.CH
Slot Type Channel	S.CH
Grate Type Channel	G.CH
Tactile Paving	TAC
Crash Barrier	C/BR
Column	O COL
Stanchion	☐ STAN
Car Vacuum	☐ VAC
Offset Fill	o OF
Air Valve	o AV
Trough	TR
Chimney	O CHY
Telephone Call Box	☐ TCB

OVERHEAD FEATURES

Electricity Pylon	E.PYLON
Electricity	ETL
Telephone	OTL

WATER FEATURES

Canal	Canal
Stream	Stream
Ditch	Ditch
Weir	Weir
Culvert	Cul
Grip (Land Drain)	=======
Spring	o SPR

RELIEF AND VEGETATION

Hedge	
Edge of wood/Bushes	
Stump	● STUMP
Individual Tree	
Slopes with Height Greater than 1m	
Cliff Face	
Marsh	
Reeds	

LEVEL AND HEIGHT INFORMATION

Standard Spot Height	+ 123.45
Precision Spot Height	+ 123.456
Bed Level	+ BL23.92
Water Level	+ WL24.92
Soffit Level	+ SL25.92
Threshold Level	+ TH26.98
Cover Level	+ CL26.45
Invert Level	+ IL25.15
Pipe Soffit Level	+ PSL5.00
Floor Level	+ FL6.00
Finished Floor Level	+ FFL6.00
Top of Tank Level	+ TT7.00
Eave Level	+ EL7.00
Ridge Level	+ RL9.00
Roof Hip Level	+ RHL8.50
Flat Roof Level	+ FRL7.00
Top of Canopy Level	+ TOP/C7.00
Underside of Canopy Level	+ SOF/C6.50
Window Sill Level	+ WSL8.00
Window Head Level	+ WHL9.00
Springing Level	+ SPL8.50
Arch Level	+ AL7.00
Cable Level	+ CHT8.55
Top of Wall Level	+ TWL10.00
Underside of Beam Level	+ UBL9.55
General Height	+ HT9.00

SURVEY INFORMATION SIGNS

Permanent Ground Marker	
O.S. Trig Station	
O.S. Bench Mark	

Sheet Index

Rev.	Date	Description

MALCOLM HUGHES
CHARTERED LAND SURVEYORS

65 Cross Street, Sale, Manchester
M33 7HF, Tel: 0161 905 1265
www.malcolmhughes.co.uk
survey@mhls.co.uk

Accreditations

RICS
THE SURVEY ASSOCIATION
chartered ices
RISQS QUALIFIED
bsi. ISO 9001 Quality Management
FS 14126

Client
ECUS LTD
BROOK HOLT, 3 BLACKBURN ROAD
SHEFFIELD, S61 2DW

Project
GREAT WESTERN ROAD
GLOUCESTER

Drawing Title
TOPOGRAPHICAL SURVEY

Drawn By	ZS	11/02/19	Survey Date	JANUARY 2019
Checked by	CT	11/02/19	Scale	A0@1:200

Drawing No
53083/TOPO-3

Revision

Unless otherwise stated all dimensions are in millimeters. Where dimensions are not given, drawings must not be scaled and the matter must be referred to the Landscape Architect. If the drawing includes conflicting details/dimensions the matter must be referred to the Landscape Architect. All dimensions must be checked on site. The Landscape Architect must be informed, by the Contractor, of any discrepancies before work proceeds.

THIS DRAWING IS TO BE READ IN CONJUNCTION WITH RELEVANT CONSULTANT'S DRAWINGS.

LEGEND:

SOFTSCAPE:

PROPOSED PLANTING

● Existing Trees to be retained

Standard Trees

Tree Tags	Species	Girth	Height	Spec
Ac	Acer campestre 'Elsrijk'	20-25cm	5-5.5m	3xtr. (R/B)
Ag	Alnus glutinosa 'Imperialis'	25-30cm	6.0-6.5m	5xtr. (R/B)
Bp	Betula pubescens	16-18cm	4.5-5.5m	3xtr. (R/B)
M	Malus tchonoskii	16-18cm	4.5-5.5m	3xtr. (R/B)
Pa	Prunus avium	20-25cm	5-5.5m	3xtr. (R/B)
Pp	Prunus padus	20-25cm	5-5.5m	3xtr. (R/B)
Pt	Prunus serrulata 'Tai-Haku'	16-18cm	3.5-4.0m	3xtr. (R/B)
Pc	Pyrus calleryana 'Chanticleer'	16-18cm	4.5-5.5m	3xtr. (R/B)
Sa	Sorbus aucuparia	25-30cm	5-5.5m	3xtr. (R/B)
Tc	Tilia cordata 'Greenspire'	25-30cm	6.0-6.5m	3xtr. (R/B)

Multistem Trees

Tree Tags	Species	Height	Spec
Al	Amelanchier lamarkii	2.0-2.5m	3xtr. (R/B)
Bu	Betula utilis var. jacquemontii	4-4.5m	3xtr. (R/B)
Hd	Hamamelis x intermedia 'Diane'	3.5-4.0m	3xtr. (R/B)
Ma	Malus domestica	3.5-4.0m	3xtr. (R/B)
Tw	Cornus mas	2.0-2.5m	3xtr. (R/B)

Hedge Planting

Low Hedge

	Species	Stock	Height	Spec	Density
▬	Carpinus betulus	RB/C	1.0m	Double staggered row	6/lnm

Shrubs, Perennials, Grasses

Naturalistic Planting Mix

	Species	Stock	Height	Spec	Density
🟩	Cornus alba 'Sibirica'	C5	60-80cm	Branched	2/m2
	Euonymus fortunei 'Silver Queen'	C5	60-80cm	Branched	2/m2
	Sarcococca hookeriana	C5	60-80cm	Branched	2/m2
	Aster novi-belgii	C2	20-30cm		2/m2
	Echinacea purpurea	C2	20-30cm		4/m2
	Persicaria amplexicaulis 'Firedance'	C2	30-40cm		4/m2
	Lavandula angustifolia 'Hidcote'	C5	30-40cm	bushy	5/m2
	Aster 'Asran' / 'Stardust'	C2	30-40cm		2/m2
	Rudbekia fulgida 'Goldstrum'	C2	30-40cm		4/m2
	Achillea filipendulina 'Moonshine'	C2	30-40cm		4/m2
	Allium sphaerocephalon	C2	20-30cm		4/m2
	Verbena bonariensis	C2	30-40cm		4/m2
	Deschampsia cespitosa	C2	30-40cm		4/m2
	Stipa tenuissima	C2	20-30cm		4/m2
	Miscanthus s. 'Kleine Fontaine'	C2	30-40cm		4/m2
	Helleborus foetidus	P9	20-30cm		4/m2
	Narcissus 'Tete a Tete'	Bulb			6/m2
	Colchium autumnale	bulbs			100/m2
	Hyacinthoides non-scripta	Bulb			36/m2
	Lonicera periclymenum	C2	60-80cm	Bushy	2/m2

SUDs Planting Mix

	Species	Stock	Height	Spec	Density
🟩	Cornus alba 'Sibirica'	C5	60-80cm	Branched	2/m2
	Cornus sanguinea 'Midwinter Fire'	C5	30-40cm	Branched	5/m2
	Osmunda regalis	C2	30-40cm		4/m2
	Iris pseudoacodrus	C2	30-40cm		4/m2
	Deschampsia cespitosa	C2	30-40cm		4/m2
	Molinia caerulea	C2	30-40cm		4/m2
	Miscanthus s. 'Kleine Fontäne'	C2	30-40cm		4/m2
	Geum 'Mai Tai'	C2	30-40cm		4/m2
	Valeriana officinalis	C2	30-40cm		4/m2
	Achillea filipendulina 'Moonshine'	C2	30-40cm		4/m2
	Aster novi-belgii	C2	30-40cm		4/m2
	Sanguisorba officinalis	C2	30-40cm		4/m2
	Alchemilla mollis	C2	30-40cm		4/m2
	Angelica sylvestris 'Purpurea'	C2	30-40cm		2/m2
	Geranium macrorrhizum 'Gerwat'	C2	30-40cm		6/m2
	Primula japonica 'Millers's Crimson'	C2	20-30cm		6/m2
	Helleborus foetidus	C2	10-20cm		6/m2

Wildlife Buffer Planting Mix

	Species	Stock	Height	Spec	Density
🟩	Rubus fruticosus	C5		branched	1/m2
	Prunus spinosa	C5		branched	1/m2
	Crataegus monogyna	C5		bushy	8/m2
	Helleborus foetidus	P9			20/m2
	Colchium autumnale	P9			20/m2
	Hyacinthoides non-scripta	Bulb			100/m2
	Hedera helix	C2	60-80cm	Bushy	2/m2

🟩 Private gardens

🟩 Wildflower Meadow Mix

🟩 Lawn
Lawn areas seed with Coburns "Low Maintenance" mix:
60% (Perennial Ryegrass) + 35% (Slender Creeping Red Fescue) +
5% (Browntop Bent) + Sowing rate: 35g/m2 (350kgs/ha)
Cutting height: Between 20-50mm

HARDSCAPE:

PROPOSED HARD LANDSCAPING

- Tarmac
- Paving 1
- Paving 2
- Paving 3
- Paving 4
- Private parking
- Grasscrete
- Seating / Furniture

Description	Revision Notes	XX / XX By / Chk	DD/MM/YY Date	00 Rev

Status: PLANNING

Park Hood
Chartered Landscape Architects

Hawarden House, 163 Upper Newtownards Road, Belfast, BT4 3HZ
T: +44 (0) 28 9029 8020 **E:** info@parkhood.com **parkhood.com**

Client: Eutopia Homes

Project: Great Western Yard
Gloucester

Title: Proposed Landscape Plan

Job No: 7594 | **Scale@A0** 1:500 | **Date:** June 2022

Drawing Number

Project	Originator	Volume	Level	Type	Role	Number	Revision
7594	PHL	SW	XX	DR	L	1000	00

Flood map for planning

Your reference	Location (easting/northing)	Created
Great Western Yard	**384152/218375**	**1 Jun 2022 11:16**

Your selected location is in flood zone 1, an area with a low probability of flooding.

You will need to do a flood risk assessment if your site is **any of the following:**

- bigger that 1 hectare (ha)
- In an area with critical drainage problems as notified by the Environment Agency
- identified as being at increased flood risk in future by the local authority's strategic flood risk assessment
- at risk from other sources of flooding (such as surface water or reservoirs) and its development would increase the vulnerability of its use (such as constructing an office on an undeveloped site or converting a shop to a dwelling)

Notes

The flood map for planning shows river and sea flooding data only. It doesn't include other sources of flooding. It is for use in development planning and flood risk assessments.

This information relates to the selected location and is not specific to any property within it. The map is updated regularly and is correct at the time of printing.

Flood risk data is covered by the Open Government Licence **which** sets out the terms and conditions for using government data. https://www.nationalarchives.gov.uk/doc/open-government-licence/version/3/

Use of the address and mapping data is subject to Ordnance Survey public viewing terms under Crown copyright and database rights 2021 OS 100024198. https://flood-map-for-planning.service.gov.uk/os-terms

Environment Agency

Flood map for planning

Your reference
Great Western Yard

Location (easting/northing)
384152/218375

Scale
1:2500

Created
1 Jun 2022 11:16

📍	Selected point
🟦	Flood zone 3
▨	Flood zone 3: areas benefitting from flood defences
▭	Flood zone 2
☐	Flood zone 1
━	Flood defence
━	Main river
⁘	Water storage area

0 20 40 60m

EA Flood Maps

Extent of flooding from rivers or the sea

Extent of flooding from rivers or the sea

● High ● Medium ● Low ● Very low ⊕ Location you selected

Extent of flooding from surface water

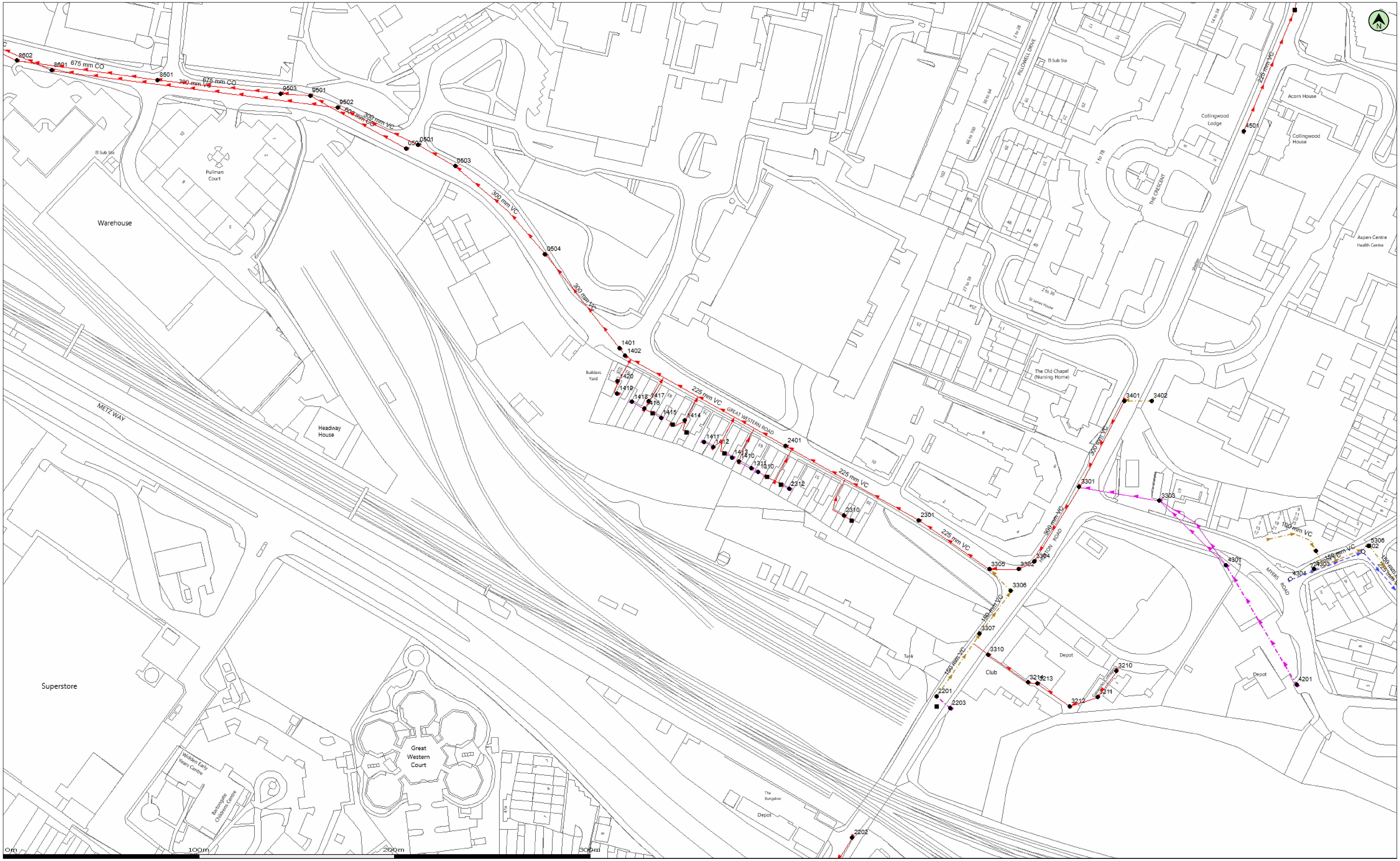
Extent of flooding from surface water

● High ● Medium ● Low ○ Very low ⊕ Location you selected

Extent of flooding from reservoirs

Maximum extent of flooding from reservoirs:

● when river levels are normal ▨ when there is also flooding from rivers ⊕ Location you selected



(c) Crown copyright and database rights 2022 Ordnance Survey 100031673 Date: 30/05/22 Scale: 1:1250 Map Centre: 384160,218418 Data updated: 14/03/22 Our Ref: 867523 - 1 Wastewater Plan A2

Do not scale off this Map. This plan and any information supplied with it is furnished as a general guide, is only valid at the date of issue and no warranty as to its correctness is given or implied. In particular this plan and any information shown on it must not be relied upon in the event of any development or works (including but not limited to excavations) in the vicinity of SEVERN TRENT WATER assets or for the purposes of determining the suitability of a point of connection to the sewerage or distribution systems. On 1 October 2011 most private sewers and private lateral drains in Severn Trent Water's sewerage area, which were connected to a public sewer as at 1 July 2011, Transferred to the ownership of Severn Trent Water and became public sewers and public lateral drains. A further transfer takes place on 1 October 2012. Private pumping stations, which form part of these sewers or lateral drains, will transfer to ownership of Severn Trent Water on or before 1 October 2016. Severn Trent Water does not ossess complete records of these assets. These assets may not be displayed on the map. Reproduction by permission of Ordnance Survey on behalf of HMSO. © Crown Copyright and database right 2004. All rights reserved. Ordnance Survey licence number: 100031673. Document users other than SEVERN TRENT WATER business users are advised that this document is provided for reference purpose only and is subject to copyright, therefore, no further copies should be made from it.

Public Foul Gravity/Lateral Drain	▶	Highway Drain	—	Manhole Foul	●
Public Combined Gravity/Lateral Drain	▶	Overflow Pipe	▶	Manhole Surface	○
Public Surface Water Gravity/Lateral Drain	▶	Disposal Pipe	▶	Abandoned Pipe	—
Pressure Foul	—	Culverted Water Course	=	Section 104 sewers are shown in green	
Pressure Combined	—	Pumping Station	▲ ▲ ▲	Private sewers are shown in magenta	
Pressure Surface Water	—	Fitting	■		

c.oliveira@merebrook.co.uk

TBC - G.W Yard

SEVERN TRENT

SEVERN
TRENT

GENERAL CONDITIONS AND PRECAUTIONS TO BE TAKEN WHEN CARRYING OUT WORK ADJACENT TO SEVERN TRENT WATER'S APPARATUS

Please ensure that a copy of these conditions is passed to your representative and/or your contractor on site. If any damage is caused to Severn Trent Water Limited (STW) apparatus (defined below), the person, contractor or subcontractor responsible must inform STW immediately on:
0800 783 4444 (24 hours)

a) These general conditions and precautions apply to the public sewerage, water distribution and cables in ducts including (but not limited to) sewers which are the subject of an Agreement under Section 104 of the Water Industry Act 1991(a legal agreement between a developer and STW, where a developer agrees to build sewers to an agreed standard, which STW will then adopt); mains installed in accordance with an agreement for the self-construction of water mains entered into with STW and the assets described at condition b) of these general conditions and precautions. Such apparatus is referred to as "STW Apparatus" in these general conditions and precautions.

b) Please be aware that due to The Private Sewers Transfer Regulations June 2011, the number of public sewers has increased, but many of these are not shown on the public sewer record. However, some idea of their positions may be obtained from the position of inspection covers and their existence must be anticipated.

c) On request, STW will issue a copy of the plan showing the approximate locations of STW Apparatus although in certain instances a charge will be made. The position of private drains, private sewers and water service pipes to properties are not normally shown but their presence must be anticipated. This plan and the information supplied with it is furnished as a general guide only and STW does not guarantee its accuracy.

d) STW does not update these plans on a regular basis. Therefore the position and depth of STW Apparatus may change and this plan is issued subject to any such change. Before any works are carried out, you should confirm whether any changes to the plan have been made since it was issued.

e) The plan must not be relied upon in the event of excavations or other works in the vicinity of STW Apparatus. It is your responsibility to ascertain the precise location of any STW Apparatus prior to undertaking any development or other works (including but not limited to excavations).

f) No person or company shall be relieved from liability for loss and/or damage caused to STW Apparatus by reason of the actual position and/or depths of STW Apparatus being different from those shown on the plan.

In order to achieve safe working conditions adjacent to any STW Apparatus the following should be observed:

1. All STW Apparatus should be located by hand digging prior to the use of mechanical excavators.

2. All information set out in any plans received from us, or given by our staff at the site of the works, about the position and depth of the mains, is approximate. Every possible precaution should be taken to avoid damage to STW Apparatus. You or your contractor must ensure the safety of STW Apparatus and will be responsible for the cost of repairing any loss and/or damage caused (including without limitation replacement parts).

3. Water mains are normally laid at a depth of 900mm. No records are kept of customer service pipes which are normally laid at a depth of 750mm; but some idea of their positions may be obtained from the position of stop tap covers and their existence must be anticipated.

4. During construction work, where heavy plant will cross the line of STW Apparatus, specific crossing points must be agreed with STW and suitably reinforced where required. These crossing points should be clearly marked and crossing of the line of STW Apparatus at other locations must be prevented.

5. Where it is proposed to carry out piling or boring within 20 metres of any STW Apparatus, STW should be consulted to enable any affected STW Apparatus to be surveyed prior to the works commencing.

6. Where excavation of trenches adjacent to any STW Apparatus affects its support, the STW Apparatus must be supported to the satisfaction of STW. Water mains and some sewers are pressurised and can fail if excavation removes support to thrust blocks to bends and other fittings.

7. Where a trench is excavated crossing or parallel to the line of any STW Apparatus, the backfill should be adequately compacted to prevent any settlement which could subsequently cause damage to the STW Apparatus. In special cases, it may be necessary to provide permanent support to STW Apparatus which has been exposed over a length of the excavation before backfilling and reinstatement is carried out. There should be no concrete backfill in contact with the STW Apparatus.

8. No other apparatus should be laid along the line of STW Apparatus irrespective of clearance. Above ground apparatus must not be located within a minimum of 3 metres either side of the centre line of STW Apparatus for smaller sized pipes and 6 metres either side for larger sized pipes without prior approval. No manhole or chamber shall be built over or around any STW Apparatus.

9. A minimum radial clearance of 300 millimetres should be allowed between any plant or equipment being installed and existing STW Apparatus. We reserve the right to increase this distance where strategic assets are affected.

10. Where any STW Apparatus coated with a special wrapping is damaged, even to a minor extent, STW must be notified and the trench left open until the damage has been inspected and the necessary repairs have been carried out. In the case of any material damage to any STW Apparatus causing leakage, weakening of the mechanical strength of the pipe or corrosion-protection damage, the necessary remedial work will be recharged to you.

11. It may be necessary to adjust the finished level of any surface boxes which may fall within your proposed construction. Please ensure that these are not damaged, buried or otherwise rendered inaccessible as a result of the works and that all stop taps, valves, hydrants, etc. remain accessible and operable. Minor reduction in existing levels may result in conflict with STW Apparatus such as valve spindles or tops of hydrants housed under the surface boxes. Checks should be made during site investigations to ascertain the level of such STW Apparatus in order to determine any necessary alterations in advance of the works.

12. With regard to any proposed resurfacing works, you are required to contact STW on the number given above to arrange a site inspection to establish the condition of any STW Apparatus in the nature of surface boxes or manhole covers and frames affected by the works. STW will then advise on any measures to be taken, in the event of this a proportionate charge will be made.

13. You are advised that STW will not agree to either the erection of posts, directly over or within 1.0 metre of valves and hydrants,

14. No explosives are to be used in the vicinity of any STW Apparatus without prior consultation with STW.

TREE PLANTING RESTRICTIONS

There are many problems with the location of trees adjacent to sewers, water mains and other STW Apparatus and these can lead to the loss of trees and hence amenity to the area which many people may have become used to. It is best if the problem is not created in the first place. Set out below are the recommendations for tree planting in close proximity to public sewers, water mains and other STW Apparatus.

15. Please ensure that, in relation to STW Apparatus, the mature root systems and canopies of any tree planted do not and will not encroach within the recommended distances specified in the notes below.

16. Both Poplar and Willow trees have extensive root systems and should not be planted within 12 metres of a sewer, water main or other STW Apparatus.

17. The following trees and those of similar size, be they deciduous or evergreen, should not be planted within 6 metres of a sewer, water main or other STW Apparatus. E.g. Ash, Beech, Birch, most Conifers, Elm, Horse Chestnut, Lime, Oak, Sycamore, Apple and Pear. Asset Protection Statements Updated May 2014

18. STW personnel require a clear path to conduct surveys etc. No shrubs or bushes should be planted within 2 metre of the centre line of a sewer, water main or other STW Apparatus.

19. In certain circumstances, both STW and landowners may wish to plant shrubs/bushes in close proximity to a sewer, water main of other STW Apparatus for screening purposes. The following are shallow rooting and are suitable for this purpose: Blackthorn, Broom, Cotoneaster, Elder, Hazel, Laurel, Privet, Quickthorn, Snowberry, and most ornamental flowering shrubs.

Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert
0501	C	17.88	15.82	2.06
0502	C	17.89	15.15	2.74
0503	C	18.06	16.07	1.99
0504	C	18.51	16.59	1.92
1310	C	-	0	0
1311	C	-	0	0
1401	C	18.94	17.06	1.88
1402	C	18.95	17.15	1.81
1410	C	-	0	0
1411	C	-	0	0
1412	C	-	0	0
1413	C	-	0	0
1414	C	-	0	0
1415	C	-	0	0
1416	C	-	0	0
1417	C	-	0	0
1418	C	-	0	0
1419	C	-	0	0
1420	C	-	0	0
2202	C	20.53	18.73	1.8
2301	C	20.78	18.98	1.8
2310	C	-	0	0
2312	C	-	0	0
2401	C	19.7	18.11	1.59
3210	C	-	0	0
3211	C	-	0	0
3212	C	-	0	0
3213	C	-	0	0
3214	C	-	0	0
3301	C	22.76	20.79	1.97
3302	C	21.68	20.37	1.31
3303	C	24.43	23.8	0.63
3304	C	21.93	20.61	1.32
3305	C	21.48	19.49	1.99
3310	C	-	0	0
3401	C	23.93	22.11	1.82
4301	C	26.41	0	0
4501	C	26.31	24.96	1.35
8501	C	17.43	14.13	3.3
8601	C	17.26	14.62	2.64
8602	C	16.91	13.71	3.2
9501	C	17.81	14.6	3.21
9502	C	17.71	15.56	2.15
9503	C	17.72	14.52	3.2
	F			
2201	F	21.5	20.42	1.09
2203	F	21.61	20.79	0.82
3306	F	21.69	19.68	2.01
3307	F	21.6	19.97	1.64
3402	F	25.39	22.24	3.15
4201	F	26.56	25.29	1.27
4303	F	26.62	25.12	1.5
5306	F	26.28	24.69	1.59
4302	S	26.34	24.18	2.16
4304	S	26.61	24.48	2.13

Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert

Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert

Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert

APPENDIX 2

- Environment Agency Correspondence
- Lead Local Flood Authority Correspondence
- Severn Trent Water Correspondence

Jessica Broomfield

From:	Enquiries_Westmids <Enquiries_Westmids@environment-agency.gov.uk>
Sent:	08 June 2022 15:08
To:	Jessica Broomfield
Subject:	Our ref: 265778 Product 4. Customer request reference XA56PGG5AAP5
Attachments:	P4.doc; 3_CC Guidance_Aug2021.pdf

Dear Jessica

Request for Product 4.

Thank you for your request for a Product 4 as detailed above received by us on XX

Please see the attached supporting information document.

We have considered your request under the provision of the Freedom of Information Act 2000 / Environmental Information Regulations 2004 (EIR). The Act requires that we respond to requests by advising you whether or not information is held, and if so by providing you with that information.

EIR Regulation 3(2) states that information is held if it is in our possession and has been produced or received by us, or is held by another person on our behalf at the time the request is made.

Information not held
We are unable to provide you with a Product 4 response because the site is in Flood Zone 1 and the information you have requested is not held by the Environment Agency. There is no detailed modelled information available for this site and we have no records of flooding in the area. We are therefore refusing this part of your request on the grounds that there is no information we can provide.

The Lead Local Flood Authority may have more information on how surface water flooding is managed in the local area.

As a public body we are required under the Freedom of Information Act / Environmental Information Regulations (EIR) to give reasons for this refusal. We also need to show that we have considered the Public Interest balance between refusal and disclosure.

The duty to make information available to you under EIR Regulation 5(1) does not arise because in accordance with EIR Regulation 3(2) we do not hold the information you have requested. Regulation 12(4)(a) also applies – we cannot supply the information because we do not hold it. It is not possible to conduct a meaningful public interest test when a refusal is made on this ground.

If you are not satisfied you can contact us within 2 calendar months to ask for our decision to be reviewed. We shall review our response to your request and give you our decision in writing within 40 working days.

If you are still not satisfied following this, you can raise a concern with the Information Commissioner, who is the statutory regulator for Freedom of Information and the Environmental Information Regulations. The contact details are:

Information Commissioner's Office
Wycliffe House
Water Lane
Wilmslow
Cheshire, SK9 5AF.

Tel: 0303 123 1113
Website: http://ico.org.uk

Yours sincerely

Rachel Hamer
Customers & Engagement Officer
West Midlands Area

For further information please contact the Customers & Engagement Team
Team Tel: 02084747856
E-mail: Enquiries_WestMids@environment-agency.gov.uk

Flood Risk and Coastal Change

Climate Change allowances for planning (SHWG area)

August 2021

The National Planning Practice Guidance refers to Environment Agency guidance on considering climate change in planning decisions which is available online: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

This has been updated and replaces the March 2016 guidance.

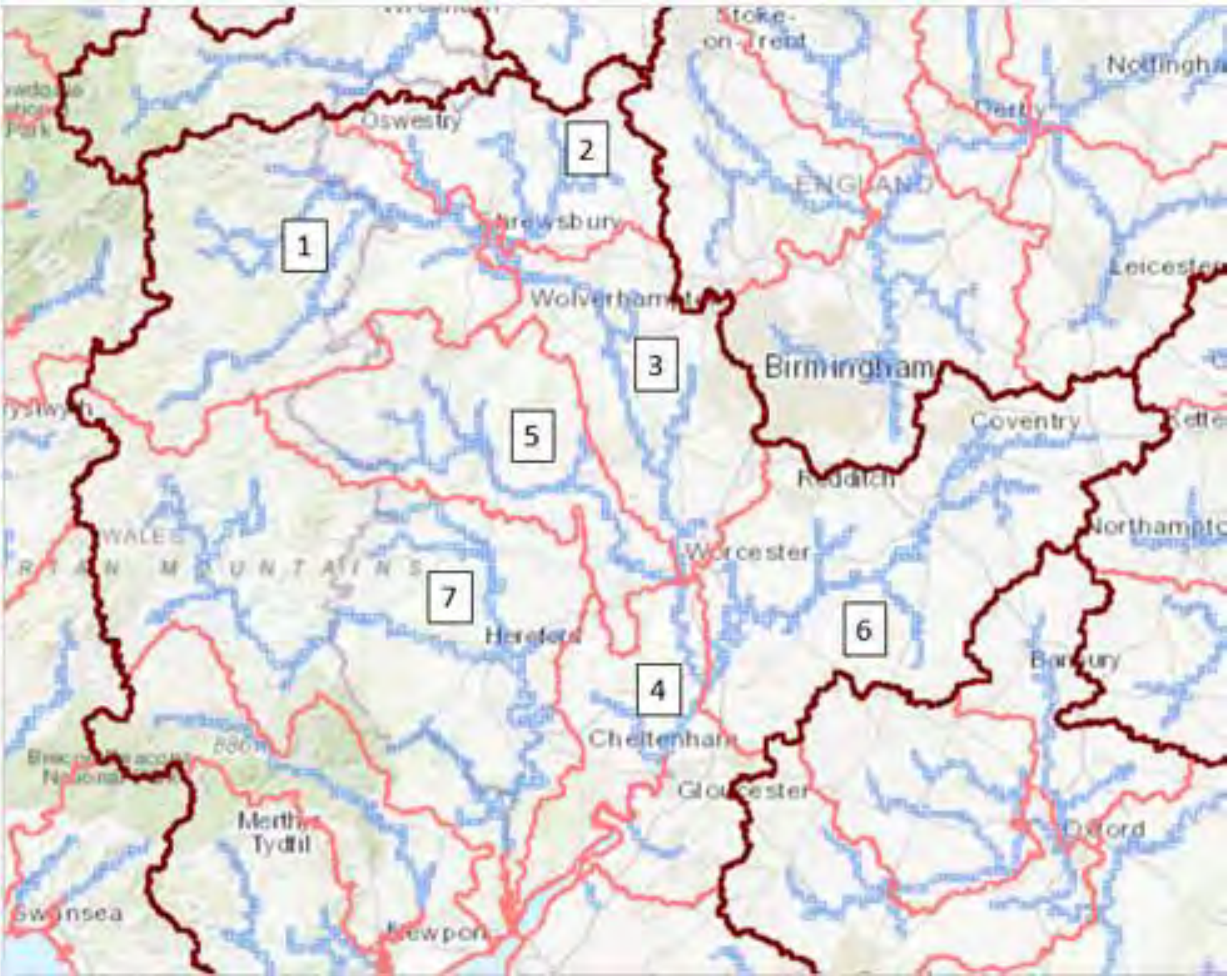
It should be used to help planners, developers and advisors implement the National Planning Policy Framework (NPPF)'s policies and practice guidance on flood risk. It will help inform Flood Risk Assessments (FRA's) for planning applications, local plans, neighbourhood plans and other projects.

Fluvial flooding – peak river flows

NPPG advises that an allowance should be added to 'peak river flows' to account for 'climate change' which should be specific to a 'management catchment' and development type (vulnerability). To work out which management catchment allowances to use, you need to: access the climate change allowances for peak river flow map

In Shropshire, Herefordshire, Worcestershire and Gloucestershire area, we would refer you to the map extract on page 2 below. This outlines the **'peak river flows'** within the specific 'Management catchments' for the Severn River Basin District, and specifies the range of percentage allowances to reflect individual development's vulnerability and lifetime. The following allowances should be used:

Development Vulnerability	Allowance (lifetime)
Essential Infrastructure	Higher Central - 2080's
Highly Vulnerable and More Vulnerable (residential)	Central - 2080's
Less Vulnerable and Water Compatible	Central - 2050's



1. Severn UplandsPeak River Flows	2020's	2050's	2080's
Higher Central	17%	24%	43%
Central	13%	18%	33%

2. Severn Middle Shrops Peak River Flows	2020's	2050's	2080's
Higher Central	20%	25%	44%
Central	15%	18%	33%

3. Severn Middle Worcs River Flows	2020's	2050's	2080's
Higher Central	16%	21%	40%
Central	12%	15%	30%

4. Severn Vale Peak River Flows	2020's	2050's	2080's
Higher Central	20%	28%	53%
Central	14%	19%	37%

5. Teme Peak River Flows	2020's	2050's	2080's
Higher Central	21%	33%	60%
Central	16%	24%	45%

6. Avon Peak River Flows	2020's	2050's	2080's
Higher Central	12%	14%	32%
Central	7%	8%	21%

7. Wye Peak River Flows	2020's	2050's	2080's
Higher Central	19%	27%	49%
Central	14%	20%	37%

Extract: Management Catchments within the Severn River Basin District – refer to interactive peak river flow map for more detail. The Environment Agency also provide these allowances in the peak river flow climate change allowances by management catchment **table** – you have to know your management catchment to get the information you need. (Allowances reflect the latest projections in UKCP18 and subsequent research that models how the latest rainfall projections are likely to affect peak river flows).

Sea Level rise allowances

Table 3 of the guidance (extract below) indicates that net sea level risk is as follows (updated from the 2013 version).

Area of England	Allowance	2000 to 2035 (mm)	2036 to 2065 (mm)	2066 to 2095 (mm)	2096 to 2125 (mm)	Cumulative rise 2000 to 2125 (metres)
South West	Higher central	5.8 (203)	8.8 (264)	11.7 (351)	13.1 (393)	1.21
South West	Upper end	7 (245)	11.4 (342)	16 (480)	18.4 (552)	1.62

Note - For sites utilising the Severn tidal model the above allowances should be considered and applied. As of August 2020, specific updated flood level data is now available for the 2096 to 2125 epoch based upon the Environment Agency's Tidal Severn model within the West Midlands area and will be provided where relevant as part of our Request For Information service; contact Enquiries_Westmids@environment-agency.gov.uk

Flood Risk Assessment considerations:

The design flood (1% flood level fluvial, or 0.5% tidal, plus climate change allowance) should be used to inform the sequential test, including appropriate location of built development; consideration of flood risk impacts, mitigation/enhancement and ensure 'safe' development.

Vulnerability classification

- Development classed as 'Essential Infrastructure' (as defined within Table 2 - Flood Risk Vulnerability Classification, Paragraph: 066 Reference ID: 7-066-20140306 of the NPPG) should be designed to the 'higher central' climate change allowance (2080).
- For highly vulnerable or more vulnerable development e.g. housing, the FRA should use the 'central' climate change allowance (2080), as a minimum, to inform built in resilience.
- For water compatible or less vulnerable development e.g. commercial, the FRA should use the 'central' climate change allowance (2050), as a minimum, to inform built in resilience.

Assessing off-site impacts and calculating floodplain storage compensation

The appropriate allowance to assess off-site impacts and calculate floodplain storage compensation depends on land uses in affected areas. Use the central 2080 allowance for most cases (including where more vulnerable or highly vulnerable is affected) but apply the higher central allowance when the affected area contains essential infrastructure.

Modelling approach

- **Major Development**:

For 'major' development (as defined within The Town and Country Planning Development Management Procedure (England) Order 2015)*, see definition note below, we would expect a detailed FRA to provide an appropriate assessment (hydraulic model) of the 1% with relevant climate change ranges.
There are two options:

Scenario 1 - Produce a model and incorporate relevant climate change allowances within your Management catchment area location.

Scenario 2 - Re-run an existing model and incorporate relevant climate change allowances as specified in the Management catchment area data.

- **Non Major Development**:

For 'non major' development, we would advise that a model is produced or existing model is re-run, similar to the above approach (Scenario 1 and 2). This would give a greater degree of certainty on the design flood extent to inform a safe development.

However, for 'non major' development only, in the absence of modelled climate change information it may be reasonable to utilise an alternative approach. To assist applicants and Local Planning Authorities we have provided some ‘nominal’ climate change allowances within the 'Table of nominal allowances' below. These should be considered as appropriate within any FRA. There are three additional options:

Scenario 3 - Where previous modelled data (for a variety of return periods) is available, you could interpolate your own climate change figure (see note iv below).
Scenario 4 - Where the 1% level is available from an existing model add on the relevant 'nominal climate change allowance' provided in the 'Table of nominal allowances' below.
Scenario 5 - Establish the 1% level, for example using topographical levels (including LiDAR) and assessment of watercourse flow and nature and then add on the relevant 'nominal climate change allowances' provided in the 'Table of nominal allowances' below.

– *Note: For definitions of 'major' development see 'Interpretation 2.—(1)', on page 5, at: www.legislation.gov.uk/uksi/2015/595/pdfs/uksi_20150595_en.pdf

Table of Nominal Allowances

Watercourse	Central allowance (2050) Water compatible and Less Vulnerable.	Central allowance (2080) More Vulnerable
Upper Severn	600mm	850mm
River Wye		
River Teme		
River Avon	200mm	400mm
Lower Severn	400mm	600mm
Tributaries and 'ordinary watercourses'	200mm	300mm

Notes to above:-

(i) Watercourse definition:
The "Upper Severn"/"Lower Severn" boundary is taken as Bevere Weir, North of Worcester, (national grid reference SO8376859428). These do not directly relate to management catchments.

Use of the Avon nominal is only valid upstream of the M5 crossing and downstream of that point the Lower Severn nominals should be used.

An 'Ordinary Watercourse' is a watercourse that does not form part of a main river. Main Rivers are indicated on our Flood Map. You can also check the classification of the watercourse with the LLFA, some of which have produced Drainage and Flooding Interactive Maps.

(ii) Where a site is near the confluence of two, or more, watercourses, the FRA should use the larger river climate change allowances.

(iii) We may hold more precise information for some of the "tributaries". We would recommend that you seek this information from us via a 'pre-planning enquiry/data request', to the email address below.

(iv) We would also recommend that you contact us for our modelled '20%' allowances and associated flow data. This is available for some rivers. This data may help inform a more detailed climate change analysis (where necessary), including any interpolation of levels or flow to create a 'stage discharge rating' in order to estimate the required percentage; or be of assistance to inform 'less vulnerable' or 'water compatible' development proposals.

IMPORTANT NOTE
Please note the nominal climate change allowances are provided as a pragmatic approach, for consideration, in the absence of a modelled flood level and the applicant undertaking a detailed model of the watercourse. Use of nominal climate change allowances are not provided/ recommended as a preference to detailed modelling and historical data.

The Local Planning Authority may hold data within their Strategic Flood Risk Assessment (SFRA), or any future updates, which may help inform the above.

FREEBOARD NOTE
It is advised that Finished Floor Levels should be set no lower than '600mm' above the 1% river flood level plus climate change. Flood proofing techniques might be considered where floor levels cannot be raised (where appropriate). This 600mm freeboard takes into account any uncertainties in modelling/flood levels and wave action (or storm surge effects).

Surface Water

Table 2 of the guidance also indicates the relevant increases that surface water FRA should consider for an increase in peak rainfall intensity.

The following table is for **'peak rainfall intensity'** allowance in small and urban catchments. Please note that **surface water (peak rainfall intensity) climate change allowances should be discussed with the Lead Local Flood Authority (LLFA).**

Peak Rainfall Intensity - Applies across all of England	Total potential change anticipated for 2010-2039	Total potential change anticipated for 2040-2069	Total potential change anticipated for 2070-2115
Upper end	10%	20%	40%
Central	5%	10%	20%

Note to above:-

For river catchments around or over 5 square kilometres, the peak river flow allowances are appropriate.

Produced by: WestMidsPlanning@environment-agency.gov.uk

West Midlands Area -

Shropshire, Herefordshire, Worcestershire and Gloucestershire Sustainable Places Team.

Product 4 (Detailed Flood Risk Data) for 384153, 218397 (easting and northing coordinates)

Reference number: 265778 [XA56PGG5AAP5]
Date of issue: 01 June 2022

Product 4 requests are usually only provided for sites within flood zone 2 and/or 3 to help inform detailed flood risk assessments within these zones.

The location you have requested information for is within **flood zone 1,** defined as the area within the lowest probability of flooding from rivers and the sea, where the chance of flooding in any one year is less than 0.1% (i.e. a 1000 to 1 chance), and as such we do not have any detailed modelling for this site to provide as a Product 4 request.

Should you wish to download a Flood Map for Planning (rivers and sea) map which displays the area and associated flood zones, please use the following website (https://flood-map-for-planning.service.gov.uk/) and select the 'Download printable map (PDF)' option.

Flood Map for Planning (Rivers and Sea)

The Flood Map for Planning (Rivers and Sea) indicates the area at risk of flooding, **assuming no flood defences exist**, for a flood event with a 0.5% chance of occurring in any year for flooding from the sea, or a 1% chance of occurring for fluvial (river) flooding (flood zone 3). It also shows the extent of the Extreme Flood Outlines (flood zone 2) which represents the extent of a flood event with a 0.1% chance of occurring in any year, or the highest recorded historic extent if greater. The flood zones refer to the land at risk of flooding and **do not** refer to individual properties. It is possible for properties to be built at a level above the floodplain but still fall within the risk area.

The Flood Map only indicates the extent and likelihood of flooding from rivers or the sea. It should also be remembered that flooding may occur from other sources such as surface water sewers, road drainage, etc.

Definition of flood zones

- **Zone 1** - The area is within the lowest probability of flooding from rivers and the sea, where the chance of flooding in any one year is less than 0.1% (i.e. a 1000 to 1 chance).
- **Zone 2** - The area which falls between the extent of a flood with an annual probability of 0.1% (i.e. a 1000 to 1 chance) fluvial and tidal, or greatest recorded historic flood, whichever is greater, and the extent of a flood with an annual probability of 1% (i.e. a 100 to 1 chance) fluvial / 0.5% (i.e. a 200 to 1 chance) tidal. (Land shown in light blue on the Flood Map).

- **Zone 3** - The chance of flooding in any one year is greater than or equal to 1% (i.e. a 100 to 1 chance) for river flooding and greater than or equal to 0.5% (i.e. a 200 to 1 chance) for coastal and tidal flooding.

Note: The Flood Zones shown on the Environment Agency's Flood Map for Planning (Rivers and Sea) do not take account of the possible impacts of climate change and consequent changes in the future probability of flooding. Reference should therefore also be made to the Strategic Flood Risk Assessment when considering location and potential future flood risks to developments and land uses.

Areas Benefitting From Defences

Where possible we show the areas that benefit from the flood defences, in the event of flooding:

- from rivers with a 1% (1 in 100) chance in any given year, or;
- from the sea with a 0.5% (1 in 200) chance in any given year.

If the defences were not there these areas would flood. Please note that we do not show all areas that benefit from flood defences.

The associated Dataset is available here: https://data.gov.uk/dataset/flood-map-for-planning-rivers-and-sea-areas-benefiting-from-defences

Recorded Flooding

Following examination of our records of historical flooding we have no record of flooding in the area. The absence of coverage for an area does not mean that the area has never flooded, only that we do not currently have records of flooding in this area. It is also possible that the pattern of flooding in this area has changed and that this area would now flood or not flood under different circumstances.

Please note; the records of flooding from between October 2019 and March 2020 and beyond are still being reviewed, the outcomes of which have not yet been published or reflected within this request for information.

You may also wish to contact your Local Authority or Internal Drainage Board to see if they have other relevant local flood information.

Flood Defences

Flood defences do not completely remove the chance of flooding, they can be overtopped by water levels which exceed the capacity of the defences.

If flood defences are located in your area you can access this data here:
https://data.gov.uk/dataset/spatial-flood-defences-including-standardised-attributes

Planning developments

If you have requested this information to help inform a development proposal then you should note the information on GOV.UK on the use of Environment Agency Information for Flood Risk Assessments. You can also request pre application advice:

https://www.gov.uk/planning-applications-assessing-flood-risk
https://www.gov.uk/government/publications/pre-planning-application-enquiry-form-preliminary-opinion

Supporting Information

River Modelling: Technical Standards and Assessment Guidance

The link below contains standards for the flood risk management industry on how to build and review hydraulic models and provide evidence for flood risk management decisions.

https://www.gov.uk/government/publications/river-modelling-technical-standards-and-assessment

Surface Water

Managing the risk of flooding from surface water is the responsibility of Lead Local Flood Authorities. The 'risk of flooding from surface water' map has been produced by the Environment Agency on behalf of government, using information and input from Lead Local Flood Authorities.

You may wish to contact your Local Authority who may be able to provide further detailed information on surface water.

It is not possible to say for certain what the flood risk is but we use the best information available to provide an indication so that people can make informed choices about living with or managing the risks. The information we supply does not provide an indicator of flood risk at an individual site level. Further information can be found on the Agency's website:

https://flood-warning-information.service.gov.uk/long-term-flood-risk

Flood Risk from Reservoirs

The Flood Risk from Reservoirs map can be found on the Long Term Flood Risk Information website:

https://flood-warning-information.service.gov.uk/long-term-flood-risk/map?map=Reservoirs

Flood Alert & Flood Warning Area

We issue flood alert/warnings to specific areas when flooding is expected. If you receive a flood warning you should take immediate action.

You can check whether you are in a Flood Alert/Warning Area and register online using the links below:

https://www.gov.uk/check-flood-risk

https://www.gov.uk/sign-up-for-flood-warnings

If you would prefer to register by telephone, or if you need help during the registration process, please call Floodline on 0345 988 1188.

The associated dataset for flood warning areas is available here:
https://data.gov.uk/dataset/flood-warning-areas3

The associated dataset for flood alert areas is available here:
https://data.gov.uk/dataset/flood-alert-areas2

Flood Risk Activity Permits

We now consider applications for works, which may be Flood Risk Activities, under Environmental Permitting Regulations. This replaces the process of applying for a Flood Defence Consent. You may need an Environmental Permit for flood risk activities if you want to do work:

- in, under, over or near a main river (including where the river is in a culvert)
- on or near a flood defence on a main river
- in the flood plain of a main river
- on or near a sea defence

Please go to this website to find out more about how to apply:
https://www.gov.uk/guidance/flood-risk-activities-environmental-permits.

Please be aware that Bespoke and Standard Rules permits can take up to 2 months to determine and will incur a charge.

Further details about the Environment Agency information supplied can be found on the GOV.UK website:

https://www.gov.uk/browse/environment-countryside/flooding-extreme-weather

Jessica Broomfield

From: HALL, Julia <Julia.Hall@gloucestershire.gov.uk> on behalf of Flood Risk Management <FloodRiskManagement@gloucestershire.gov.uk>
Sent: 08 June 2022 13:31
To: Jessica Broomfield
Subject: RE: General Enquiry - Reference: GEN-2240938
Attachments: PreApp advice - Great Western Road.docx

Hi Jessica,

Please find attached our pre-app advice.

I hope this helps, but if you have any further questions please don't hesitate to ask.

Kind regards,
Julia

Julia Hall
Flood Risk Management Officer
Flood Risk Management (Strategic Infrastructure)
Gloucestershire County Council
1st Floor (West), Block 5, Shire Hall, Gloucester, GL1 2TH

Tel: 01452 427472
Email: julia.hall@gloucestershire.gov.uk

Go to www.gloucestershire.gov.uk to find information on any County Council service.
It couldn't be easier to find information instantly and in some cases apply for services online.

You can now report property flooding online using **FORT**

If your home or business has been affected by flooding and you would like the Council to investigate the cause, you can report the incident on FORT. Click here or visit "Flooding and Drainage" at www.Gloucestershire.gov.uk.

From: ABBOTT, Vicky **On Behalf Of** Customer Services
Sent: 01 June 2022 14:57
To: jbroomfield@idom.com
Cc: Flood Risk Management <FloodRiskManagement@gloucestershire.gov.uk>
Subject: RE: General Enquiry - Reference: GEN-2240938

Good afternoon

Your enquiry has been received by Customer Services at Gloucestershire County Council.

We have copied in the relevant department, and they will respond accordingly. Please do not reply to this message, please respond directly to the enquirer or team.

Kind regards,
Vicky
Customer Service Officer
Corporate Customer Services Team & Adult Support Services
Gloucestershire County Council
Block 4, 4th Floor (Block 5 end)
Shire Hall, Westgate Street, Gloucester, GL1 2TG

Tel: 01452 425000
Email: customerservices@gloucestershire.gov.uk
Go to www.gloucestershire.gov.uk to find information on any County Council service. It couldn't be easier to find information and in some cases to apply for services online.

From: no-reply@gloucestershire.gov.uk <no-reply@gloucestershire.gov.uk>
Sent: 01 June 2022 14:37
To: Customer Services <customerservices@gloucestershire.gov.uk>
Subject: General Enquiry - Reference: GEN-2240938

Submitted: 01/06/2022 14:37:02

What is the query in relation to: Customer Services Team

Your Name: Jessica Broomfield

Your Email Address: jbroomfield@idom.com

Details of your enquiry: Dear Sir/Madam We are preparing a Flood Risk Statement and Drainage Strategy in support of the planning application submission for the proposed development of c. 300 residential units (flat blocks and townhouses). For further information, the approximate OS Grid Reference SO 84091 18413 and the nearest post code is GL1 3ND. With reference to the flood map for planning, the site lies within Flood Zone 1. I would be grateful for any information you may hold in regards to this site and any constraints there may be. I look forward to your response. Best regards, Jessica Broomfield

Jessica Broomfield

From:	Network Solutions <Network.Solutions@severntrent.co.uk>
Sent:	13 June 2022 15:22
To:	Jessica Broomfield
Subject:	Developer Enquiry Response: Great Western Road, Gloucester - 322 Dwellings Our Ref: 1047240
Attachments:	Severn Trent Surface Water Guidance Note (August 2021).pdf; Sewer Record Plan.pdf; Developer Enquiry Response.pdf

ST Classification: UNMARKED

Dear Jessica,

Please find attached below our Developer Enquiry response letter, along with a sewer record extract and supplementary guidance notes with regard to the above site.

If you have any further queries with regard to our response, please do not hesitate to contact us on the number / email address mentioned below. Please refrain from sending responses to a certain individual directly. Our email address below will ensure that your response is logged and tracked for a response. When responding, please quote our reference number above in all return correspondence.

Regards,

Network Solutions
Developer Services

Please reply to Network.Solutions@severntrent.co.uk

For further information on guidance and applications please follow the link below:
https://www.stwater.co.uk/building-and-developing/regulations-and-forms/application-forms-and-guidance/

We have listened to our customers & local communties and as a result, Severn Trent have made a pledge to transform and protect the health of our rivers. For more information please follow the link below:
https://www.stwater.co.uk/get-river-positive/our-river-pledges/

WONDERFUL ON TAP SEVERN TRENT Proudly supporting LGBTQ+ inclusion Mental Health Aware MHFA England

WONDERFUL ON TAP

SEVERN TRENT

Severn Trent Water Ltd
Leicester Water Centre
Gorse Hill
Anstey
Leicester
LE7 7GU

Tel: 0345 266 7930
www.stwater.co.uk

Email:
Network.Solutions@SevernTrent.co.uk

Our ref: 1047240

Idom Merebrook Ltd,
Cromford Mill,
Mill Road,
Cromford,
Matlock,
DE4 3RQ.

FAO: Jessica Broomfield

13th June 2022

Dear Jessica,

Proposed Residential Development (322 Dwellings) at: Great Western Road, Gloucester GL1 3ND

X: 486870 / Y: 411490

I refer to your Development Enquiry Request submitted in respect of the above site. Please find enclosed the sewer records that are included in the fee together with the Supplementary Guidance Notes (SGN) referred to below.

Public Sewers in Site – Required Protection

There are no public sewers crossing the proposed development site.

Due to a change in legislation on 1 October 2011, there may be former private sewers on the site which have transferred to the responsibility of Severn Trent Water which are not shown on the statutory sewer records but are located in your client's land. These sewers would also have protective strips that we will not allow to be built over. If such sewers are identified to be present on the site, please contact us for further guidance.

Foul Water Drainage

The sewer records demonstrate a 300mm diameter combined sewer within, Great Western Road. It is proposed to split flows from the development across three separate points of connection along the network: -

- Between manholes 1402 & 1401
- Between manholes 0504 & 0503

- Between manholes 0501 & 9502

The proposed development of 322 properties will generate approximately 5 l/s (at 2DWF). The network demonstrates some surcharging on the sewer, along with the complex arrangement, within London Road. Alternatively, it is advised to connect ontot he 600mm combined network northwest of the site which may have greater capacity. Modelling will be required to better understand the impact of the additional flows on the system.

In a change to our previous process, we no longer charge developers for the hydraulic modelling service. We will liaise with you over time with regards to the outcome of our investigations and any impact that may have on the planning status, occupation, or phasing of the site. However, while we can provide a brief summary of our findings if you need us to, we will no longer provide the full external capacity assessment report.

From the application you have submitted, I am assuming that the development has not been granted planning approval. Please inform us as and when planning has progressed as this will help determine how quick we carry out the modelling exercise. In the meantime, the site will be added to our modelling tracker and reviewed regularly until the site can be progressed for sewer modelling. I would therefore be grateful if you would forward as soon as possible the following details:

- Proposed submission of your Planning Application
- Proposed point of connection(s) and proportion of development to connect at each manhole (either in no. of houses or as a percentage of development).
- Proposed planned start and completion date
- Any phasing details of the proposed development
- Planned occupation date

Surface Water Drainage

Under the terms of Section H of the Building Regulations 2000, the disposal of surface water by means of soakaways should be considered as the primary method. If this is not practical and no watercourse is available as an alternative, the use of sewerage should be considered. In addition, other sustainable drainage methods should also be explored before a discharge to the public sewerage system is considered.

In the event that following testing, it is demonstrated that soakaways would not be possible on the site; satisfactory evidence will need to be submitted. The evidence should be either percolation test results or a statement from the SI consultant (extract or a supplementary letter).

STW will need to be satisfied that all SUDs options have been exhausted before discharge to public sewer. Severn Trent Water expects all surface water from the development to be drained in a sustainable way to the nearest watercourse or land drainage channel, subject to the developer discussing all aspects of the developments surface water drainage with the Local Lead Flood Authority (LLFA). Any discharge rate to a watercourse or drainage ditch will be determined by the LLFA.

There are no separate surface water sewers within the vicinity of the site that can be accessed via gravity. The closest sewer is the 300mm combined network in Great Western Road. You may well be aware of the sensitivity of such an arrangement in relation to surface water flow, with the recent media coverage and the impact on the receiving watercourses. In this instance, we cannot accept additional surface water flows into this network due to the impact on the receiving network, CSO and the associated risks.

Our records do show a separate surface water network east of the site in Myers Road. Although not preferred by STW, a pumped surface water connection to this network would alleviate the need for additional flows in the combined network in Great Western Road.

Alternatively, it is suggested that further investigations are undertaken to determine any highway network within the vicinity and to contact the Local Highway Authority.

Subject to all the above, a connection to the public combined network may be considered as a last resort only if a previous connection can be proved, and all options mentioned above have been investigated with supplementary evidence to prove their unfeasibility.

On all brownfield sites, Severn Trent propose at least 50% reduction of surface water flows in comparison to the existing development's discharge. For us to be in a position to confirm your proposed discharge rate, please provide supporting evidence demonstrating the betterment of existing discharge rate.

Evidence should be in the form of a survey, demonstrating what flows positively discharged into the network (and which sewer) and supporting calculations showing the reduction. If former connections cannot be proved, greenfield rates of 5l/s/ha will apply.

Regardless of what option is chosen for surface water, modelling will be needed for either option. Therefore, please submit discharge rate proposals and preferred point of connection as soon as possible.

New Connections

For any new connections including the use, reuse and indirect to the public sewerage system, the developer will need to submit Section 106 application. Our Developer Services department are responsible for handling all such enquiries and applications. To contact them for an application form and associated guidance notes please call 0800 707 6600, email new.connections@severntrent.co.uk or download from www.stwater.co.uk

Please quote the above reference number in any future correspondence (including e-mails) with STW Limited. Please send **all correspondence** to the network.solutions@severntrent.co.uk email inbox address, a response will be made within 15 days.

If you require a VAT receipt for the application fee please email MISCINCOME.NC@SEVERNTRENT.CO.UK quoting the above Reference Number.

Please note that Developer Enquiry responses are only valid for 6 months from the date of this letter.

Yours sincerely

[redacted]

WONDERFUL ON TAP

SEVERN
TRENT

Emma Nowak.
Senior Evaluation Technician
Network Solutions
Developer Services

APPENDIX 3

- Existing Runoff Rate Estimates
- Surface Water Storage Estimates
- 22471-IDM-XX-DR-D-0500 P0 Drainage GA

EXISTING RUNOFF RATE ESTIMATES

BROWNFIELD

Pre-development discharge

Site Makeup: Brownfield
Brownfield Method: MRM
Contributing Area (ha): 2.220
PIMP (%): 100
CV: 0.800
Time of Concentration (mins): 5.00
Betterment (%): 50

Return Period (years)	Q (l/s)
1	149.8
30	349.5
100	440.4

GREENFIELD

Pre-development discharge

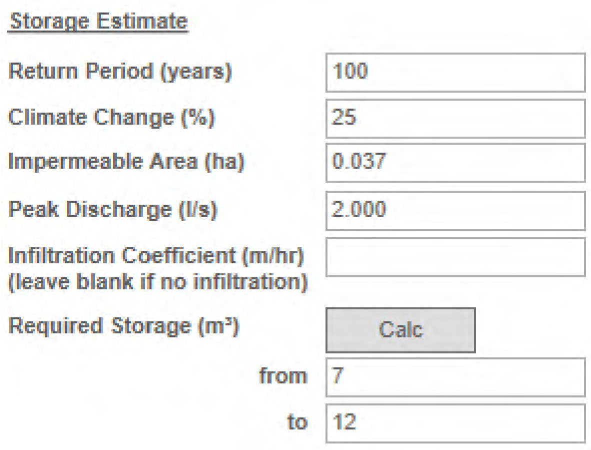
Site Makeup: Greenfield
Greenfield Method: IH124
Positively Drained Area (ha): 3.200
SAAR (mm): 645
Soil Index: 3
SPR: 0.37
Region: 4
Betterment (%): 0

QBar (l/s): 8.4

Return Period (years)	Growth Factor	Q (l/s)
1	0.83	6.9
30	1.99	16.6
100	2.57	21.5

SURFACE WATER STORAGE ESTIMATES

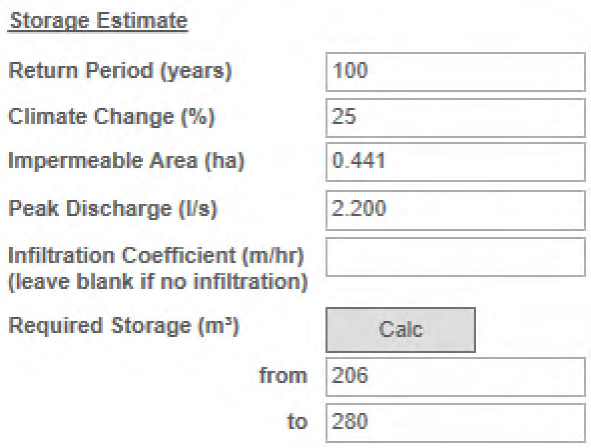
AREA A



Storage Estimate

Return Period (years)	100
Climate Change (%)	25
Impermeable Area (ha)	0.037
Peak Discharge (l/s)	2.000
Infiltration Coefficient (m/hr) (leave blank if no infiltration)	
Required Storage (m³)	
from	7
to	12

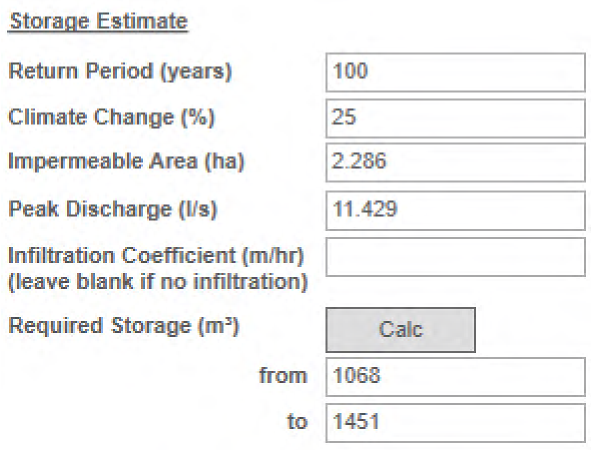
AREA B



Storage Estimate

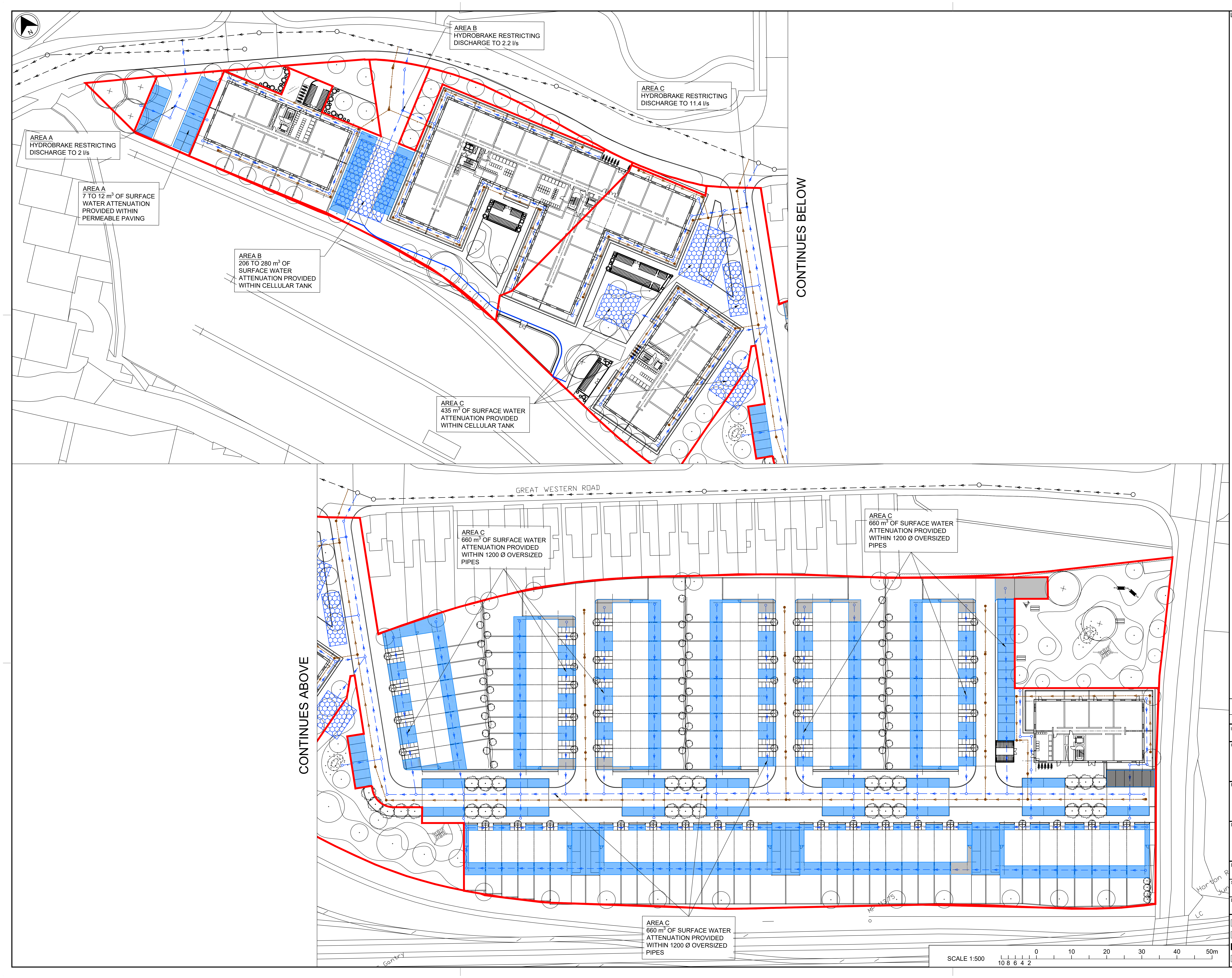
Return Period (years)	100
Climate Change (%)	25
Impermeable Area (ha)	0.441
Peak Discharge (l/s)	2.200
Infiltration Coefficient (m/hr) (leave blank if no infiltration)	
Required Storage (m³)	
from	206
to	280

AREA C



Storage Estimate

Return Period (years)	100
Climate Change (%)	25
Impermeable Area (ha)	2.286
Peak Discharge (l/s)	11.429
Infiltration Coefficient (m/hr) (leave blank if no infiltration)	
Required Storage (m³)	
from	1068
to	1451



LEGEND

🟥	SITE BOUNDARY
	FOUL WATER DRAINAGE
	SURFACE WATER DRAINAGE
	COMBINED PUBLIC SEWER
🟦	PERMEABLE PAVING
	FILTER STRIP

NOTES

1. THIS IS AN INDICATIVE LAYOUT, SUBJECT TO DETAILED DESIGN.
2. BUILDING CONNECTIONS OMITTED. ADDITIONAL MANHOLES MAY BE REQUIRED.
3. AREA C - 360 m^3 OF SURFACE WATER ATTENUATION WILL BE PROVIDED WITHIN PERMEABLE PAVING

FIRST ISSUE	21/06/22		P0
	JB	JR	MB
	DWN	CHD	APP'D

ISSUE PURPOSE
PRELIMINARY

CLIENT
EUTOPIA HOMES

PROJECT
GREAT WESTERN YARD
GLOUCESTER

DWG TITLE
DRAINAGE GA

DWG NO.		REVISION
22471-IDM-XX-DR-D-0500		P0
SCALE 1:500	DATE JUNE 2022	FRAM DIMENSIONS (mm) (A1) 791 x 544
DRAWN JB	CHECKED JR	APPROVED MB

London
Kent
Derbyshire
Manchester

IDOM

[redacted]

APPENDIX 4

- SuDS Maintenance Schedule
- SuDS Inspection Checklist

SuDS Maintenance Schedule

	Maintenance Activity	Frequency of activity (months)				
		1	3	6	12	A/R
A	**Manholes (General)**					
1	Check cover is not damaged and fits securely			X		
2	Check inlet and outlet are free flowing and not obstructed			X		
3	Check security of fitting for all manhole ironmongery			X		
4	Check benching for scour or build-up of debris			X		
5	Check joints in construction for damage or inflow				X	
6	Record maintenance inspection in logbook			X		
B	**Conveyance Pipes**					
1	Carry out flow test between manholes to ensure free flow of system				X	
2	Jetting and clearance of blockages, debris or silt					X
3	Inspection by CCTV – should problem arise as a result of the flow test					X
4	Cutting of growth into pipe					X
5	Record maintenance inspection in logbook				X	
C	**Flow Controls**					
1	Check flow control mount to ensure secure fitting		X			
2	Check inlet to flow control is free flowing and not obstructed		X			
3	Remove silt from the sump			X		
4	Record maintenance inspection in logbook	X				
D	**Porous Pavement**					
1	Initial inspection (monthly for 3 months after installation)	X				
2	Inspect for evidence of poor operation and/or weed growth – if required, take remedial action	Three-monthly, 48 hrs after long storms in first six months				
3	Inspect for silt accumulation to establish appropriate brushing frequencies. Identify any depressions which may require re-setting.				X	
4	Monitor any inspection chambers. Check for water level and silt at base of pavement.				X	
5	Brushing and vacuuming (adjust equipment to avoid removing jointing material)				X	X
6	Removal of weeds (treat directly with glyphosate – no spray)					X
7	Record maintenance inspection in logbook	X				
E	**Landscape adjacent to Porous Pavements**					
1	Grass cutting to public areas (clean grass from porous paving)					X
2	Re-level landscaping which has become level with porous paving through vegetation maintenance or soil slip					X

3	Record maintenance inspection in logbook		X			
F	**Cellular attenuation Tank**					
1						

SuDS Inspection Checklist

DRAINAGE & SUDS INSPECTION CHECKLIST	
ACTIVITY	**OBSERVATION**
Are inlets or outlets blocked?	OK/ACTION REQUIRED
Does any part of the system appear to be leaking (in or out)?	OK/ACTION REQUIRED
Is the surrounding vegetation healthy and well kept?	OK/ACTION REQUIRED
Is maintenance access unimpeded?	OK/ACTION REQUIRED
Is there evidence of poor water quality (algae/oils/milky froth/odour/unusual colourings)?	OK/ACTION REQUIRED
Is there evidence of sediment build-up?	OK/ACTION REQUIRED
Is there evidence of oil accumulation?	OK/ACTION REQUIRED
Is there evidence of ponding?	OK/ACTION REQUIRED
Is there evidence of structural damage that requires repair?	OK/ACTION REQUIRED
Is there any evidence of regular or unplanned overtopping flooding or ponding?	OK/ACTION REQUIRED
Is water flowing freely through the network?	OK/ACTION REQUIRED
Are there any concerns that require further investigation?	OK/ACTION REQUIRED
Recommended maintenance or re-inspection for the following 12 months ITEMS REQUIRING IMMEADITE MAINTENANCE ITEMS REQUIRING IMMEDIATE FURTHER INSPECTION ITEMS REQUIRING MORE REGULAR INSPECTION	

EUTOPIA

HOMES

Great Western Yard,
Gloucester

Heritage Assessment

July 2022

Pegasus Group

EUTOPIA
HOMES

Document Management

Version	Date	Author	Checked / Approved by:	Reason for revision
1	01.07.22	AR	GS	
2	11.07.22	AR	GS	Minor amendments to text

Contents

Appendices contents

Plates:

1. Introduction

1.1. Pegasus Group have been commissioned by Eutopia Homes to prepare a Heritage Assessment to consider the proposed redevelopment of the application site at Great Western Yard, Gloucester, as shown on the Site Location Plan provided at Plate 1: Site Location Plan.

Plate 1: Site Location Plan.

1.2. The application site comprises a 3.14 ha brownfield site, and incorporates two adjacent land parcels, the southern/eastern being the derelict former rail yard, and the northern/western currently being in use as a timber/builders' yard and motor garage.

1.3. The application site does not contain any statutorily Listed Building, nor is it located within the boundaries of a Conservation Area. Additionally, there are no statutorily Listed Buildings within the vicinity of the site which may be sensitive to development within their setting. The site does not lie within a Scheduled Monument.

1.4. The assessment within this Report will thus focus on the potential archaeological resource within the site and also an assessment of the existing built form within the site as described below.

1.5. This Assessment provides information with regards to the significance of the historic environment to fulfil the requirement given in paragraph 194 of the Government's *National Planning Policy Framework* (the *NPPF*) which requires:

> ***"…an applicant to describe the significance of any heritage assets affected, including any contribution made by their setting".***[1]

1.6. In order to inform an assessment of the acceptability of the scheme in relation to impacts on the historic environment, following paragraphs 199 to 203 of the *NPPF*, any harm to the historic environment resulting from

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[1] Department for Levelling Up, Housing and Communities (DLUHC), *National Planning Policy Framework (NPPF)* (London, July 2021), para. 194.

the proposed development is also described, including impacts on significance through changes to setting.

1.7. As required by paragraph 194 of the *NPPF*, the detail and assessment in this Report is considered to be "*proportionate to the assets' importance*".[2]

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[2] DLUHC, *NPPF*, para. 194.

2. Proposed Development

2.1. The application seeks full Planning Permission for the following:

"Residential development of up to 315 dwellings with associated landscaping, parking, open space and ancillary works including demolition of existing buildings"

2.2. The proposals are detailed on the following plans which form the application package and which this assessment considers:

- 19050-03-0-01 Proposed Phasing Plan
- 19050-03-0-00 Proposed Site Plan

2.3. ***Section 7*** of this Report presents an analysis of the impact of the proposed development on identified heritage assets discussed in ***Section 6.***

3. Site Description and Planning History

Site Description

3.1. The application site is located to the north-east of Gloucester City Centre and comprises a 3.14 ha brownfield site. The site is located between Great Western Road to the north, the mainline railway to the south, Horton Road to the east and an existing industrial area to the west.

3.2. The site comprises former railway sidings and associated sheds to the east and south, builders' merchants and car repair businesses to the north, each with associated structures, and a hard surfaced area formerly used for car parking to the north-west of the site.

3.3. To the east of the site is Horton Road and to the southeast Horton Road level crossing. The mainline railway is located to the south of the site, with Metz Way flyover beyond.

3.4. Network Rail retain three sidings tracks off the mainline railway to the south-west of the site.

3.5. The site will be accessed from Great Western Road to the north with cycle and pedestrian connectivity also achievable from Horton Road. Great Western Road leads to Horton Road which provides access to the north of the site to the A38 and the A40. Great Western Road also provides connectivity to London Road to the west which provides vehicular connectivity to the City Centre and to the west and south of the City beyond.

3.6. As discussed in detail below in ***Section 6***, there are a number of vacant, derelict buildings within the eastern part of the site, whilst the modern sheds to the western part of the site are occupied by builders/motors vehicle yards.

Planning History

3.7. Prior Approval has been granted under application reference 22/00482/PRIOR for the demolition of the disused buildings within the site as shown on the plan provided at Plate 2.

3.8. This confirms that notwithstanding the assessment of the buildings as set out below, they could be demolished at any point without the need for further permissions being granted and thus this should be a material consideration which attracts significant weight within the assessment of the development proposals.

Plate 2: Extract of approved Demolition Strategy showing buildings to be demolished.

3.9. Pre-application Advice has also recently been sought from Gloucester City Council within regards to the redevelopment proposals, with comments received from both the Council's Conservation Officer and Archaeological Advisor. The Conservation Officer stated:

"The proposed development of the site is to be welcomed however I make the following observations. The remaining engine sheds Buildings 1 &2 may be considered to be Non Designated Heritage Assets selected as part of the Gloucester Local List, currently in draft and due for consultation and adoption in May 2022.

The Heritage Statement is generally thorough however the general outcome is that the remaining buildings are of 'minor local interest' it does not evidence this conclusion with comparisons of similar buildings at for example Swindon which are listed and more complete/intact which would be helpful in understanding where they sit in the wider regional and national context of buildings of this type.

In terms of the local community interest or value this would be considered to be high, so this should be considered and addressed.

Any standing remains will require building recording prior to any loss.

In terms of retention, the fact that the buildings are incomplete does not completely negate their inclusion in some form within any development so this could be considered in more depth as part of any justification for complete demolition. An understanding of the current condition needs to be more explicit, are they capable of repurposing?

With regards to the proposed development design. Overall the proposals are heading in the right direction with the use of red brick, grey roof tile, but there are some details… as on the terraces that don't quite work such as the dental cornice (Saw tooth detail) with the texture brick finish and white render panel's, the design of the door in relation to windows and render on the ground floor is messy. This is overcomplicated and we will be looking for simplified designs of high

quality. Four light bifolds on the rear would be better reduced to three light to give more balance to the elevation, privacy and useful space inside.

The height and massing of the proposed apartment blocks is of concern, the proposed design is very repetitious of other developments within the city and other cities generally and doesn't really convince me that it takes its design influences from the local area or railway heritage, more careful consideration of the historic use of the site needs to be given. However I like the brick pilasters with the recessed fields and the details at stringcourse and eaves level, but not so much the textured panels which on block A is overdone and needs simplification. Black metal for the fenestration would be preferable.

Balconies should be meaningful and juliette type balconies do not offer any design or functional value. An industrial type black metal solution externally constructed or meaningful balconies recessed into the building would be acceptable depending on design. White renders such as K rend tend to discolour and look shabby very quickly and I am not in favour of it ."

3.10. The Archaeologist stated:

" Whilst I found the heritage assessment to be very good, I really do disagree with its assessment of the significance of buildings 1 and 2 as defined in their report. These are unique and rare survivals from Gloucester's industrial past and I know anecdotally they are much loved by many people in Gloucester. I believe very strongly that there would be a great deal of public concern should these buildings be demolished. Whilst I don't doubt the reuse of the building would cost money it is entirely possible and would have the following advantages:

1. The retention and reuse of this buildings would have a lesser carbon footprint than demolition and new-build;

2. It would help to retain the unique character of the place, helping this development to stand out;

3. It would reduce the impact of the development on the significance of the heritage assets (including below ground archaeology); and

4. It is likely to be a popular approach (in my judgment) with the people of Gloucester.

We at the City Council are, more and more, trying to encourage developers to reuse existing buildings rather than demolish them. There are really good environment and heritage reasons for this. The most sustainable building is the building that's already standing. I urge the developer in this instance to seriously consider the opportunities for reuse. With imagination I'm sure a good quality scheme could be produced that retained these last elements of a rapidly disappearing part of Gloucester's story."

3.11. Where relevant, the above comments which relate to the extant buildings on site and below ground archaeological matters will be discussed below. Comments relating to design matters are addressed in the other documentation which accompanies the application.

4. Methodology

4.1. The aims of this Report are to assess the significance of the heritage resource within the site/study area, to assess any contribution that the site makes to the heritage significance of the identified heritage assets, and to identify any harm or benefit to them which may result from the implementation of the development proposals, along with the level of any harm caused, if relevant.

4.2. This assessment considers both Built Heritage and the archaeological potential of the site.

4.3. The scope of archaeological assessment works and further investigations have been discussed with the Archaeological Advisor to the LPA, Mr Andrew Armstrong.

Sources

4.4. The following key sources have been consulted as part of this assessment:

- The Gloucestershire Historic Environment Record (HER), for information on the recorded heritage resource in the vicinity of the site;
- The National Heritage List for England for information on designated heritage assets;
- Historic maps available online;
- Aerial photographs available online via Historic England's Aerial Photo Explorer and Britain from Above;
- Old photographs accessible via the Historic England Architectural Red Box Collection; and
- Google Earth satellite imagery.

Site Visit

4.5. A site visit was undertaken by a Heritage Consultant from Pegasus Group on 25th January 2022, during which the site and its surrounds were assessed.

Photographs

4.6. Photographs included in the body text of this Report are for illustrative purposes only to assist in the discussions of heritage assets, their settings, and views, where relevant. Unless explicitly stated, they are not accurate visual representations of the site or development proposals, nor do they conform to any standard or guidance i.e., the Landscape Institute Technical Guidance Note 06/19. However, the photographs included are intended to be an honest representation and are taken without the use of a zoom lens or edited, unless stated in the description or caption.

Assessment Methodology

4.7. Full details of the assessment methodology used in the preparation of this Report are provided within ***Appendix 1***. However, for clarity, this methodology has been informed by the following:

- *Historic Environment Good Practice Advice in Planning: 2 - Managing Significance in Decision-Taking in the Historic Environment* (hereafter *GPA:2);*[3]

- *Historic Environment Good Practice Advice in Planning Note 3 (Second Edition) - The Setting of Heritage Assets*, the key guidance of assessing setting (hereafter *GPA:3*);[4]

- *Historic England Advice Note 1 (Second Edition) - Conservation Area Appraisal, Designation and Management* (hereafter *HEAN:1*).[5]

- *Historic England Advice Note 12 – Statements of Heritage Significance: Analysing Significance in Heritage Assets* (hereafter *HEAN:12*);[6] and

- *Conservation Principles: Polices and Guidance for the Sustainable Management of the Historic Environment.*[7]

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[3] Historic England, *Historic Environment Good Practice Advice in Planning: 2 – Managing Significance in Decision-Taking in the Historic Environment (GPA:2)* (2nd edition, Swindon, July 2015).

[4] Historic England, *Historic Environment Good Practice Advice in Planning Note 3 - The Setting of Heritage Assets (GPA:3)* (2nd edition, Swindon, December 2017).

[5] Historic England, *Historic England Advice Note 1 - Conservation Area Appraisal, Designation and Management (HEAN:1)* (2nd edition, Swindon, February 2019).

[6] Historic England, *Historic England Advice Note 12 – Statements of Heritage Significance: Analysing Significance in Heritage Assets (HEAN:12)* (Swindon, October 2019).

[7] English Heritage, *Conservation Principles: Policies and Guidance for the Sustainable Management of the Historic Environment* (London, April 2008).

5. Policy Framework

Legislation

5.1. Legislation relating to the built historic environment is primarily set out within the *Planning (Listed Buildings and Conservation Areas) Act 1990*, which provides statutory protection for Listed Buildings and their settings and Conservation Areas.[8]

5.2. In addition to the statutory obligations set out within the aforementioned Act, Section 38(6) of the *Planning and Compulsory Purchase Act 2004* requires that all planning applications, including those for Listed Building Consent, are determined in accordance with the Development Plan unless material considerations indicate otherwise.[9]

5.3. Full details of the relevant legislation are provided in ***Appendix 2***.

National Planning Policy Guidance

5.4. National Planning Policy guidance relating to the historic environment is provided within Section 16 of the Government's *National Planning Policy Framework* (*NPPF*), an updated version of which was published in July 2021. The *NPPF* is also supplemented by the national *Planning Policy Guidance* (*PPG*) which comprises a full and consolidated review of planning practice guidance documents to be read alongside the *NPPF* and which contains a section related to the Historic Environment.[10] The PPG also contains the *National Design Guide*.[11]

5.5. Full details of the relevant national policy guidance is provided within ***Appendix 3***.

The Development Plan

5.6. Applications for Planning Permission and Listed Building Consent within Gloucester City are currently considered against the policy and guidance set out within the adopted Joint Core Strategy. [12]

5.7. Details of the policy specific relevant to the application proposals are provided within ***Appendix 4***.

Emerging Policy

5.8. The Council is currently preparing the Gloucester City Plan, the current draft of which includes the application site as proposed allocation SA05, and at Great Western Buildings.

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[8] UK Public General Acts, Planning (Listed Buildings and Conservation Areas) Act 1990.

[9] UK Public General Acts, Planning and Compulsory Purchase Act 2004, Section 38(6).

[10] Department for Levelling Up, Housing and Communities (DLUHC), *Planning Practice Guidance: Historic Environment (PPG)* (revised edition, 23rd July 2019), https://www.gov.uk/guidance/conserving-and-enhancing-the-historic-environment.

[11] Department for Levelling Up, Housing and Communities (DLUHC), *National Design Guide* (London, January 2021).

[12] Gloucester City Council, Cheltenham Borough Council and Tewkesbury Borough Council, *Joint Core Strategy 2011-2031 (JCS)*, (December 2017).

6. The Historic Environment

6.1. The following Section provides an assessment of elements of the historic environment that have the potential to be impacted upon by the proposed development.

6.2. As set out in ***Section 1***, the site comprises a 3.14 ha brownfield site which lies to the north-east of Gloucester City Centre, between Great Western Road to the north, the mainline railway to the south, Horton Road to the east and an existing industrial area to the west.

6.3. As noted above, the site does not contain any designated heritage assets (as defined by the *NPPF*), and is not within the boundaries, or vicinity of any of the City's Conservation Areas.

6.4. With regards to other heritage assets within the surrounds of the site, Step 1 of the methodology recommended by *GPA3* (see methodology), is to identify which heritage assets might be affected by a proposed development. [13]

6.5. Development proposals may adversely impact heritage assets where they remove a feature which contributes to the significance of a heritage asset, or where they interfere with an element of a heritage asset's setting which contributes to its significance, such as interrupting a key relationship or a designed view.

6.6. It is however widely accepted (paragraph 207 of the *NPPF*) that not all parts of a heritage asset will necessarily be of equal significance.[14] In some cases, certain elements of a heritage asset can accommodate substantial changes whilst preserving the significance of the asset.

6.7. Significance can be derived from many elements, including the historic fabric of a building or elements of its surrounds.

6.8. Consideration, based upon professional judgement and on-site analysis, was therefore made as to whether any of the heritage assets present within the surrounding area may include the site as part of their setting, whether the site contributes to their overall heritage significance, and whether the assets may potentially be affected by the proposed scheme as a result.

6.9. With regard to other heritage assets in the vicinity of the site, assessment has concluded that the site does not form any part of setting that positively contributes to overall heritage significance due the nature of the asset and a lack of visual connections, spatial relationships or historic connections. Accordingly, the proposed development is not anticipated to result in a change that would impact upon the overall heritage significance of these assets. Other heritage assets have therefore been excluded from further assessment within this Report.

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[13] Historic England, *GPA:3*, p. 4.

[14] DLUHC, *NPPF*, para. 207.

6.10. The application site forms part of the former Great Western Road/Horton Road railway depot, which was once the largest depot in the Gloucestershire Motive Power District, at its peak having over 100 steam locomotives allocated to it.

6.11. The Depot was constructed in association with the development of the railway through Gloucester during the mid 19th century.

6.12. Copies of the historic mapping from this period onwards show the development of the site, including the evolution of the buildings which are still extant.

6.13. The first edition Ordnance Survey map (Plate 3) is the first map to show the site in accurate detail, showing the large locomotive shed served by 10 lines, four in the southern shed, and six in the northern shed. Attached to the northern shed are two small ancillary structures, one served by a single line.

6.14. The southern shed is believed to be the original locomotive shed which was constructed in 1854 and was served by four tracks, whilst the northern shed had a lower roof and was of two bays, and was constructed in 1872 and served by six tracks.

6.15. To the north of the locomotive shed is a small building which was likely an office and appears to relate to the linear building (Building 2) which is still within the site (see below).

6.16. The western part of the site comprises open land with interspersed trees.

6.17. This arrangement is also shown on the 1879-1888 Town Plan (Plate 4), with the larger locomotive shed being the prominent feature within the site.

6.18. The 2nd edition Ordnance Survey Map (Plate 5) more clearly shows the two buildings which formed the locomotive sheds. The layout of the western part of the site has been formed by this time, with the additional lines being added as part of the goods yard which has developed to the west.

6.19. An aerial photograph, an extract of which is shown below at Plate 6, shows the site from the east and shows the two locomotive sheds and the original small building which was located on the northern side in 1932.

6.20. The most significant change in the site is during the mid 20th century (see Plate 7) when the small shed attached to the northern elevation of the northern locomotive shed was replaced by a larger structure, which is likely to be the building which remains on site (Building 1 as discussed below).

6.21. A further building was also constructed in this period at the northern end of the site, which appears to relate to the metal shed which is still present on site (Building 3 as discussed below).

6.22. By the 1980s (see Plate 8), the two earliest locomotive sheds had been demolished and the single track repair shop shed was the only large shed remaining on site.

Plate 3: Extract of 1st edition Ordnance Survey Map 1848-1888.

(Source: knowyourplace)

Plate 4: Extract of 1879-1888 Town Plan.

(Source: knowyourplace)

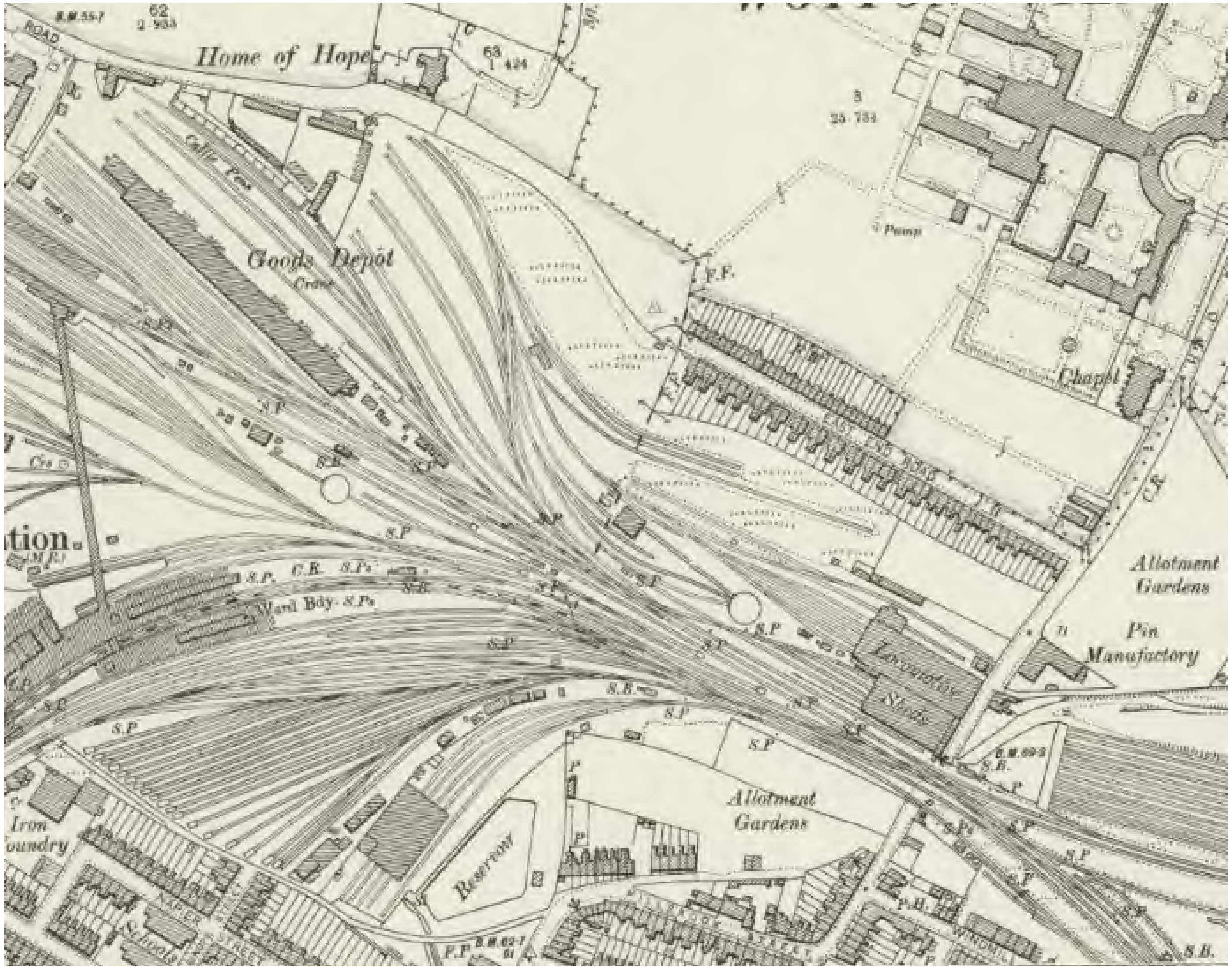

Plate 5: Extract of the 2nd edition Ordnance Survey Map - 1894-1903.

(Source: knowyourplace)

Plate 6: Site in 1932.

(Source: Britain from Above ref EPW037838)

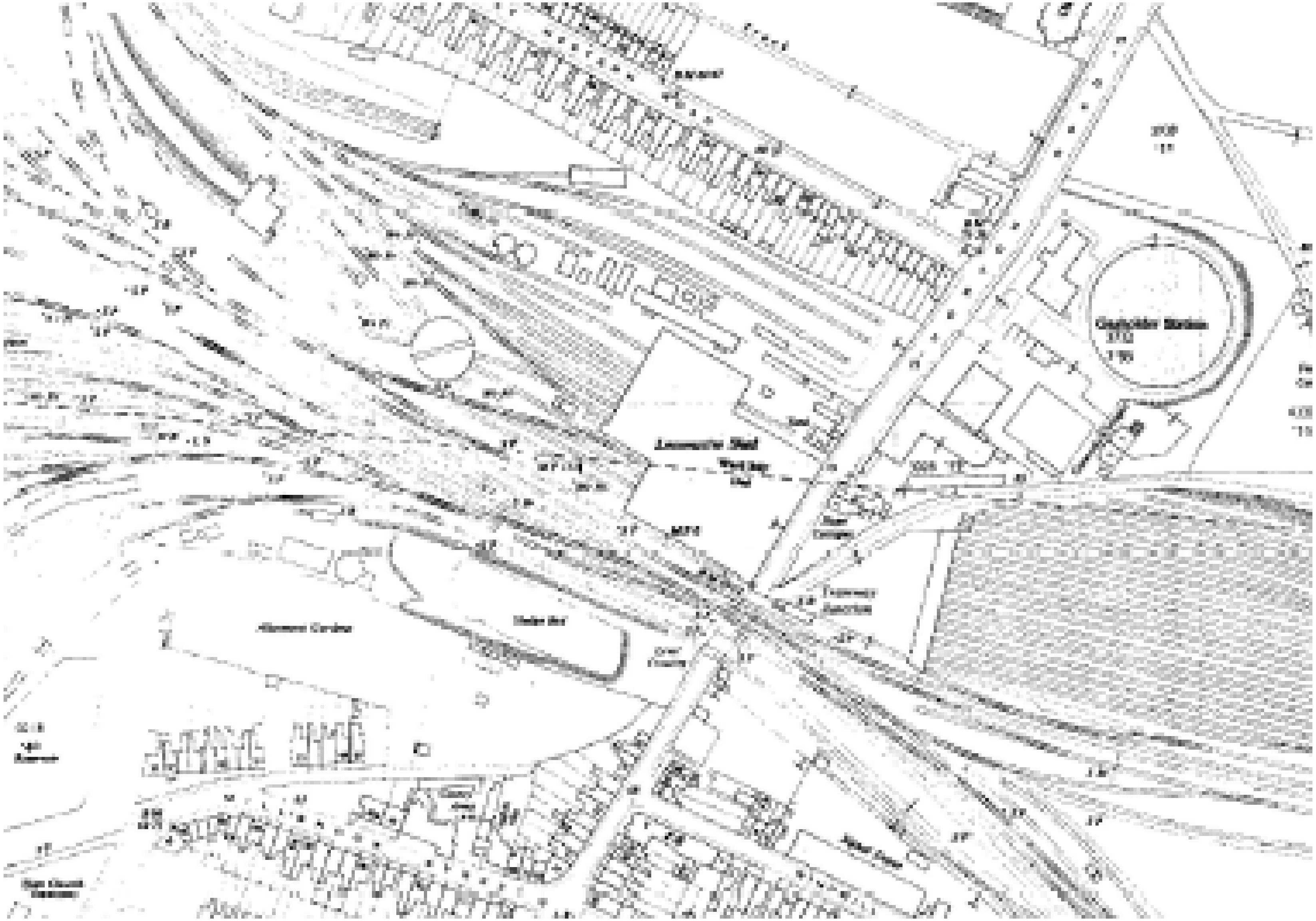

Plate 7: 1955 Map Extract.

Plate 8: 1981-1989 Map Extract.

6.23. Today, the site is in a derelict condition with all of the building inaccessible and having been subject to vandalism and failing fabric. A series of small modern buildings are located throughout the site, but are of limited interest, with the land being mostly clear of structures, secured by modern fencing and overgrown.

6.24. The evolution of the site is also described within 'Gloucestershire Locomotive Sheds' by Steve Bartlett (2018) as follows:

> ***"..the ex-GWR ten-road straight shed had been erected in two stages. The initial brick-built four-road shed section nearest the main line dated from 1854. A further six-road extension had been added in 1872 on the side furthest from the main line. Both sections had slated roofs interspersed with tall smoke ventilators. A single road repair shop with wheel drop was attached to the far side of the extension and a modest single storey office building stood separately beyond the repair shop near the entrance from the road. Three stop blocked sidings, latterly used for locomotive storage, were located end on to the public road and running along the far boundary fence. The shed yard's track layout had been remodelled in 1921, with the original coaling hoist replaced by a large standard GWR coaling stage. This was located at the front of and between the two main shed sections and was topped by a 74,250 gallons water tank. The depot turn table had as part of the 1921 remodelling been relocated between the coaling stage and shed building. Its tracks led off to a either side giving access to both shed sections. Further sidings were located at the far station end of the shed yard, also used for wagons using the adjacent ex-GWR good depot."***

6.25. The original locomotive sheds (now lost) can be seen in a series of photographs dating from the 1960s, 70s and 80s as shown below.

6.26. Historically, Gloucester was an important rail centre with a number of stations, freight yards and motive power depots. The application site was once one of the largest depots in the Gloucester Motive Power District, however it closed to steam in 1966 and ceased operations as a maintenance centre in 1990, becoming disuse din 2010. After this, much of the site was cleared.

6.27. Unlike other depots nationally, which have been statutorily designated, such as at Swindon, the site is no longer intact, and as described in detail all of the key historic buildings have been previously lost.

Plate 9: The southern locomotive Shed October 1962.

(Source: *'Gloucestershire Locomotive Sheds'*; 2018.)

Plate 10: The two bay 1872 sheds (west elevation) from August 1964.

(Source: 'Gloucestershire Locomotive Sheds', 2018)

Plate 11: The depot in July 1965 showing the three older locomotive sheds and the repair shop to the north.

(Source: *'Gloucestershire Locomotive Sheds'*, 2018)

Plate 12: Interior of the locomotive sheds (now demolished) Dec 1965.

(Source: *'Gloucestershire Locomotive Sheds'*, 2018)

Plate 13: Site in 1982, with the remaining shed shown in the right of the image.

(Source: https://commons.wikimedia.org)

Extant Built Form

6.28. The following assessment will focus solely on the buildings within the eastern/southern part of the site as these have been identified by officers within eth pre-application response as having the potential to be considered be non-designated heritage assets. It is not considered that any of the buildings within the norther/western part of the site are of any historic interest and thus will not be described in detail below.

6.29. It is also important to note from the outset, that the applicant has been advised by the Council's Heritage Engagement Officer that the buildings will not feature on the updated Local List (see Appendix 5), the implications of this will be described in turn below.

6.30. The three principal buildings within the site which will be discussed in detail below are shown on the plan provided at Plate 15.

Building 1

6.31. Building 1 is a single storey, brick built building with a pitched, glazed and corrugated metal roof. The building has a simple rectangular form, and is in a poor condition, having been vacant for many years and having been subject to vandalism despite being secured and the windows and doors blocked with hording.

6.32. The building primarily dates from the mid 20th century, being first shown on the historic mapping dated to 1955, yet not shown on the 1921-1943 25th Edition Ordnance Survey Map, and is noted as being the repair shop.

6.33. The east elevation features a large door opening, and a pair of small multi pane windows, one of which has been altered to incorporate a pedestrian door. These appear to be the same openings which are shown on the historic photos from the 1970s.

Plate 14: East elevation of Building 1.

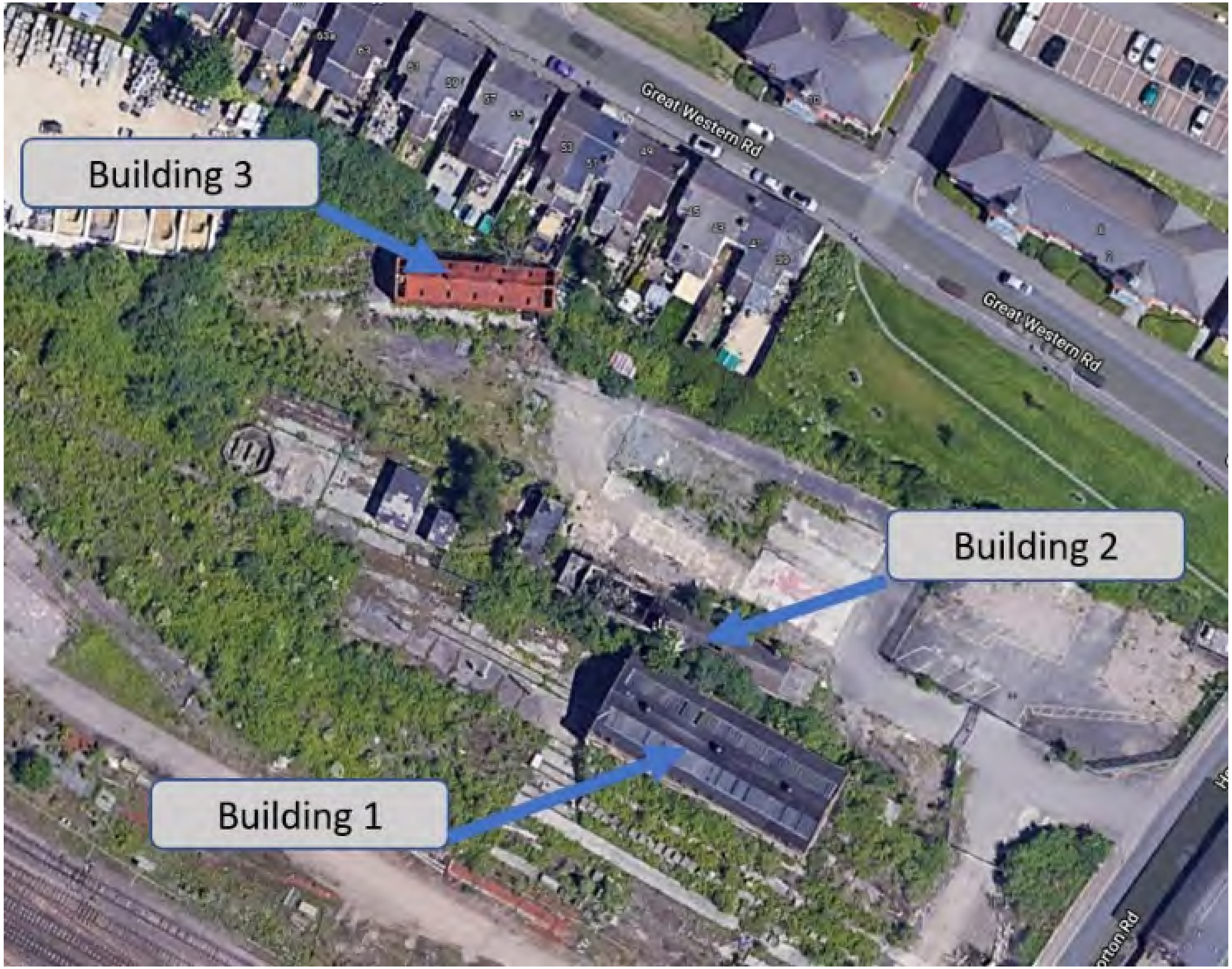

Plate 15: Buildings Plan.

6.34. The southern elevation is the most prominent, now facing onto the open yard and features six tall arched openings, with the second from the west now blocked and with evidence of an also now blocked pedestrian door being inserted within the opening. This elevation appears to be the remnants of the northern elevation of the shed which was previously adjoined to the building and which was demolished in the late 20th century. The external face of the southern elevation of extant Building 1 originally formed the internal face of the earlier, now demolished adjoining shed.

Plate 16: Building 1 south elevation which incorporates part of older structure.

6.35. The west elevation is a mirror image of the east elevation with a large off centre opening with a pair of windows to the north side.

Plate 17: West elevation of Building 1.

6.36. The northern elevation is obscured by overgrown vegetation, although it appears to feature a series of square window openings with multi pane window units.

6.37. Whilst internal access was not possible and thus a close inspection could not be undertaken, photographs reveal the metal roof structure and also the detailing on the now-internal face of the southern wall around the tall arched windows. As noted above, and evidenced by the historic mapping, this was once the external face of the adjoining, now largely-demolished shed.

Plate 18: Internal view of south elevation of Building 1.

Plate 19: Internal view of Building 1 (looking east).

6.38. It is clear that the building has been very much altered and represents a small part of the original block of locomotive sheds which were once within the site.

6.39. The southern elevation of the building incorporates fabric which can be demonstrated to be part of the shed constructed in 1872 as an extension to the original locomotive shed, but this in itself is only of very minor local interest, with the remainder of the building dating to the mid 20th century.

6.40. Overall, the building is considered to be of very minor local interest given that it was not one of the earliest two phases of built form within the site.

6.41. A structural assessment of the building has been undertaken which has confirmed that the walls of the building are all in an extremely poor and dangerous condition, with concrete lintels degraded beyond repair, bricks degraded and significant structural movement evident throughout.

Plate 20: East elevation of Building 1 in 1977.

(Source: https://www.derelictplaces.co.uk/threads/gloucester-horton-rd-mpd-july-2011.19504)

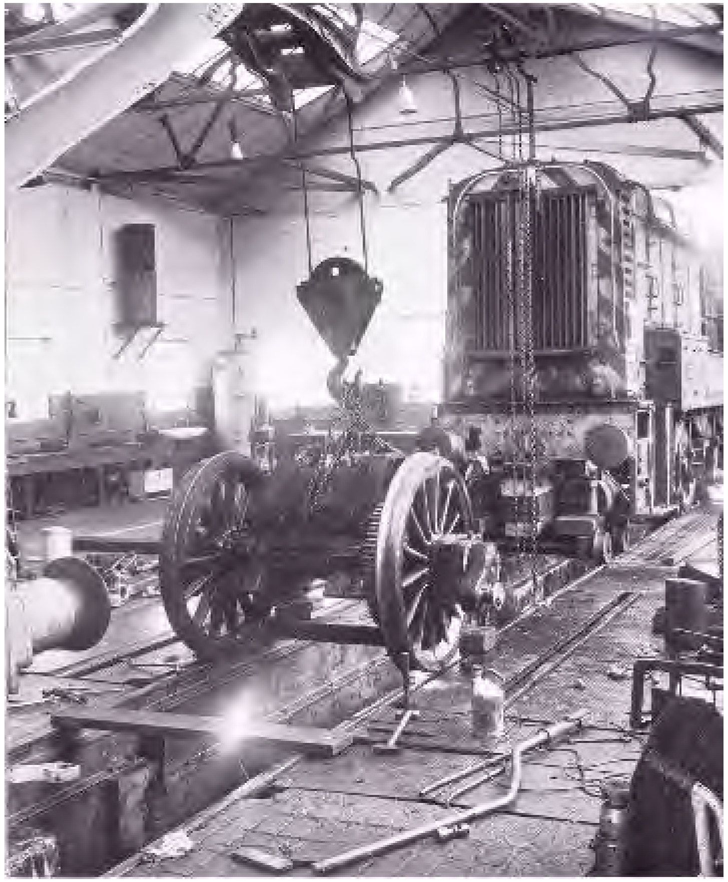

Plate 21: Interior of Building 1 in 1974.

(Source: https://www.derelictplaces.co.uk/threads/gloucester-horton-rd-mpd-july-2011.19504/)

Building 2

6.42. Building 2 is a long linear building with a pitched roof and constructed of red brick. It is located to the north of the site, adjacent to the remaining large shed described above.

6.43. As set out within the Site Description section above, it is considered that the building was once the office for the Depot.

6.44. The building has been variously extended and altered and its condition is very poor. It is not currently possible to access the interior of the building.

6.45. Whilst being mainly utilitarian in design, with little architectural detailing to its facades, there are some remnants of detailing which remain, including the decorative timber bargeboards and pointed finial on the east gable end, which is the most intact part of the building.

6.46. What remains of the roof covering is slate tiles, with two, tall chimney stacks on the north side. The windows, now broken and boarded, are set within arched openings, although a number of these have been altered. Scarring to the brickwork elevations and the remnants of internal floor coverings in the northern yard indicates the presence of previously removed extensions to the building, which have been tied into the original structure, and which are also evidenced on the historic mapping set out above.

6.47. What remains of the building is of very minor local interest, being one of the earlier buildings on site, associated with its original and former use. The fabric of the building is however significantly deteriorated.

Plate 22: East end of Building 2 with modern extension, decorative bargeboards, finials and tall chimneys.

Plate 23: Collapsed end of Building 2.

Plate 24: Evidence of former lean-too adjacent to Building 2.

<u>Building 3</u>

6.48. Building 3 is a rectangular, metal framed former engine shed which is clad in steel sheeting, including to its roof which also features vents and rooflight openings, A series of metal framed window openings which previously held multipaned windows run along the north and south facades of the building.

6.49. The building is first shown on the 1955 mapping and is likely to be contemporary with the main phase of Building 1.

6.50. Overall, the building is not considered to be of any historic or architectural significance, being a modern addition to the former depot and in a derelict state.

Plate 25: Building 3.

Plate 26: Building 3 interior (looking east).

7. Archaeological Resource

7.1. The archaeological resource of the site has previously been assessed though the Ecus Limited Archaeological Desk-Based Assessment, dated 2019, and previously completed trial trenching of limited scope which took place in 1992. This Section has been informed by these works, as well as a new HER search, geotechnical data and a site visit, and discussions with Mr Andrew Armstrong, the City Archaeologist.

7.2. The archaeological evaluation works carried out at the site in 1992 comprised the excavation of three test pits within the site. These works and the geotechnical works indicated that some areas of the site had experienced significant changes in ground level in the 19th century associated with the railway works, although it was also demonstrated that other areas still held potential for pre-modern deposits. Specifically, one of the archaeological trenches (in the southern-central area of the site) uncovered what was thought to be a north-south running river channel, within which preserved organic material was observed, and from which material of Roman date was recovered.

7.3. The site lies on a gravel terrace and, as such, has low potential for Palaeolithic remains. The presence of the Twyver Brook in the vicinity and the results of the evaluation raise the possibility of the palaeochannels in those areas not previously disturbed. The geotechnical data suggests the presence of organic material in the south-western area of the site. This may conceivably be of archaeological interest.

7.4. The site lies beyond the known Roman extent of the Colonia of Gloucester, and its precursor fort at Kingsholm. It is also not sited adjacent to any of the main Roman roads known to extend from these areas. However, two Roman coffins have been recorded to the east of the site, and the site of a Roman building lies a couple of hundred metres to the south-west of the site, which has been interpreted as a possible corn drying mill.

7.5. The site also lay beyond the urban area of the medieval town, again not lying adjacent to any major roads leading from that area. Mills are known to have been present in the wider area, but not within the site. The earliest available mapping (the Gloucester Enclosure Map of 1799) shows the site as fields.

7.6. As discussed above, the site was developed as a railway siding in the 19th century. This has fallen out of use, but tracks, inspection pits and various pieces of equipment remain, as well as the extant buildings discussed below.

7.7. In summary, limited evaluation through the excavation of test pits has taken place within the site to date, but this and the results of previous geotechnical works has indicated archaeological potential. A further programme of evaluation works will be required to delineate the areas which have previously been disturbed and to assess any archaeological potential of remaining undisturbed areas. This archaeological potential specifically relates to paleoenvironmental potential from former river channels and Roman archaeology, specifically burials.

7.8. An appropriate programme of archaeological works will be agreed with Mr Armstrong as part of ongoing discussions.

7.9. There is no current evidence to suggest that remains of a significance that would preclude development are present within the site.

8. Assessment of Impacts

8.1. This Section addresses the heritage planning issues that warrant consideration in the determination of the application for redevelopment of the site in line with the proposals set out within ***Section 3*** of this Report.

8.2. As detailed above, the *Planning and Compulsory Purchase Act (2004)* requires that applications for Planning Permission are determined in accordance with the Development Plan, unless material considerations indicate otherwise. The policy guidance set out within the *NPPF* is considered to be a material consideration which attracts significant weight in the decision-making process.

8.3. In addition, the *NPPF* states that the impact of development proposals should be considered against the particular significance of heritage assets, and this needs to be the primary consideration when determining the acceptability of the proposals.

8.4. It is also important to consider whether the proposals cause harm. If they do, then one must consider whether the harm represents "*substantial harm*" or "*less than substantial harm*" to the identified designated heritage assets, in the context of paragraphs 201 and 202 of the *NPPF*.[15] With regard to non-designated heritage assets, potential harm should be considered within the context of paragraph 203 of the *NPPF*.[16]

8.5. The *PPG* clarifies that within each category of harm ("*less than substantial*" or "*substantial*"), the extent of the harm may vary and should be clearly articulated.[17]

8.6. The guidance set out within the *PPG* also clarifies that "*substantial harm*" is a high test, and that it may not arise in many cases. It makes it clear that it is the degree of harm to the significance of the asset, rather than the scale of development, which is to be assessed.[18] In addition, it has been clarified in a High Court Judgement of 2013 that substantial harm would be harm that would:

> ***"…have such a serious impact on the significance of the asset that its significance was either vitiated altogether or very much reduced."*** [19]

8.7. This Section will consider the heritage resource within the site and assess the impact of the proposed development, whether that be harmful or beneficial to the significance identified above.

8.8. There are no designated heritage assets which warrant consideration as part of the assessment of impact.

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[15] DLUHC, *NPPF*, paras. 201 and 202.

[16] DLUHC, *NPPF*, para. 203.

[17] DLUHC, *PPG*, Paragraph: 018 (ID: 18a-018-20190723 Revision date: 23.07.2019).

[18] DLUHC, *PPG*, Paragraph: 018 (ID: 18a-018-20190723 Revision date: 23.07.2019).

[19] EWHC 2847, R DCLG and Nuon UK Ltd v. Bedford Borough Council.

8.9. With regard to non-designated heritage assets, potential harm should be considered within the context of Paragraph 203 of the *NPPF*.[20] There is no basis in policy for describing harm to them as substantial or less than substantial, rather the *NPPF* requires that the scale of any harm or loss is articulated whilst having regard to the significance of the asset.

8.10. High Court Judgements have confirmed that when considering potential impacts on non-designated heritage assets within the decision-making process, the balanced judgement required is different from the public benefits exercise associated with designated heritage assets (as set out in Paragraphs 201 and 202 of the *NPPF*).[21]

8.11. Within a High Court Judgment of 2017, Jarman HHJ confirmed that the only requirement of the *NPPF* in respect of non-designated heritage assets is "*that the effect of an application on the significance should be taken into account*".[22]

8.12. This was further expressed in the Bohm decision, which stated that:

> ***[34] "Unsurprisingly, given that an NDHA [non-designated heritage asset] does not itself have statutory protection, the test in para 135*** [Paragraph 203 of the 2021 *NPPF*] ***is different from that in paras 132-4*** [Paragraphs 200-202 of the 2021 *NPPF*]***, which concern designated heritage assets. Paragraph 135*** [Paragraph 203 of the 2021 *NPPF*] ***calls for weighing "applications" that affect an NDHA, in other words the consideration under that paragraph must be of the application as a whole, not merely the demolition but also the construction of the new building. It then requires a balanced judgement to be made by the decision maker. The NPPF does not seek to prescribe how that balance should be undertaken, or what weight should be given to any particular matter."***[23]

> ***"Section 72 requires an <u>overall assessment</u> of the likely impact of a proposed development on the conservation area, and <u>not just that part of it where the development site is located</u>".***[24] (my emphasis)

8.13. Officers have previous indicated that the extant buildings within the application site have the potential to be considered to be non-designated heritage assets, although this is in the context of them being confirmed as not meeting the criteria to be added to the Local List.

8.14. The proposals seek the demolition of all the extant buildings on site and the construction of new built form across the site to provide residential accommodation and association hard and soft landscaping.

8.15. The assessed, extant buildings within the site are clearly in a derelict and extremely poor condition.

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[20] DLUHC, *NPPF*, para.203.

[21] DLUHC, *NPPF*, paras. 201 and 202.

[22] Travis Perkins (Properties) Limited v Westminster City Council [2017] EWHC 2738 (Admin), Paragraph 44.

[23] Bohm [2017] EWHC 3217 (Admin).

[24] Spitfire Bespoke Homes Ltd v Secretary of State for Housing Communities And Local Government [2020] EWHC 958 (Admin).

8.16. Buildings 1 and 3 were later additions to the site, being constructed in the mid 20th century and clearly of a lesser quality, both architecturally and through the use of lower quality materials, than the mid 19th century buildings within the site. Whilst the southern façade of Building 1 is the former external wall of the locomotive shed to which it was attached and thus contains older fabric, this is much altered and in a poor condition and has lost its significance following the removal of the remainder of the building in the late 20th century.

8.17. Building 2 was a simple, utilitarian office building of limited significance and not one of the key landmark buildings within the site, set behind the prominent locomotive sheds which were at the centre of the site, both physically and operationally. The building maintains some architectural details of limited interest in the form of the decorative bargeboards and chimneys, however these are also in a poor condition.

8.18. The Council has previously identified that Buildings 1 and 2 could be defined as non-designated heritage assets due to their historic interest and age, however it has been demonstrated that Building 1 is of a mid 20th century date, albeit incorporating part of the northern elevation of the older locomotive shed, and its significance in its own right is very limited.

8.19. Similarly, whilst Building 2 has its origins as one of the older phases of development on the site, this building has been significantly altered and changed during its lifetime and is now in a derelict condition with very little of its original form and design detailing remaining.

8.20. The significance of these two buildings is very low, and due to their condition, it is not possible to retain or renovate them without significant works to their fabric, including addressing the fact that Building 1 was never designed to be a standalone building.

8.21. The NPPF states at paragraph 203 that the effect on the significance of a non-designated heritage asset should be taken into account when determining an application, and that a balanced judgement should be made, having regard to the level of significance of the asset and the scale of any harm or loss.

8.22. Given that the proposals involve the complete demolition of the buildings, their very low significance will be lost, and thus this will need to be considered in a balanced judgement considering all of the benefits of the proposals as a whole as part of the planning assessment.

8.23. Notwithstanding the above, with regards to the proposed demolition of the buildings, it is a significant material consideration that consent has been granted for the demolition of the buildings.

Archaeology

8.24. There is no current evidence to suggest that archaeological remains that are of a significance commensurate with a designated heritage asset are present within the site and would be impacted upon.

8.25. Following an agreed programme of archaeological works, an updated note on archaeological impacts will be completed.

9. Conclusions

Built Heritage

9.1. Three structures associated with the former locomotive works are present within the site, two of which are of very low heritage significance, and the other of no significance. Due to their condition, it is not possible to retain or renovate the buildings, which have a very modest level of significance, without significant works to their fabric.

9.2. The proposed scheme would result in the demolition of these buildings. It should be noted that Prior Consent has been granted for the demolition of these structures, and they could legally be demolished at any time.

9.3. The NPPF states at paragraph 203 that the effect on the significance of a non-designated heritage asset should be taken into account when determining an application, and that a balanced judgement should be made, having regard to the level of significance of the asset and the scale of any harm or loss.

9.4. Given that the proposals involve the complete demolition of the buildings, their very low significance will be lost. This will need to be considered as part of a balanced judgement, considering all the benefits of the proposals as part of the overall planning balance.

Archaeology

9.5. There is no current evidence to suggest that archaeological remains that are of a significance commensurate with a designated heritage asset are present within the site and would be impacted upon.

9.6. Following an agreed programme of archaeological works, an updated note on archaeological impacts will be completed.

Appendix 1: Assessment Methodology

Assessment of significance

In the *NPPF*, heritage significance is defined as:

> ***"The value of a heritage asset to this and future generations because of its heritage interest. That interest may be archaeological, architectural, artistic or historic. Significance derives not only from a heritage asset's physical presence, but also from its setting. For World Heritage Sites, the cultural value described within each site's Statement of Outstanding Universal Value forms part of its significance."***[25]

Historic England's *GPA:2* gives advice on the assessment of significance as part of the application process. It advises understanding the nature, extent, and level of significance of a heritage asset.[26]

In order to do this, *GPA 2* also advocates considering the four types of heritage value an asset may hold, as identified in English Heritage's *Conservation Principles*.[27] These essentially cover the heritage 'interests' given in the glossaries of the *NPPF* and the *PPG* which are archaeological, architectural and artistic, and historic.[28]

The *PPG* provides further information on the interests it identifies:

- ***Archaeological interest:*** *As defined in the Glossary to the National Planning Policy Framework, there will be archaeological interest in a heritage asset if it holds, or potentially holds, evidence of past human activity worthy of expert investigation at some point.*

- ***Architectural and artistic interest:*** These are interests in the design and general aesthetics of a place. They can arise from conscious design or fortuitously from the way the heritage asset has evolved. More specifically, architectural interest is an interest in the art or science of the design, construction, craftsmanship and decoration of buildings and structures of all types. Artistic interest is an interest in other human creative skills, like sculpture.

- ***Historic interest*:** An interest in past lives and events (including pre-historic). Heritage assets can illustrate or be associated with them. Heritage assets with historic interest not only provide a material record of our nation's history, but can also provide meaning for communities derived from their collective experience of a place and can symbolise wider values such as faith and cultural identity.[29]

Significance results from a combination of any, some, or all of the interests described above.

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[25] DLUHC, *NPPF*, pp. 71-72.

[26] Historic England, *GPA:2*.

[27] Historic England, *Conservation Principles: Policies and Guidance for the Sustainable Management of the Historic Environment* (London, April 2008). These heritage values are identified as being 'aesthetic', 'communal', 'historical' and 'evidential', see idem pp. 28–32.

[28] DLUHC, *NPPF*, p. 71; DLUHC, *PPG, Annex 2*.

[29] DLUHC, *PPG*, paragraph 006, reference ID: 18a-006-20190723.

The most-recently issued Historic England guidance on assessing heritage significance, *HEAN:12*, advises using the terminology of the *NPPF* and *PPG*, and thus it is that terminology which is used in this Report. [30]

Listed Buildings and Conservation Areas are generally designated for their special architectural and historic interest. Scheduling is predominantly, although not exclusively, associated with archaeological interest.

Setting and significance

As defined in the NPPF:

> ***"Significance derives not only from a heritage asset's physical presence, but also from its setting."***[31]

Setting is defined as:

> ***"The surroundings in which a heritage asset is experienced. Its extent is not fixed and may change as the asset and its surroundings evolve. Elements of a setting may make a positive or negative contribution to the significance of an asset, may affect the ability to appreciate that significance or may be neutral."***[32]

Therefore, setting can contribute to, affect an appreciation of significance, or be neutral with regards to heritage values.

Assessing change through alteration to setting

How setting might contribute to these values has been assessed within this Report with reference to *GPA:3*, particularly the checklist given on page 11. This advocates the clear articulation of "*what matters and why*".[33]

In *GPA:3*, a stepped approach is recommended, of which Step 1 is to identify which heritage assets and their settings are affected. Step 2 is to assess whether, how and to what degree settings make a contribution to the significance of the heritage asset(s) or allow significance to be appreciated. The guidance includes a (non-exhaustive) checklist of elements of the physical surroundings of an asset that might be considered when undertaking the assessment including, among other things: topography, other heritage assets, green space, functional relationships and degree of change over time. It also lists aspects associated with the experience of the asset which might be considered, including: views, intentional intervisibility, tranquillity, sense of enclosure, accessibility, rarity and land use.

Step 3 is to assess the effect of the proposed development on the significance of the asset(s). Step 4 is to explore ways to maximise enhancement and minimise harm. Step 5 is to make and document the decision and monitor outcomes.

A Court of Appeal judgement has confirmed that whilst issues of visibility are important when assessing setting, visibility does not necessarily confer a contribution to significance and factors other than visibility should also be considered, with Lindblom LJ stating at

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[30] Historic England, *Statements of Heritage Significance: Analysing Significance in Heritage Assets, Historic England Advice Note 12* (Swindon, October 2019).

[31] DLUHC, *NPPF*, p. 72.

[32] DLUHC, *NPPF*, p. 71.

[33] Historic England, *GPA:3*, pp. 8, 11.

paragraphs 25 and 26 of the judgement (referring to an earlier Court of Appeal judgement):

> ***Paragraph 25 – "But – again in the particular context of visual effects – I said that if "a proposed development is to affect the setting of a listed building there must be a distinct visual relationship of some kind between the two – a visual relationship which is more than remote or ephemeral, and which in some way bears on one's experience of the listed building in its surrounding landscape or townscape" (paragraph 56)".***
>
> ***Paragraph 26 – "This does not mean, however, that factors other than the visual and physical must be ignored when a decision-maker is considering the extent of a listed building's setting. Generally, of course, the decision-maker will be concentrating on visual and physical considerations, as in Williams (see also, for example, the first instance judgment in R. (on the application of Miller) v North Yorkshire County Council [2009] EWHC 2172 (Admin), at paragraph 89). But it is clear from the relevant national policy and guidance to which I have referred, in particular the guidance in paragraph 18a-013-20140306 of the PPG, that the Government recognizes the potential relevance of other considerations – economic, social and historical. These other considerations may include, for example, "the historic relationship between places". Historic England's advice in GPA3 was broadly to the same effect."***[34]

Levels of significance

Descriptions of significance will naturally anticipate the ways in which impacts will be considered. Hence descriptions of the significance of Conservation Areas will make reference to their special interest and character and appearance, and the significance of Listed Buildings will be discussed with reference to the building, its setting and any features of special architectural or historic interest which it possesses.

In accordance with the levels of significance articulated in the *NPPF* and the *PPG*, three levels of significance are identified:

- **Designated heritage assets of the highest significance,** as identified in paragraph 200 of the NPPF, comprising Grade I and II* Listed buildings, Grade I and II* Registered Parks and Gardens, Scheduled Monuments, Protected Wreck Sites, World Heritage Sites and Registered Battlefields (and also including some Conservation Areas) and non-designated heritage assets of archaeological interest which are demonstrably of equivalent significance to Scheduled Monuments, as identified in footnote 68 of the NPPF;[35]

- **Designated heritage assets of less than the highest significance,** as identified in paragraph 200 of the NPPF, comprising Grade II Listed buildings and Grade II Registered Parks and Gardens (and also some Conservation Areas);[36] and

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[34] Catesby Estates Ltd. V. Steer [2018] EWCA Civ 1697, paras. 25 and 26.

[35] DLUHC, *NPPF*, para. 200 and fn. 68.

[36] DLUHC, *NPPF,* para. 200.

- **Non-designated heritage assets.** Non-designated heritage assets are defined within the PPG as "*buildings, monuments, sites, places, areas or landscapes identified by plan-making bodies as having a degree of significance meriting consideration in planning decisions, but which do not meet the criteria for designated heritage assets*".[37]

Additionally, it is of course possible that sites, buildings or areas have no heritage significance.

Grading significance

There is no definitive grading system for assessing or categorising significance outside of the categories of Designated Heritage Assets and Non-Designated Heritage Assets, specifically with regards to the relative significance of different parts of an asset.

ICOMOS guidance recognises that a degree of professional judgement is required when defining significance:

> ***"…the value of heritage attributes is assessed in relation to statutory designations, international or national, and priorities or recommendations set out in national research agendas, and ascribed values. Professional judgement is then used to determine the importance of the resource. Whilst this method should be used as objectively as possible, qualitative assessment using professional judgement is inevitably involved."***[38]

This assessment of significance adopts the following grading system:

- **Highest significance:** Parts or elements of a heritage asset, or its setting, that are of particular interest and are fundamental components of its archaeological, architectural, aesthetic or historic interest, and form a significant part of the reason for designation or its identification as a heritage asset. These are the areas or elements of the asset that are most likely to warrant retention, preservation or restoration.

- **Moderate significance:** Parts or elements of the heritage asset, or its setting, that are of some interest but make only a modest contribution to the archaeological, architectural, aesthetic or historic interest of the heritage asset. These are likely to be areas or elements of the asset that might warrant retention but are capable of greater adaption and alteration due to their lesser relative significance.

- **Low or no significance:** Parts or elements of the heritage asset, or its setting, that make an insignificant, or relatively insignificant contribution to the archaeological, architectural, aesthetic or historic interest of the heritage asset. These are likely to be areas or elements of the asset that can be removed, replaced or altered due to their minimal or lack of

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[37] DLUHC, *PPG*, paragraph 039, reference ID: 18a-039-20190723.

[38] International Council on Monuments and Sites (ICOMOS), *Guidance on Heritage Impact Assessment for Cultural World Heritage Properties* (Paris, January 2011), paras. 4-10.

significance and are areas and elements that have potential for restoration or enhancement through new work.

Assessment of harm

Assessment of any harm will be articulated in terms of the policy and law that the proposed development will be assessed against, such as whether a proposed development preserves or enhances the character or appearance of a Conservation Area, and articulating the scale of any harm in order to inform a balanced judgement/weighing exercise as required by the NPPF.

In accordance with key policy, the following levels of harm may potentially be identified for designated heritage assets:

- **Substantial harm or total loss.** It has been clarified in a High Court Judgement of 2013 that this would be harm that would *"have such a serious impact on the significance of the asset that its significance was either vitiated altogether or very much reduced"*;[39] and
- **Less than substantial harm.** Harm of a lesser level than that defined above.

With regards to these two categories, the *PPG* states:

> ***"Within each category of harm (which category applies should be explicitly identified), the extent of the harm may vary and should be clearly articulated."***[40]

Hence, for example, harm that is less than substantial would be further described with reference to where it lies on that spectrum or scale of harm, for example low end, middle, and upper end of the less than substantial harm spectrum/scale.

With regards to non-designated heritage assets, there is no basis in policy for describing harm to them as substantial or less than substantial, rather the *NPPF* requires that the scale of any harm or loss is articulated whilst having regard to the significance of the asset. Harm to such assets is therefore articulated as a level of harm to their overall significance, using descriptors such as minor, moderate and major harm.

It is also possible that development proposals will cause no harm or preserve the significance of heritage assets. Here, a High Court Judgement of 2014 is relevant. This concluded that with regard to preserving the setting of a Listed building or preserving the character and appearance of a Conservation Area, "*preserving*" means doing "*no harm*".[41]

Preservation does not mean no change, it specifically means no harm. *GPA:2* states that "*Change to heritage assets is inevitable but it is only harmful when significance is damaged*".[42] Thus, change is accepted in Historic England's guidance as part of the evolution of the landscape and environment. It is whether such change is neutral, harmful or beneficial to the significance of an asset that matters.

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[39] Bedford Borough Council v Secretary of State for Communities and Local Government [2013] EWHC 2847 (Admin), para. 25.

[40] DLUHC, *PPG*, paragraph 018, reference ID: 18a-018-20190723.

[41] R (Forge Field Society) v Sevenoaks District Council [2014] EWHC 1895 (Admin).

[42] Historic England, *GPA:2*, p. 9.

As part of this, setting may be a key consideration. When evaluating any harm to significance through changes to setting, this Report follows the methodology given in *GPA:3*, described above. Fundamental to this methodology is a consideration of "*what matters and why*".[43] Of particular relevance is the checklist given on page 13 of *GPA:3.*[44]

It should be noted that this key document also states:

> ***"Setting is not itself a heritage asset, nor a heritage designation…"***[45]

Hence any impacts are described in terms of how they affect the significance of a heritage asset, and heritage interests that contribute to this significance, through changes to setting.

With regards to changes in setting, *GPA:3* states that:

> ***"Conserving or enhancing heritage assets by taking their settings into account need not prevent change".***[46]

Additionally, whilst the statutory duty requires that special regard should be paid to the desirability of not harming the setting of a Listed Building, that cannot mean that any harm, however minor, would necessarily require Planning Permission to be refused. This point has been clarified in the Court of Appeal.[47]

Benefits

Proposed development may also result in benefits to heritage assets, and these are articulated in terms of how they enhance the heritage interests, and hence the significance, of the assets concerned.

As detailed further in ***Appendix 3***, the *NPPF* (at Paragraphs 201 and 202) requires harm to a designated heritage asset to be weighed against the public benefits of the development proposals.[48]

Recent High Court Decisions have confirmed that enhancement to the historic environment should be considered as a public benefit under the provisions of Paragraphs 201 to 203.[49]

The *PPG* provides further clarity on what is meant by the term 'public benefit', including how these may be derived from enhancement to the historic environment ('heritage benefits'), as follows:

> ***"Public benefits may follow from many developments and could be anything that delivers economic, social or environmental objectives as described in the National Planning Policy Framework (paragraph 8). Public benefits should flow from the proposed development. They should be of a nature or scale to be of benefit to the public at large and not just be a private benefit. However, benefits do not always have to be visible or accessible to the public in order to be genuine public benefits, for example, works to a listed***

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[43] Historic England*, GPA:3*, p. 8.
[44] Historic England*, GPA:3*, p. 13.
[45] Historic England, *GPA:3*, p. 4.
[46] Historic England, *GPA 3.*, p. 8.
[47] Palmer v Herefordshire Council & Anor [2016] EWCA Civ 1061.

[48] DLUHC, *NPPF,* paras. 201 and 202.
[49] Including - Kay, R (on the application of) v Secretary of State for Housing Communities and Local Government & Anor [2020] EWHC 2292 (Admin); DLUHC, *NPPF,* paras. 201 and 203.

> ***private dwelling which secure its future as a designated heritage asset could be a public benefit.***
>
> ***Examples of heritage benefits may include:***
>
> - ***sustaining or enhancing the significance of a heritage asset and the contribution of its setting***
> - ***reducing or removing risks to a heritage asset***
> - ***securing the optimum viable use of a heritage asset in support of its long term conservation."[50]***

Any "*heritage benefits*" arising from the proposed development, in line with the narrative above, will be clearly articulated in order for them to be taken into account by the decision maker.

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[50] MHCLG, *PPG*, paragraph 020, reference ID: 18a-020-20190723.

Appendix 2: Legislative Framework

Legislation relating to the built historic environment is primarily set out within the *Planning (Listed Buildings and Conservation Areas) Act 1990*, which provides statutory protection for Listed Buildings and Conservation Areas.[51] It does not provide statutory protection for non-designated or Locally Listed heritage assets.

Section 66(1) of the Act goes on to state that:

> ***"In considering whether to grant planning permission [or permission in principle] for development which affects a listed building or its setting, the local planning authority or, as the case may be, the Secretary of State, shall have special regard to the desirability of preserving the building or its setting or any features of special architectural or historic interest which it possesses."***[52]

In the 2014 Court of Appeal judgement in relation to the Barnwell Manor case, Sullivan LJ held that:

> ***"Parliament in enacting section 66(1) did intend that the desirability of preserving the settings of listed buildings should not simply be given careful consideration by the decision-maker for the purpose of deciding whether there would be some harm, but should be given "considerable importance and weight" when the decision-maker carries out the balancing exercise."***[53]

A judgement in the Court of Appeal ('Mordue') has clarified that, with regards to the setting of Listed Buildings, where the principles of the NPPF are applied (in particular paragraph 134 of the 2012 version of the NPPF, the requirements of which are now given in paragraph 202 of the current, revised NPPF, see ***Appendix 3***), this is in keeping with the requirements of the 1990 Act.[54]

With regards to development within Conservation Areas, Section 72(1) of the *Planning (Listed Buildings and Conservation Areas) Act 1990* states:

> ***"In the exercise, with respect to any buildings or other land in a conservation area, of any powers under any of the provisions mentioned in subsection (2), special attention shall be paid to the desirability of preserving or enhancing the character or appearance of that area."***[55]

Unlike Section 66(1), Section 72(1) of the Act does not make reference to the setting of a Conservation Area. This makes it plain that it is the character and appearance of the designated Conservation Area that is the focus of special attention.

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[51] UK Public General Acts, Planning (Listed Buildings and Conservation Areas) Act 1990.

[52] UK Public General Acts, Planning (Listed Buildings and Conservation Areas) Act 1990, Section 66(1).

[53] Barnwell Manor Wind Energy Ltd v (1) East Northamptonshire DC & Others [2014] EWCA Civ 137. para. 24.

[54] Jones v Mordue [2015] EWCA Civ 1243.

[55] UK Public General Acts, Planning (Listed Buildings and Conservation Areas) Act 1990. Section 72(1).

In addition to the statutory obligations set out within the *Planning (Listed Buildings and Conservations Area) Act 1990*, Section 38(6) of the *Planning and Compulsory Purchase Act 2004* requires that all planning applications, including those for Listed Building Consent, are determined in accordance with the Development Plan unless material considerations indicate otherwise.[56]

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[56] UK Public General Acts, Planning and Compulsory Purchase Act 2004, Section 38(6).

Appendix 3: National Policy Guidance

The National Planning Policy Framework (July 2021)

National policy and guidance is set out in the Government's *National Planning Policy Framework* (*NPPF*) published in July 2021. This replaced and updated the previous *NPPF* 2019. The *NPPF* needs to be read as a whole and is intended to promote the concept of delivering sustainable development.

The *NPPF* sets out the Government's economic, environmental and social planning policies for England. Taken together, these policies articulate the Government's vision of sustainable development, which should be interpreted and applied locally to meet local aspirations. The *NPPF* continues to recognise that the planning system is plan-led and that therefore Local Plans, incorporating Neighbourhood Plans, where relevant, are the starting point for the determination of any planning application, including those which relate to the historic environment.

The overarching policy change applicable to the proposed development is the presumption in favour of sustainable development. This presumption in favour of sustainable development (the 'presumption') sets out the tone of the Government's overall stance and operates with and through the other policies of the *NPPF*. Its purpose is to send a strong signal to all those involved in the planning process about the need to plan positively for appropriate new development; so that both plan-making and development management are proactive and driven by a search for opportunities to deliver sustainable development, rather than barriers. Conserving historic assets in a manner appropriate to their significance forms part of this drive towards sustainable development.

The purpose of the planning system is to contribute to the achievement of sustainable development and the *NPPF* sets out three 'objectives' to facilitate sustainable development: an economic objective, a social objective, and an environmental objective. The presumption is key to delivering these objectives, by creating a positive pro-development framework which is underpinned by the wider economic, environmental and social provisions of the *NPPF*. The presumption is set out in full at paragraph 11 of the *NPPF* and reads as follows:

> ***"Plans and decisions should apply a presumption in favour of sustainable development.***
>
> ***For plan-making this means that:***
>
> ***a. all plans should promote a sustainable pattern of development that seeks to: meet the development needs of their area; align growth and infrastructure; improve the environment; mitigate climate change (including by making effective use of land in urban areas) and adapt to its effects;***
>
> ***b. strategic policies should, as a minimum, provide for objectively assessed needs for housing and other uses, as well as any needs that cannot be met within neighbouring areas, unless:***
>
> > ***i. the application of policies in this Framework that protect areas or assets of particular importance provides a strong reason for restricting***

> ***the overall scale, type or distribution of development in the plan area; or***
>
> ***ii. any adverse impacts of doing so would significantly and demonstrably outweigh the benefits, when assessed against the policies in this Framework taken as a whole.***
>
> ***For decision-taking this means:***
>
> ***a. approving development proposals that accord with an up-to-date development plan without delay; or***
>
> ***b. where there are no relevant development plan policies, or the policies which are most important for determining the application are out-of-date, granting permission unless:***
>
> ***i. the application policies in this Framework that protect areas or assets of particular importance provides a clear reason for refusing the development proposed; or***
>
> ***ii. any adverse impacts of doing so would significantly and demonstrably outweigh the benefits, when assessed against the policies in this Framework taken as a whole."***[57]

However, it is important to note that footnote 7 of the NPPF applies in relation to the final bullet of paragraph 11. This provides a context for paragraph 11 and reads as follows:

> ***"The policies referred to are those in this Framework (rather than those in development plans) relating to: habitats sites (and those sites listed in paragraph 180) and/or designated as Sites of Special Scientific Interest; land designated as Green Belt, Local Green Space, an Area of Outstanding Natural Beauty, a National Park (or within the Broads Authority) or defined as Heritage Coast; irreplaceable habitats; designated heritage assets (<u>and other heritage assets of archaeological interest referred to in footnote 68</u>); and areas at risk of flooding or coastal change."***[58] (our emphasis)

The *NPPF* continues to recognise that the planning system is plan-led and that therefore, Local Plans, incorporating Neighbourhood Plans, where relevant, are the starting point for the determination of any planning application.

Heritage Assets are defined in the *NPPF* as:

> ***"A building, monument, site, place, area or landscape identified as having a degree of significance meriting consideration in planning decisions, because of its heritage interest. It includes designated heritage assets and assets identified by the local planning authority (including local listing)."***[59]

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[57] DLUHC, *NPPF*, para. 11.

[58] DLUHC, *NPPF*, para. 11, fn. 7.

[59] DLUHC, *NPPF*, p. 67.

The NPPF goes on to define a Designated Heritage Asset as a:

> ***"World Heritage Site, Scheduled Monument, Listed Building, Protected Wreck Site, Registered Park and Garden, Registered Battlefield or Conservation Area designated under relevant legislation."***[60]

As set out above, significance is also defined as:

> ***"The value of a heritage asset to this and future generations because of its heritage interest. The interest may be archaeological, architectural, artistic or historic. Significance derives not only from a heritage asset's physical presence, but also from its setting. For World Heritage Sites, the cultural value described within each site's Statement of Outstanding Universal Value forms part of its significance."***[61]

Section 16 of the NPPF relates to 'Conserving and enhancing the historic environment' and states at paragraph 195 that:

> ***"Local planning authorities should identify and assess the particular significance of any heritage asset that may be affected by a proposal (including by development affecting the setting of a heritage asset) taking account of the available evidence and any necessary expertise. They should take this into account when considering the impact of a proposal on a heritage asset, to avoid or minimise any conflict between the heritage asset's conservation and any aspect of the proposal."***[62]

Paragraph 197 goes on to state that:

> ***"In determining planning applications, local planning authorities should take account of:***
>
> ***a. the desirability of sustaining and enhancing the significance of heritage assets and putting them to viable uses consistent with their conservation;***
>
> ***b. the positive contribution that conservation of heritage assets can make to sustainable communities including their economic vitality; and***
>
> ***c. the desirability of new development making a positive contribution to local character and distinctiveness."***[63]

With regard to the impact of proposals on the significance of a heritage asset, paragraphs 199 and 200 are relevant and read as follows:

> ***"When considering the impact of a proposed development on the significance of a designated heritage asset, great weight should be given to the asset's conservation (and the more important the asset, the greater the weight should be). This is irrespective of whether any potential harm amounts to***

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[60] DLUHC, *NPPF*, p. 66.
[61] DLUHC, *NPPF*, pp. 71-72.
[62] DLUHC, *NPPF*, para. 195.
[63] DLUHC, *NPPF*, para. 197.

> ***substantial harm, total loss or less than substantial harm to its significance."***[64]

> ***"Any harm to, or loss of, the significance of a designated heritage asset (from its alteration or destruction, or from development within its setting), should require clear and convincing justification. Substantial harm to or loss of:***
>
> > ***a. grade II listed buildings, or grade II registered parks or gardens, should be exceptional;***
> >
> > ***b. assets of the highest significance, notably scheduled monuments, protected wreck sites, registered battlefields, grade I and II* listed buildings, grade I and II* registered parks and gardens, and World Heritage Sites, should be wholly exceptional."***[65]

Section b) of paragraph 200, which describes assets of the highest significance, also includes footnote 68 of the NPPF, which states that non-designated heritage assets of archaeological interest which are demonstrably of equivalent significance to Scheduled Monuments should be considered subject to the policies for designated heritage assets.

In the context of the above, it should be noted that paragraph 201 reads as follows:

> ***"Where a proposed development will lead to substantial harm to (or total loss of significance of) a designated heritage asset, local planning authorities should refuse consent, unless it can be demonstrated that the substantial harm or total loss is necessary to achieve substantial public benefits that outweigh that harm or loss, or all of the following apply:***
>
> > ***a. the nature of the heritage asset prevents all reasonable uses of the site; and***
> >
> > ***b. no viable use of the heritage asset itself can be found in the medium term through appropriate marketing that will enable its conservation; and***
> >
> > ***c. conservation by grant-funding or some form of not for profit, charitable or public ownership is demonstrably not possible; and***
> >
> > ***d. the harm or loss is outweighed by the benefit of bringing the site back into use."***[66]

Paragraph 202 goes on to state:

> ***"Where a development proposal will lead to less than substantial harm to the significance of a designated heritage asset, this harm should be weighed against the public benefits of the proposal including, where appropriate, securing its optimum viable use."***[67]

The NPPF also provides specific guidance in relation to development within Conservation Areas, stating at paragraph 206 that:

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[64] DLUHC, *NPPF*, para. 199.
[65] DLUHC, *NPPF*, para. 200.
[66] DLUHC, *NPPF*, para. 201.
[67] DLUHC, *NPPF*, para. 202.

> ***"Local planning authorities should look for opportunities for new development within Conservation Areas and World Heritage Sites, and within the setting of heritage assets, to enhance or better reveal their significance. Proposals that preserve those elements of the setting that make a positive contribution to the asset (or which better reveal its significance) should be treated favourably."***[68]

Paragraph 207 goes on to recognise that "*not all elements of a World Heritage Site or Conservation Area will necessarily contribute to its significance*" and with regard to the potential harm from a proposed development states:

> ***"Loss of a building (or other element) which makes a positive contribution to the significance of the Conservation Area or World Heritage Site should be treated either as substantial harm under paragraph 200 or less than substantial harm under paragraph 201, as appropriate, taking into account the relative significance of the element affected and its contribution to the significance of the Conservation Area or World Heritage Site as a whole."***[69] (our emphasis)

With regards to non-designated heritage assets, paragraph 203 of NPPF states that:

> ***"The effect of an application on the significance of a non-designated heritage asset should be taken into account in determining the application. In weighing applications that directly or indirectly affect non-designated heritage assets, a balanced judgement will be required having regard to the scale of any harm or loss and the significance of the heritage asset."***[70]

Overall, the NPPF confirms that the primary objective of development management is to foster the delivery of sustainable development, not to hinder or prevent it. Local Planning Authorities should approach development management decisions positively, looking for solutions rather than problems so that applications can be approved wherever it is practical to do so. Additionally, securing the optimum viable use of sites and achieving public benefits are also key material considerations for application proposals.

National Planning Practice Guidance

The then Department for Communities and Local Government (now the Department for Levelling Up, Housing and Communities (DLUHC)) launched the planning practice guidance web-based resource in March 2014, accompanied by a ministerial statement which confirmed that a number of previous planning practice guidance documents were cancelled.

This also introduced the national Planning Practice Guidance (PPG) which comprised a full and consolidated review of planning practice guidance documents to be read alongside the NPPF.

The PPG has a discrete section on the subject of the Historic Environment, which confirms that the consideration of 'significance' in decision taking is important and states:

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[68] DLUHC, *NPPF*, para 206.
[69] DLUHC, *NPPF*, para. 207.
[70] DLUHC, *NPPF*, para. 203.

> ***"Heritage assets may be affected by direct physical change or by change in their setting. Being able to properly assess the nature, extent and importance of the significance of a heritage asset, and the contribution of its setting, is very important to understanding the potential impact and acceptability of development proposals."***[71]

In terms of assessment of substantial harm, the PPG confirms that whether a proposal causes substantial harm will be a judgement for the individual decision taker having regard to the individual circumstances and the policy set out within the NPPF. It goes on to state:

> ***"In general terms, substantial harm is a high test, so it may not arise in many cases. For example, in determining whether works to a listed building constitute substantial harm, an important consideration would be whether the adverse impact seriously affects a key element of its special architectural or historic interest. <u>It is the degree of harm to the asset's significance rather than the scale of the development that is to be assessed.</u> The harm may arise from works to the asset or from development within its setting.***
>
> ***While the impact of total destruction is obvious, partial destruction is likely to have a considerable impact but, depending on the circumstances, it may still be less than substantial harm or conceivably not harmful at all, for example, when removing later inappropriate additions to historic buildings which harm their significance. Similarly, works that are moderate or minor in scale are likely to cause less than substantial harm or no harm at all. However, even minor works have the potential to cause substantial harm."***[72] (our emphasis)

National Design Guide:

Section C2 relates to valuing heritage, local history and culture and states:

> ***"When determining how a site may be developed, it is important to understand the history of how the place has evolved. The local sense of place and identity are shaped by local history, culture and heritage, and how these have influenced the built environment and wider landscape."***[73]
>
> ***"Sensitive re-use or adaptation adds to the richness and variety of a scheme and to its diversity of activities and users. It helps to integrate heritage into proposals in an environmentally sustainable way."***[74]

It goes on to state that:

> ***"Well-designed places and buildings are influenced positively by:***
>
> - ***the history and heritage of the site, its surroundings and the wider area, including cultural influences;***

---

[71] DLUHC, *PPG*, paragraph 007, reference ID: 18a-007-20190723.
[72] DLUHC, *PPG*, paragraph 018, reference ID: 18a-018-20190723.
[73] DLUHC, *NDG*, para. 46.
[74] DLUHC, *NDG*, para. 47.

- ***the significance and setting of heritage assets and any other specific features that merit conserving and enhancing;***

- ***the local vernacular, including historical building typologies such as the terrace, town house, mews, villa or mansion block, the treatment of façades, characteristic materials and details - see Identity.***

Today's new developments extend the history of the context. The best of them will become valued as tomorrow's heritage, representing the architecture and placemaking of the early 21st century."[75]

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[75] DLUHC, *NDG*, paras. 48-49.

Appendix 4: Relevant Development Plan Policies

Applications for Planning Permission and Listed Building Consent where relevant, within Gloucester City are currently considered against the policy and guidance set out within the Joint Core Strategy which was adopted in December 2017.

The Council have previously identified that the relevant Local Development Plan policy is Policy SD8: Historic Environment of the Joint Core Strategy, and this will be a material consideration in the assessment of the proposed development.

This states that:

> ***"1. The built, natural and cultural heritage of Gloucester City, Cheltenham town, Tewkesbury town, smaller historic settlements and the wider countryside will continue to be valued and promoted for their important contribution to local identity, quality of life and the economy;***
>
> ***2. Development should make a positive contribution to local character and distinctiveness, having regard to valued and distinctive elements of the historic environment;***
>
> ***3. Designated and undesignated heritage assets and their settings will be conserved and enhanced as appropriate to their significance, and for their important contribution to local character, distinctiveness and sense of place. Consideration will also be given to the contribution made by heritage assets to supporting sustainable communities and the local economy. Development should aim to sustain and enhance the significance of heritage assets and put them to viable uses consistent with their conservation whilst improving accessibility where appropriate;***
>
> ***4. Proposals that will secure the future conservation and maintenance of heritage assets and their settings that are at risk through neglect, decay or other threats will be encouraged Proposals that will bring vacant or derelict heritage assets back into appropriate use will also be encouraged;***
>
> ***5. Development proposals at Strategic Allocations must have regard to the findings and recommendations of the JCS Historic Environment Assessment (or any subsequent revision) demonstrating that the potential impacts on heritage assets and appropriate mitigation measures have been addressed."***

Appendix 5: Email ref Local List

PEGASUS GROUP

Planning (Listed Buildings and Conservation Areas) Act 1990
Town & Country Planning Act 1990 (as amended)
Planning and Compulsory Purchase Act 2004

Cirencester
Pegasus House, Querns Business Centre,
Whitworth Road, Cirencester, GL7 1RT
[redacted]
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Landscape Management and Maintenance Plan

Great Western Yard

Parkhood

LANDSCAPE MANAGEMENT AND MAINTENANCE PLAN

Great Western Yard, Gloucester

prepared on behalf of

Eutopia Homes

June 2022 / Project No. 7594

parkhood.com

Great Western Yard, Gloucester

Landscape Management and Maintenance Plan

Client Name:	Eutopia Homes
Document Reference:	7594/LMMP
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Issue	Date	Prepared by
Planning Draft	*24-06-2022*	*Dominika Trybe*

Disclaimer

All feasible and reasonable attempts have been made to ensure that the information provided by a range of public sector institutions and presented in this report is accurate and up-to-date. Park Hood is not responsible for accidental perpetuation of inaccuracies in these records and any consequent effect on the conclusions in this report.

This report has been prepared by Park Hood with all reasonable skill, care and diligence within the General Terms and Conditions of the Contract with the client.

Contents

Notes

This document is to be read in conjunction with the following drawings:

7594-PHL-SW-XX-DR-L-1000

1.0 INTRODUCTION

Purpose and Scope

1.1 The Landscape Management and Maintenance Plan is part of a standard requirement for the planning application process and relates to the management proposals for open space / external landscape areas which are part of this proposed and phased residential development.

1.2 The Plan shall be taken to include this document and any supporting plans, reports and specifications approved as for this proposed residential development. This includes any documentation containing quantitative and qualitative information about the external areas of the site that will be useful to those responsible for managing and maintaining them.

1.3 The Management Plan sets out the management aims and objectives for the site along with the specific management objectives for each landscape component, and the associated maintenance works required on an Annual and Occasional basis. Annual Works are those works that will be required every year, such as watering, weeding and cleaning. Occasional Works are those that will be required on an irregular or cyclical basis, such as repairs and renewals.

Contract Requirements

1.4 The company undertaking any part of the works:

- must adhere to all local government legislations and regulations concerning their respective industry;
- must adhere to all local government legislations and regulations concerning health and safety; and
- must be a member of the local statutory body representing and regulating their respective industry.

1.5 Any personnel working on site:

- must be supervised by an appointed senior member of staff;
- must be suitable trained in their respective task; and
- must hold the necessary government approved certificates if required (i.e. use of chemicals, machinery etc.)

1.6 Any hazardous material:

- has to be correctly labelled, stored and used as per the concerning local government regulations;
- shall only be used by a supervised, trained, certified (if applicable) and appointed member of staff; and
- must be approved for use by a representative of the owner.

Health & Safety

1.7 Management of all areas will be undertaken in accordance with current Health and Safety regulations and **Construction (Design and Management) Regulations 2015.**

1.8 This will include staff must undergoing a site health and safety induction course regarding the site-specific issues and submission of a Health and Safety Plan prior to commencement of any works.

2.0 SITE INFORMATION AND INTRODUCTION

Table 1 General Site Information	
Site Location	*Great Western Yard, Gloucester*
Council Authority	*Gloucester Council*
Client	*Eutopia Homes*

Table 2 Landscape Works and Types Summary	
Summary description of external Landscape treatments, areas and components	**Soft Landscape Areas** include the following elements: • Existing Trees and Hedging; • Amenity Grass Seeding; • Tree planting; • Shrub and Buffer Planting; • Hedgerow planting; • Rain Gardens; • Sedum/Biodiverse Roofs and • Meadow planting **Hard Landscape Areas** include the following elements: • Footpaths and public realm hard landscape treatments; • Roads; • Fencing; • Drainage; • Play equipment; • Outdoor Furniture; • Walls and Copings;

Management Plan Objectives

2.1 The aim of the Management Plan is to coordinate a high standard for maintenance and management of landscape elements across the site to ensure successful visual integration of the development proposal into the surroundings and to protect and enhance nature conservation interests in accordance with the design objectives in the approved planning documents. This includes the appropriate maintenance of existing retained and proposed landscape components within an easily maintained comprehensive landscape framework that can provide (where possible) a diversity of landscape experiences for the users, residents and visitors.

2.2 The objectives are summarised as follows:

- To ensure a high standard of sustainable management of all landscape areas in a neat, tidy and substantially weed free condition;
- To ensure that all seeded areas are established and maintained in a condition that contributes to the visual amenity of the development;
- To establish and maintain tree and shrub planting to provide an overall landscape framework and landscape character;
- To maintain and enhance biodiversity and fulfil all legal requirements in relation to the protection and management of ecological features and the protection and management of protected species To ensure health and safety to minimise risk of injury and damage to people and property; and
- To provide a mechanism or monitoring and review with practices reviewed on an annual basis in accordance with changing site circumstances and the views of key stakeholders.

2.3 There will be a five year guarantee after construction that all the proposed planting works still exist and is established in line with landscape design expectations. This is just to make sure that no planting has been removed or damaged due to the subsequent construction or plant failure.

2.4 If removal of any tree is necessary, agreement shall be reached with the Council as to replacement with matching or appropriate species in the next planting season.

Landscape Specifications

2.5 Landscape works to be undertaken by an BALI approved landscape contractor and in accordance with *BS 4428:1989 Code of practice for general landscape operations (excluding hard surfaces)*. The general landscape proposals are indicated on the drawings listed on page 2.

2.6 When using pesticides, the Contractor must use a certified operator and take appropriate safety precautions in accordance with the European Communities (Sustainable Use of Pesticides) and Sustainable Use Directive (SUD) Regulations.

2.7 Plant supply shall be obtained from a nursery that are members of the Horticultural Trades Association Nursery Certification Scheme and approved by the project and local authority landscape architect.

2.8 All planting stock shall be of local provenance or if unavailable national provenance. Origin and provenance have the meaning given in the National Plant Specification and grown in Ireland or the UK.

Ground Preparation

2.9 Prior to cultivation, planted areas shall be cleared of all loose debris, rubbish, stones over 25mm in diameter, roots, and other extraneous matter. Grass and weeds shall be sprayed with 'Glyphosate' or similar *COSHH* approved herbicide.

2.10 Topsoil Depths: spread over prepared subsoil in layers not exceeding 150 mm, each layer firmed before spreading the next. Top Soils shall comply with multipurpose grade within *BS 3882:2015: Specification for Top Soil.* Overall minimum depths after firming and settlement to be:-

Shrub / Hedgerow areas	500 mm
Lawn and Grass areas	150mm

2.11 Planted areas to be cultivated to a depth of 300mm by hand or rotovator, incorporating planting compost, soil improver and fertilizer base dressing of the types. The topsoil shall have been reduced to a fine tilth on completion of the cultivation works.

Timetable for Landscape Works

2.12 The landscape works shall be undertaken by the end of the next available planting season and during the following periods:

- Deciduous trees and shrubs: Late October to late March;
- Conifers and evergreens: September/ October or April/ May; and
- Container grown plants: At any time if ground and weather conditions are favourable.

Proposed Standard Tree Planting

2.13 Tree supply and planting shall correspond to *BS 8545:2014 Trees: from nursery to independence in the landscape - Recommendations*. Planting of trees shall be undertaken in favourable weather conditions between October 31st to March 31st.

2.14 Tree pits shall be excavated to suitable dimensions to accommodate roots or root-balls or baskets with bases and sides broken up to a minimum depth of 150mm to assist drainage and root penetration. Any unsuitable material such as large clay lumps, bricks, concrete, timber and sand shall be removed off-site. All tree pits shall be backfilled, after planting, with a 3:1 volume mixture of topsoil and mulching compost/manure or similar approved.

2.15 The planted trees shall be full and well-shaped with crowns thinned by 30% according to good horticultural practice and in a manner that does not affect the overall stature, structure or good appearance of the tree. All work shall conform to a minimum standard as set out in *BS 4043:1989 Recommendations for transplanting root-balled trees.*

Proposed Screen / Boundary Planting

2.16 Trees supply and planting shall correspond to *BS 8545: 2014 Trees: from nursery to independence in the landscape - Recommendations*. Planting of trees shall be undertaken in favourable weather conditions between October 31st to March 31st.

Proposed Shrub Planting

2.17 Shrub plants to be planted at the indicated plants per m² (refer to Dwg No. 7594-PHL-SW-XX-DR-L-1000). Transplants and container grown shrubs shall be of the size stated and conform to *BS 3936 - Part 1: Nursery stock specification for trees and shrubs.*

2.18 Planting pockets 400x400x300mm deep with cultivated and evenly incorporated: organic manure 100mm layer over area of pit, fertiliser 35g. 75mm depth bark mulch dressing on completion of planting.

Hedgerow Planting

2.19 Hedgerow plants to be planted at 4 per linear meter (in double staggered row at 500mm centres). Transplants shall be of the size stated, shall conform to *BS 3936 - Part 1: Nursery stock specification for trees and shrubs*.

2.20 Planting pockets 400x400x300mm deep with cultivated and evenly incorporated: organic manure 100mm layer over area of pit, fertiliser 35g. 50mm depth bark mulch dressing on completion of planting.

Grass Seeding

2.21 Coburn's 'GreenLawn' mixture (or similar approved) suitable for general amenity areas. Sowing rate 35g per m².

Biodiversity roofs

2.22 Green roofs and the Bio roof shall require between 8 and a 12 weeks period upon which to establish the plants through irrigation if the installed season is not during the dormant season.

Performance Criteria

2.23 Performance criteria are indicators for assessing the quality and success of the particular plant mixtures used for a purpose i.e. screen planting, seeding, tree planting etc. Such indicators will be based upon aspects such as:-

- Health and condition of planting;
- Plant growth; and
- Achievement of desired visual effect.

3.0 LANDSCAPE SOFTWORKS – ESTABLISHMENT MAINTENANCE

General Introduction

3.1 Establishment maintenance will form part of the landscape contractors works. The period of establishment maintenance will be 12 months after the completion of the planting and grassing works prior to handover.

3.2 Prior to handing over, all plants deaths shall be replaced, and all defects made good to the satisfaction of the landscape architect and/or the management company.

Establishment Maintenance Operations – Amenity Grass Areas

3.3 The developer and contractor shall be responsible for maintaining all grassed areas in a neat and tidy, weed free and litter free condition, throughout the complete growing season, or when the landscape works are completed, whichever is the later.

Works required prior to First Cut

3.4 When the new sward has reached a height of 50mm the contractor shall remove all loose debris, stones and rubbish above 25mm in any direction prior to cutting. Following the surface clearance and prior to cutting the contractor shall lightly roll all newly grassed areas with a smooth and even weight.

First Cut

3.5 All new grass sward shall be given first cut at least two days after rolling. The first cut shall leave not less than 35mm height.

Subsequent and Management

3.6 Grass shall be cut regularly (a total of 12-16 times during the growth season) to a length consistent with the season and quality of growth. The normal establishment of cut shall be 25mm. All arisings shall be removed if the height of the grass exceeds 100mm prior to cutting

3.7 All established grass areas shall receive an application of an approved top dressing (N:P:K) (20:10:10) at the rate of 15g/M2 as directed by the site management or landscape architect.

3.8 Any areas of settlement or local depressions shall be made up and re-sown by the contractor at his own expense.

3.9 The edges of seeded areas, adjacent to shrub beds and margins are to be carefully trimmed square and to a true line. The contractor should note that this also applies to the area around the base of trees planted in grass areas.

3.10 All areas of failed grass shall be reinstated using the seed mix as specified within the landscape contract, with ground cultivation prior to seeding meeting the same requirements.

3.11 All new grass areas shall be handed over as complete, well established sward at the end of the establishment maintenance period.

Establishment Maintenance Operations – Meadow Areas

3.12 Fertility of the ground in meadow areas should be low otherwise grasses will compete and crowd out the flowers. For this reason Rye grass used for hard wearing lawns should not be used as it is too vigorous.

3.13 Perennial Weeds also need to be removed and ground prepared similar to that for grass seeding. The grass is sown first lightly raked and then the wildflower seed is sown and left unraked. The ground should then be rolled to encourage good contact between seed and ground. Do not over seed the area.

3.14 Management in the first summer is critical to ensure successful establishment. The sward should be cut 6-8 weeks after sowing when it is over 10 cm high using an Allen scythe or rotary mower.

Establishment Maintenance Operations – Planting operations

3.15 Weed Control: All planted areas shall be kept entirely weed free throughout the establishment maintenance period, using approved residual and translocated herbicides, or mechanical means, or a combination of both.

3.16 Wind Firming: All plants shall be inspected at monthly intervals for wind firmness, and re-firmed as necessary.

3.17 Stakes & Tree Ties Checking: Stakes shall be checked monthly for firmness, and re-firmed as necessary, and all tree and plant ties inspected and loosened as required.

3.18 Pruning: Shall be carried out on a monthly basis, and will include the removal of minor dead wood or damaged wood. Formative pruning shall be undertaken at the appropriate time of the year for the species involved in order to enhance the plants best feature e.g. flowering, stem colour etc.

3.19 Inorganic Fertilizer: All shrub-planting areas shall receive a fertilizer top dressing in July of ‘Osmocote’ slow release fertilizer (N:P:K) (18:11:10) to be lightly raked in.

3.20 Watering: All plants shall be watered as required during the establishment maintenance period to ensure survival of all plant material. Suggested water requirements for tree irrigation are as per following **Table 3 Watering Requirements** below.

3.21 Litter Removal: Litter that may have accumulated in grass and planted areas must be lifted and removed from the site each month.

3.22 Failed Planting Areas: Prior to the end of the establishment maintenance period, the contractor will receive from the landscape architect a list of plant material that must be replaced by the contractor. Any plant material which has failed to establish, or has died, throughout this period must be replaced with healthy plant stock of similar specification at the contractors own expense. Successfully established plant material shall be those plants showing positive signs of growth i.e. shoot extension and growth over time. Breaking into leaf is not to be taken as evidence of successful establishment.

3.23 Handover of Planted Areas: All newly planted areas shall be handed over as complete and well established at the end of the establishment maintenance period.

Establishment Maintenance Operations – Biodiversity Roofs

3.24 Water regularly for the first 8-12 weeks to establish the green roof planting mixes.

3.25 Weed control: All planted areas shall be kept entirely weed free throughout the establishment maintenance period, all weeds to be removed by hand (no use of residual and translocated herbicides shall be permitted on sedum carpet beds).

3.26 Wind firm any perennial plants that have become loose or leaning.

3.27 Check all ties and net structures for the log pile are tight to prevent movement of log piles.

Table 3 **Watering Requirements for Establishment Maintenance Period (in days)**

	Feathered	Light Standard	Standard	Heavy Standard	Extra Heavy Standard	Semi-Mature
Girth (cm)	6	6-8	8-10	10-12	12-14	14-16
Height (m)	1.8-3.0	2.4-2.7	2.7-3.0	3.0-3.6	3.6-4.2	4.2-4.8
Estimated daily* transpiration rate (litres)	1	1	1.2	2	3	4
Suggested first season summer watering requirements (litres per month)	36	36	45	75	115	150

*Calculations for transpiration and suggested watering requirements are based on a typical Plane Tree in a tree pit ameliorate with 25% peat and with a 50mm mulch layer. The figures are approximate and are for guidance only. Allow an extra day for every 10mm of rainfall.

4.0 LANDSCAPE SOFTWORKS – LONG TERM MANAGEMENT

Amenity Grass Areas

4.1 Performance Criteria: Grassed areas shall have good grass cover without obvious bare patches.

4.2 Maintenance Objectives: To establish and maintain an even cover of grass sward.

Maintenance Operations Years 1 – 20

- Grass Cutting: All grassed areas will be maintained between 20 – 40mm in height during April to August inclusive and between 30 – 50mm at all other times;
- Frequency of cuts may be up to 20 cuts per annum, dependent on the length of the growing season and weather, with the majority undertaken during the spring and summer months. Clippings may be let fly, but all adjacent hard surfaces shall be swept clean after cutting with all clippings removed to contractors tip;
- Grass Verges & Edges: All edges to grassed areas against buildings, footpaths, roadways, trees and any other obstruction shall be kept neat and tidy. Border edges shall be clipped and not exceed 50mm length at any time;
- Weeding: Spot weeding of isolated areas of weed infestation may be undertaken using an approved natural weed control; and
- Reinstatement of failed areas: All areas of failed grass shall be reinstated using the seed mix as specified within the original landscape contract, with ground cultivation prior to seeding meeting the same requirements.

Groundcover and Shrub Planting Areas (Including Green Roofs)

4.3 Performance Criteria: By year 5 all ground cover planting shall have achieved closed canopy and shall have been thinned and pruned.

4.4 Maintenance Objectives: To establish and maintain a weed free cover of healthy growth, clipped or pruned as necessary to give a neat and tidy finish contained within the planted area.

Maintenance Operations Years 1 – 3

- Monthly inspection for wind firming and watering to establish good growth;
- Annual application of an approved fertilizer in July of 17:17:17, N:P:K at a rate of 30g/M2; and
- Remove and replace all dead, dying and diseased or vandalized plant material, replacements to be as originally specified within the main landscape contract or as agreed with Management Company.

Maintenance Operations Years 3 – 5

- Annual application of an approved natural weed control in the winter months, with removal or spot treatment with an approved translocated natural weed control during the main growing season;
- In the appropriate season for the species involved, prune and tidy the plants removing dead, dying or diseased plant material;
- Selectively thin plants that are restricting the natural and attractive development of their neighbours; and
- Remove all arising from site.

Maintenance Operations Years 5 – 20

Operations to include the above, plus:

- Bi – annually prune and tidy the plants removing all dead, dying or diseased plant material from the site; and
- Replace as necessary all shrubs that are not contributing satisfactorily to overall objectives of the landscape management plan. Replacements shall be approved with the supervising officer.

Rain Gardens

4.5 Performance Criteria: The rain garden feature has been designed for easy maintenance. To provide a space on the site to deal with surface water run-off locally.

4.6 Maintenance Objectives: To establish and maintain weed free cover of healthy growth within the rain garden feature. Pruned and weeded when necessary to give a tidy finish within the planted area.

- Regular weekly care to involve litter collection, checking inlets/outlets into the feature.
- Occasional tasks to involve the removal of any silt that builds up in the feature.
- Seasonal work to involve the cutting back and or / strimming of seasonal planting to ground level in autumn and remove annual weeds. Rake off and remove arisings.
- Remedial work to involve the repair of any damage, the replacement of any planting and the checking of trees.

Hedgerows

4.7 Performance Criteria: All hedges shall have a complete canopy and be managed to form a continuous impenetrable thicket to the desired height by year 5.

Maintenance Operations Years 1 – 3

- Monthly inspection for wind firming and watering as required ensuring establishment and survival of plant material;

- Pruning shall be directed at maintaining true and even levels as necessary during the growing season, with all arisings removed from site;
- The first cut can commence when all danger of frost has receded. When cutting avoid strong sunlight, best carried out on a dull and wet day;
- The last cut shall commence no later than 4 weeks before the first frost. Annual application of an approved fertilizer in July of 17:17:17, N:P:K at a rate of 30g/M2;
- Maintain the planted area weed free by applying an annual dressing of an approved residual herbicide in the winter months and spot treatment with an approval translocated herbicide during the growing season; and
- Remove and replace all dead, dying, diseased or damaged plant material, replacements to be as originally specified within the main landscape contract, or as agreed with management company representative.

Maintenance Operations Years 3-20

Operations to include the above, plus:

- Maintain top and side of hedges in a rectangular profile using suitable, approved mechanical methods, to true and even levels. Remove any cuttings lodged in the surface of the hedge and rake up and remove all arisings; and
- Maintain weeds or grass growth at the base of the hedge to a maximum height of 100mm by regular hand cutting or by application of an approved natural weed control.

Standard Tree Planting

4.8 Performance Criteria: To provide a healthy growing tree that contributes to the overall aesthetics of the landscape.

4.9 Maintenance Objectives: To ensure establishment and maintenance of trees with a well-shaped habit.

Maintenance Operations Years 1 – 3

- Monthly inspection for wind firming and watering as required ensuring establishment and survival of plant material (fortnightly during dry spells);
- Bi-monthly tree tie check to ensure that the trees are not being strangled by support. Loosening of trees ties as necessary;
- Maintain a 1m diameter area of weed free soil around the base of each tree by hand. This to be carried out monthly during the main growing season and bi-monthly thereafter;
- Annual application of an approved fertilizer in July of 17:17:17, N:P:K at a rate of 60g/tree;

- Remove and replace all dead, dying, diseased or damaged plant material, replacements to be as originally specified within the main landscape contract, or as agreed with the supervising officer;
- Prune the trees to remove any dead, dying or diseased shoots and limbs to create a balanced form for future growth, remove; and
- Tree Guards and Grilles: Where supplied and fitted, tree guards (mild steel and 'Weldmesh') are to be inspected, re-fixed or replaced as necessary to original specification and to prevent chaffing of tree.

Maintenance Operations Years 3-5

Operations to include the above, plus:

- Removal of tree stakes, tree ties and tree guards as necessary, as trees become wind firm and established to prevent strangulation of tree.

Maintenance Operations Years 5-20

Operations to include the above, plus:

- Some selective thinning of tree groups may be required during this period, at years 10 and 20;
- Visibility Splays: Any vegetation other than grass on visibility splays or road sight lines will be kept to below 600mm above channel lines on road. In addition, the visibility splay will be kept free of all structures or vegetation other than that approved in the planning consent.

Watering

4.10 In any period of extended drought ensure survival of all plants, for recommended water requirements refer to Table 3 for guidance.

Existing / Mature Trees

4.11 Management Objectives:

- To maintain the trees in as healthy and attractive condition for as long as possible;
- To ensure continuity in tree cover and their contribution to the landscape structure, biodiversity, and screening/amenity value of the site;
- To ensure that trees are healthy and safe, particularly in places in proximity to residential properties and with public access. and
- In certain locations, arising's from woodland management activity can be used as basis for opportunities for amphibians, invertebrates and bryophytes micro-habitats by leaving piles of dead wood or recumbent dead logs.

Maintenance Operations – Annual and Occasional

- Trees should be regularly visually checked for the presence of any diseased or rotten wood; fungal or other infections/disease; and stability. If any such issues are identified, then the advice of qualified Arboricultural consultant should be sought immediately;
- The health of the trees shall be monitored and any works required for health and safety or to promote the health and sustainability of existing trees shall be identified, scheduled and actioned at a suitable time of year (Note that appropriate consent will required from Council for works to trees within TPO, Conservation Areas etc.);
- Any works recommended for each tree should be documented and a formal application made to the Council (if required) with the exception of the removal of dead wood in advance of the works being undertaken wherever necessary;
- All works should be completed at an appropriate time of year and in accordance with relevant EU and UK wildlife legislation. Where possible this should be outside of the bird nesting season (i.e. between October through to March inclusive). In any event according to the nature of the works, there may be an additional requirement for monitoring or a watching brief by a qualified ecologist to ensure there are no nesting birds or bats present;
- All works shall be carried out by a skilled, qualified and approved Arboricultural Contractor in accordance with *BS3998: 2010 'Tree Work - Recommendations*. All works within the site will be undertaken in accordance with the Environment Agency Pollution Prevention Guidelines PPG5. All personnel will be familiar with the content of these guidelines prior to commencing work within the site;
- Where possible, and where health and safety constraints permit, arisings may be formed into habitat piles within public open spaces, and standing dead wood maybe left within the woodland to provide additional dead wood habitats to maximise invertebrate biodiversity. All other brushwood and logs that result from surgery and felling of trees on site shall be removed off site. Brushwood may be chipped on site, but all wood chippings resulting from these operations shall be raked up, bagged and removed;
- Where surgery works affect carriageways or public roads, the Arboricultural Contractor shall ensure the relevant permissions and road control permits are obtained, and all necessary health and safety parameters are met;
- Selective thinning and coppicing of existing scrub and trees is to be assessed on site. This will allow trees and shrubs to develop diversity of form and different types of nesting, feeding and foraging habitat and extend the potential life of individual plants. Additional thinning of the scrub areas may be required at intervals following an initial selective thin and coppice. The timing of thinning should be informed by an assessment on site. A competent person, such as a qualified arboriculturist

should plan thinning and coppicing operations. All thinning and coppicing operations should be undertaken between October and February;

- Any tree that dies or is necessarily felled, but which is not removed as part of a programme of thinning or coppicing, shall be replaced with a tree of appropriate species and stock size. Such replacement shall be with a tree of either the same or similar species as those existing. Replacement and enhancement planting is best undertaken during the planting season (November through to March inclusive.); and

Possible damage to drainage/services and adjoining building foundations must be considered before choosing a replacement tree species and location.

Monitoring Objectives and Performance Criteria

4.12 At the end of the defects liability period (1 year), the overall soft landscape areas shall be in a visually neat and tidy condition and completed to the contract specification prior to handing over to the appointed management company. The management company will inspect all areas of seeding and planting regularly throughout the year, to ensure the landscape management objectives are achieved.

4.13 The landscape sub-contractors with responsibility for the site shall record all site visits, maintenance operations undertaken and any other significant events i.e. fire, theft or vandalism of plant materials. This information shall be used to prepare an annual report at the end of each year that will summarize maintenance operations together with an assessment by the contractor of the current state of the site.

4.14 The appointed supervising officer shall prepare a long-term review after years 5, 10, 15 and 20. This report shall summarize the management undertaken together with an assessment of the performance of the landscaped areas against the performance criteria stated within this plan. This review shall include recommendations for improving the management plan, if necessary dependant on findings.

5.0 LANDSCAPE HARDWORKS – LONG TERM MANAGEMENT

Paved Areas

5.1 Performance Criteria: All hard surface areas shall remain in good repair and free of any trip hazards.

5.2 Maintenance Objectives: To repair any sunken/raised paving elements, making good damaged units or subsistence to match original materials and retain the paved areas in clean condition.

Maintenance Operations

- Annual inspections of hard surface areas and maintenance carried out as necessary e.g. re-pointing as required;
- Sweep with pedestrian equipment and dispose arisings (1 x per month, March – September);
- Apply herbicide, weed wipe (1 x per year); and
- Clean paved surfaces according to manufacturer's recommendations including removal of stained surfaces and removal of chewing gum.

Fencing, Barriers & Bollards

5.3 Performance Criteria: All fences shall remain in good visual condition.

5.4 Maintenance Objectives: To repair any damaged elements and ensure barriers succeed in design objective e.g. protect planting

Maintenance Operations

- Annual inspections of hard works areas and maintenance carried out as necessary;
- Extension or strengthening of barriers as required;
- Clean bollards and barriers only according to manufacturer's recommendation; and
- Repaint fencing as required and as per manufacturer's recommendation.

Walls and Copings

5.5 Performance Criteria: All walls, planters and copings shall remain in good visual condition.

5.6 Maintenance Objectives: To repair any structural damage as required and retain surfaces in clean condition.

Maintenance Operations

- Annual inspections of hard surface areas and maintenance carried out as necessary;
- Maintain and clean painted surfaces;
- Remove graffiti as required; and
- Repaint and/or re-point as required and as per manufacturer's recommendation.

Street and Parkland Furniture

5.7 Performance Criteria: All street furniture shall remain in good visual and workable condition;

5.8 Maintenance Objectives: To repair any structural damage as required and retain surfaces in clean condition.

Maintenance Operations

- Annual inspections and maintenance carried out as necessary;
- Maintain and clean surfaces, remove graffiti as required;
- Repaint as required and as per manufacturer’s recommendations;
- Remove severely damaged and broken street furniture immediately; and
- All repair works to be carried out according to the latest H&S and BS legislation.

Litter Bins

5.9 Performance Criteria: All litter bins should remain in good visual condition and hygienic condition

5.10 Maintenance Objectives: To maintain litter bins in clean condition

Maintenance Operations

- Empty litter bins and remove contents to tip;
- To retain the litter bin in clean condition;
- To replace any damaged litter bin as per original selection; and
- Clean and/or repaint as required and as per manufacturer’s recommendation.

Light Fittings

5.11 Performance Criteria: All external lighting within public realm areas should remain in good working order and good visual condition

5.12 Maintenance Objectives: To maintain lighting fitting in good working order.

Maintenance Operations

- Regular inspections and repair as necessary;
- Clean and/or repaint as required and as per manufacturer’s recommendation;
- All repair works to be carried out according to the latest H&S and BS legislation; and
- All repair works to be inspected and signed off by a certified electrician.

Litter Operations

5.13 Performance Criteria: To maintain as far as possible a clean, litter free environment.

5.14 Maintenance Objectives: Collect and remove from site all extraneous matter on a regular basis so that its presence is not detrimental to the appearance of the site.

- Collect and remove to contractor's tip all extraneous rubbish not arising from routine maintenance works which is detrimental to the appearance of the site. This rubbish to include stones, bricks debris, paper, confectionery and other wrappings, bottle, cans and plastic containers;
- Collect and remove to the contractors tip all extraneous matter which has been deliberately deposited on site by persons known or unknown; and
- This work is to be carried out in accordance with the code of practise on litter and refuse issued under Section 89 of the Environmental Protection Act (1990) (NI) Particular care to be taken to remove all broken bottles glass, tins likely to constitute a hazard to the general public.

6.0 MAINTENANCE AND INSPECTION OF PLAY AREAS

6.1 *Performance Criteria: All equipped areas of play to remain in safe condition, good repair and in good visual condition. Maintenance of the play area will be in line with the requirements of BSEN 1176 and / or BSEN 1177 or BS 5696, DIN 7926 and BS 7188, with inspections every 2 weeks by qualified personnel, and quarterly and annual inspections by an independent inspection company.*

6.2 *Litter: Play areas shall be kept free of litter, so that at no time it will not be greater than 5%.*

Maintenance Operations

- Every two weeks, all play equipment, fencing, gates and bins will be visually inspected and any damage reported to the Management Company in accordance with ROSPA Information Sheet 24. If any equipment is damaged, the equipment will be made inoperable at the time of visit pending repair;
- Each play area will receive a post installation inspection with a corresponding report, and will receive three quarterly and one annual inspection from an independent inspection company;
- At each maintenance visit, all extraneous material including stones, bricks, debris, paper, confectionery, bottles, cans, glass, dog fouling, soil washing onto paths and paved areas and any other materials whatever their composition considered detrimental to the appearance of the site will be collected and removed. This excludes any arisings from fly tipping wherein the cost and arrangements for the removal of such material will be agreed separately from the removal of litter;
- Loose surfacing such as Bark chips shall be re-spread to maintain an even depth over the whole of the covered area. Particular attention shall be paid to fall areas around play equipment;

- All equipped areas for play shall be inspected and maintained in accordance with the requirements of BSEN1176 and/or BSEN1177 and amendments; and
- Annual inspections of play equipment in accordance with ROSPA Guidance and EN 1176/7 shall be carried out. Inspections shall be by an independent specialist. A written report shall be generated to included, but not limited to: site safety, safety and condition of equipment, surfacing and ancillary safety items, compliance with EN 1176. The report should include any remedial action required with an assessment of the degree of risk.

7.0 GENERAL SUMMARY

Introduction

7.1 All works, materials and operations will be in accordance with relevant legislation, British Standards, Regulations (including the CDM Regulations) and Codes of Practice.

7.2 It is important that all maintenance activities, significant events, surveys and monitoring activities are recorded. These provide an effective database against which the effects of maintenance and management activities can be assessed.

7.3 The landscape contractor responsible for maintaining the site shall maintain a record of site visits and the maintenance operations undertaken. The landscape contractor shall also record any significant events, i.e. fire, theft or vandalism of plant material or fencing. Specialist Contractors may be used on an as needs basis to complete specialist operations and/or occasional works.

Process for Monitoring and Review

7.4 The Landscape Management Plan and maintenance schedules will be monitored and assessed for their effectiveness on an annual basis for the first five years following the completion of the development. The review will include advice from specialist consultants as required (such as a qualified arboriculturist and ecologist), the Landscape Management Contractor and other stakeholders including representative(s) from the Council and local residents The review shall include (as appropriate):

- Technical Reports - advising on particular aspects such as protected species, general management and health & safety issues;
- Records / Attendance sheets demonstrating the maintenance work undertaken;
- Site visit to assess landscape components, condition, and need for any mitigation or enhancement; and
- Record and Minutes.

Annual Reviews

7.5 The landscape contractor will prepare an annual report at the end of each year of maintenance that shall be made available to the appointed member of the management committee supervising the maintenance contract.

7.6 The report will include a summary of the maintenance tasks undertaken during the course of the year together with an assessment by the landscape contractor of their perceived effects be they positive or negative. The appointed member will prepare a long-term review report after 5, 10 and 15 years of the maintenance contract.

7.7 The report shall include a brief summary of the preceding period of the management plan together with an assessment of the performance of the landscape areas against the performance criteria stated in this plan. The review shall also include recommendation for future maintenance including potential remedial or enhancement works.

Five Year Review

7.8 The Landscape Management Plan will be reviewed every five years, or as required to ensure the satisfactory management of the landscape in perpetuity.

Appendix A Management and Maintenance Report

SAMPLE MAINTENANCE REPORT			
Date		**Weather**	
Start Time		**Finish Time**	
Personnel on Site			
Staff Names		**Skills**	
Tasks Undertaken			
Management Tasks	**Tick Box**	**Comments**	
Cutting Grass	☐		
Weeding	☐		
Strimming Meadow	☐		
Pruning	☐		
Dead-heading	☐		
Litter Picking	☐		
Weed Spraying	☐	Specify chemicals and location	
Other	☐		
Tasks incomplete			
Management Task	**Specify Reasons**		
Management and Maintenance Notes			
Date of next site Visit			
Management Signoff			
Site Foreman		**Signature**	
Approved Manager		**Signature**	

Appendix B Specifications for Replacements - Post planting

Plant Material Generally

B1 Trees, shrubs and other plant materials as specified on the drawing shall be supplied from an approved source. Landscape products will be obtained from sustainable sources and from suppliers committed to sustainability.

B2 All trees and shrubs shall correspond exactly with the species, varieties and sizes shown on the planting plan, and shall comply with the relevant sections of *BS 3936 - Part 1: Nursery stock specification for trees and shrubs.*

B3 All shrubs, hedging plants, whips, feathered whips and climbing plants shall be properly grown, healthy, well established nursery transplants of good form, stock & strain, and shall have a well-developed fibrous root system.

Trees

B4 All trees shall have a well – balanced crown with an established framework of branches consistent with the species, a single straight stem and a well-developed fibrous rooting system.

B5 Bare rooted trees, where specified shall conform to the above.

B6 Root-balled trees, where specified shall be supplied with a root-ball of diameter and depth appropriate to the size and species of the tree. The minimum diameter shall be no less than ten times the diameter of the stem measured at 300mm above ground level. The root-ball shall be thoroughly moistened, prior to lifting from the nursery.

Appendix C Maintenance Task Schedules

Month	Location	Task	Duration	Comments
January	Lawn Shrubs/Borders Green/Biodiverse Roof	Cut and collect arising Weeding/Litter picking Weeding/Debris Clearing	Every 3 weeks Every 3 weeks Once	
February	Lawn Shrubs/Borders	Cut and collect arising Weeding/Litter picking	Every 3 weeks Every 3 weeks	
March	Lawn Shrubs/Borders Roses Rhododendrons Topiary	Apply slow release fertiliser Cut and collect arising Apply Medium release fertiliser Weeding/Litter picking Mulch all beds Apply slow release fertiliser Remove dead buds Prune dead wood Prune into shape	Once Every 2 weeks Once Every 2 weeks Once Once Once Once Once	$10\%N:5\%P_2O_5:3\%K_2O$ $7\%N:7\%P_2O_5:7\%K_2O$ $15\%N:6\%P_2O_5:12\%K_2O$ Only light prune
April	Lawn Shrubs/Borders Green/Biodiverse Roof	Cut and collect arising Weeding/Litter picking Apply slow-release fertilizer Weeding/debris Clearing	Every 2 weeks Every 2 weeks Once Once	$15\%N:6\%P_2O_5:12\%K_2O$
May	Lawn Shrubs/Borders Rhododendrons	Cut and collect arising Weeding/Litter picking Apply natural weed control Dead Heading	Every 2 weeks Every 2 weeks Once Every 2 weeks	Aphids, Vine Weevil, Black Spot, Mildew etc. Start as soon as the flowers are going over
June	Lawn Shrubs/Borders Rhododendrons	Water on Sulphate of Ammonium Cut and collect arising Weeding/Litter picking Apply natural weed control Dead Heading	Once Weekly Weekly Every 2 weeks Weekly	Only necessary if lawn appears pale Aphids, Vine Weevil, Black Spot, Mildew etc.
July	Lawn Roses Shrubs/Borders Rhododendrons	Water on Sulphate of Ammonium Cut and collect arising Apply slow release fertiliser Dead Heading Weeding/Litter picking Apply natural weed control Dead Heading	Once Weekly Once Weekly Weekly Every 2 weeks Weekly	Only necessary if lawn appears pale $15\%N:6\%P_2O_5:12\%K_2O$ Aphids, Vine Weevil, Black Spot, Mildew etc.

August	Lawn	Cut and collect arising	Weekly	
	Roses	Dead Heading	Weekly	
	Shrubs/Borders	Weeding/Litter picking	Weekly	Aphids, Vine Weevil, Black Spot, Mildew etc.
		Apply natural weed control	Every 2 weeks	
	Rhododendrons	Dead Heading	Weekly	
	Topiary	Prune into shape	Once	Only guidance prune
	Green/Biodiverse Roof	Cut and remove flowers Weeding/ debris clearing	Once Once	
September	Lawn	Apply slow release fertiliser	Once	10%N:5%P_2O_5:3:K_2O
		Aerate and overseed	Once	
		Cut and collect arising	Every 2 weeks	
	Shrubs/Borders	Weeding/Litter picking	Every 2 weeks	
		Apply natural weed control	Once	Aphids, Vine Weevil, Black
		Apply medium release	Once	Spot, Mildew etc.
	Rhododendrons	fertiliser	Every 2 weeks	7%N:7%P_2O_5:7%K_2O
	Lavenders	Dead Heading	Every 2 weeks	
		Dead Heading		
October	Lawn	Cut and collect arising	Every 2 weeks	
	Roses	Prune back	Once	
	Shrubs/Borders	Weeding/Litter picking	Every 2 weeks	
		Prune back	Once	
		Apply natural weed control	Once	Aphids, Vine Weevil, Black Spot, Mildew etc.
	Rhododendrons	Prune out dead wood	Once	
	Lavender	Cut back	Once	
	Climber	Prune back	Once	
	Topiary	Prune into shape	Once	Hard prune and shaping for next year
	Hedges	Prune into shape	Once	Hard prune and shaping for next year
	Green/Biodiverse Roof	Apply slow-release fertilizer Weeding/debris Clearing	Once Once	15%N:6%P_2O_5:12%K_2O
November	Lawn	Cut and collect arising	Every 2 weeks	
	Shrubs/Borders	Weeding/Litter picking	Every 2 weeks	
		Apply natural weed control	Every 2 weeks	
December	Lawn	Cut and collect arising	Every 3 weeks	
	Shrubs/Borders	Weeding/Litter picking	Every 3 weeks	
		Apply natural weed control	Every 3 weeks	

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Noise Impact Assessment

Great Western Yard

Hann Tucker Associates

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Noise Impact Assessment Report
29454/NIA1

Document Control

Rev	Date	Comment	Prepared by	Authorised by
3	11/07/2022	Minor updates	[redacted] Tom Bonnert Associate BEng(Hons), MIOA	
2	05/07/2022	Updated following comment from Client.team	Michael Hartley Consulting Engineer MEng(Hons), MIOA	Tom Bonnert Associate BEng(Hons), MIOA
1	24/06/2022	Draft issue for comment Update to include reference to Part ‘O’ of the Building Regulations	Thomas Jebson Assistant Consultant BSc(Hons)	Jake Howarth Associate BEng(Hons), MIOA
0	22/04/2022	Draft issue for comment	Thea Strother Technical Assistant	Tom Bonnert Associate BEng(Hons), MIOA

Noise Impact Assessment Report
29454/NIA1

Contents

Attachments

1.0 Introduction

Hann Tucker Associates Limited (HTA) has been commissioned by Eutopia Homes to undertake a noise assessment for a site in Gloucester.

The site, which is located off Great Western Road, is being considered for residential development. The proposals are for approximately 315No. units across houses and apartments with a mixture of private gardens and communal outdoor amenity spaces.

The site is subject to road noise from Great Western Road and Horton Road as well as rail noise. There is also potential for noise from emergency vehicle sirens associated with the nearby hospital.

Baseline noise conditions have been established by means of a detailed noise survey, presented herein. The findings have subsequently been used to assess the suitability of the site for residential use. Measures required to mitigate noise impacts for the proposed development (when operational) have been discussed in context with relevant national & local planning policies, design standards and good practice guides.

2.0 Objectives

To establish by means of an unmanned 24 hour (min) survey the existing L_{Amax}, L_{Aeq} and L_{A90} environmental road, rail and air traffic noise levels at secure and accessible on-site positions, using fully computerised noise monitoring equipment.

To undertake critical manned noise measurements to inform possible industrial/commercial noise impacts on the future proposed scheme.

To identify suitable noise emission limits from the development with reference to the requirements of the Local Authority and/or the application of BS 4142: 2014 and to minimise the possibility of noise nuisance to neighbours.

To undertake a noise assessment to assess the suitability of the proposed development for residential use in accordance with the Noise Policy Statement for England (NPSE), National Planning Policy Framework (NPPF), Planning Practice Guidance (ProPG), British Standard BS8233:2014 and Local Authority guidance/requirements.

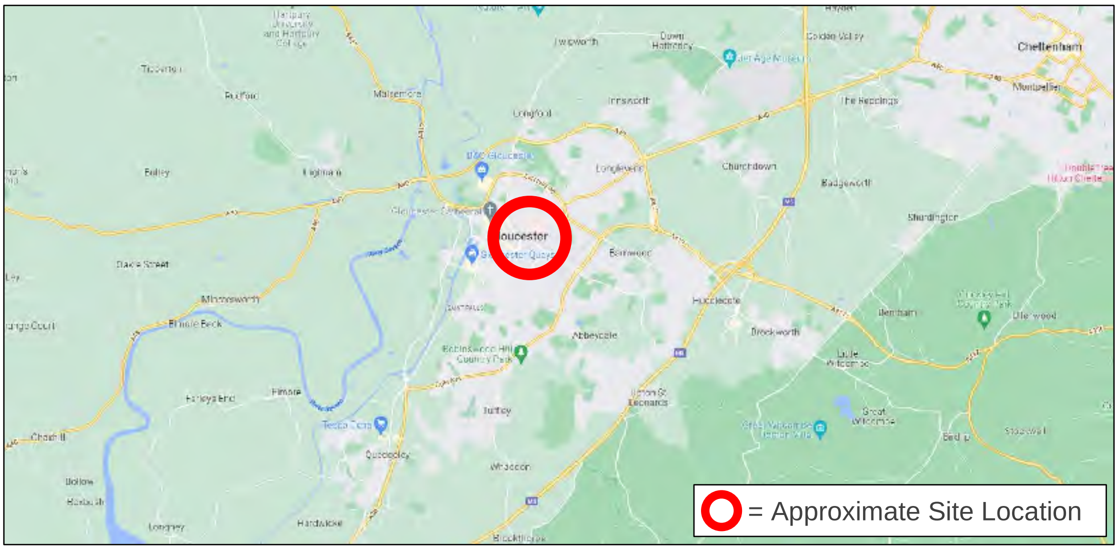
3.0 Acoustic Terminology

For an explanation of the acoustic terminology used in this report please refer to Appendix A enclosed.

4.0 Site Description

4.1 Location

The site is located in Gloucester and falls within the jurisdiction of Gloucester City Council. See Location Map below.

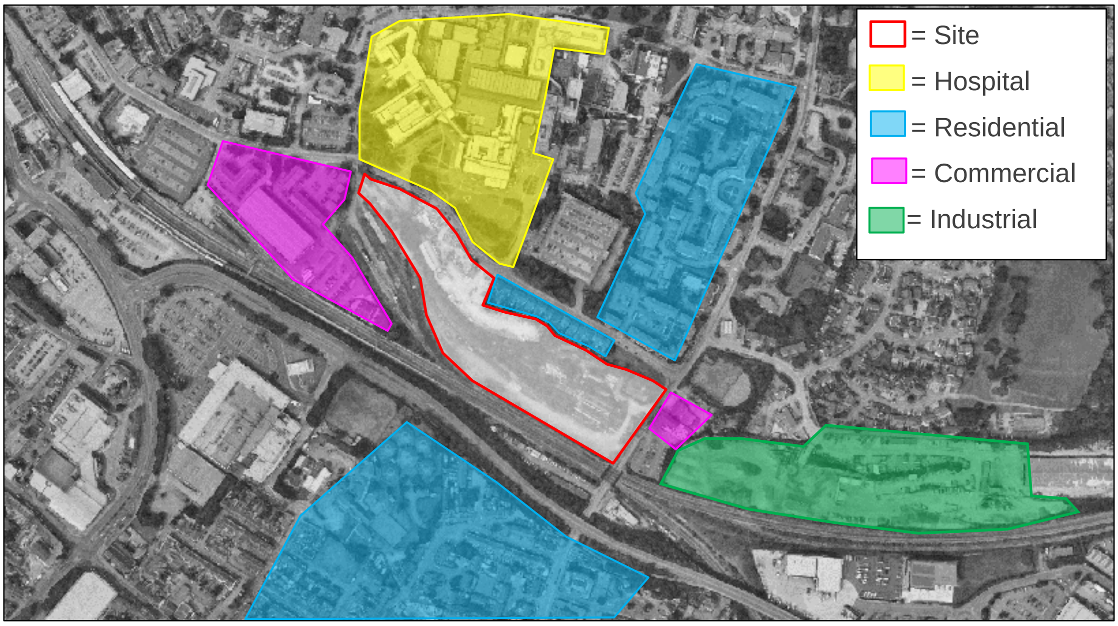


Location Map (©maps.google.com)

4.2 Description

The site lies off Great Western Road in Gloucester with Great Western Road and existing and established residential premises to the North, Horton Road to the East and railroad to the south. At the North boundary of the site beyond Great Western Road, lies Gloucestershire Royal Hospital, south of the site lies the railway close to Gloucester Train Station, and to the east of the site beyond Horton Road lies Allstones sand and gravel crushing.

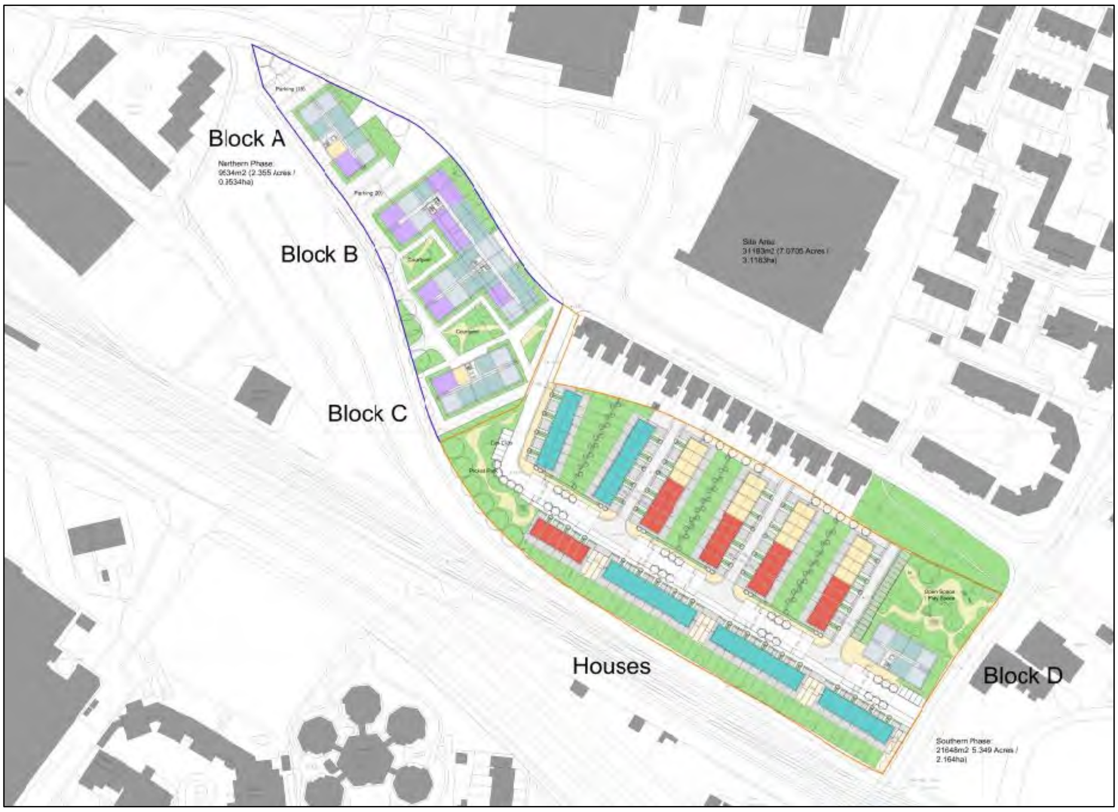
The dominant noise sources at site were noted to be road traffic noise from Great Western Road and Horton Road and rail noise from the railway to the south of site. Whilst on site it was subjectively observed that activity associated with the use of the Allstones site was not audible above the underlying road traffic and rail noise. See Site Plan below.



Site Plan (©earth.google.com)

5.0 Proposed Development

A site layout plan illustrating the site boundary and building massing is provided in the figure below for ease of context.



Proposed Site Plan (c/o Darling Associates Architects)

6.0 Planning Policy, Standards & Guidance

6.1 National Planning Policies

In order to provide a suitable assessment a number of national planning policies have been considered, including:

- The National Planning Policy Framework (NPPF), 2021
- The Noise Policy Statement for England (NPSE), 2010
- Planning Practice Guidance – Noise (PPGN), 2019

The above documents highlight the importance of considering the potential noise effects on any new residential development and provide a qualitative approach to assessment. However, each of the above does not provide any quantitative guidance. As such, all quantitative guidance used to form a noise impact assessment is taken from various other standards and guidance s as detailed in the following sections.

A detailed summary of each of the above National Planning Polices is provided in Appendix B for reference.

6.2 Standards & Guides

6.2.1 ProPG: Planning & Noise

ProPG: Planning & Noise 'Professional Practice Guidance on Planning & Noise' was issued in May 2017 with the primary goal of assisting the delivery of sustainable residential development by promoting good health and well-being through the effective management of noise. It seeks to do that through encouraging a good acoustic design process in and around proposed new residential development having regard to national policy on planning and noise.

It is applicable to noise from existing transport sources (noting that good professional practice should have regard to any reasonably foreseeable changes in existing and/or new sources of noise). The recommended approach is also considered suitable where some industrial or commercial noise contributes to the acoustic environment provided that is "not dominant".

ProPG advocates a systematic, proportionate, risk based, 2-stage, approach. The approach encourages early consideration of noise issues, facilitates straightforward accelerated decision making for lower risk sites, and assists proper consideration of noise issues where the acoustic environment is challenging.

The two sequential stages of the overall approach are:

- **Stage 1** – an initial noise risk assessment of the proposed development site; and
- **Stage 2** – a systematic consideration of four key elements.
    - Element 1 – demonstrating a "Good Acoustic Design Process";
    - Element 2 – observing internal "Noise Level Guidelines";
    - Element 3 – undertaking an "External Amenity Area Noise Assessment"; and
    - Element 4 – consideration of "Other Relevant Issues".

The ProPG considers suitable guidance on internal noise levels found in BS 8233 (see below) with the addition of an $L_{Amax,f}$ requirement for bedrooms at night, as below.

"Regular individual noise events (for example, scheduled aircraft or passing trains) can cause sleep disturbance. A guideline value may be set in terms of SEL or $L_{Amax,F}$*, depending on the character and number of events per night. Sporadic noise events could require separate values. In most circumstances in noise-sensitive rooms at night (e.g. bedrooms) good acoustic design can be used so that individual noise events do not normally exceed 45 dB* $L_{Amax,F}$ *more than 10 times a night. However, where it is not reasonably practicable to achieve this guideline then the judgement of acceptability will depend not only on the maximum noise levels but also on factors such as the source, number, distribution, predictability and regularity of noise events."*

6.2.2 BS 8233:2014

British Standard 8233: 2014 "Sound insulation and noise reduction for buildings" recommends design criteria for internal ambient noise levels for dwellings providing a reasonable or good level of protection from external noise. It states that it is desirable that ambient noise levels do not exceed the following guidelines:

Activity	Location	Desirable Internal Ambient Noise Levels	
		07:00 – 23:00	23:00 – 07:00
Resting	Living Rooms	35 dB $L_{Aeq,16hour}$	-
Dining	Dining Room/Area	40 dB $L_{Aeq,16hour}$	-
Sleeping (Daytime Resting)	Bedroom	35 dB $L_{Aeq,16hour}$	30 dB $L_{Aeq,8hour}$

Note 1: the above provides recommended levels for overall noise in the design of a building. However, ground borne noise is assessed separately and is not included as part of these targets, as human response to ground borne noise varies with many factors such as level, character, timing, occupant expectation and sensitivity

Note 2: If relying on closed windows to meet the guide values, there needs to be an appropriate alternative ventilation that does not compromise the façade insulation or the resulting noise level.

Note 3: Where development is considered necessary or desirable, despite external noise levels above WHO guidelines, the internal target levels may be relaxed by up to 5 dB and reasonable internal conditions still achieved.

Note 4: The levels detailed in the table above are based on the existing guidelines issued by the WHO and assume normal diurnal fluctuations in external noise and are not appropriate in all locations. Where atypical external noise levels are measured (ie high levels of traffic during certain times of the night) an appropriate alternative assessment period (eg 1 hour) and an assessment of individual night time events in terms of SEL or $_{LAmax,F}$ may be more suitable.

For outdoor living spaces, BS 8233 states For traditional external areas that are used for amenity space, such as gardens and patios, it is desirable that the external noise level does not exceed 50 dB $L_{Aeq,T}$, with an upper guideline value of 55 dB $L_{Aeq,T}$ which would be acceptable in noisier environments. However, it is also recognized that these guideline values are not achievable in all circumstances where development might be desirable and a compromise between elevated noise levels and other factors, such as the convenience of living in these locations or making efficient use of land resources to ensure development needs can be met, might be warranted. In such a situation, development should be designed to achieve the lowest practicable levels in these external amenity spaces but should not be prohibited.

Other locations, such as balconies, roof gardens and terraces, are also important in residential buildings where normal external amenity space might be limited or not available, i.e. in flats, apartment blocks, etc. In these locations, specification of noise limits is not necessarily appropriate. Small balconies may be included for uses such as drying washing or growing pot plants, and noise limits should not be necessary for these uses.

6.2.3 World Health Organisation (WHO)

The current Environmental Noise Guidelines 2018 for the European Region (ENG) supersede the Guidelines for Community Noise from 1999 (CNG). Nevertheless, the ENG recommends that all CNG indoor guideline values and any values not covered by the current guidelines (such as industrial noise and shopping areas) remain valid. A summary of the guidance from the ENG and CNG is shown in the table below.

Noise Source	CNG guideline indoors all sources	ENG guideline outdoors noise from specific source only
Road traffic	35 dB $L_{Aeq, 16h}$	53 dB L_{den}
	30 dB $L_{Aeq, 8h}$	45 dB L_{night}
Railway	35 dB $L_{Aeq, 16h}$	54 dB L_{den}
	30 dB $L_{Aeq, 8h}$	44 dB L_{night}
Aircraft	35 dB $L_{Aeq, 16h}$	45 dB L_{den}
	30 dB $L_{Aeq, 8h}$	40 dB L_{night}

With regard to single-event noise indicators, Section 2.2.2 of the WHO Environmental Noise Guidelines 2018 state:

"In many situations, average noise levels like the L_{den} or L_{night} indicators may not be the best to explain a particular noise effect. Single-event noise indicators – such as the maximum sound pressure level (L_{Amax}) and its frequency distribution – are warranted in specific situations, such as in the context of night-time railway or aircraft noise events that can clearly elicit awakenings and other physiological reactions that are mostly determined by $L_{A,max}$.

Nevertheless, the assessment of the relationship between different types of single-event noise indicators and long-term health outcomes at the population level remains tentative. The guidelines therefore make no recommendations for single-event noise indicators."

6.2.4 Part O of the Building Regulations

Building Regulations Approved Document O relates to setting standards for overheating in new residential buildings. It aims to protect the health and welfare of occupants of the building by reducing the occurrence of high indoor temperatures.

Requirement O1 of Approved Document O is met by designing and constructing the building to achieve both of the following:

- Limiting unwanted solar gains in summer.
- Providing an adequate means of removing excess heat from the indoor environment.

Sections 3.2 to 3.4 of this document relate to noise and state the following:

"In locations where external noise may be an issue (for example, where the local planning authority considered external noise to be an issue at the planning stage), the overheating mitigation strategy should take account of the likelihood that windows will be closed during sleeping hours (11pm to 7am).

Windows are likely to be closed during sleeping hours if noise within bedrooms exceeds the following limits.

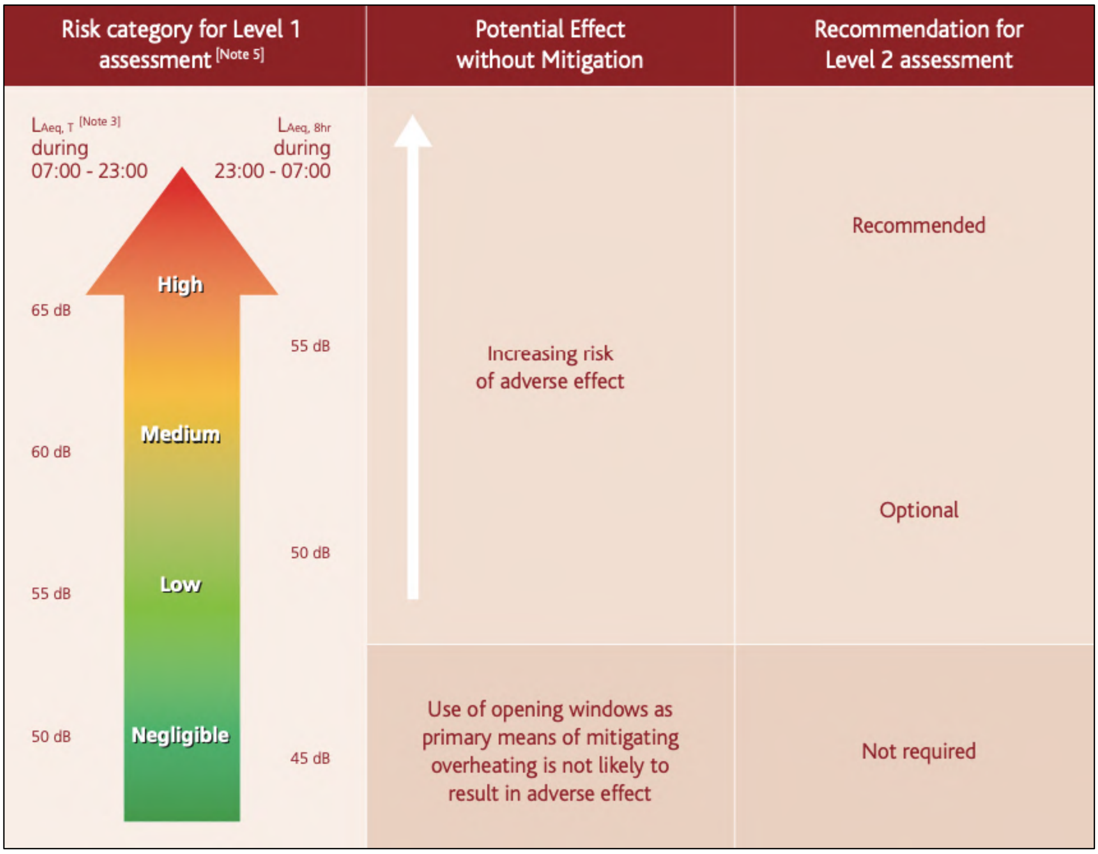
- *40 dB* $L_{Aeq,T}$*, averaged over 8 hours (between 11pm and 7am).*
- *55 dB* L_{AFmax}*, more than 10 times a night (between 11pm and 7am)."*

6.2.5 Acoustics, Ventilation & Overheating Residential Design Guide

The Acoustics, Ventilation and Overheating Residential Design Guide (Version 1.1) was issued in January 2020 by the Association of Noise Consultants (ANC) and the Institute of Acoustics (IOA). This document provides guidance on the interdependence between acoustics, ventilation and overheating.

The AVO guide recommends a two-level approach to assess the potential impact of noise ingress through windows that have been opened to mitigate overheating and also noise from any mechanical services used to provide comfort cooling.

The level 1 assessment relates to incident environmental noise levels across a proposed site, it is used to define “risk categories” for each building façade based on these levels. These categories are set out below:



Risk category for Level 1 assessment [Note 5]			Potential Effect without Mitigation	Recommendation for Level 2 assessment
$L_{Aeq,T}$ [Note 3] during 07:00 - 23:00		$L_{Aeq,8hr}$ during 23:00 - 07:00	Increasing risk of adverse effect	Recommended
65 dB	High	55 dB		
60 dB	Medium	50 dB		Optional
55 dB	Low			
50 dB	Negligible	45 dB	Use of opening windows as primary means of mitigating overheating is not likely to result in adverse effect	Not required

© ANC 2020. AVO Level 1 Assessment

Where a Level 2 assessment is recommended the AVO guide states that the Significant Observed Adverse Effect Level (SOAEL), which is the noise level above which significant adverse effects on health and quality of life occur, is dependent on how frequently and for what duration the overheating condition occurs (i.e. how often the windows need to be open to mitigate overheating). However, the document refers to the overheating condition being “rare” or “most of the time” rather than providing specific durations. Therefore this is open to interpretation.

At planning stage the level of information required to undertake a level 2 assessment in-line with the AVO guide is often not available and a level 1 assessment, which establishes the risk categories of each proposed façade would be most suitable.

6.2.6 BS 4142:2014

BS 4142: 2014 describes methods for rating and assessing the effects of outdoor sound levels, of an industrial and/or a commercial nature, "*on people who might be inside or outside a dwelling or premises used for residential purposes upon which sound is incident*".

The impact of a specific sound is indicated by subtracting the existing background noise level from the rating level (i.e. noise level from the proposed items of plant/machinery/etc plus any acoustic feature corrections). The standard states that:

- "a difference of around +10dB or more is likely to be an indication of a significant adverse impact";
- "a difference of around +5dB is of marginal significance is likely to be an indication of an adverse impact";
- "where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact".

The noise from the new development is expressed in terms of a rating level and given as a $L_{Aeq, T}$ noise level. The existing background noise level is expressed in terms of a $L_{A90, T}$ noise level. T is the assessment time interval, which is 1-hour for operations during daytime hours (07:00 to 23:00) and 15-minutes for operations during night-time hours (23:00 to 07:00).

BS 4142:2014 states that if a noise source contains an 'acoustic feature', such as tonality, intermittency or impulsiveness, an appropriate penalty should be applied.

6.3 Local Planning Guidance

The site lies within the jurisdiction of Gloucester City Council. Based on past email correspondence with Alex Mason (Environmental Health Officer at Gloucester City Council) it is understood that the noise egress requirements for newly installed building services plant is as follows:

> *"The cumulative noise assessment level (Excess of rating level over background level (L_{A90}) of sound emitted from any fixed plant or machinery associated with the development hereby permitted shall not exceed 0 dBA at the nearest noise sensitive receptor(s). All measurements shall be made in accordance with the methodology of BS 4142:2014+A1:2019 Methods for rating and assessing industrial and commercial sound."*

Although not specifically highlighted in past liaison with Gloucester, we expect that both internal and external amenity noise levels should be designed to be in-line with the requirements of

BS8233:2014 and WHO guidelines.

6.4 Proposed Assessment Criteria

6.4.1 Internal Noise Levels

Based on the above, it is proposed to assess noise intrusion in-line with the following noise level criteria to be for this development.

Area	Location	Desirable Internal Ambient Criteria	
		07:00 – 23:00	23:00 – 07:00
Residential	Living Room	35 dB $L_{Aeq,16hour}$	-
	Bedroom	35 dB $L_{Aeq,16hour}$	30 dB $L_{Aeq,8hour}$ 45 dB* L_{Amax}

* not normally exceeded (typically no more than 10-15 “events”)

Should an initial assessment of industrial noise indicate the possibility of an adverse impact in line with BS 4142:2014 “Methods for rating and assessing industrial and commercial sound”, these can be mitigated with suitably specified facades to secure good internal noise levels (ie embedded mitigation). Based on this, the following criteria is proposed regarding industrial noise control:

- Where industrial noise could ‘contribute’ to incident external noise levels on a given façade but are not considered to ‘dominate’, the above internal noise limits noted in BS 8233 should be met;
- However, where the industrial noise has the potential to ‘dominate’ the external noise climate, we would advise that industrial noise intrusion achieves limits 5 dB lower than the BS 8233 limits.

6.4.2 Outdoor Amenity Noise Levels

BS 8233:2014 states a desired noise level of 55 dB $L_{Aeq,16hr}$ be achieved within external amenity spaces. It is therefore proposed that this noise level be targeted within external amenity areas used for resting/relaxing (ie large communal terraces).

For small private balconies, whilst an ideal noise level of 55 dB $L_{Aeq,16hr}$ would be achieved BS 8233:2014 also states the *“Small balconies may be included for uses such as drying washing or growing pot plants, and noise limits should not be necessary for these uses.”*

Considering the above, we would suggest that a review of expected noise on small private balconies be considered, however there should not be an over-riding target as suggested for larger external amenity.

6.4.3 Building Services Plant Noise Egress

It is noted that the local planning authority has previously imposed planning conditions that plant noise limits be 5 dB below background when assessed in accordance with BS 4142:2014. It is therefore proposed for plant noise emission limits to be specified as a rating level 5 dB below typical lowest background sound level.

7.0 Baseline Noise Surveys

7.1 Procedure

Unattended noise monitoring was undertaken around the site over an 8-day period to establish full daytime and night-time noise levels over typical weekday and weekend periods. The monitoring was carried out between 14:30 hours on Wednesday 5th January 2022 and 14:30 hours on Thursday 13th January 2022 with equipment set up to record broadband and spectral (octave band) sound pressure levels over discrete 5 and 15-minute periods.

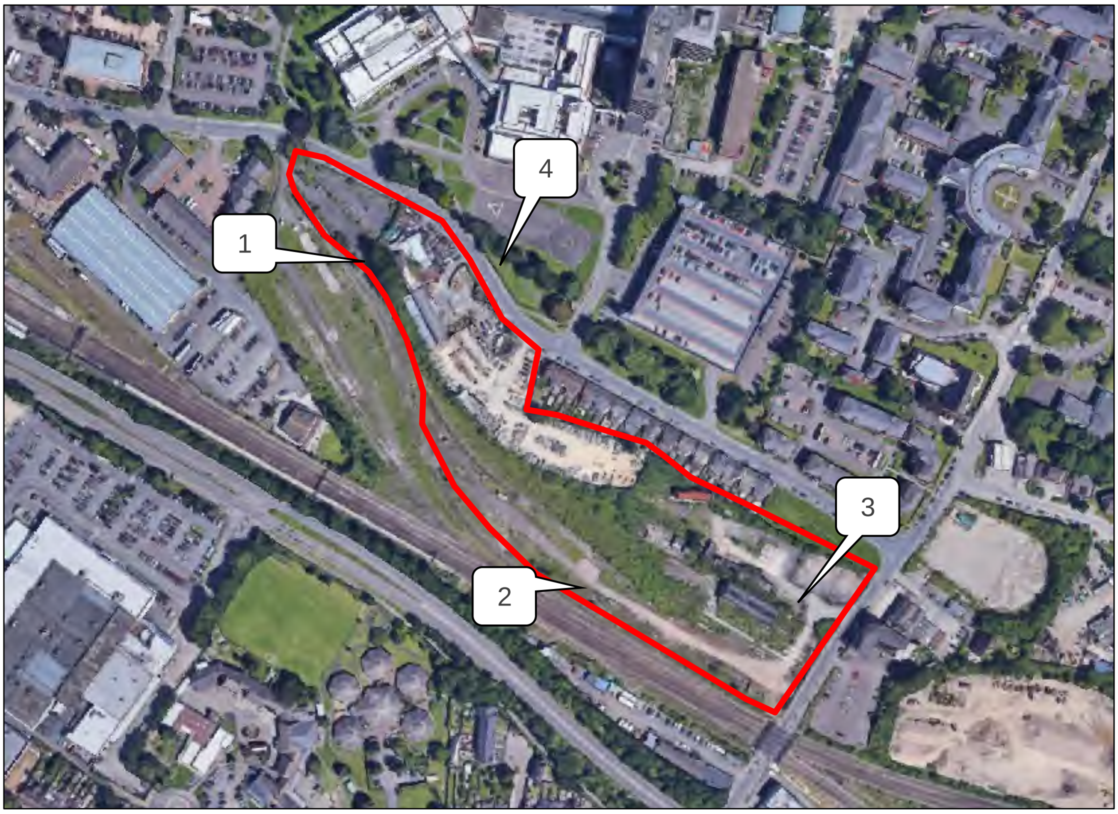
Additional manned measurements were performed between 14:00 hours and 16:20 hours on Thursday 13th January 2022 with the purpose of establishing specific noise levels associated with the operation of nearby industrial units and Great Western Road.

The surveys were performed by Thomas Jebson. All measurements were collated in general accordance with BS 7445-1:2003 *Description and Measurement of Environmental Noise*.

7.2 Measurement Positions

The measurement positions were as described and illustrated below.

Position	Type	Description
1	Unattended	To the North Western corner of the site, approx. 45m from the nearside edge of Great Western Road. Microphone in free-field conditions approx. 2m above ground.
2	Unattended	To the southern border of the site, approx. 116m from the nearside edge of Great Western Road, 140m from the nearest edge of Horton Road and 12m from the centre of the rail tracks. Microphone in free-field conditions approx. 2m above ground.
3	Unattended	To the Eastern border of the site, approx. 28 m from the nearside edge of Horton Road. Microphone in free-field conditions approx. 1.5m above ground.
4	Manned	Beyond the Northern border of site, at the far side of Great Western Road towards Royal Gloucestershire Hospital.



Site Plan (© maps.google.co.uk)

7.3 Weather Conditions

For the unattended survey between Wednesday 5th January 2022 and Thursday 13th January, local weather reports indicated no notable periods of prolonged and/or heavy rainfall, with wind speeds less than 5 m/s. During our time on site, skies were clear, wind conditions were calm and road surfaces were dry.

During the attended survey on Wednesday 5th January 2022, the weather was generally clear and dry with no periods of rainfall and calm wind conditions.

Weather conditions were deemed suitable for obtaining representative noise readings.

7.4 Instrumentation

The instrumentation used during the survey is presented in the table below.

Position	Description	Manufacturer	Type	Serial Number	Last Calibration
1	Type 1 Sound Level Meter	Larson Davis	824	3157	15/07/2021
2	Type 1 Sound Level Meter	Larson Davis	824	3824	15/07/2021
3	Type 1 Sound Level Meter	Larson Davis	824	3533	15/07/2021

Position	Description	Manufacturer	Type	Serial Number	Last Calibration
1, 2 & 3	Type 1 Calibrator	Larson Davis	Cal200	3083	06/05/2021
4	Type 1 Sound Level Meter	Bruel and Kjaer	2250	2600445	14/12/2020
4	Type 1 Calibrator	Bruel and Kjaer	4231	2115545	13/12/2021

Each unattended sound level meter was housed in a weatherproof case with the microphone connected via an extension cable. Manned measurements were taken with a handheld sound level meter mounted onto a tripod. All microphones were fitted with a windshield.

Each sound level meter was calibrated prior to and on completion of the surveys. No significant deviations occurred (not more than 0.3 dB).

7.5 Results

7.5.1 Unattended Noise Measurements

The results of the unattended survey have been plotted on Time History Graphs 29494/TH1, 29494/TH2 and 29494/TH3 enclosed. These graphs present the 15 minute A-weighted (dBA) L_{90}, L_{eq} and L_{max} levels at Positions 1, 2 and 3 throughout the duration of the survey.

A summary of the results, as used to inform subsequent assessments against current guidelines, is presented in the table below. The L_{A90} values presented are the 'representative' levels determined through statistical analysis of the 15-minute readings, in line with BS 4142. L_{Afmax} values are the '15th highest' 5-minute value. All results are free-field levels.

Position	Daytime (07:00 – 23:00 hrs)		Night-time (23:00 – 07:00 hrs)			
	$L_{Aeq,16hr}$	L_{A90}	$L_{Aeq,8hr}$	L_{A90}	Ventilation L_{Amax}	Overheating L_{Amax}
1	57	48	52	36	74	83
2	62	49	59	37	83	93
3	57	47	53	38	78	89

[1] External L_{AFmax} noise level not normally exceeded more than 10 times a night. This is considered to be the ventilation design case.

[2] Not normally exceeded absolute night-time maximum events should be calculated in-line with the paper *Assessing L_{max} for residential developments: the AVO Guide Approach.* This is considered to be the overheating design case when assessing opening windows as a means of overheating control.

7.5.3 Attended Noise Measurements

The following table summarises noise levels recorded at each of the manned measurement positions.

Position	Date	Period	Sound Pressure Level (dB)		
			$L_{Aeq,T}$	$L_{A90,T}$	$L_{Amax,T}$
4	05/01/2022	5 minutes	62	55	74
		5 minutes	65	55	77
		5 minutes	71	54	97
		5 minutes	67	60	78

7.6 Discussion of Noise Climate

Due to the nature of a portion of the survey, i.e. unattended, it is not possible to accurately describe the dominant noise sources, or specific noise events throughout the entire survey period. However, at the beginning and end of the survey period the noise climate across site was noted to be dominated by road traffic noise from Metz Way to the South of site and existing industrial units on site to the North West.

More specifically, the noise climate at Position 1 was dominated by industrial noise, however it was noted to be from a site that falls within the site boundary meaning it will not be a future noise emitter when the proposed development is brought forward. The noise climate at Position 2 was dominated by railway noise and road traffic noise from Metz Way, and the noise climate at Position 3 was also dominated by railway noise and road traffic noise from Metz Way with some influence from Horton Way.

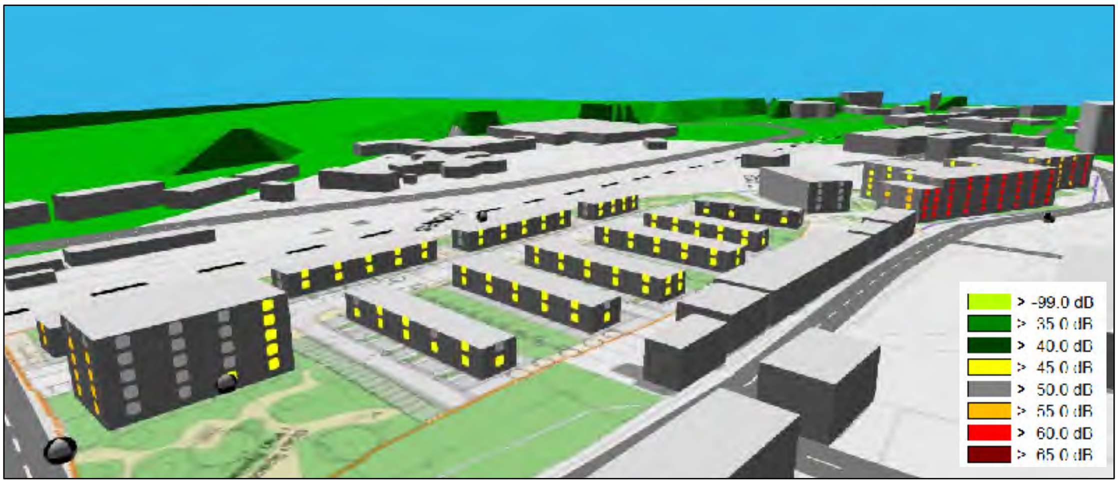
During the install and collection of the unattended noise monitors, as well as during the attended noise measurements, noise associated with the use of the Allstones site was not noted to be subjectively audible above the underlying environmental noise (ie road and rail).

8.0 Incident Noise Levels

The results of the baseline noise survey have been used to calibrate a 3-dimensional acoustic model of the site to better understand how noise is expected to propagate through the future development.

The calculated incident noise levels are provided in the figures below.

Northeast elevation daytime incident noise levels.



Northeast elevation night time incident noise levels.

Southwest elevation daytime incident noise levels.

Southwest elevation night time incident noise levels.

9.0 Assessment Overview

The following sections within this report present the findings of assessments that form the basis of this Noise Impact Assessment Report:

Industrial Noise Impact Assessment: The control of noise ingress to proposed residential apartments from existing industrial noise sources;

Internal Ambient Noise Assessment: The control of noise ingress to proposed residential apartments from external environmental noise sources;

Outdoor Living Spaces: The control of noise levels on external amenity areas used for resting/relaxing;

Plant Noise Emission Limits: Assessing new items of fixed building services plant against plant noise emission criteria.

10.0 Industrial Noise Impacts

As discussed in Section 4.2 And 7.6, the industrial site known as Jays Timber that falls within the site boundary and are therefore proposed to be demolished as part of the works has been excluded from our assessment.

The logistics centre to the West of site is expected to remain operational when the proposed development is brought forward. When on site, our engineer observed that the operations at this site were relatively quiet, and any noise produced was subjectively inaudible over the road traffic noise at the nearest site boundary. It was also noted that only 1No. lorry arrived in a period in which the attending engineer was on-site.

Operations at the Allstones site to the east, across Horton Road, were not noted to be of significance during our time on site and is expected to be inaudible over the surrounding road traffic noise at the nearest site boundary. We further understand that Allstones operates during daytime hours only and our longer term noise survey results did not indicate elevated noise level that have been attributed from activity at the Allstones site.

Due to the above observations, we have not carried out an objective assessment of these industrial sites as, a) they were not considered to be a subjective impact whilst on-site, and b) sufficient attenuation would be considered achieved by way of attenuation of the underlying environmental noise sources affecting the site.

11.0 Achieving Internal Noise Levels

11.1 Proposed Criteria

With reference to the acoustic standards and guidelines as reviewed in Section 6.4, we propose external noise intrusion levels from environmental sources be controlled so as to not exceed the following criteria.

Activity	Location	Desirable Ambient Criteria	
		07:00 – 23:00	23:00 – 07:00
Resting	Living Rooms	$L_{Aeq,16hour}$ 35 dB	-
Dining	Dining Room/Area	$L_{Aeq,16hour}$ 40 dB	-
Sleeping (Daytime Resting)	Bedroom	$L_{Aeq,16hour}$ 35 dB	$L_{Aeq,8hour}$ 30 dB L_{Amax} 45 dB[1]

[1] regular noise events such as trains, aircraft (10-15th highest)

The above shall be subject to the final approval of Gloucester City Council.

11.2 Preliminary Guidance for Windows & Ventilators

11.2.1 Overview

The current façade design proposals allow for cavity masonry external walls with punched-in double glazed windows. We understand that background ventilation will be provided to each dwelling by means of individual MVHR, or trickle ventilators with constant mechanical extract ventilation (MEV). There will be openable panels/windows for purge ventilation.

Our calculations follow BS 8233 procedures and consider the typical room dimensions and window sizes, as per the latest design drawings (at the time of writing).

11.2.2 Preliminary Specifications

Based on the external noise levels in the vicinity of the site, a reliance upon openable windows as a means of background ventilation is unlikely to be suitable as internal noise levels across all facades would likely exceed the proposed criteria in Section 6.2.2.

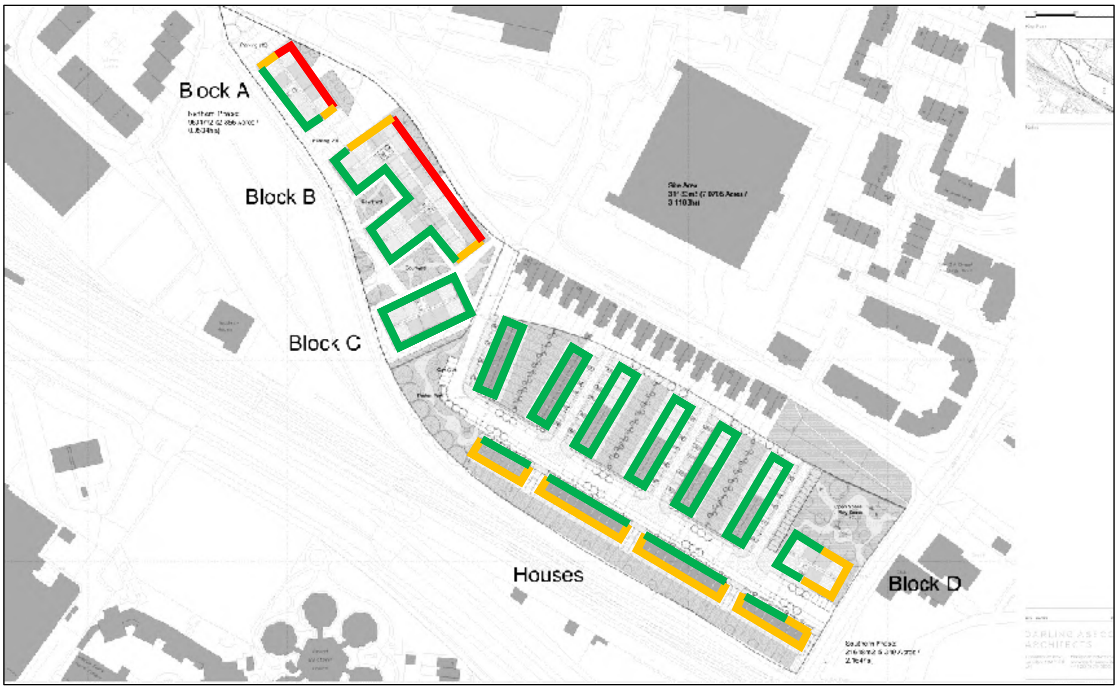
As such, suitable façade specifications for glazing and ventilators would be required to achieve suitable internal noise levels with windows closed whilst maintaining suitable ventilation rates. Windows can remain operable for purge situations.

Preliminary sound insulation calculations have been carried out to determine the minimum sound insulation performance of windows and ventilators. From the results of our assessment, the following minimum preliminary acoustic performance specifications are recommended:

Façade Zone		Façade Element	Preliminary Minimum Sound Reduction Specification
A	Red	Window	38 dB $R_w + C_{tr}$
		Ventilator	44 $D_{new} + C_{tr}$
B	Orange	Window	30 dB $R_w + C_{tr}$
		Ventilator	36 $D_{new} + C_{tr}$
C	Green	Window	27 dB $R_w + C_{tr}$
		Ventilator	33 $D_{new} + C_{tr}$

At detaled design stage octave band acoustic specifications will need to be developed, and it will be essential that the prospective glazing/cladding system suppliers can demonstrate compliance with these specifications, rather than simply offering generic glazing configurations as described above.

The following plans show the location of each façade zone noted in the table above.



Markup showing different glazing specification zones.

11.2.3 Example Glazing Configurations

Example glazing configurations commensurate with achieving the sound insulation performances are given below.

Glazing Specification, $R_w + C_{tr}$ (dB)	Example Configuration
38	Acoustic double glazed system e.g. 10/16/8.8 mm
30	double glazed system e.g 10/16/4 mm.
27	double glazed system e.g 6/16/6 mm.

11.2.4 Example Ventilation Solutions

Example ventilation solutions commensurate with achieving the sound insulation performances are discussed below.

Ventilator Specification, Dnew + Ctr (dB)	Example Configuration
44	High performance in-wall acoustic ventilator with absorption, or a mechanically assisted supply & extract solution (e.g. local MVHR).
41	High performance in-wall acoustic ventilator, or a mechanically assisted supply & extract solution (e.g. local MVHR).
36	1 x 2,500mm2 acoustic hit-miss trickle vent per habitable room, or a mechanically assisted supply & extract solution (e.g. local MVHR).
33	1 x 2,500mm2 standard hit-miss trickle vent per habitable room, or a mechanically assisted supply & extract solution (e.g. local MVHR).

The preliminary performance specifications included above are based on the provision of either full MVHR for dwellings or 1no. ventilator only per habitable room as required. If additional numbers of ventilators are required to achieve the ventilation rates, the performance requirement for the individual ventilators will need to increase.

The table below provides guidance on the increase in performance specification required for additional numbers of ventilators.

Number of Ventilators	Performance Increase on Ventilator Specifications Stated Above
1	+0 dB
2	+3 dB
3	+5 dB
4	+6 dB

11.2.5 Hospital Operations Noise Egress

We understand that Gloucester City Council has previously highlighted the potential for noise impact from emergency vehicle sirens and the air ambulance associated with the Gloucester Royal Hospital.

Whilst on site it was observed that although several ambulances arrived at and departed the hospital, sirens were switched off when driving past the existing residential plots on Great Western Road. This observation is congruent with the unattended monitoring data which after examination does not appear to exhibit events with characteristics typical of sirens. As such, we do no expect noise from sirens to be likely to cause a significant impact at the proposed site.

Furthermore, over the course of our survey we have not captured any results that would suggest that the helipad at the hospital was used for an air ambulance. It would be reasonable to assume that the helipad is not used regularly. The helipad is 50m from the closest border of site and so noise from the helicopter would be significantly quieter at the nearest façade than at the source. Due to the distance and infrequent use of the helipad, this should not be expected to have adverse negative impact on the proposed development.

11.3 Ventilation & Overheating

The above presents solutions to satisfy the proposed internal ambient noise limits within dwellings during normal ventilation conditions where windows are closed but MVHR systems to meet Part F minimum ventilation requirements are operational.

During purge requirements (ie to remove odour / smell, or at user discretion), windows will be openable as acoustic conditions are not considered to be a concern during such a time.

The remaining ventilation condition relates to overheating, whereby dwellings may require a higher number of air changes (ie higher ventilation rate) to achieve thermal comfort. During such instances, unlike for purge conditions, acoustic comfort remains a consideration therefore the overheating strategy should be designed with this in mind. For this development, the strategy to mitigate overheating is to incorporate over-sized MVHR units with a manual boost button, supplemented with attenuated façade openings.

Currently there are 2No documents which stipulate acoustic criteria for overheating conditions; Approved Document O (ADO) which took effect on 15 June 2022, and The Acoustics, Ventilation and Overheating Residential Design Guide (Version 1.1) (AVO) was issued in January 2020 by the Association of Noise Consultants (ANC) and the Institute of Acoustics (IOA). Given that ADO is legislation and AVO is guidelines, we will base our assessment on the criteria set out in ADO.

Based on the measured noise levels and the results of the acoustic modelling, traditional openable windows are unlikely to provide sufficient attenuation across proportions of the site due to the elevated noise climate, notably rail and road traffic noise at lower floors.

As such, an exercise has been carried out to establish if providing an attenuated façade opening would result in the ADO limits being achieved. Based on our calculations and measured noise levels, the attenuation provided by the attenuated façade openings would need to be as follows in each zone to comply with the requirement of the ADO.

Façade Zone		**Façade Element**	**Preliminary Minimum Sound Reduction Specification**
A	**Red**	Open Attenuated Façade Opening Panel	24 dB D_w
B	**Yellow**	Open Attenuated Façade Opening Panel	20 dB D_w
C	**Green**	Open Attenuated Façade Opening Panel	16 dB D_w

For **Red** façade zones the specification may be achievable by an opening panel/window but remains at the higher performance of what could reasonably be expected through a specially selected attenuated ventilation panel. We recommend this is reviewed further as the design progresses, and further information regarding potential for overheating is known.

Ultimately, the above does not advocate for sealed facades but highlights at an early stage measures to reduce reliance on open windows would be a sensible design item. Suitable measures could be, but are not limited to , solar rated glazing, or through fenestration design. It can be assisted with mechanical ventilation too, such as oversized MVHR with a manual summer boost function (as is understood to be proposed).

Air conditioning can also be considered for quality developments. However, the introduction of mechanical solutions should be considered carefully; not only with regard to cost and maintenance, but sustainability and the environment, which are likely to be more prominent drivers for any new development with the LPA’s jurisdiction.

For the **Yellow** façade zone, the use of attenuated façade openings as a means of overheating control is likely to achieve the criteria within internal spaces.

Within the **Green** façade zone, the specification is likely commensurate with that of an attenuated façade opening as this performance is only a marginal betterment of a traditional open window.

12.0 Outdoor Living Spaces

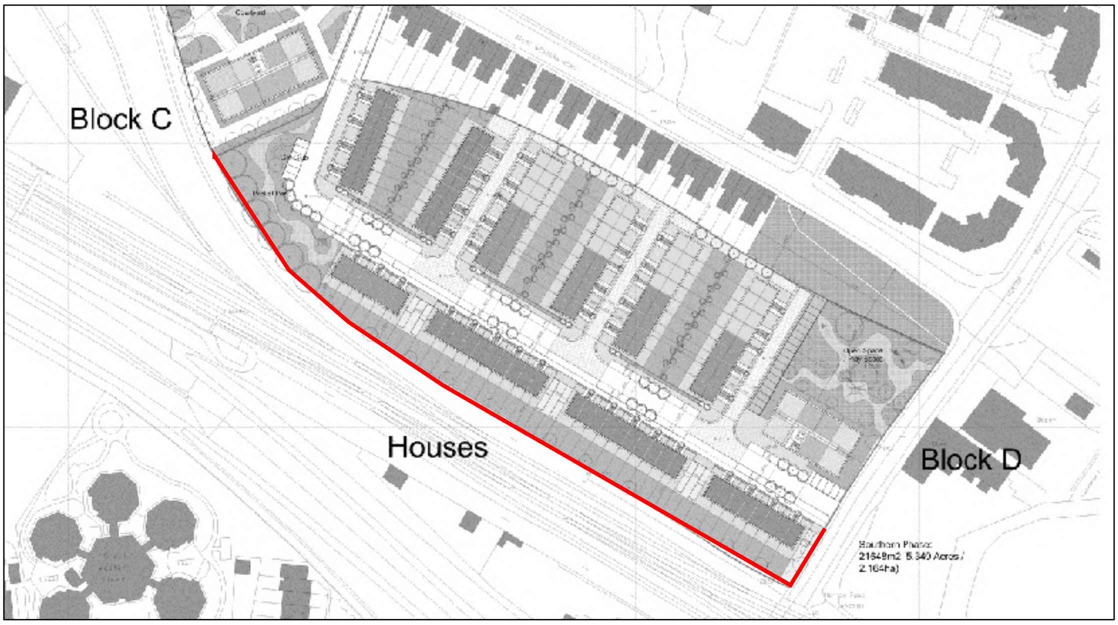
On this scheme, there are communal outside spaces, 88No. private gardens and small balconies on most apartments.

12.1.1 Gardens and Communal Spaces

Our noise model indicates that it is unlikely for the private gardens along the southern border to achieve noise levels below the upper noise limit of 55dBA without the use of a 2m high solid fence. However, with the use of a solid fence, noise levels of up to 56dBA would be expected in gardens.

As the gardens towards the West only exceed the limit by approximately 1dB, the residents may be able to use these gardens with little negative impact. An exceedance of 1dB is barely perceptible to the human ear and so would not be expected to cause adverse impact. There is also shared outside amenity space that achieves lower noise levels that is available to residents of the development, and so despite minor exceedance of the criterion in some private gardens these other areas should be taken into consideration.

Ultimately, we advise that a 2m tall solid fence is installed along the boundary of the site as indicated to mitigate noise intrusion from Horton Road and the railway.



The noise level within the Play Space will likely still exceed 55dBA, however, we note that an outdoor seating area already exists in this location and the proposals are simply to incorporate an outdoor playground (ie renovation rather than addition). As such, not only is the space expected to generate noise which in itself would mask underlying road noise, the area is not considered to be sensitive to noise as is not used for resting/relaxing. Given this, we do not consider it appropriate to target a specific noise criterion, and no specific noise mitigation is considered necessary to the Play Space.

12.1.2 Private Balconies

Based on our noise model, the following is noted for private balconies:

- Within the Red façade zones indicated on the ventilation and overheating markup in Section 10.4, it is expected that noise levels on the private balconies would be in excess of the desired noise levels;
- Within the Green and Orange façade zones on the same markup in Section 10.4, the private balconies are noted to comply with the desired noise level of 55 dB $L_{Aeq,16hr}$;

Whilst an ideal noise level of 55 dB $L_{Aeq,16hr}$ would not be achieved in all private balconies, in addition to outlining dispensation towards exceedances at the outer edge of balconies, BS 8233 also states the following with regards to small private balconies (which those proposed within the development would classify under):

> *"Small balconies may be included for uses such as drying washing or growing pot plants, and noise limits should not be necessary for these uses."*

Also, ProPG states that where despite following a good acoustic design, adverse noise impacts remain on any private external amenity space (ie garden or balcony), then the impact may be partially off-set if the residents are provided through the design of the development or the planning process, with access to:

> *"a relatively quiet alternative or additional external amenity space for sole use by a household, (e.g. a garden, roof garden or large open balcony in a different, protected, location)"*

Considering the above, we do not consider it appropriate to target a specific noise criterion and no specific noise mitigation is considered necessary to small private balconies.

13.0 Development-Generating Noise Impacts

13.1 Fixed Plant & Equipment

Based on the results of the noise site and the requirements of the Local Authority, we propose that the following plant noise emission criteria be achieved at the nearest noise sensitive residential windows, in free-field conditions, with all plant operating simultaneously.

Plant Noise Emission Criteria ($L_{Ar,Tr}$, dB)	
Daytime **(07:00 – 23:00 hours)**	**Night-time** **(23:00 – 07:00 hours)**
47	36

Noise shall be assessed in accordance with BS 4142:2014 with corrections applied for any plant emitting noise of a tonal or irregular quality. The above limits shall be subject to the final approval of Gloucester City Council.

14.0 Conclusions

A detailed environmental noise survey has been undertaken in order to establish the currently prevailing environmental noise climate around the site.

The environmental noise impact upon the proposed dwellings has been assessed in the context of national and local planning policies.

Our assessment indicates that acceptable internal noise levels are achievable within dwellings with appropriate selection of critical façade elements.

Openable windows should not be relied upon as a means of background ventilation, and an alternative ventilation strategy should be offered such as MEV with suitably acoustically specified ventilation openings in the facade or MVHR.

Windows can be operable by the user for rapid purge ventilation (i.e. to expel fumes and/or odours).

If overheating is a concern, measures to reduce reliance on open windows would be sensible, and consideration toward alternative measures such as solar rated glazing, fenestration design, attenuated façade openings, or manually boosted MVHRs.

The assessment shows the site, subject to appropriate mitigation measures, is suitable for residential development in terms of noise. The mitigation set out within this report is not considered to be unduly onerous and is typical of a residential development in an urban area boarding roads and a rail line.

Appendix A – Acoustic Terminology

The acoustic terms used in this report are defined as follows:

dB	Decibel - Used as a measurement of sound level. Decibels are not an absolute unit of measurement but an expression of ratio between two quantities expressed in logarithmic form. The relationships between Decibel levels do not work in the same way that non-logarithmic (linear) numbers work (e.g. 30dB + 30dB = 33dB, not 60dB).
dBA	The human ear is more susceptible to mid-frequency noise than the high and low frequencies. The 'A'-weighting scale approximates this response and allows sound levels to be expressed as an overall single figure value in dBA. The $_{A}$ subscript is applied to an acoustical parameter to indicate the stated noise level is A-weighted It should be noted that levels in dBA do not have a linear relationship to each other; for similar noises, a change in noise level of 10dBA represents a doubling or halving of subjective loudness. A change of 3dBA is just perceptible.
$L_{90,T}$	L_{90} is the noise level exceeded for 90% of the period *T* (i.e. the quietest 10% of the measurement) and is often used to describe the background noise level.
$L_{eq,T}$	$L_{eq,T}$ is the equivalent continuous sound pressure level. It is an average of the total sound energy measured over a specified time period, *T*.
L_{max}	L_{max} is the maximum sound pressure level recorded over the period stated. L_{max} is sometimes used in assessing environmental noise where occasional loud noises occur, which may have little effect on the L_{eq} noise level.
L_p	Sound Pressure Level (SPL) is the sound pressure relative to a standard reference pressure of 2×10^{-5} Pa. This level varies for a given source according to a number of factors (including but not limited to: distance from the source; positioning; screening and meteorological effects).
L_w	Sound Power Level (SWL) is the total amount of sound energy inherent in a particular sound source, independent of its environment. It is a logarithmic measure of the sound power in comparison to a specified reference level (usually 10^{-12} W).

Appendix B –National Planning Policies

National Planning Policy Framework (NPPF)

The National Planning Policy Framework (NPPF) was first published in 2012, replacing the existing Planning Policy Guidance Note 24 (PPG24) "Planning and Noise", and sets out the government's planning policies for England and how these are expected to be applied.

The latest revision of the NPPF (July 2021) states that planning system should contribute to, and enhance, the natural and local environment by (amongst others) *"preventing both new and existing development from contributing to or being put at unacceptable risk from, or being adversely affected by unacceptable levels of soil, water or noise pollution or land stability."*

NPPF advises that planning policies and decisions should ensure:

"…*new development is appropriate for its location taking into account the likely effects (including cumulative effects) of pollution on health, living conditions and the natural environment, as well as the potential sensitivity of the site or the wider area to impacts that could arise from the development*." [In doing so they should] "*mitigate and reduce to a minimum potential adverse impacts resulting from noise from new development – and avoid noise giving rise to significant adverse impacts on health and the quality of life*" and "*identify and protect tranquil areas which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason*."

"*…new development can be integrated effectively with existing businesses and community facilities (such as places of worship, pubs, music venues and sports clubs). Existing businesses and facilities should not have unreasonable restrictions placed on them as a result of development permitted after they were established. Where the operation of an existing business or community facility could have a significant adverse effect on new development (including changes of use) in its vicinity, the applicant (or 'agent of change') should be required to provide suitable mitigation before the development has been completed.*"

The NPPF makes reference to the Noise Policy Statement for England.

Noise Policy Statement for England (NPSE)

The Noise Policy Statement for England (NPSE) was published in March 2010 (i.e. before the NPPF). The NPSE is the overarching statement of noise policy for England and applies to all forms of noise other than occupational noise, setting out the long term vision of Government noise policy which is to "Promote good health and a good quality of life through the effective management of noise within the context of Government policy on sustainable development."

That vision is supported by the following NPSE noise policy aims which are reflected in three of the four aims of planning policies and decisions in the NPPF as below:

"Through the effective management and control of environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development:

- *avoid significant adverse impacts on health and quality of life;*
- *mitigate and minimise adverse impacts on health and quality of life; and*
- *where possible, contribute to the improvement of health and quality of life."*

The Explanatory Note to the NPSE has three concepts for the assessment of noise in this country:

NOEL – No Observed Effect Level
This is the level below which no effect can be detected and below which there is no detectable effect on health and quality of life due to noise.

LOAEL – Lowest Observable Adverse Effect Level
This is the level above which adverse effects on health and quality of life can be detected.

SOAEL – Significant Observed Adverse Effect Level
This is the level above which significant adverse effects on health and quality of life occur.

None of these three levels are defined numerically and for the SOAEL the NPSE makes it clear that the noise level is likely to vary depending upon the noise source, the receptor and the time of day/day of the week, etc. The need for more research to investigate what may represent an SOAEL for noise is acknowledged in the NPSE and the NPSE asserts that not stating specific SOAEL levels provides policy flexibility in the period until there is further evidence and guidance.

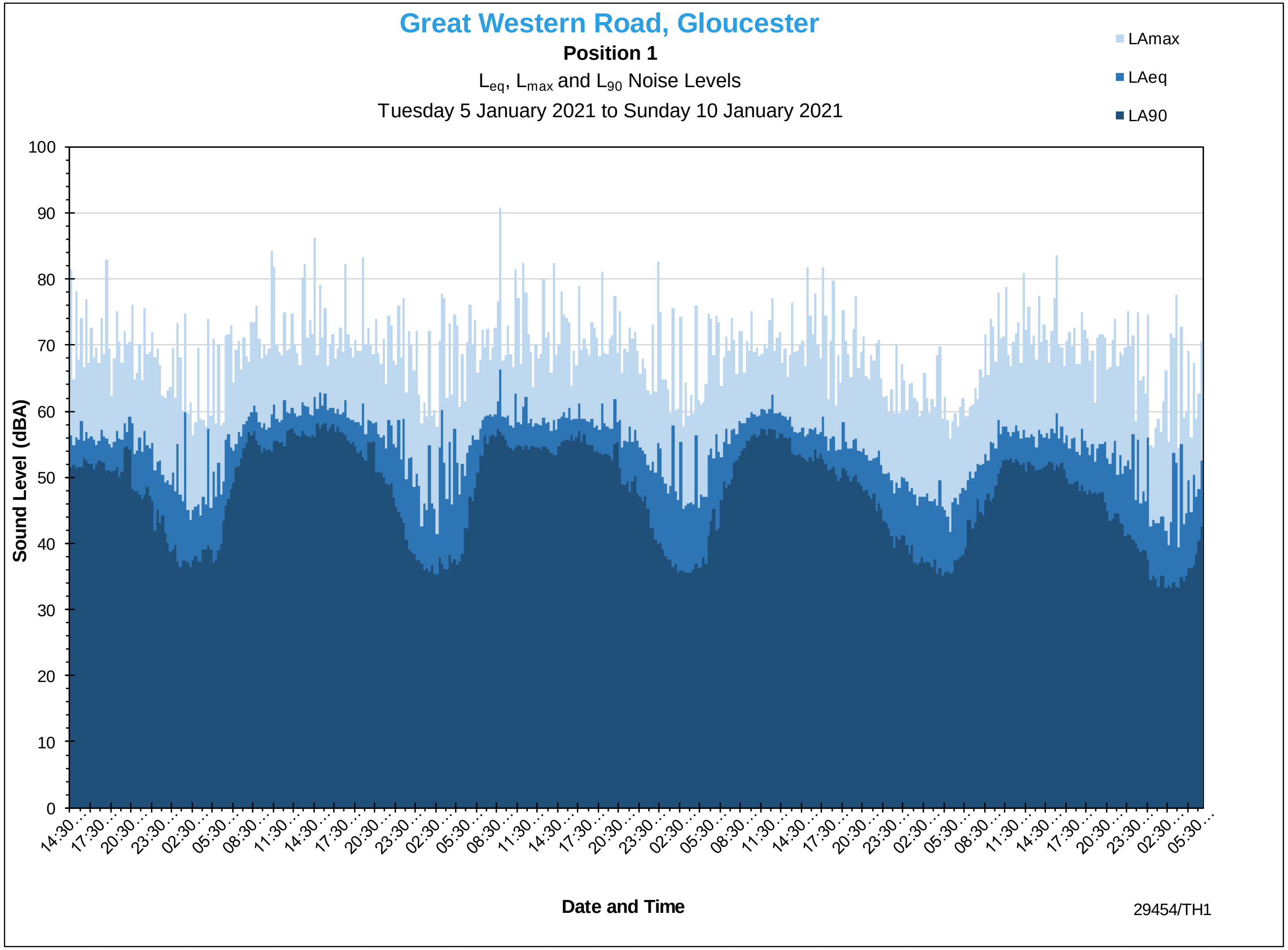
The NPSE concludes by explaining in a little more detail how the LOAEL and SOAEL relate to the three NPSE noise policy aims listed above. It starts with the aim of avoiding significant adverse effects on health and quality of life, then addresses the situation where the noise impact falls between the LOAEL and the SOAEL when *"all reasonable steps should be taken to mitigate and minimise adverse effects on health and quality of life while also taking into account the guiding principles of sustainable development."* The final aim envisages pro-active management of noise to improve health and quality of life, again taking into account the guiding principles of sustainable development which include the need to minimise travel distance between housing and employment uses in an area.

Planning Practice Guidance on Noise (PPG)

Planning Practice Guidance (PPG) under the NPPF has been published by the Government as a web based resource. This includes specific guidance on Noise although, like the NPPF and NPSE, the PPG does not provide any quantitative advice. It seeks to illustrate a range of effect levels in terms of examples of outcomes as set out in the following table:

Response	Examples of Outcomes	Increasing Effect Level	Action
No Observed Effect Level			
Not present	No effect	No Observed Effect	No specific measures required
Present and not intrusive	Noise can be heard, but does not cause any change in behaviour, attitude or other physiological response. Can slightly affect the acoustic character of the area but not such that there is a change in the quality of life.	No Observed Adverse Effect	No specific measures required
Lowest Observed Adverse Effect Level			
Present and intrusive	Noise can be heard and causes small changes in behaviour, attitude or other physiological response, e.g. turning up volume of television; speaking more loudly; where there is no alternative ventilation, having to close windows for some of the time because of the noise. Potential for some reported sleep disturbance. Affects the acoustic character of the area such that there is a small actual or perceived change in the quality of life.	Observed Adverse Effect	Mitigate and reduce to a minimum
Significant Observed Adverse Effect Level			
Present and disruptive	The noise causes a material change in behaviour, attitude or other physiological response, e.g. avoiding certain activities during periods of intrusion; where there is no alternative ventilation, having to keep windows closed most of the time because of the noise. Potential for sleep disturbance resulting in difficulty in getting to sleep, premature awakening and difficulty in getting back to sleep. Quality of life diminished due to change in acoustic character of the area.	Significant Observed Adverse Effect	Avoid
Present and very disruptive	Extensive and regular changes in behaviour, attitude or other physiological response and/or an inability to mitigate effect of noise leading to psychological stress, e.g. regular sleep deprivation/awakening; loss of appetite, significant, medically definable harm, e.g. auditory and non-auditory.	Unacceptable Adverse Effect	Prevent

Appendix C – Time History Plots

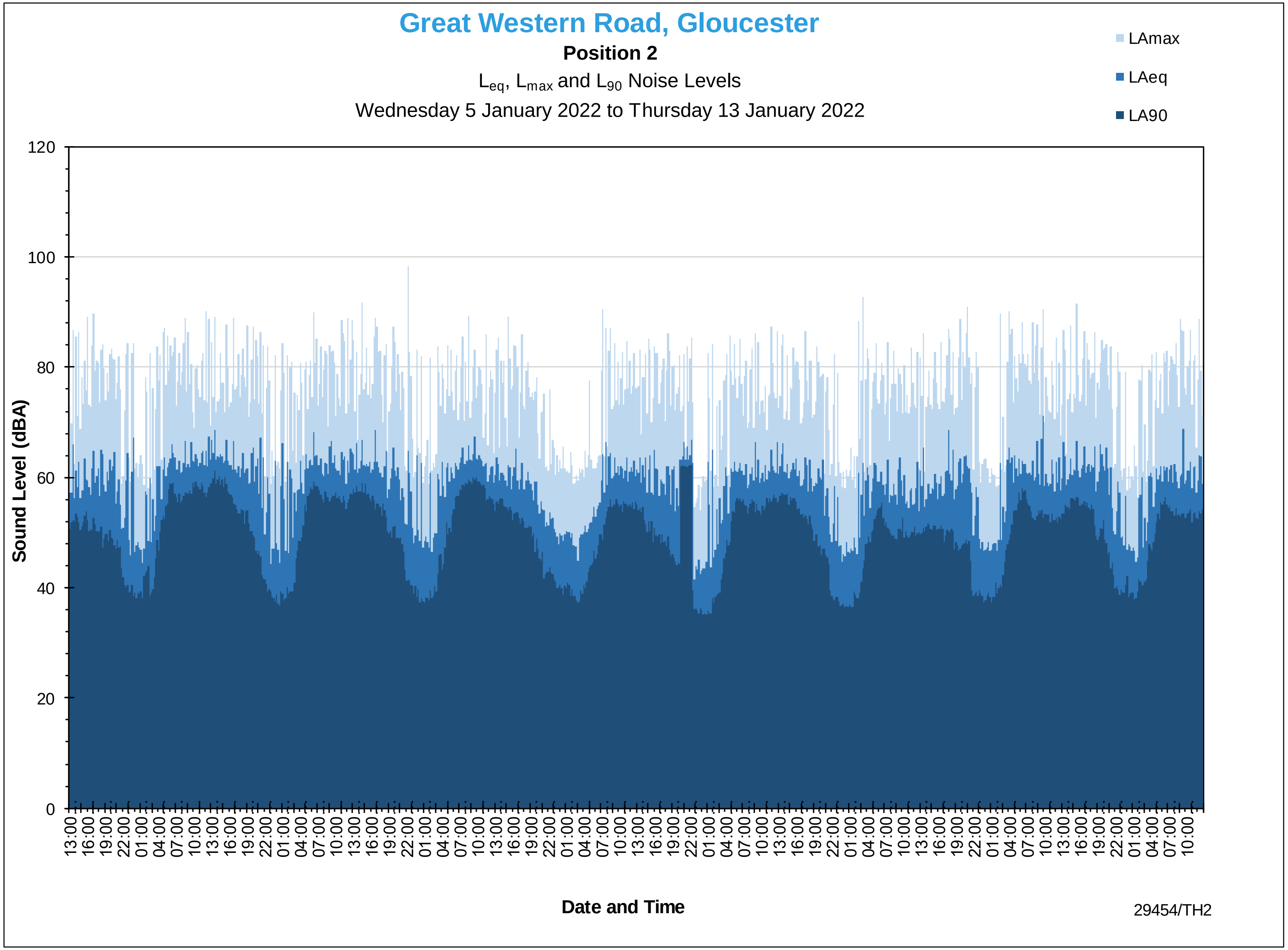


Great Western Road, Gloucester

Position 1

L_{eq}, L_{max} and L_{90} Noise Levels

Tuesday 5 January 2021 to Sunday 10 January 2021


Great Western Road, Gloucester
Position 2
L_{eq}, L_{max} and L_{90} Noise Levels
Wednesday 5 January 2022 to Thursday 13 January 2022
LAmax
LAeq
LA90
Sound Level (dBA)
120
100
80
60
40
20
0
13:00
16:00
19:00
22:00
01:00
04:00
07:00
10:00
13:00
16:00
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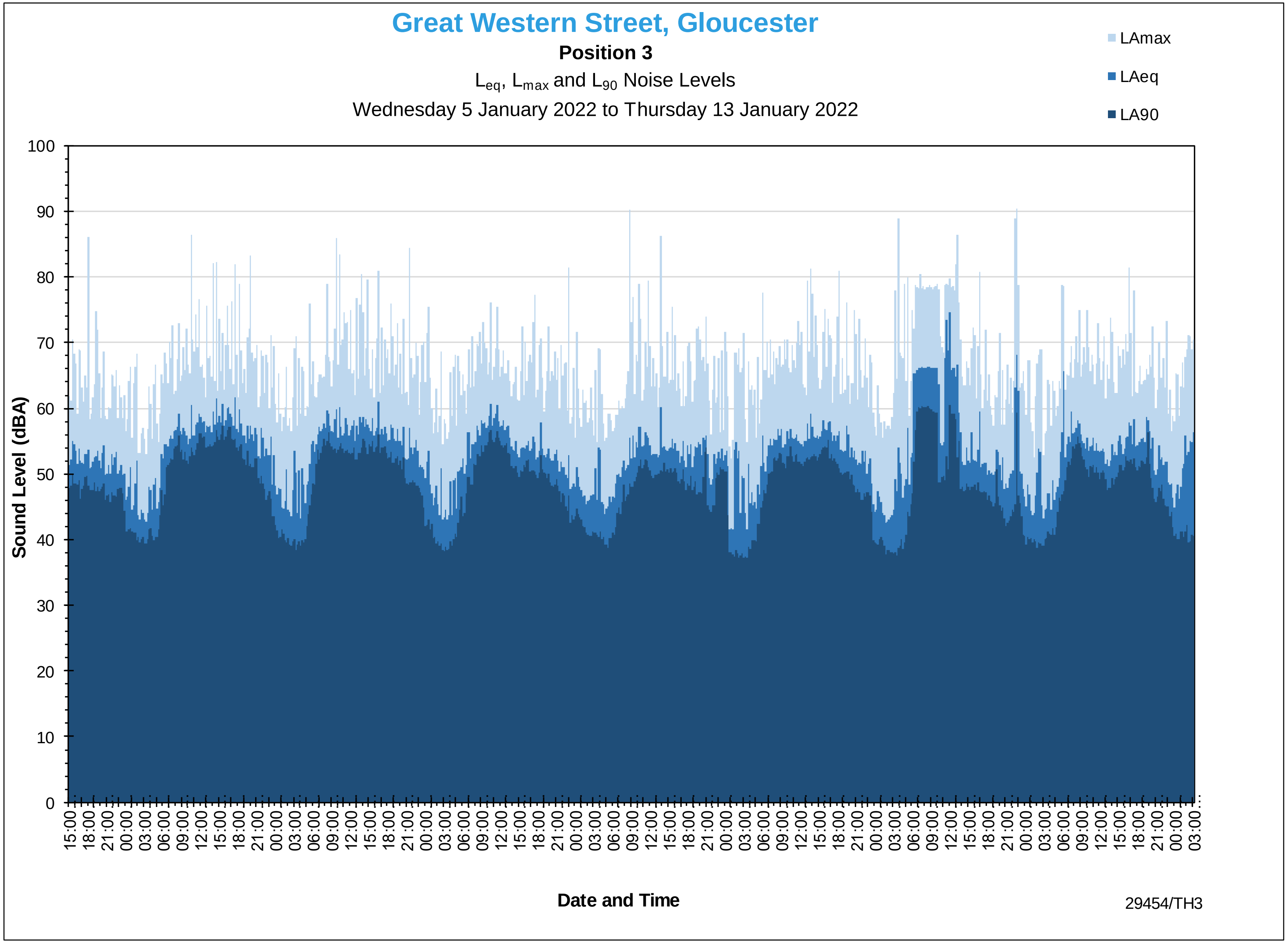
Date and Time
29454/TH2



Great Western Street, Gloucester

Position 3

L_{eq}, L_{max} and L_{90} Noise Levels

Wednesday 5 January 2022 to Thursday 13 January 2022

29454/TH3

EUTOPIA
HOMES

Planning Statement

Great Western Yard

Pegasus Group

Document Management.

Version	Date	Author	Checked/ Approved by:	Reason for revision
3	July 2022	LF	DH	

Contents.

Appendices contents.

1. Introduction

1.1. This Planning Statement has been prepared by Pegasus Group on behalf of Eutopia Homes (Gloucester) Ltd and its successors in title to the land, in support of proposals for full planning permission for a residential development of up to 315 dwellings on land at Great Western Yard, off Great Western Road, Gloucester.

1.2. This Planning Statement provides an overview of the decision making context including the National Planning Policy Framework (2021), the online National Planning Practice Guidance, the adopted Gloucester, Cheltenham and Tewkesbury Joint Core Strategy (Dec 2017), the saved policies of the Gloucester City Plan, the adopted Gloucestershire Minerals Local Pan (March 2020) and the emerging Gloucester City Plan.

1.3. The application is submitted following pre-application discussions held with Gloucester City Council in February 2022 as well as community consultation which took place between 21st May 2022 and 21st June 2022. Details of the public consultation are set out in the Statement of Community Involvement, with the pre-application discussions similarly summarised in the Design and Access Statement.

1.4. This Statement takes the following form:

Section 2 describes the Application Site and the surrounding area;

Section 3 provides a summary of the planning history of the site

Section 4 sets out the application proposals

Section 5 describes the relevant national and local planning policy

Section 6 comprises the Affordable Housing Statement

Section 7 discusses the planning merits of the proposal

Section 8 provides the overall conclusions

1.5. The application is accompanied by a number of supporting technical documents including an Ecological Assessment, Transport Statement, Flood Risk Assessment and Drainage Strategy, Acoustic Assessment and Heritage Report.

1.6. A Screening Opinion was submitted to Gloucester City Council on 25th March 2022 under Regulation 6 of the Town and County Planning (Environmental Impact Assessment) Regulations 2017 (as amended) for the proposed of up to 330 dwellings, associated infrastructure and landscaping on land at Great Western Yard, Great Western Road, Gloucester.

1.7. Gloucester City Council confirmed by letter dated 26th April 2022 that the proposed development would not constitute EIA development (22/00323/EIA).

2. Application site and surroundings

2.1. The application site is located to the north east of Gloucester City Centre and comprises a 3.14 ha brownfield site. The site is located between Great Western Road to the north, the mainline railway to the south, Horton Road to the east and an existing industrial area to the west.

2.2. The site was previously owned by Network Rail and comprises former railway sidings and associated sheds to the east and south, builders merchants and car repair businesses to the north, each with associated structures, and a hard surfaced area formerly used for car parking to the north west of the site.

2.3. The application site lies wholly within the ward of Kingsholm and Wotton.

2.4. The campus of Royal Gloucestershire Hospital (GRH) is located to the north of the site, including a multi storey car park and tower block. A terrace of two storey dwellings are located to the south of Great Western Road and to the immediate north of the site. To the east of the terrace is a small area of public open space known as Great Western Road Rest Gardens. Opposite the rest gardens on the northern side of Great Western Road is a three storey apartment block development.

2.5. To the east of the site is Horton Road and to the southeast Horton Road level crossing. To the east of Horton Road is the three-storey local community facility of Gloucester Irish Club with associated car parking. Beyond the Irish Club is the Allstones waste and recycling facility including a crushing and screening facility the subject of temporary planning permission until 5th October 2022.

2.6. The mainline railway is located to the south of the site, with Metz way flyover beyond.

2.7. To the west of the site is Pullman Court which comprises two and three storey brick-built office buildings plus a warehouse building currently occupied by WMB with associated surface level car parking.

2.8. Network Rail retain three sidings tracks off the mainline railway to the south west of the site.

2.9. The site will be accessed from Great Western Road to the north with cycle and pedestrian connectivity also achievable from Horton Road. Great Western Road leads to Horton Road which provides access to the north of the site to the A38 and the A40. Great Western Road also provides connectivity to London Road to the west which provides vehicular connectivity to the City Centre and to the west and south of the City beyond.

2.10. The application site boundary and context is identified at Appendix 1.

APPENDIX 1 – SITE LOCATION PLAN

2.11. A Transport Assessment has been prepared to support the application. The site is located in close proximity to the City Centre making it suitable for active modes of travel including walking and cycling. It is located in very close proximity to the City's transport interchange including Gloucester Railway Station and the new Gloucester Bus Station. The close proximity of the site to Gloucestershire Royal Hospital and the City Centre ensures access to employment opportunities accessible by walking and cycling.

2.12. The Environment Agency online mapping 'Flood Map for Planning (Rivers and Sea) shows the site to be entirely within Flood Zone 1, low risk, having an annual probability of flooding of less than 1:1,000. The National Planning Policy Framework (NPPF), and National Planning Practice Guidance (NPPG) on Flood Risk and Coastal Change confirm that all types of development are appropriate in Flood Zone 1.

2.13. There are no significant flooding or drainage issues that would prevent the development of the site. Therefore, in terms of flooding and drainage the site is considered to be a sustainable location for development.

2.14. It is proposed that the new development will be served by existing utilities services subject to any necessary reinforcement identified at the detailed design stage and to the details contained within the site-specific Flood Risk Assessment and Drainage Strategy submitted in support of this application.

2.15. There are no statutory or non-statutory sites of nature conservation interest within the site.

2.16. There are no designated heritage assets on the site itself. A number of listed buildings are recorded in the wider area, but no demonstrable harm would result to their setting or significance as a result of proposed development.

2.17. The nearest statutory Listed Building, which is situated to the east of the application site, is the Grade II* Horton Road Hospital which is located to the north of the site to the west of Horton Road.

2.18. A gas holder was formerly situated at the junction of Horton Road and Myers Road. The facility gas now been decommissioned. Reference to the Health & Safety Executive consultation website for planning purposes indicated in March 2022 that with regard to proposed development at Great Western Road Sidings;

> ***"Your development does not intersect a pipeline of hazard zone, HSE Planning Advice does not have an interest in the development."***

2.19. The result of the online consultation can be found at Appendix 2.

APPENDIX 2 – HSE ONLINE CONSULTATION RESULT

2.20. Development at this location provides the opportunity for travel choices other than the private car with bus and train services accessible from Gloucester City Centre to Cheltenham, Stroud, Bristol, Birmingham, London, South Wales and beyond. The site therefore offers the opportunity to deliver a housing development in a highly sustainable location.

3. Planning history of the application site

3.1. An application for the Prior Approval of demolition of the existing brick-built sheds and other associated structures on the eastern part of the site was submitted to Gloucester City Council on 6th May 2022 (22/00482/PRIOR).

3.2. The local planning authority granted Prior Approval for the demolition described above on 14th June 2022. The decision notice is attached at Appendix 3.

APPENDIX 3 – DECISION NOTICE 22/00482/PRIOR

3.3. Owing to the cyber attack on Gloucester City Council it is not possible to interrogate the planning history of the site further than this most recent application.

3.4. The site comprised part of a wider area covered by the Interim Adoption Railway Corridor Planning Brief[1] adopted by the City Council in 2011. This matter is considered further in the Planning Policy section.

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[1] https://www.gloucester.gov.uk/media/2289/railwaycorridorplanningbrief2011.pdf

4. Application Proposals

4.1. This application seeks full planning permission for '**Residential development of up to 315 dwellings with associated landscaping, parking, open space and ancillary works including demolition of existing buildings**'.

4.2. The application is submitted in full including all floor plans and elevations of the apartment blocks and houses proposed. The site layout plan demonstrates how the site responds to existing constraints and opportunities on the site, including those identified in the technical reports submitted as part of the planning application.

4.3. The application proposes a total of 87 two storey town houses and 228 apartments. Both the town houses and apartments provide a mix of size and type of units which are detailed in the accompanying Design and Access Statement.

4.4. A policy compliant proportion of the proposed dwellings will be provided as affordable units, with the remaining units provided as open market dwellings. The Affordable Housing Statement is included at Section 6.

4.5. The site is able to contribute to the Council's five-year housing land supply (including the provision of affordable housing) in a timely manner, this is a significant material consideration in the determination of this application as set out in greater detail at Section 7.

4.6. The application proposes the demolition of existing structures across the whole site, however it should be noted that prior approval for the demolition of the former engine sheds on the eastern part of the site was granted by the local planning authority on 14th June 2022.

4.7. Vehicular access to the site is provided from Great Western Road with pedestrian and cycle linkages to Horton Road.

4.8. A more detailed description of development and the justification for the design concept that has been followed is set out in the Design and Access Statement accompanying this application.

4.9. A new area of public open space is proposed adjacent to the existing Great Western Road Rest Gardens. The public open space has been designed to allow integration of the existing public open space into the wider scheme should the Council wish to pursue this option in due course.

4.10. The landscape strategy for the site is detailed in the Landscape Design and Access Statement prepared by Park Wood Design, it proposes pocket parks, public open space and local areas for play and includes increased levels of tree planting as well as naturalistic areas of planting to compliment the sustainable drainage strategy across the site.

4.11. The submitted Transport Assessment details the car and cycling parking strategy for the site which includes a reduced level of on-site car parking owing to the sustainable location of the site which offers opportunities for active travel including walking and cycling.

4.12. The proposal incorporates both biodiverse roofs on the apartment blocks for biodiversity purposes and solar panels on apartments and houses to meet carbon reduction and on site renewable energy requirements.

4.13. The Daylight and Sunlight Assessment detailed in the DAS and the revised site layout and building heights resulting from pre-application discussions with the Council ensure that the proposals do not have an adverse impact on the residential amenity of existing dwellings to the south of Great Wester Road as a result of reduced daylight and sunlight.

4.14. The Noise Impact Assessment Report states that internal and external noise can be adequately addressed with appropriate mitigation.

4.15. The submitted development proposal will result in a circa 25% net gain in biodiversity units on site as well as a significant uplift in hedgerow units on site as detailed in the Biodiversity Net Gain report.

Community Consultation

4.16. A site visit and briefing for Cllr Richard Cook (Leader of Gloucester City Council) and David Oakhill (Head of Place) plus local ward Councillors for Kingsholm & Wooton Cllrs Angela Conder and Jeremy Hilton took place on 7th April 2022.

4.17. A public consultation event was held between the period 21st May 2022 and 21st June 2022 with over 800 local residents in the vicinity of the site advised of the consultation with a letter delivered to their home. The consultation website went live on 21st May 2022.

4.18. An in person public exhibition was held on Monday 30th May 2022 at the Irish Club on Horton Road, and a virtual public consultation event was held via Zoom on the evening of Tuesday 31st May 2022. Written responses to the proposals could be made via a dedicated email address [redacted] and via the feedback form on the consultation website https://www.greatwesternyard .

4.19. Overall, the main issues raised by the consultation were:

- Local traffic conditions – congestion/highway capacity and how the scheme works alongside the Gloucestershire Royal Hospital and the Horton Road level crossing;
- The quantum of parking for residents' vehicles and the rationale for a low car development;
- The proposed heights of the new properties and their relationship to the nearest properties on Great Western Road; and
- How the proposed open space at the eastern edge of the site works with and relates to the Council owned open space to the northeast of the site.

4.20. A full account of all comments received, and relevant responses are provided in the Statement of Community Engagement which accompanies this application.

5. Relevant Planning Policy

National Planning Policy

5.1. The most recent revised National Planning Policy Framework was published and came into immediate effect on 20th July 2021. The NPPF sets out at paragraph 10 that;

> ***"..at the heart of the Framework is a presumption in favour of sustainable development"***

5.2. Paragraph 8 identifies the three dimensions to sustainable development which include economic, social and environmental roles. Paragraph 8 states that these roles are mutually dependent and need to be pursued in mutually supportive ways. Therefore, to achieve sustainable development, the NPPF recognises that economic, social and environmental gains should be sought jointly and simultaneously through the planning system.

5.3. Paragraph 11 sets out how policy in the NPPF pursues sustainable development through both plan-making and decision taking. Paragraph 11 states that for decision-taking this means;

> ***"c) Approving development proposals that accord with an up-to-date development plan without delay; or***
>
> ***d) Where there are no relevant development plan policies, or the policies which are most important for determining the application are out-of-date, granting permission unless:***
>
> ***i. the application of policies in this Framework that protect areas or assets of particular importance provides a clear reason for refusing the development proposed; or***
>
> ***ii. any adverse impacts of doing so would significantly and demonstrably outweigh the benefits, when assessed against the policies in this Framework taken as a whole."***

5.4. Paragraph 18 states that*;*

> ***"Policies to address non-strategic matters should be included in local plans that contain both strategic and non-strategic policies, and/or in local or neighbourhood plans that contain just non-strategic policies."***

5.5. Paragraph 19 continues by clarifying that;

> ***"The development plan for an area comprises the combination of strategic and non-strategic polices which are in force at a particular time."***

5.6. Section 4 of the NPPF 'Decision Taking' states at paragraph 39 that;

> ***"Local planning authorities should approach decisions on proposed development in a <u>positive and creative way</u>. They should use the full range of planning tools available, including brownfield registers and permission in principle, and work proactively with applicants to secure developments that***

> ***will improve the economic, social and environmental conditions of the area. Decision-makers at every level <u>should seek to approve applications</u> for sustainable development where possible."*** *(emphasis added)***.**

5.7. Paragraph 39 continues;

> ***"Good quality preapplication discussion enables better coordination between public and private resources and improved outcomes for the community."***

5.8. Paragraph 41 states that;

> ***"The more issues that can be resolved at pre-application stage, including the need to deliver improvements in infrastructure and affordable housing, the greater the benefits."***

5.9. Paragraph 46 continues;

> ***"Applicants and local planning authorities should consider the potential for voluntary planning performance agreements, where this might achieve a faster and more effective application process. Planning performance agreements are likely to be needed for applications that are particularly large or complex to determine."***

5.10. Paragraph 47 states that;

> ***"Planning law requires that applications for planning permission be <u>determined in accordance with the development plan,</u> unless material considerations indicate otherwise. <u>Decisions on applications should be made as quickly as possible, and within statutory timescales</u> unless a longer period has been agreed by the applicant in writing." (emphasis added)***

5.11. With regard to the use of planning conditions and obligations the NPPF states at paragraph 55 that;

> ***"Planning obligations should only be used where it is not possible to address unacceptable impacts through a planning condition."***

5.12. Paragraph 56 states with regard to the use of conditions that;

> ***"Planning conditions should be kept to <u>a minimum</u> and only imposed where they are necessary, relevant to planning and to the development to be permitted, enforceable, precise and reasonable in all other respects. Agreeing conditions early is beneficial to all parties involved in the process and can speed up decision making. <u>Conditions that are required to be discharged before development commences should be avoided, unless there is a clear justification</u>.[2]" (emphasis added).***

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[2] Sections 100ZA(4-6) of the Town and Country Planning Act 1990 will require the applicant's written

5.13. Section 5 of the NPPF 'Delivering a sufficient supply of homes', sets out the need to significantly boost the supply of housing. In order to achieve this, paragraph 68 states that Local Planning Authorities should use their evidence base to ensure that their Local Plan identifies a sufficient supply and mix of sites, taking into account their availability, suitability and likely economic viability. Planning policies should identify a supply of;

> ***"a) specific, deliverable sites for years one to five of the plan period; and***
>
> ***b) specific, developable sites or broad locations for growth, for years 6-10 and, where possible, for years 11- 15 of the plan."***

5.14. Paragraph 74 requires local authorities to identify and update annually a supply of specific deliverable sites sufficient to provide a minimum of five years' worth of housing against their housing requirement set out in adopted strategic policies, or against their local housing need where the strategic policies are more than five years old. In addition, a buffer is required to be applied, the level of buffer relating to the authority's recent performance on housing delivery. An authority's performance with regard to the delivery of new housing is to be measured against the Housing Delivery Test (paragraph 76 of the NPPF).

5.15. Paragraph 61 of the NPPF states that in order to determine the minimum number of homes that strategic policies should be informed by a housing needs assessment – Paragraph 62 continues that;

> ***"Within this context, the size, type and tenure of housing needed for different groups in the community should be assessed and reflected in planning policies (including, but not limited to, those who require affordable housing, families with children, older people, students, people with disabilities, service families, travellers, people who rent their homes and people wishing to commission or build their own homes)."***

5.16. Section 8 'Promoting Safe and Healthy Communities' states at paragraph 92 that;

> ***Planning policies and decisions should aim to achieve healthy, inclusive and safe places"***

which promote social interaction, are safe and accessible and enable and support healthy lifestyles.

5.17. With regard to open space and recreation paragraph 92 states that;

> ***"Access to a network of high quality open spaces and opportunities for sport and physical activity is important for the health and well-being of communities, and can deliver wider benefits for nature and support efforts to address climate change."***

5.18. Section 9 'Promoting sustainable transport' recognises that transport policies have an important role to play in facilitating sustainable development. Paragraph 105 states that;

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agreement to the terms of a pre-commencement condition, unless prescribed circumstances apply.

> ***"Significant development should be focused on locations which are or can be made sustainable, through <u>limiting the need to travel and offering a genuine choice of transport modes</u>. This can help to reduce congestion and emissions, and improve air quality and public health." (emphasis added).***

5.19. The accompanying Transport Assessment explains that the additional demand arising from the proposed development can be safely and satisfactorily accommodated on the local transport network in accordance with paragraph 111 of the NPPF and that there will not be an acceptable impact on highway safety and that the residual cumulative impact on the road network will not be severe.

5.20. Section 11 'Making best use of land' states at paragraph 120 and subsection c) that;

> ***"120. Planning policies and decisions should:***
>
> ***c) <u>give substantial weight</u> to the value of using suitable brownfield land within settlements for homes and other identified needs, and support appropriate opportunities to remediate despoiled, degraded, derelict, contaminated or unstable land; (emphasis added)***

5.21. Paragraph 121 states that;

> ***"Local planning authorities, and other plan-making bodies, should take a proactive role in identifying and helping to bring forward land that may be suitable for meeting development needs, including suitable sites on brownfield registers or held in public ownership, using the full range of powers available to them."***

5.22. With regard to density and making the best use of land paragraph 124 sates that;

> ***"Planning policies and decisions should support development that makes efficient use of land."***

5.23. Paragraph 125 states that;

> ***"Where there is an <u>existing</u> or anticipated <u>shortage of land for meeting identified housing needs</u>, it is especially important that planning policies and decisions avoid homes being built at low densities, and <u>ensure that developments make optimal use of the potential of each site</u>." (emphasis added)***

5.24. Paragraph 125 continues at subsection c);

> ***"In this context, when considering applications for housing, authorities <u>should take a flexible approach</u> in applying policies or guidance <u>relating to daylight and sunlight</u>, where they would otherwise inhibit making efficient use of a site (as long as the resulting scheme would provide acceptable living standards)."***

5.25. Section 9 – Achieving well-designed places provides guidance on design highlighting that the Government attaches great importance to the design of the built environment and that applicants should work closely with those affected by their proposals to evolve designs that take account of the views of the community.

5.26. Full details of the design and design rationale for the proposal are provided in the Design and Access Statement and details of community engagement are provided in the Statement of Engagement.

5.27. Paragraph 131 of the NPPF states that;

> ***"131. Trees make an important contribution to the character and quality of urban environments, and can also help mitigate and adapt to climate change. Planning policies and decisions should ensure that new streets are tree-lined, that opportunities are taken to incorporate trees elsewhere in developments (such as parks and community orchards), that appropriate measures are in place to secure the long-term maintenance of newly-planted trees, and that existing trees are retained wherever possible."***

5.28. Section 14 - Meeting the challenge of climate change, flooding and coastal change outlines at paragraph 159 -169 the approach to planning and flood risk.

5.29. Paragraph 167 states that;

> ***"When determining any planning applications, local planning authorities should ensure that flood risk is not increased elsewhere."***

5.30. With regard to major development paragraph 169 states;

> ***"Major developments should incorporate sustainable drainage systems unless there is clear evidence that this would be inappropriate."***

5.31. The site is situated within Flood Zone 1 on land at the lowest risk of flooding. Further details are provided in the site-specific Flood Risk Assessment submitted with the application.

5.32. Section 15 - Conserving and enhancing the natural environment requires at paragraph 174 subsections d-f decisions to contribute and enhance the natural and local environment by:

> ***"d) minimising impacts on and providing net gains for biodiversity, including by establishing coherent ecological networks that are more resilient to current and future pressures;***
>
> ***e) preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil, air, water or noise pollution or land instability. Development should, wherever possible, help to improve local environmental conditions such as air and water quality, taking into account relevant information such as river basin management plans; and***
>
> ***f) remediating and mitigating despoiled, degraded, derelict, contaminated and unstable land, where appropriate."***

5.33. These matters are all considered further in the Ecological and Arboricultural Reports submitted with the application and the Landscape and Visual section of the Design and Access Statement.

5.34. With regard to ground conditions the NPPF states at paragraph 183 subsection a) that planning decision should ensure that;

> ***"a) a site is suitable for its proposed use taking account of ground conditions and any risks arising from land instability and contamination."***

5.35. Section 16 – Conserving and Enhancing the Built Environment provides advice and guidance on heritage assets. The site does not contain any statutory built heritage assets and Prior Approval has been granted by the local planning authority for the demolition of the existing brick built former engine sheds on the eastern part of the site.

5.36. Notwithstanding this point the NPPF states at paragraph 203 that;

> ***"The effect of an application on the significance of a non-designated heritage asset should be taken into account in determining the application. In weighing applications that directly or indirectly affect non-designated heritage assets, a balanced judgement will be required having regard to the scale of any harm or loss and the significance of the heritage asset."***

5.37. This matter together with other heritage related matters are considered further in the Heritage Report that accompany the planning application.

5.38. Overall, the Proposed Development is consistent with the objectives of the NPPF and provides for sustainable development.

5.39. Annex 1 of the NPPF deals with implementation stating at paragraph 212 that;

> ***"….the policies of the Framework are material considerations which should be taken into account in dealing with applications from the day of its publication".***

5.40. Paragraph 218 states that the weight to be afforded to policies adopted prior to the publication of the revised NPPF should be in accordance with their consistency with the Framework.

5.41. The Proposed Development provides for sustainable development, contributing to the social, economic and environmental roles identified within the NPPF.

The Development Plan

5.42. Section 38(6) of the 2004 Planning and Compulsory Purchase Act requires planning applications to be determined in accordance with the relevant policies of the adopted Development Plan unless material considerations indicate otherwise. The Development Plan for this site currently comprises the following;

- Gloucester Cheltenham and Tewkesbury Joint Core Strategy (2017)
- saved Polices of the Gloucester Local Plan (1983)
- Gloucestershire Waste Core Strategy 2012-2027 (2012)
- Minerals Local Plan for Gloucestershire 2018-2032 (March 2020)

5.43. The 2002 2nd Deposit Local Plan is a draft plan that was published and approved by the council for development management decision making in 2002. It has not been subject to Local Plan Examination or adopted by the Council however some policies are considered to be a material consideration and have significant weight in the decision making process while others policies are considered to have partial relevance.

Local Planning Policy

Gloucester Cheltenham and Tewkesbury Joint Core Strategy (2017) (JCS)

5.44. Policy SP1 of the JCS identifies a housing requirement for Gloucester City of 14,359 for the period 2011-2031.

5.45. Paragraph .3.1.18 states that;

> ***"Each authority will also be covered by a district-level plan, namely the Gloucester City Plan, Cheltenham Borough Plan and Tewkesbury Borough Plan. These plans will provide more detailed and locally specific planning policies as well as local site allocations. The District plans will deliver the individual district capacities identified through the JCS in accordance with the spatial strategy."***

5.46. Policy SP2 of the JCS states at criteria 2 that;

> ***"To meet the needs of Gloucester City the JCS will make provision for at least 14,359 new homes. At least 13,287 dwellings will be provided within the Gloucester City administrative boundary, including the Winneycroft Strategic Allocation, and urban extensions at Innsworth and Twigworth, South Churchdown and North Brockworth within Tewkesbury Borough defined in Policy SA1, and sites covered by any Memoranda of Agreement."***

5.47. Paragraph 3.2.16 states;

> ***"In meeting the needs of Gloucester it has been necessary to allocate sites on the edge of the urban area in Tewkesbury Borough. However, due to significant constraints and availability of land it has not been possible to allocate sites in the JCS to meet all of Gloucester's need over the plan period. Nevertheless, Gloucester has a good supply of housing land for the short to medium term that will enable it to meet its requirements to at least 2028/29."***

5.48. Table SP2a of the JCS identified a supply of homes from the Gloucester City Plan of 1,518 contributing towards the overall supply for the City of 13,287 identified in the JCS.

5.49. As well as considering housing and employment land requirements the JCS contains strategic level development control policies.

5.50. Policy SD3 Sustainable Design and Construction requires proposals to;

> ***"..demonstrate how they contribute to the aims of sustainability by increasing energy efficiency, minimising waste and avoiding the unnecessary pollution of air, harm to the water environment, and contamination of land or interference in other natural systems."***

5.51. The policy requires applications to be accompanied by an Energy Statement and Waste Minimisation Statement. The policy also requires consideration to be given to the unnecessary sterilisation of identified mineral resources.

5.52. Policy SD4 Design Requirements sets out the design matters that proposals will be required to address with tables SD4a – SD4d providing further detail and guidance.

5.53. The Design and Access Statement submitted with the application clearly details how local distinctiveness has been taken into consideration with regard to the design of the proposed dwellings and apartment blocks at the site.

5.54. Policy SD8 Historic Environment states how the historic environment should be taken into consideration by development proposals. Paragraph 4.8.13 states;

> ***"Development proposals must describe the significance of any heritage assets affected, including any contribution made by their setting. Proposals should also be supported by proportionate evidence demonstrating that the historic character and distinctiveness of the locality have been assessed and taken into account when preparing proposals. Where a development site includes, or has the potential to include, heritage assets with archaeological interest, a desk based assessment and , where necessary, a field evaluation must be submitted to the planning authority."***

5.55. A Heritage Report detailing these matters is submitted with the planning application.

5.56. Policy SD9 Biodiversity and Geodiversity seeks to ensure that the biodiversity of the JCS area will be protected and enhanced in order to establish and reinforce ecological networks that are resilient to current and future pressures. It requires new development to contribute positively to biodiversity whilst linking with wider networks of green infrastructure. The policy also seeks development that has the potential to have a likely significant effect on an international site to be subject to a Habitats Regulations Assessment.

5.57. Criteria 6 of the Policy SD9 states that any biodiversity harms arising from a development should be mitigated by integrating enhancements into the scheme and that are appropriate to the location and satisfactory to the local planning authority. The criteria also states that off-site enhancements may also be acceptable if harm cannot be mitigated on site.

5.58. Policy SD10 provides further detail with regard to the appropriate locations for residential development in the JCS area. Criteria 2 states that;

> ***"Housing development will be permitted at sites allocated for housing through the development plan, including Strategic Allocations and <u>allocations in district</u> and neighbourhood <u>plans</u>." (emphasis added)***

5.59. Policy SD11 Housing Mix and Standards requires new development to provide a mix of new housing that addresses local needs and contributes to the creation of mixed and balanced communities. Criteria 2 requires new housing to meet and where possible exceed appropriate minimum space standards.

5.60. Policy SD12 -Affordable Housing states at Criteria 1 that;

> ***"1. The JCS authorities will seek, through negotiation, for new development to deliver new affordable housing on a sliding scale approach as set out below:***
>
> ***i. Within the Strategic Allocation sites a minimum of 35% affordable housing will be sought;***
>
> ***ii. Outside of the Strategic Allocation sites, on sites of 11 dwellings or more, or sites with a maximum combined gross floor space of greater than 1000 sqm; a minimum of 20% affordable housing will be sought on developments within the Gloucester City administrative area…"***

5.61. Criteria 9 of Policy SD12 permits developers to submit a viability assessment with a planning application where it is considered that it will not be possible to meet the full affordable housing requirement. Paragraph 4.12.7 of the JCS states;

> ***"Sites across the JCS area will be able to contribute to affordable housing to a greater or lesser degree depending on the circumstances of each case. The viability and infrastructure challenges need to be taken into account when considering how to meet the overall need for affordable housing across the wider area."***

5.62. This application proposes a policy compliant level of affordable housing. Further details on this matter are provided in Section 6.

5.63. Policy SD14 Health and Environmental Quality requires new development to result in no exposure to unacceptable risk from existing or potential sources of pollution, it also requires the investigation and remediation of any land contamination within a site.

5.64. Policy INF1 Transport Network requires new development to enable travel choice for residents and commuters. Planning applications are required to assess their impact on the Transport Network through the submission of a Transport Assessment and Travel Plan's are required to address the requirements of the NPPF.

5.65. Policy INF2 Flood Risk Management requires development proposals to avoid area at risk of flooding, in accordance with a risk-based sequential approach. New development that could cause or exacerbate flooding should be subject to a flood risk assessment as well as incorporating suitable sustainable drainage systems.

5.66. Policy INF3 Green Infrastructure states that development proposals should consider and contribute positively towards green infrastructure and that where residential development will create, or add to, a need for publicly accessible green space or outdoor space for sports and recreation that this will be fully met in accordance with Policy INF4.

5.67. Policy INF4 Social and Community Infrastructure requires proposals to either fully meet on site, or to make off site contributions to social and community facilities as part of development proposals to ensure that community need are met to promote social wellbeing and to create healthy and inclusive communities.

5.68. Policy INF6 Infrastructure Delivery states that the local planning authority will seek to secure appropriate infrastructure that is necessary, directly related and fairly and reasonably related to the scale and kind of the development proposal. Criteria 3 states that priority for provision will be assessed on a site-by-site basis.

5.69. Policy INF7 Developer Contributions states that where planning obligations are required under Section 106 of the Town and Country Planning Act 1990 that these will be negotiated with developers before the grant of planning permission. Criteria 2 provides for the viability of a proposal to be taken into consideration with regard to the provision of on and off site infrastructure.

5.70. Paragraph 5.8.45 states that the JCS authorities recognise that the economic viability of development can be finely balanced, particularly with respect to the redevelopment of brownfield land. In such instances it is in the interests of both the local planning authority and the developer for an independent viability assessment to be undertaken to enable an objective appraisal to inform negotiations.

Gloucester City Plan (1983)

5.71. In light of the adoption of the JCS, and a review of the NPPF, the only policy from the 1983 Local Plan relevant to the proposal is:

Policy A1.a Heights of buildings and protection of views

5.72. Policy A1.a would remain relevant to the proposed development however the extent to which it would be material has to be weighed against the age of the policy (39 years old) and the publication of subsequent national planning policy guidance in the NPPF (July 2021).

Second Stage Deposit Local Plan (2002)

5.73. The Second Stage Deposit City of Gloucester Local Plan is a draft plan that was published and approved by the council for development management decision making in 2002. As the Second Stage Deposit is not an adopted plan the policies contained within it could not be superseded by the adoption of the Joint Core Strategy in accordance with Regulation 8(5) of the Town and Country Planning (Local Planning) (England) Regulations 2012.

5.74. The policies of the Second Stage Deposit have therefore been reviewed in light of the Joint Core Strategy and the National Planning Policy Framework (NPPF), however they are not statutory or adopted polices as they have not been subject to Local Plan Examination, they do not therefore comprise part of the development plan.

5.75. Those policies considered to be material and have significant weight in the decision-making process relevant to this application include the following;

- Policy BE.2 Views and Skyline
- Policy OS.2 Public Open Space Standard for New Residential Development
- Policy OS.3 New Housing and Public Open Space
- Policy OS.7 New Areas of Public Open Space
- PolicyA.1 New Housing and Allotments

5.76. Additional polices are considered to have partial relevance, they are a material consideration and the relevant parts are afforded weight in the decision-making process. Relevant policies to this application include;

- Policy PS.4 Design of Public Open Space

Gloucestershire Waste Core Strategy 2012-2027 (2012)

5.77. Gloucestershire Waste Core Strategy 2012-2027 was adopted in 2012 and explains how the County Council and its partners will address the issue of planning for waste management in Gloucestershire in the plan period. It provides a policy framework to guide decisions on planning applications for waste management developments, which include facilities to deal with key waste 'streams' such as municipal, commercial & industrial, construction & demolition and hazardous wastes. It also considers how radioactive, clinical, and agricultural wastes and waste water should be dealt with locally.

Minerals Local Plan for Gloucestershire 2018-2032 (March 2020)

5.78. The Minerals Local Plan for Gloucestershire was adopted by the County Council in March 2020. Gloucestershire County Council (GCC) is the Mineral Planning Authority (MPA) for the entire county. It has a statutory responsibility to plan for future supplies of minerals from within its area and to determine planning applications for new local mineral developments.

5.79. Paragraph 38 of the plan sates that;

> ***"Significant housing and employment growth is also being planned through local plans prepared by the county's district councils. Significant urban development, regeneration and renewal and a number of urban extensions have been identified for the built-up areas of the Severn Vale – mostly in and around Cheltenham and Gloucester City. By the early 2030s an additional 30,000+ new homes will have been built along with commercial developments capable of supporting upwards of 40,000 new jobs"***

5.80. The plan states at paragraph 47 that the County's economic sand and gravel resources are mainly located in the Upper Thames Valley (UTV) and '*parts of*' the Severn Vale.

5.81. The policies map for the Minerals Local Plan shows that the western half of the application site is located within a Minerals Safeguarding Area for Sand and Gravel, that the eastern half of the site is within a Minerals Consultation Zone and that the following policies of the Local Plan apply;

- MS01 – Non-Minerals Developments within Mineral Safeguarding Areas's
- MW01 – Aggregate Provision

5.82. The Minerals Local Plan identifies at Appendix 2 the Allstones site to the east of the application site as a Safeguarded Minerals Infrastructure Site for handling and / or processing and distributing recycled and secondary aggregates.

5.83. Policy MW02- Safeguarding Minerals Infrastructure therefore applies. This policy provides a criteria based approach to the consideration of non-mineral developments located on / or adjoining a safeguarded mineral infrastructure site.

Supplementary Planning Documents

5.84. Supplementary Planning Documents adopted by the Council relevant to this application include the following;

- SuDS Design Guide (2013)
- SPG6 New housing and open space
- Interim adoption 'Designing Safer Places' SPD (August 2008)
- Interim adoption 'Heights of Buildings' SPD (November 2008)
- Waste Minimisation in Development Projects SPD (September 2006)

Planning Brief

5.85. The '*Interim Adoption 'Railway Corridor' Planning Brief'* (March 2011) included the site as part of a much wider brownfield area to the east of the City Centre proposed by the City Council for redevelopment and regeneration comprising some 36.6ha. situated adjacent to the mainline railways running through the City.

5.86. At the time the Planning Brief was written the emerging policy position of the Council for the Great Western Road Sidings site was for mixed use B1 employment and residential development. It was also envisaged that the sidings site would provide an integral linear community park link between the train station and the Horton Road sidings site (the area occupied by Allstones).

5.87. The emerging City Plan has superseded this locally adopted planning brief with elements of the brief being bought forward into the current emerging policy for the Great Western Road Sidings site.

5.88. It should be noted that the Brief was locally adopted before first publication of the NPPF in 2012. The subsequent revisions to the NPPF in 2018, 2019 and 2021 clearly emphasise the delivery of housing at sustainable locations plus making the best use of land as key government priorities.

Emerging Planning Policy - Gloucester City Plan (2011-2031)

5.89. The Gloucester City Plan has been on preparation since for many years with a Scoping Consultation in 2011, Regulation 18 consultations in 2012 and 2013, a further draft plan consultation in 2017 and a Pre-Submission Regulation 19 consultation in 2019.

5.90. Examination of the Gloucester City Plan took place in May/June 2021 with eth Inspector setting pout ger findings by letter in August 2021.

5.91. The Inspector found that the City Plan was legally compliant, had met the duty to cooperate, however it was unsound, but could be made sound with 'Main Modifications'.

5.92. A Main Modifications public consultation has taken place over the summer of 2022, closing on 4th July 2022.

5.93. The City Council currently anticipate that the City Plan will be adopted by the end of 2022.

5.94. NPPF paragraph 48 states that the weight to be applied to emerging local pan policy is dependent on the extent to which it is subject to unresolved objections and the degree of consistency of the relevant policies in the emerging plan to the Framework.

5.95. Policies within the emerging City Plan, with reference to MM numbering, of relevance to the application submission include the following;

- Policy A1 – Effective and efficient use of housing land and buildings
- Policy A6 – Accessible and adaptable homes
- Policy A7 – Self build and custom build homes
- Policy B1 – Employment and skills plans
- Policy C1 – Active design and accessibility
- Policy C3 – Public open space, [playing fields and sports facilities
- Policy C5 – Air quality
- Policy C7 – Fall prevention from taller buildings
- Policy D1 – Historic Environment
- Policy D2 – Non-designated heritage assets
- Policy D4 – Views of the Cathedral and historic places of worship
- Policy E1 – Biodiversity and geodiversity
- Policy E3 - Green/Blue Infrastructure
- Policy E4 – Flooding, sustainable drainage and wastewater
- Policy E6 – Development affecting the Cotswold Beechwoods Special Area of Conservation
- Policy E7 – Trees, woodlands and hedgerows
- Policy F1 – Materials and finishes
- Policy F2 – Landscape and planting
- Policy F3 – Community Safety
- Policy F4 – Gulls
- Policy F6 – Nationally Described Space Standards
- Policy G1 – Sustainable transport and parking
- Policy G2 – Cycling
- Policy G3 – Walking
- Policy SA – Gloucester City Plan Site Allocations

- Site Allocation Statement – SA05

5.96. Some of the above policies remain the subject of outstanding objections as a result of the Main Modifications public consultation.

5.97. Site Allocation Statement SA05: Land at Great Western Road Sidings is attached at Appendix 4.

APPENDIX 4 : MAIN MODIFICATION SITE ALLOCATION STATEMENT SA05

5.98. The City Council's emerging site-specific policy for the site seeks the following;

- Approximately 300 dwellings at the site
- To create a well-defined built frontage to Great Western Road.
- To create a green link between Great Western Road and the southern end of Horton Road.
- Increased tree coverage and a more meaningful useable open space that connects to the hospital and could be utilised by hospital visitors.
- Provision of appropriate crossing point to access open space.
- An expansion of Great Western Road Rest Gardens and a functional area of open space including a Locally Equipped Area for Play.
- A new strategic cycle and footway linking to city centre and transport hub to the west and the new residential development at the Allstone site to the east.
- Built heritage and ecological assessments
- Creation of green corridor following the proposed walking/cycle route from Horton Road (with links to the Allstone site / Armscroft Park), through the sidings towards former Wessex House and railway station.
- Creation of bat habitat/roosts.
- Any loss of brownfield habitat to be mitigated through brown roofs
- Encourages early engagement with the Minerals Planning Authority
- That mitigation measures be put in place to avoid unacceptable land-use incompatibility issues arising.
- That development should demonstrate compliance in meeting EU limit values and national objectives for air pollutants.
- Regard to the City Council's adopted 'Railway Corridor' Planning Brief.

6. Affordable Housing Statement

6.1. Paragraph 62 of the NPPF requires local authorities to plan for the size type and tenure of housing needed for different groups in the community, including those who require affordable housing, by assessing need as part of plan making and reflecting need in planning policy.

6.2. Paragraph 63 states that where a need for affordable housing is identified that planning policy should specify the type of affordable housing required. Such housing is expected to be met on site unless off site contributions can be robustly justified and the agreed approach contributes to the objectives of creating mixed and balanced communities.

6.3. The adopted Gloucester Cheltenham and Tewkesbury Core Strategy (2017) Policy SD12 - Affordable Housing states the locally adopted policy for the delivery of affordable housing on development schemes within Gloucester City of 20% from all major development proposals. The criteria based policy allows for the level of affordable housing to be provided to be subject to viability considerations.

6.4. Eutopia Homes are committed to delivering affordable housing at the site and this is reflected in the Draft Heads of Terms submitted with the planning application.

6.5. A viability report prepared by Pioneer will be submitted in due course to support our client's position should it be necessary for a request to be made for reduced affordable contributions at the site.

7. Planning Considerations

7.1. **The JCS focuses development at the urban areas of Gloucester and Cheltenham.** Gloucester is identified in the adopted JCS as a main urban area. The spatial strategy states at Strategic Policy SP2 that development will be focused at Gloucester and Cheltenham. Gloucester urban area is therefore a sustainable location for growth in accordance with the adopted spatial strategy of the strategic development plan.

7.2. **The need for a range and choice of sites to ensure housing delivery.** The spatial strategy for delivering Gloucester's growth needs relies on the delivery of a range and mix of sites across the City and strategic urban extensions in Tewkesbury Borough.

7.3. In accordance with the NPPF it is necessary to deliver a wide choice of high-quality homes. The location of the site is consistent with both the strategy in the adopted strategic development plan, the JCS (2017) and the emerging Gloucester City Plan.

7.4. The proposed development will deliver a range and mix of new market and affordable homes to meet a range and mix of housing needs. The proposed development provides both apartments and two storey terraced housing, all of which are designed to meet minimum space standard requirements.

7.5. The application demonstrates that there is sufficient utility, highway and social infrastructure capacity to accommodate the proposed development.

7.6. **Making the best use of land.** The NPPF (2021) states at paragraph 119 that;

> ***"Planning policies and decisions should promote an effective use of land in meeting the need for homes and other uses, while safeguarding and improving the environment and ensuring safe and healthy living conditions. Strategic policies should set out a clear strategy for accommodating objectively assessed needs, in a way that makes as much use as possible of previously-developed or 'brownfield' land."***

7.7. The site is a large brownfield site on the edge of the City Centre for which the Council have long held aspirations for regeneration as witnessed by the succession of draft allocations at the site and the Railway Corridor Development Brief.

7.8. The site contributes significantly to meeting the objectively assessed needs for Gloucester City (2011-2031) as identified through the JCS. The JCS identified that Gloucester was unable to meet its full housing requirement of approximately 14,300 homes and was adopted subject to an immediate review, one limb of which was to address the housing land supply shortfall for the City.

7.9. Paragraph 125 of the NPPF states that;

> ***"Where there is an existing or anticipated shortage of land for meeting identified housing needs, it is especially important that planning policies and decisions avoid homes being built at low densities, and ensure that developments make optimal use of the potential of each site." (emphasis added)***

7.10. Criteria a) of paragraph 125 states that at locations that are well served by public transport that there should be a significant uplift in the average density of residential development unless it can be shown that there are strong reasons why this would be inappropriate.

7.11. The proposed development seeks to make best use of a former brownfield site by creating a new urban quarter with 315 new homes provided in a location that is accessible to the Transport Hub of Gloucester comprising the Railway Station and the new Bus Station. Further detail on the proximity of these facilities to the site is provided in the DAS and Transport Assessment.

7.12. The proposed development will result in the regeneration and de-contamination of the site and will provide homes, public open space, public access and permeability for walking and cycling through a site that is currently private and inaccessible.

7.13. The proposal seeks to make the best use of a brownfield site to deliver new homes, formerly owned by Network Rail, by bringing forward a higher density development on that part of the site closest to the public transport interchange of the City accessible by walking and cycling in accordance with the policies of the Framework.

7.14. **Emerging Gloucester City Plan Draft Allocation.** The site comprises a draft allocation (SA05) in the emerging Gloucester City Plan, a Local Plan Examination has been held and a main Modification consultation undertaken by the Council.

7.15. The Main Modification consultation increased the potential capacity at the site from 200 dwellings to 300, the draft allocation at the site is not a maximum but an approximate figure. The submission for 315 dwellings is considered to be appropriate and in accordance with the emerging policy for the site.

7.16. The site is one of only two large brownfield sites located on the edge of the City Centre, SA05 and SA11, to come forward as draft allocations in the City Plan. The site is therefore important to the City in terms of delivering 'City Plan capacity' identified through the JCS.

7.17. The City rely on delivery of new homes from the site for their five-year housing land supply as witnessed by the '2020 Five Year Housing Land Supply Statement' (October 2020)3. Appendix 2 of the report – City Plan Sites – shows site SA05 contributing 125 dwellings to the City's five-year supply.

7.18. Neither the report nor the capacity of the site have yet been updated however it is clear that the City are relying on the site to deliver both City Plan capacity and to contribute to the City's five-year housing land supply.

7.19. The site is available now and housing can be delivered within the plan period. Even allowing an average of 3 years (which was found to be the average time taken from an outline decision notice to first dwelling completions on site), in the NLP Report 'Start to Finish' (Feb 2020) with no major infrastructure required, and in this case assuming one outlet on site; the site can deliver a substantial number of dwellings within the next five years.

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[3] https://www.gloucester.gov.uk/media/4620/gcc-5yhls-2020-report.pdf

7.20. Taking each of the points in the Main Modification Site Allocation Statement for SA05in turn;

- *Approximately 300 dwellings at the site*

  The proposed development is for 315 dwellings, 87 townhouses and 228 apartments. The size and mix of the dwelling is detailed in the accompanying DAS.

- *To create a well-defined built frontage to Great Western Road*

  The western part of the site provides apartment development that addresses Great Western Road providing a well defined frontage. Apartments are set back from the highway behind new green spaces which create the setting at ground floor level for a new street scene.

  Further detail on design and street scene is provided in the accompanying DAS.

- *To create a green link between Great Western Road and the southern end of Horton Road.*

  A key feature of the design for the site has been to address the City's long held aspiration for connectivity through the site between Horton Road and Great Western Road.

  The new linear tree lined street through the site provides connectivity for pedestrians and cyclists providing a new route from the Horton Road to Gloucestershire Royal Hospital. Exiting opposite the Irish Club the route also provides connectivity to Armscroft Park and beyond.

  The SuDS scheme for the site allows for tree pits and rain gardens allowing this route to be greened in accordance with the submitted landscape strategy and landscape designs for the site.

- *Increased tree coverage and a more meaningful useable open space that connects to the hospital and could be utilised by hospital visitors.*

  The submitted landscape strategy for the site demonstrates the level of new tree planting proposed across the site and the range of open space typologies provided throughout the site. The Green Frontage and Sidings Park are located directly opposite access pints into to Gloucestershire Royal Hospital.

  Landscape Zones include;

  - Green Frontage
  - The Green
  - Sidings Park
  - The Avenue
  - Private Gardens

- *Provision of appropriate crossing point to access open space.*

  Open space is provided within the site, any off site highway safety requirements to be negotiated through the consideration of the application with the Highway Authority.

- *An expansion of Great Western Road Rest Gardens and a functional area of open space including a Locally Equipped Area for Play.*

A new large area of public open space, accommodating a locally equipped area for play (LEAP) is proposed adjacent to Great Western Road Rest Gardens.

- *A new strategic cycle and footway linking to city centre and transport hub to the west and the new residential development at the Allstone site to the east.*

  The new linear tree lined street through the site provides connectivity for pedestrians and cyclists providing a new route from the Horton Road to Gloucestershire Royal Hospital. Exiting opposite the Irish Club the route also provides connectivity to Armscroft Park and beyond.

- *Built heritage and ecological assessments*

  Both a Heritage Assessment and the relevant ecological assessments re included with the submission.

  The Pegasus Heritage Assessment considers matters relating to the built environment and archaeology. Locations for trail trenching have been agreed with the City Archaeologist Mr Andrew Armstrong and are included as an Appendix to the Assessment.

  The report concludes that the proposed development will result in the loss of three structures associated with the former locomotive works that are present within the site, two of which are of very low heritage significance, and the other of no significance. It should be noted that Prior Approval has been granted for the demolition of these buildings and they could therefore be legally demolished at any time.

  Given that the proposals involve the complete demolition of the buildings, their very low significance will be lost. This will need to be considered as part of a balanced judgement, considering all the benefits of the proposals as part of the overall planning balance.

  There is no current evidence to suggest that archaeological remains that are of a significance commensurate with a designated heritage asset are present within the site and would be impacted upon.

  Following the completion of the archaeological trial trenching, an updated note on archaeological impacts will be completed.

  The Ecological Assessments provided by Burton Reid Associates include the following;

  - Biodiversity Net Gain Report
  - Biodiversity Metric 3.1 Spreadsheet
  - Ecological Impact Assessment

- Shadow Habitats Regulations Assessment

These reports demonstrate that the site provides a 25% biodiversity net gain. The reports also demonstrate that there will be no adverse impact on any protected habitats or species as a result of the proposed development and that appropriate mitigation is proposed as part of the development to account for bats, birds and small mammals.

The Shadow Habitat Regulations Assessment concludes that with proposed mitigation measures and relevant policy protections, including a Construction Environmental Management Plan and Drainage Strategy, that it is considered unlikely that there would be an adverse effect on the integrity of Cotswold Beechwoods SAC, Severn Estuary SAC/SPA/Ramsar and Walmore Common SPA from changes in water quality/levels as a result of the development alone or in-combination with other developments.

- *Creation of bat habitat/roosts.*

The provision of new bat roosts and bird habitats and roosts is detailed in the ecological mitigation measures in the ecological reports and illustrated pictorially in the DAS.

- *Any loss of brownfield habitat to be mitigated through brown roofs*

The proposed development incorporates biodiverse roofs for ecological, carbon reduction and climate change purposes.

- *Encourages early engagement with the Minerals Planning Authority as site within Minerals Safeguarding Area and a Minerals Consultation Area*

Pegasus Group (on behalf of Eutopia Homes) has objected to the inclusion of this criteria in the Main Modifications consultation because it is considered to be an unnecessary repeat of a policy requirement that is already included in the adopted development plan for the area. Policy MS01 of the adopted Gloucestershire Minerals Local Plan (2020) (GMLP) exempts non-mineral development from a mineral resource assessment within a mineral safeguarded subject to specific criteria including the following;

"*All development that would accord with emerging and adopted local development plans by way of their inclusion within a plan allocation following previous consultation with the Mineral Planning Authority and the satisfactory resolution of possible mineral resource safeguarding matters identified at that time;*"

Policy MS01 is clearly designed to avoid unnecessary duplication of effort on the part of both the Mineral Planning Authority and applicants. The presence of a viable mineral resource within the site ideally needs to be established during the preparation of the Local Plan because of the fundamental implications for deliverability of allocated sites for residential development. This, however, relies on the competent authority (Gloucestershire County County) providing a full and detailed view on the suitability of the individual sites proposed for allocation at the local plan preparation stage.

The Minerals Planning Authority will have been consulted on the emerging Local Plan and will have had sufficient opportunity to provide full and detailed comments on the suitability of the proposed allocations. On this basis, there is no obvious reason why the Mineral Planning Authority would then need to be consulted again at the planning application stage. However, it would appear that the County Council has not responded in detail to the consultation on the Gloucester City Local Plan.

Notwithstanding the fact that the detailed response has not been provided during the Local Plan preparation, the County Council's Minerals Planning Officers are capable of making a reasoned professional judgement on whether a finite mineral resource would be sterilised by development proposals on a case-by-case basis without imposing unnecessary and onerous burdens on applicants. The Minerals Local Plan for Gloucestershire 2018 - 2032 includes the following criteria as part of its high level 'Strategy':

- *"setting out a proportionate approach to the protection of mineral resources and supporting infrastructure, without unreasonably burdening and / or overly restricting non-minerals development*

- *supporting local decision makers in determining whether mineral resources or mineral infrastructure represents a justified constraint on non-minerals development, or that satisfactory measures can be put in place to avoid affecting minerals, or that provision for prior-working can be made before non-minerals development takes place."*

Nonetheless, for the avoidance of doubt, the proposed development will not result in the sterilisation of mineral resource for the following reasons:

- The site is on brownfield land, with contaminants present in the soil. Investigative tests carried out as part of the contaminated land assessment have demonstrated that sand and gravel is present within the site but not at a significant thickness.

- The workable area for mineral extraction at this location would be extremely limited. The site is just 3.1 hectares in size and is approximately 100m in width at its widest point which narrows to approximately 50m in width in places. It would generally not be economically viable to extract the mineral for such a small site, particularly where the deposits are relatively thin.

- When taking into account an appropriate standoff from the railway (vibration and land stability) and the incorporation of a reasonable separation distance from residential areas, to ensure that the extraction and processing of sand and gravel would not result in unacceptable harm to residential amenity, the site would be impractical to work.

The site is effectively already sterilised by its limited dimensions and incompatibility with adjacent non-mineral uses. It is clear, therefore, that the mineral resource does not represent a justified constraint to residential development in this case.

- *That due to the presence of nearby safeguarded mineral and waste infrastructure sufficient mitigation measures be put in place to avoid unacceptable land-use incompatibility issues arising.*

  Again, this duplicates Policy MS02 of the Minerals Local Plan and, to some extent, Saved Policy 7 of the Waste Local Plan. The nearest operational minerals or waste is Allstones, which produces recycled aggregate, and is located approximately 40m to the east of the application site, off Myers Road. The Allstone's processing plant is located some 60m, at its closest point, to the application site boundary. There is a three storey Irish Club building, single storey warehouse and car park located between the two sites. A mature scrub boundary is present between the Irish Club boundary and functional activities on the Allstones site.

  It is noted that there are a number of existing dwellings at Norman Ball Way that are within 50m of the Allstones site. Furthermore, it is also noted that the external crushing and screening activities at the western end of the Allstones site are subject to a temporary permission (19/0070/GLMAJW) which ceases on 5th October 2022.

  This matter has been satisfactorily addressed through acoustic and air quality evidence submitted to support this planning application.

- *That development should demonstrate compliance in meeting EU limit values and national objectives for air pollutants.*

  The accompanying Air Quality Assessment by Miller Goodall states that the presence of the rail line and rail related emissions on air quality is concluded to be negligible and not significant as the rail line of interest does not have significant diesel locomotive traffic.

  With regard to the Allstones site the report states that the crushing and screening operations is expected to cease activities and leave the local area by 2022/23. No proposed sensitive receptors will be introduced into the development site during this time period. The potential for dust emissions to impact future receptors is therefore non-existent.

- *Regard to the City Council's adopted 'Railway Corridor' Planning Brief.*

  The Council's locally adopted Interim Adoption Railway Corridor Planning Brief (2011) has been taken into consideration in the development of the proposals for the site however it should be noted that it predates the publication of the NPPF in 2012 and subsequent updates in 2018, 2019 and 2021.

  The Planning Brief is not statutory planning policy and predates the adoption of the most recent Development Plan document for the City, the JCS (2017). Much of the vision for the Great Western Road site from the Planning Brief has been carried forward into the emerging Policy SA05 in the City Plan.

  The weight to be afforded to the Planning Brief needs to be considered by any decision maker in the light of these matters, while it is a material consideration it does not contain the full weight of a statutory policy document and in any event has been superseded by new national planning policy guidance and local statutory planning policy.

7.21. It can be seen therefore that the proposed development effectively addresses the requirements of Policy SA05 in the emerging City Plan.

7.22. **Contribution to meeting affordable housing needs**, the site will make a policy compliant contribution (subject to viability) to affordable housing and provides units that wheelchair accessibility standards as detailed sin the DAS. All dwelling units at the site meet the minimum space standards.

7.23. **Proximity of the proposed site to existing facilities and services**. The site is located in a sustainable location for development and in walking distance of the City's Transport Hub comprising the Railway Station and Bus Station.

7.24. The DAS details the education, health, retail, sport and community facilities located within 5 and 10 minute walking isochrones from the site including Aspen Medical Centre, St Peter's and Widden Primary Schools, Kingsholm Rugby Stadium, the University of Gloucestershire, Gloucestershire Royal Hospital and Gloucester City Centre.

7.25. The proximity to the City Centre and the transport interchange means the site is well located with regard to sustainable access and active travel to employment opportunities both within the City and beyond.

7.26. **Economic Benefits.** The Economic Benefits Statement attached at Appendix 5 demonstrates the financial benefits of the proposed development to the local and wider economy both in terms of the value of construction at the site and the revenue and spending streams resulting from 315 new dwellings at the site.

APPENDIX 5 – ECONOMIC BENEFITS INFOGRAPHIC

7.27. It is estimated that site will generate £44 million in estimated construction investment over a two year build programme. It is also estimated that the £1.6 million will be spent by first occupiers within the first 18 months of occupying the dwellings to make the dwellings 'feel like home'. 39% of employed residents are estimated to be working in higher value/higher income occupations and annual household expenditure is estimated at £10.1 million.

7.28. The proposed development is consistent with the NPPF taken as a whole contributing to the three dimensions of sustainable development. Irrespective of whether there is a 5-year housing land supply, increasing the supply of housing at a sustainable location and providing a contribution to meeting affordable needs at a level commensurate to that proposed by the development plan is consistent with the NPPF and for the reasons outlined above permission should be granted.

Draft Heads of Terms

7.29. A draft Heads of Terms accompanies this document at Appendix 6 and sets out those areas where the developer is willing to offer S.106 contributions to meet those needs reasonably arising from the development of the site.

APPENDIX 6 – DRAFT HEADS OF TERMS

8. Planning Balance Considerations

8.1. This section of the Planning Statement explains how the Applicant believes the decision maker should approach the determination of this application, before going on to identify the issues that need to be weighed in the overall planning balance.

The Decision-Making Framework

8.2. Section 38 (6) of the Planning and Compulsory Purchase Act 2004, requires that applications for planning permission must be determined in accordance with the Development Plan, unless material considerations indicate otherwise.

8.3. In this case, the application proposals would comply with the strategy and objectives of the Development Plan when read as a whole.

8.4. The recent judgement in Corbett, R (On the Application Of) v [2020] EWCA Civ 508 reaffirms the approach to be taken when assessing compliance with the Development Plan. It does not mean that an application must accord with every policy and provision of a Development Plan and it explains that it is not unusual for Development Plan policies to pull in different directions.

8.5. In this case the proposals accord with the spatial strategy of the adopted Strategic Plan as set out in Policy SP2 of the JCS (2017) as the site is located within the urban area of Gloucester City and the spatial strategy of the JCS states that the focus of new development across the area will be in the existing urban areas.

8.6. The proposed development of 315 new dwellings provides for a mix of new market and affordable houses and apartments on a site allocated in the emerging Gloucester City Plan for residential development. The Design and Access Statement and accompanying technical reports demonstrate how the development proposal would comply with the site specific requirements of Site Allocation SA05 of the emerging City Plan.

The benefits associated with the application proposals

8.7. It is considered that the application would secure important benefits that would respond to all three of the Government's overarching objectives for sustainable development (social, economic and environmental). The benefits of the application proposals are outlined below.

The Social Benefits

8.8. 8.8 The Applicant considers that significant weight should be afforded to the provision of **additional open market homes**. Appeal inspectors have consistently applied similar weight to this in other appeals, recognising the inadequate levels of house building in recent years, which is affecting the availability and affordability of housing across the country.

8.9. It is an undisputed fact that this country is in the middle of a housing crisis. The Government accepts that the housing market is broken and the NPPF includes the national policy imperative that requires LPA's to significantly boost the supply of housing [paragraph 60].

8.10. It is generally true that the planning system has a technocratic character which requires abstract policy to be applied to objective evidence usually expressed in statistical terms. Occasionally however, a human face emerges. This is particularly true when considering the real problems facing real people in need of affordable housing. This brings the seriousness of this issue into sharp focus. It is not just any other material consideration, and it warrants significant weight in the overall planning balance. The application proposals would deliver a meaningful number of affordable homes for real people that are in need of those homes now.

8.11. It should be noted that the site is owned by the Applicant, a national housebuilder and there are no impediments to its delivery. It is immediately available for development and capable of implementation following the necessary approvals. In other words, it is capable of assisting with the LPA's housing needs and obligations now.

<u>The Economic Benefits</u>

8.12. The Applicant considers that Significant weight should be afforded to expenditure on construction and investment in the area.

8.13. The NPPF states that "significant weight" should be placed on the need to support economic growth and productivity, taking into account both local business needs and wider opportunities for development [NPPF para 81]. Housing development has a significant role to play in supporting economic growth.

8.14. Following the recent recession, the Government placed a major emphasis on the construction industry to kick-start the economy. There has been a clear push on planning for growth including through national planning policy. More recently we have been faced with the severe economic impact of the Covid 19 pandemic.

8.15. It is widely recognised that house building has knock-on effects on other sectors which leads to increased demand for building materials and equipment at the building phase as well as domestic furniture and carpets etc. following completion. This generates/sustains employment in other sectors.

8.16. The construction industry also stimulates lending in financial markets, another important sector in the UK economy. The Secretary of State in his foreword to the White Paper, "Planning for the Future" emphasises the importance of the construction sector. He states that:-

"*Millions of jobs depend on the construction sector and <u>in every economic recovery, it has played a crucial role</u>*" (emphasis added)

8.17. The White Paper talks about increasing housing delivery nationally to 300,000pa. This is likely to lead to increased output and employment in the construction sector over the coming years. New job opportunities in construction could help to offset losses in other sectors impacted by the Covid-19 pandemic.

8.18. The Prime Minister also unveiled his 'Build, Build, Build' strategy at the end of June 2020, with the aim of making it easier to build better homes where people want to live and to aid economic recovery.

8.19. The construction industry is reliant upon a constant steam of new sites to keep people employed and to maintain delivery rates. The local housing requirement for Gloucester requires a step change in construction activity and for this to be maintained over the plan period. This indicates that new construction jobs could be created locally unless delivery is frustrated by the planning system. The Applicant would attach <u>moderate weight</u> to the newly created **construction jobs**.

8.20. Moderate weight should be attributed to the provision of homes for **economically active people** that can support the economic role of Gloucester and the surrounding area. New residents can also help to sustain local facilities and services including public transport, by bringing additional expenditure to the area on a day to day basis.

8.21. The likely economic benefits of residential element of the scheme alone can be summarised as follows:-

a. Estimated Development costs - £44m

b. Direct construction and indirect/induced job creation – 490

d. GVA – £ pa during the construction phase £56.7

e. Annual Household expenditure £10.1m pa

8.22. The application proposals will also provide **financial contributions towards off-site community infrastructure**. The Applicant recognises that these payments are essentially required to mitigate the impact of the development, however they do still represent new investment in infrastructure which will also be used by existing residents living in the surrounding area. These benefits should be afforded limited weight.

Environmental Benefits

8.23. The application proposals would deliver new **on-site green infrastructure and public open space** within the application site. It is recognised that much of this will be to meet the needs of new residents but it will also be available to existing residents also. The Applicant would afford this limited weight.

8.24. The scheme would deliver **new footpath and cycle links, new publicly accessible land and biodiversity enhancements within the site** which is currently private and inaccessible, but within the control of the Applicant. This will open up new opportunities for all residents in this part of Gloucester not just the new residents. The new public open space will also be accessible to visitors to Gloucestershire Royal Hospital. The proposals also afford the opportunity to integrate the existing Great Western Road Rest Gardens into the new open space at the site. The Applicant would afford this moderate weight.

8.25. The proposals would result in the **decontamination and regeneration** of an existing vacant and contaminated brownfield site. The development would bring this contaminated and vacant brownfield site back into use making the best use of land in a sustainable location. The applicant would afford this significant weight.

8.26. The scheme would deliver significant **on-site biodiversity net gain** in terms of habitat creation and mitigation with an increase of 25% biodiversity net gain over that currently existing at the site. The applicant would afford this moderate weight.

Adverse effects

8.27. With regards to **effects of the development on the character and appearance of the area**, this is a site which has been allocated for housing as part of the Development Plan. Such matters would have been taken into account as part of the plan making process. It is also a site which includes the redevelopment of previously developed land.

8.28. The impact of the development on the heritage significance of the brick built railway sidings sheds currently located on the site has been addressed in the Heritage Assessment. It concludes that this is a matter to be weighed in the planning balance by any decision maker.

8.29. In the context of NPPF paragraph 202 it is considered that the very limited heritage harms are outweighed by the significant public benefits.

8.30. It is important to recognise that the Development Plan allocates the site for housing and any unavoidable impacts would have been factored in during the plan making process.

8.31. The proposal will result in increased vehicular movements on the local highway network however the Transport Assessment has identified that these movements will not in a cumulative severe impact sufficient to warrant a refusal of planning permission.

Other considerations

8.32. There are no other grounds to resist development on this site which cannot be avoided, mitigated, or controlled through planning conditions and/or planning obligations.

Overall Conclusion

8.33. The overall planning balance can be summarised as follows:-

a. The development proposal is in general accordance with the Development Plan when read as a whole.

b. The proposals will also deliver a range of social, economic and environmental benefits which can be afforded varying levels of weight as identified below:-

  - Provision of Open Market Housing – Significant
  - Provision of Affordable Housing – Significant
  - Expenditure on construction and investment – Significant
  - Creation of construction jobs - Moderate
  - Providing homes for economically active people – Moderate
  - Financial contributions towards off site infrastructure – Limited
  - On site public open space and green infrastructure - Limited
  - New footpath links, new publicly accessible land and biodiversity enhancements within the off-site woodland area – Moderate
  - Decontamination and regeneration of a brownfield site to make the best use of land – Significant
  - Biodiversity Net Gain - Moderate

c. Other potential residual adverse impacts have been identified and these should also be afforded varying degrees of weight as follows:

   - Effects of the development on the character and appearance of the area - Limited

   - Impact on heritage assets – Limited

d. The Public Benefits would outweigh the less than substantial harm to heritage assets in the context of NPPF paragraph 202.

e. All other identified impacts have been mitigated through the layout and design of the proposal or can be through Planning conditions and obligations.

f. As the proposal is considered to be in accordance with the Development Plan when read as a whole, and there are no other material considerations, including national policy, which would indicate refusal, the application should be approved without delay in accordance with NPPF paragraph 11c.

9. Conclusions

9.1. This Planning Statement has been prepared on behalf of Eutopia Homes and their successors in title to the land in support of an application for full planning permission for a development comprising 315 dwellings, landscaping, public open space and demolition of existing buildings at land at Great western Yard Gloucester.

9.2. This Planning Statement explains why the application proposals represent sustainable development and it has been demonstrated that there are compelling reasons that justify the grant of planning permission.

9.3. The application is submitted with a number of supporting documents as required by the Council's Validation Checklist.

9.4. The proposed development is consistent with the NPPF contributing to the three dimensions of sustainable development and increases the supply of housing within the urban area of Gloucester City in accordance with the spatial strategy of the adopted Development Plan.

9.5. The site is allocated in the emerging Gloucester City Plan which has recently been subject to a Main Modification public consultation, including revising the number of dwellings to be delivered at the site from 200 up to 300 dwellings.

9.6. The site is available now and has the capacity for up to 300 dwellings (including much needed affordable housing) to help support the authority's five-year housing land supply.

9.7. The site is situated within close proximity to existing services and facilities including existing employment opportunities located within Gloucester City Centre and more immediately at Gloucestershire Royal Hospital. Primary educational and primary health care facilities are located in close proximity to the site and accessible by sustainable modes of transport including walking and cycling.

9.8. The proposal would also provide a range of benefits including a significant contribution to the planned housing growth of the District, a significant contribution of affordable housing and associated economic benefits. There would also be tangible environmental benefits.

9.9. The application is supported by a suite of supporting documents including inter alia, a Transport Assessment, a DAS, an Acoustic Report, an Air Quality Assessment, a Heritage Assessment and an Ecological Assessment. These do not identify any insurmountable constraints that would preclude development on this emerging allocated site.

9.10. All other identified impacts have been mitigated through the layout and design of the proposal or can be mitigated through Planning conditions and obligations.

Concluding Comments

9.11. As out in the supporting documentation, the Applicants have worked proactively with Gloucester City Council to bring forward proposals to transform the site at Great Western Yard, to create a new landmark development in area earmarked for regeneration.

9.12. In bringing forward the current proposals, the long held aspirations of the Council to the regenerate this large brownfield site can be realized in accordance with the Development

Plan, which itself has historically promoted regeneration of the application site via a succession of draft allocations and the production of the Railway Corridor Development Brief.

9.13. The Development Plan fully recognises the sustainable nature of this brownfield site, actively promoting the site for redevelopment, with the submitted proposals achieving this together with the clear and realistic delivery of a range of social, economic and environmental benefits.

9.14. Chief amongst these benefits is the ability to deliver a significant quantity of new homes of varying sizes and types, thereby making a key contribution to the Council's challenging housing requirements for the area.

9.15. Through its conception, layout, design and environmental enhancements, the proposals will transform the existing and underutilised former railway yard into a high quality, vibrant and attractive residential area, creating new communities in full accordance with the key placemaking and sustainable cornerstones of local and national planning policy.

9.16. It is therefore readily apparent that the proposal can be considered to be in accordance with the Development Plan when read as a whole, and there are no other material considerations, including national policy, which would indicate refusal, it should be approved without delay in accordance with NPPF paragraph 11c.

9.17. As set out above, it is the firm view of the Applicant, that the proposals represent a suitable and sustainable form of development in this location and that there are compelling reasons that justify the grant of planning permission.

9.18. The site is available, suitable and capable of delivering much needed development as soon as the necessary approvals are in place.

9.19. In view of the forgoing, the LPA is respectfully requested to grant Full Planning Permission, subject to any necessary conditions and planning obligations.

APPENDIX 1 – SITE LOCATION PLAN

General Notes

This drawing is copyright of Darling Associates. This drawing shall not be scaled. All dimensions are to be [illegible]. All [illegible] to be checked on site [illegible] and any discrepancies to be reported to Darling Associates. All [illegible] conform to [illegible] and statutory requirements. All materials and workmanship shall conform with the relevant British Standards, [illegible] and codes of practice. If this drawing forms part of an application for planning permission it shall not be used for any other purpose without the express permission of Darling Associates. This drawing may incorporate information from other consultants. Darling Associates cannot accept responsibility for the integrity and accuracy of such information. Any clarification and/or additions that are required appertaining to such information should be sought from the relevant professional or their appointed representative.
Drawings, specifications and schedules are to be read in conjunction with the following where applicable: Employer's Requirements, Agreements to Lease, Base and Engineer's drawings and specifications, Civil Engineer's drawings and specifications, Survey Drawings, Party Wall Boundary Awards, Other specialist design consultant's requirements as appointed by the Main Contractor, Other specialist sub contractor's requirements as appointed by the Main Contractor.

0 5m 25m 50m 60m

Key Plan

Notes

Planning Application Boundary

SCALE BAR IN mm

REV	NOTES	DATE	BY	AUTH
P1	Issue for Planning	JUN 2022	[illegible]	[illegible]

DARLING ASSOCIATES
ARCHITECTS

1 Greencoat Row
London SW1P 1DH
UK

[redacted]

DRAWING STATUS
Planning

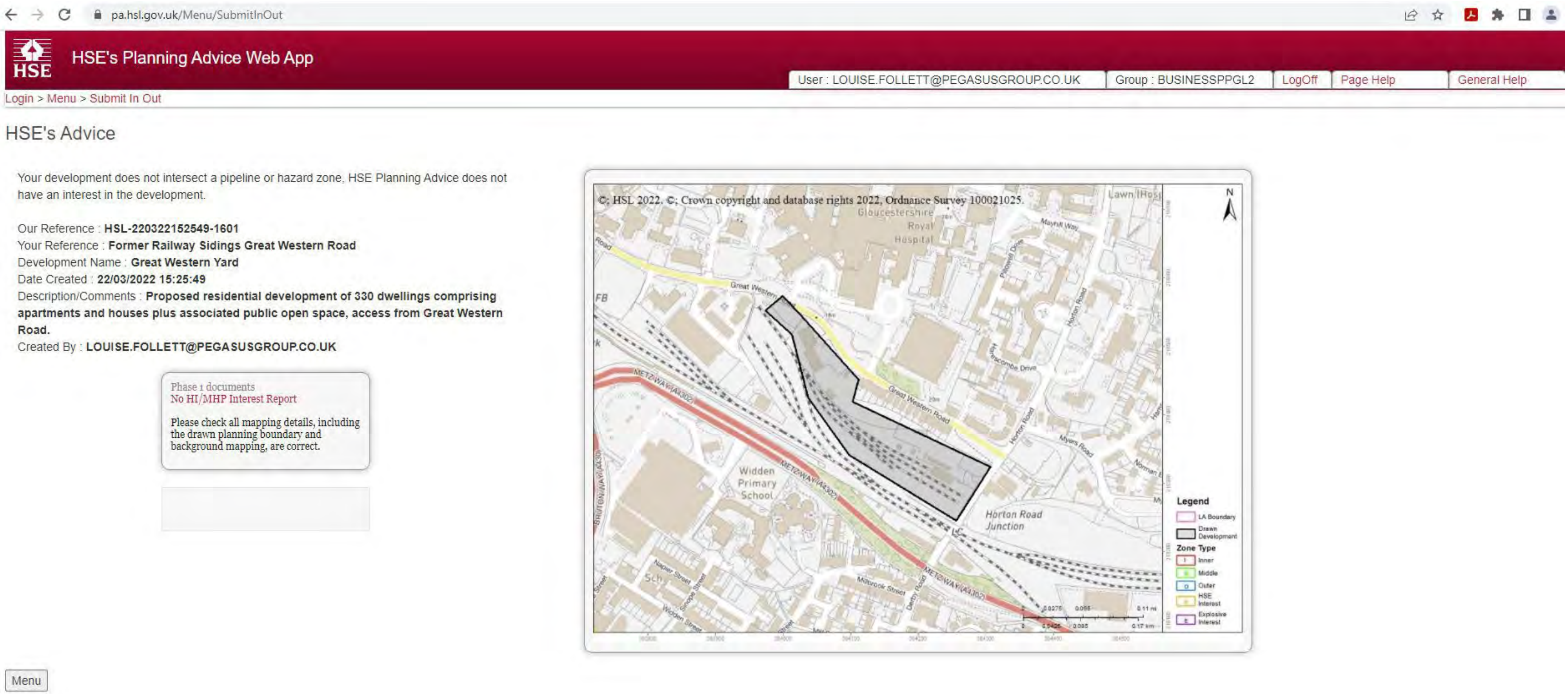
TITLE
Existing
Site Plan

PROJECT
Great Western Yard

SCALE AT A0: 1:500
SCALE AT A3: N.T.S.

JOB NO: 19050
DRAWING: 01-0-00
REV: PL

APPENDIX 2 – HSE ONLINE CONSULTATION RESULT



HSE's Advice

Your development does not intersect a pipeline or hazard zone, HSE Planning Advice does not have an interest in the development.

Our Reference : **HSL-220322152549-1601**
Your Reference : **Former Railway Sidings Great Western Road**
Development Name : **Great Western Yard**
Date Created : **22/03/2022 15:25:49**
Description/Comments : **Proposed residential development of 330 dwellings comprising apartments and houses plus associated public open space, access from Great Western Road.**
Created By : **LOUISE.FOLLETT@PEGASUSGROUP.CO.UK**

Phase 1 documents
No HI/MHP Interest Report

Please check all mapping details, including the drawn planning boundary and background mapping, are correct.

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APPENDIX 3 –DECISION NOTICE

Gloucester City Council
Transforming Your City

Development Control

PO Box 3252

Gloucester GL1 9FW

[redacted]

THE TOWN AND COUNTRY PLANNING (GENERAL PERMITTED DEVELOPMENT) (ENGLAND) ORDER 2015. SCHEDULE 2, PART 11, CLASS B

PRIOR APPROVAL REQUIRED AND GRANTED

Application Number:	22/00482/PRIOR
Date Application Valid	10th May 2022
First schedule	Demolition of disused buildings within the Great Western rail yard
Second schedule	Buildings outlined in red and blue on page 2 of the Churngold Remediation Limited Outline Method Statement for Demolition ref. TE21.021.MS001 Rev. B, Great Western Road sidings, Great Western Road/Horton Road, Gloucester

With reference to the above notification, I hereby confirm that Gloucester City Council as Local Planning Authority considers that **Prior Approval is required for the method of demolition,** specifically for amenity impacts on nearby residents, and highways and ecological impacts, for the development described in the first schedule to this notice in respect of the land specified in the second schedule to this notice and **hereby grants Prior Approval** for the development subject to the following condition:

In accordance with Class B Conditions, B.2, (b) (viii) (aa) the works shall be undertaken in accordance with the following approved documents, including the mitigation measures set out therein:

Churngold Remediation Limited Outline Method Statement for Demolition ref. TE21.021.MS001 Rev. B

Vectos Construction Management Plan ref. VN212156 Great Western Yard, Gloucester – Construction Management Plan 01c

The demolition must be carried within a period of 5 years from the date of this decision.

Notes:

1. Your attention is drawn to the requirements of the Building Regulations, which will be required as a separate consent to this planning decision. You are strongly advised to contact the Building Control Partnership 01453 754871.
2. If evidence of bats is found works should cease immediately and the advice of a licensed bat ecologist sought. A licence from Natural England may be required before works can resume.

3. As proposed in the application and recommended by the applicant's ecologist demolition of the existing buildings must be preceded by a building inspection by a licensed ecologist to confirm the continued absence of bat roosts. Where features identified as being suitable for roosting bats cannot be exhaustively searched, works to these features should be carried out using a soft-demolition approach under an ecological watching brief (i.e. in the presence of a licenced bat ecologist). Once affected areas of the building have been declared free of bats by the licenced ecologist, works may proceed without supervision.
4. Nesting birds are protected by law. All buildings should be inspected for the presence of nesting birds immediately prior to works commencing. If nesting birds are found, works should cease immediately and not resume until chicks are fully fledged.

[redacted]

Jon Bishop

Planning and Development Control Manager

Decision date: 14th June 2022

PLEASE SEE NOTES SET OUT IN THE ENCLOSED LEAFLET

APPENDIX 4 – MAIN MODIFICATION SITE ALLOCATION STATEMENT SAO5

~~Policy~~ **Site Allocation Statement** SA05: Land at Great Western Road Sidings

Ward / Postcode / GeoRef	Kingsholm and Wotton / GL1 3PZ / E: 384152 N: 218365
Gross Site Area:	4.3 ha.
Allocation:	Approximately ~~200~~ **300** residential dwellings.

Description and overview

Large brownfield site; an area of railway sidings close to Gloucestershire Royal Hospital on the junction of Great Western Road and Horton Road. The site offers the opportunity for a higher density scheme near the city centre and transport hub.

Site specific requirements and opportunities

Design and layout

- Create a well-defined built frontage to Great Western Road.
- Create a green link between Great Western Road and the southern end of Horton Road.
- Increase tree coverage and create a more meaningful useable open space that connects to the hospital and could be utilised by hospital visitors.
- Provision of appropriate crossing point to access open space.

Open space

- The site includes existing green space known as the 'Great Western Road Rest Gardens'. This should be included and expanded within the wider redevelopment, to provide a functional area of open space including a Locally Equipped Area for Play.

Highways and access

- Implementation of a new strategic cycle and footway linking to city centre and transport hub to the west and the new residential development at the Allstone site to the east.

Historic environment

- Built heritage and ecological assessments.
- Presence of historic steam engine shed is a non-designated heritage asset.

Biodiversity

- Creation of green corridor following the proposed walking/cycle route from Horton Road (with links to the Allstone site / Armscroft Park), through the sidings towards former Wessex House and railway station.
- Creation of bat habitat/roosts.
- Likely presence of nationally scarce invertebrates; any loss of brownfield habitat should be mitigated through brown roofs.
- Bat survey: Building inspections (and any required emergence/re-entry surveys) if any buildings are scheduled to be removed or altered.
- Birds survey: Not required, but vegetation scheduled for removal between March and August must be checked for evidence of breeding birds.
- Reptile survey: To assess presence.
- Invertebrates survey: To determine presence of important habitats for invertebrates.

Mineral Consultation Area (MCA)

- **The site allocation lies within a Mineral Consultation Area (MCA) due to the recorded presence ofunderlying sand & gravel resources. Early engagement with the MWPA is strongly encouraged toestablish whether a Mineral Resource Assessment (MRA) is necessary.**

Mitigation measures

- **Due to the presence of nearby safeguarded mineral and waste infrastructure sufficient mitigationmeasures should be put in place to avoid unacceptable land-use incompatibility issues arising.**

Air Quality

- Given the likely high density of development and the proximity of the site to existing potential sources of air pollution, all proposals for development should demonstrate their compliance in meeting EU limit values and national objectives for air pollutants. The development must be consistent with the Local Air Quality Action Plan.

Other

- Regard to the City Council's adopted 'Railway Corridor' Planning Brief.

APPENDIX 5 – ECONOMIC BENEFITS INFOGRAPHIC

P20-0832

Economic Benefits

Great Western Yard, Gloucester

Construction of up to **315** residential dwellings

EUTOPIA HOMES

PEGASUS GROUP

Construction Benefits

£44 million

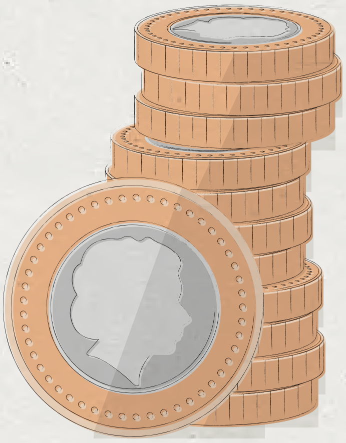
Estimated construction investment over 2-year build programme ①

490

Direct construction roles and indirect/induced jobs supported per annum during build phase

£56.7 million GVA ②

Economic output contribution from jobs supported by activities at the site over 2-years (at current prices).



Operational Benefits

404

Economically active and employed residents estimated to live in the new housing

£1.6 million

Estimated first occupation expenditure. Research suggests that the average homeowner spends approximately **£5,000** within the first 18-months to make their house ‘feel like home’

39%

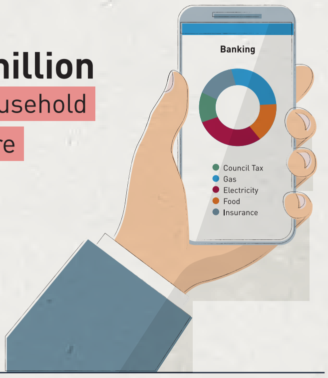
Of employed residents estimated to be working in higher value/higher income occupations

£613,755

Estimated annual increase in Council Tax revenue ③

£10.1 million

Annual household expenditure



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① The construction cost has been estimated using the BCIS Online tool and is exclusive of external works, contingencies, supporting infrastructure fees, VAT, finance charges etc. (Accessed: 27/06/2022).

② GVA, or gross value added, is the measure of the value of goods and services produced in an area, sector or industry.

③ Based on average Council Tax for band D properties in the local area of the settlement of £1,948.43 in 2022/23.

APPENDIX 6 – DRAFT HEADS OF TERMS

DRAFT HEADS OF TERMS

The Applicant will present deeds pursuant to Section 106 of the Town & County Planning Act 1990 during the course of the consideration of the planning application.

The Applicant wishes to discuss the proposed of Heads Terms with the Council. It is understood that the affordable housing and financial contributions may be requested along with CIL liability. The Applicant is willing to agree to planning obligations which meet the requirements of 122 and 123 of the CIL Regulations 2010. Regulation 122(2) requires planning obligations to be necessary to make the development acceptable in planning terms, directly related to the development, and fairly and reasonably related in scale and kind.

Likely planning obligations might include;

Education

Affordable Housing (subject to viability)

Libraries

Potential Cotswold Beechwoods SAC avoidance/mitigation measures

Off-site highways works related to the scheme

Public transport improvements if required

Travel Plan

On site POS provision, management and maintenance

Off-site sports and leisure facilties

Waste and recycling

EUTOPIA
HOMES

EUTOPIA

HOMES

Shadow Habitats Regulations Assessment

Great Western Yard

Burton Reid Associates

EUTOPIA

HOMES

COMPANY PHILOSOPHY

Burton Reid Associates are a multi-disciplinary consultancy specialising in providing high quality ecological and landscape design and advice related to the provision of embedded green and blue infrastructure and biodiversity net gains. We have a simple philosophy, designing with nature in mind supports the long-term health and wellbeing of us all. We work with clients who share this philosophy.

We can help you to achieve biodiversity net gains and deliver high-quality green infrastructure at a local and strategic level. We provide expert ecological services, undertaking surveys for protected species and habitats and supporting you to create on and off-site mitigation with our dedicated habitat management team. Our services include landscape architecture and production of high quality graphics that clearly communicate information and data.

BURTON REID
ASSOCIATES

DOCUMENT CONTROL

Site name:	Great Western Yard, Gloucester
Project No:	BR0724
Document Title:	Shadow Habitats Regulations Assessment
Document No:	BR0724/sHRA/A
Client:	Eutopia Homes Ltd.

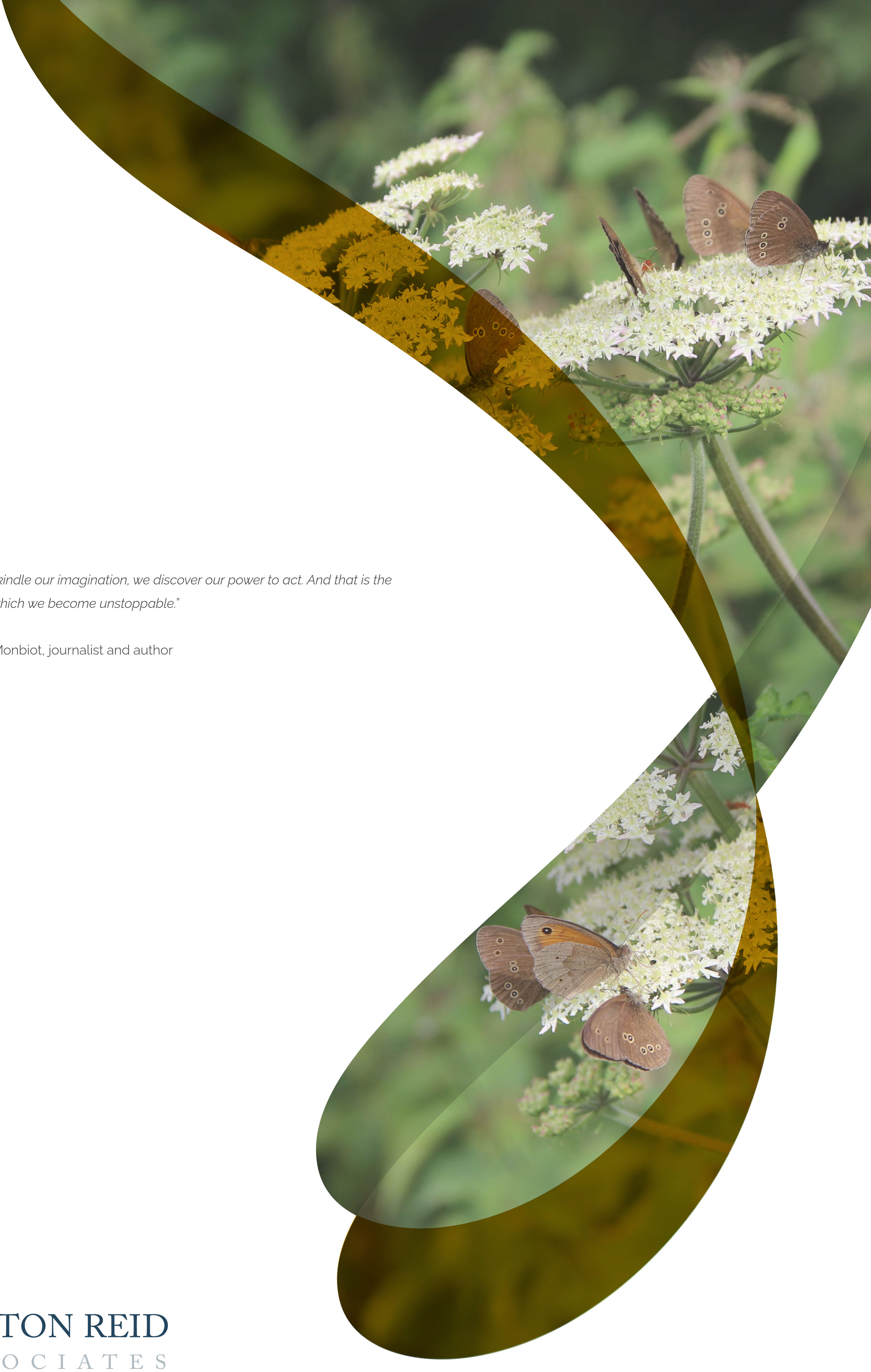
☒ Original Document ☐ Revision ☐ Revision Code

Prepared by:	Chrissy Mason MSc MCIEEM	Lead Planning and Technical Ecologist	[redacted]	28/06/2022
Checked by:	Jenni Reid CEnv MCIEEM	Founder	[redacted]	28/06/2022
Approved by:	Jenni Reid CEnv MCIEEM	Founder	[redacted]	28/06/2022

Revision Record

Rev Code	Date Prepared	Prepared By	Checker/Approved	Description of Changes

BURTON REID
ASSOCIATES



"As we rekindle our imagination, we discover our power to act. And that is the point at which we become unstoppable."

George Monbiot, journalist and author

BURTON REID
ASSOCIATES

DECLARATIONS OF COMPLIANCE

The report which we have prepared and provided is in accordance with the Chartered Institute for Ecology and Environmental Management's Code of Professional Conduct. We confirm that the opinions expressed are our true and professional bona fide opinions.

This report has been produced in accordance with British Standard 42020:2013 "Biodiversity, Code of practice for planning and development" and the Chartered Institute of Ecology and Environmental Management's Guidelines for Ecological Report Writing (CIEEM, 2017).

DATA VALIDITY

Please note that unless otherwise stated, the contents of this report will remain valid for a maximum period of 12 months from date of issue. Beyond this updated survey work may be required to establish any changes in baseline conditions.

DISCLAIMER

Burton Reid Associates has exercised all reasonable skill and due care in preparing this report. Burton Reid Associates has not, unless specifically stated, independently verified information provided by others. No other warranty, express or implied, is made in relation to the content of this report and Burton Reid Associates assumes no liability for any loss resulting from errors, omissions or misrepresentation made by others.

Any recommendation, opinion or finding stated in this report is based on circumstances and facts as they existed at the time that Burton Reid Associates performed the work (including based on the information provided by the client). Professional judgement and opinion has been utilised where required. All opinion is provided in good faith.

Nothing in this report constitutes legal advice or opinion. If legal opinion is required a qualified legal professional should be contacted for advice.

NON-TECHNICAL SUMMARY

Burton Reid Associates was commissioned by Eutopia Homes Ltd. to prepare a Shadow Habitats Regulations Assessment in relation to a planning application for a residential development of up to 315 dwellings with associated landscaping, parking, open space and ancillary works including demolition of existing buildings and associated green spaces on land at Great Western Yard, Gloucester, (OS Grid: SO 8414 1836).

This Shadow Habitats Regulations Assessment presents the necessary information in order that Gloucester City Council as competent authority can ascertain the proposed development would not adversely affect the integrity of a European site (Special Areas of Conservation (SACs), Special Protection Areas (SPAs) and Ramsar Sites) either alone or in-combination with other plans or projects.

During pre-application advice Gloucester City Council requested the following sites be screened into the assessment:

- Walmore Common Special Protection Area (SPA)
- Cotswold Beechwoods Special Area of Conservation (SAC)
- Severn Estuary SAC, SPA and Ramsar Site

The report concludes that with proposed mitigation measures taken together with additional strategic mitigation and policy safeguards in place, including provision of green infrastructure, access links to nearby public green space, an appropriate drainage strategy and Construction Environmental Management Plan together with any additional strategic mitigation payments imposed by the competent authority, it is considered an adverse effect is unlikely as a result of the development on the integrity of Walmore Common SPA, Cotswold Beechwoods SAC and Severn Estuary SAC, SPA and Ramsar Site, alone or in combination with other plans or projects.

CONTENTS

1 INTRODUCTION

1.1 BACKGROUND

Burton Reid Associates was commissioned by Eutopia Homes Ltd. to prepare a Shadow Habitats Regulations Assessment (sHRA) in relation to a planning application for a housing development and associated green spaces on land at Great Western Yard, Gloucester, herein after called 'the Site'.

The Site centre is located at National Grid Reference SO 8414 1836 between Great Western Road to the north, Horton Road to the east and the railway to the south. The Site is 4.3 ha and comprises a former railway sidings and diesel depot, with associated buildings.

This sHRA presents the information necessary for the competent authority to screen the proposals for likely significant effects (LSE) on European sites and then carry out an 'appropriate assessment' as required under the Conservation of Habitats and Species Regulations 2017 (as amended). This report should be read in conjunction with the corresponding application documents including the Ecological Impact Assessment (Burton Reid Associated, 2022a).

1.2 PROPOSED DEVELOPMENT

The proposals for the Site include a residential development of up to 315no. dwellings with associated landscaping, parking, open space and ancillary works. Site clearance work will include the demolition of all existing buildings.

1.3 LEGISLATION

Habitats Regulations Assessment is the assessment of the potential effects of a project or plan on one or more 'European sites' within the national site network which includes Special Protection Areas (SPAs), Special Areas of Conservation (SACs) and candidate Special Areas of Conservation (cSACs).

These sites have the highest level of legal protection for wildlife and originate from the European Nature Directives - the Habitats Directive (Council Directive 92/43/EC) and the Birds Directive (Council Directive 2009/147/EC). The Directives are transposed into UK legislation by the Conservation of Habitats and Species Regulations 2017 (as amended) ('the Habitats Regulations').

The term 'the national site network' was introduced into the 2017 Habitats Regulations by the Conservation of Habitats and Species (Amendment) (EU Exit) Regulations 2019 comprising European sites already protected under the Nature Directives and any further sites designated under these Regulations. As a result in the UK, sites which were part of the European Union's 'Natura 2000' network have become part of the national site setwork, together with any new sites designated after exit day under the Habitats Regulations.

Joint Defra guidance[1] to competent authorities (February 2021) advises as a matter of policy the following sites should be subject to Habitats Regulations Assessment in the same way a 'European sites' (National Site Network sites):

- Proposed SACs
- Potential SPAs
- Ramsar sites – wetlands of international importance (both listed and proposed)
- Areas secured as sites compensating for damage to a European site

Also, whilst not specifically stated in the Habitats Regulations or NPPF, land where there is evidence there is a functional link to European sites (Functionally Linked Land) is also included within the HRA process further to a number of planning test cases[2].

The term 'European site' will be used throughout this report to refer to any site considered within the HRA process.

Under Regulation 63 of the Habitats Regulations, a competent authority, before deciding to give consent to a project must make an appropriate assessment of the implications of the project which:

a) Is likely to have a significant effect on a European site either alone or in combination with other plans or projects;

b) Is not directly connected with or necessary to the management of that site.

Consequently Gloucester City Council as the relevant competent authority is required to carry out a Habitats Regulations Assessment (HRA) to ensure that the development decision does not adversely affect the integrity of European sites.

The following policies within the Gloucester, Cheltenham and Tewksbury Joint Core Strategy 2011-2031 (adopted December 2017) are relevant to this development:

1.4 POLICY

The following planning policies, guidance and local plans have been taken into account and referred to where appropriate:

---

[1] Defra, Natural England, Welsh Government Natural Resource Wales joint guidance to competent authorities (24 February 2021) [online] Habitats regulations assessments: protecting a European site - GOV.UK (www.gov.uk)

[2] Functional linkage: How areas that are functionally linked to European sites have been considered when they may be affected by plans and projects – a review of authoritative decisions (Natural England 2016)

- Gloucester, Cheltenham and Tewkesbury Joint Core Strategy (JCS) 2011 – 2031;
- Pre-Submission Gloucester City Plan 2011-2031
- Gloucester City Plan 2016-2033 Pre-Submission Habitats Regulations Assessment (HRA) Revised Screening & Appropriate Assessment Report July 2019;
- ODPM Circular 06/2005: Biodiversity and Geological Conservation;
- National Planning Policy Framework (NPPF).

The following local plan policies are relevant to the proposed project:

- *JCS Policy SD9: Biodiversity and Geodiversity*

This policy provides general protection and enhancement of biodiversity and geodiversity resources within the JCS area to establish and reinforce ecological networks that are resilient to current and future pressures. The policy states any development that has the potential to have a likely significant effect on an international site will be subject to a Habitats Regulations Assessment. Supporting text to this policy explains this requirement includes a screening process followed by the completion of an Appropriate Assessment if required. Development that would adversely affect the integrity of any SPA, SAC or Ramsar site will need to demonstrate exceptional requirements relating to the absence of alternative solutions and imperative reasons of overriding public interest.

- *Gloucester City Plan 2011-2031 (Regulation 19) Policy E2: Biodiversity and Geodiversity*

This policy requires that development proposals will only be permitted in localities that could have an impact upon designated Special Protection Areas (SPAs), Special Areas of Conservation (SAC) and Ramsar Sites, where it can be demonstrated that:

a) There will be no significant effect, alone or in-combination, considering the site's conservation objectives; or
b) Any adverse effect on the site's integrity can be mitigated.

Where an adverse effect (or effects) on integrity cannot be mitigated, further tests will apply in order to decide whether permission can be granted. Supporting text for this policy explains The River Severn, Severn Estuary and tributaries provide a route for migratory fish forming part of the reasons for the Severn Estuary's designation as a Special Area of Conservation and Ramsar Site. The Severn Rivers Trust has been established to promote projects to improve fish passage along the Severn and to develop greater use of the rivers Severn and Teme by locals and visitors. Development that may have direct and indirect impacts on watercourses used by the SAC and Ramsar species will be subject to a Habitats Regulations Assessment. Similarly, areas of land within the city such as Alney Island Nature Reserve provide a refuge land for bird species designated as part of the Severn Estuary Special Protection Area (SPA). Development that may have a direct or indirect impacts on such 'functionally linked land' used by SPA bird species will be subject to a Habitats Regulations Assessment.

- *Gloucester City Plan 2011-2031 (Regulation 19) Policy E8: Cotswold Beechwoods SAC.*

This policy states Development will not be permitted where it is likely to lead directly or indirectly to an adverse effect upon the integrity of the Cotswold Beechwoods Special Area of Conservation (SAC) (alone or in-combination), and the effects cannot be mitigated. In order to retain the integrity of the SAC, and to provide protection from recreational pressure, all development that results in a net increase in dwellings will be subject to Habitats Regulations Assessment for likely significant effects. Any development that has the potential to lead to an increase in recreational pressure on the SAC will be required to identify any potential adverse effects and provide appropriate mitigation. This will be in accordance with the SAC mitigation and implementation strategy or through a Habitats Regulations Assessment.

Development which is likely to generate road traffic emissions to air, which are capable of affecting the SAC, will be screened against the Habitats Regulations Assessment Framework in line with Natural England's guidance 'Natural England's approach to advising competent authorities on the assessment of road traffic emissions under the Habitats Regulations (NEA001) or any future iteration.

The supporting text for this policy explains there is planned growth in housing in districts surrounding the Cotswold Beechwoods Special Area of Conservation (SAC), which could lead to an increased level of recreational pressure resulting from people visiting the SAC. Due to the extent of the Beechwoods and the fact that visitors travel a significant distance to visit the site, a Gloucester wide approach is required in order to successfully mitigate any likely adverse impacts.

The Gloucestershire planning authorities commissioned a visitor survey, carried out over summer 2019, in order to better understand the recreational pressures on the SAC. The survey results are part of the evidence base of the emerging mitigation strategy. This will identify the measures that need to be put in place to mitigate the impact of new development and ensure protection of the site. The evidence may also assist in determining when a development may be likely to have an adverse impact depending on factors such as distance from the SAC. The strategy is expected to be available from September 2022.

In order to comply with the Habitats Regulations 2017, and specifically to address uncertainties regarding the effects of recreation pressure from new housing in Gloucester City a policy approach will require effective mitigation. Policy E2 ensures that by requiring that where residential development is likely to have an adverse impact on the SAC through increased recreational pressure, these impacts are mitigated. Mitigation should be undertaken as per the SAC mitigation strategy or through a bespoke Habitats Regulations Assessment for the development.

Appropriate mitigation measures may include:

- On-site measures including for example the provision of open space and green space where this can be accommodated.
- Where this is not possible, financial contributions toward off-site measures such as green infrastructure, habitat management, access management, residential travel plans, visitor infrastructure and publicity and awareness raising.

Any mitigation measures should take account of and integrate with:

- Adopted JCS Policy INF3: Green Infrastructure and the associated JCS Green Infrastructure Strategy
- City Plan Policies E2: Biodiversity and Geodiversity, E3: Nature Recovery and E5: Green Infrastructure/Building with Nature.
- The Cotswold Beechwoods SAC lies within 200m of the A46. The 'air pollution information service' (APIS) website (www.apis.ac.uk) indicates that the SAC currently exceeds its critical loads and levels for nutrient nitrogen. Natural England have therefore advised that development proposals that may generate additional traffic along this route should take account of guidance Note NEA001. This will ensure that the most-to-date information in line with the Habitats Regulations 2017 are referenced and that the information is consistent with the Wealden case law dealing with in combination effects.
- *Gloucester City Plan 2011-2031 (Regulation 19) Policy SA05: Land at Great Western Sidings*

Specific requirements and opportunities set out within this policy include the following which are relevant for consideration within the assessment process:

- Creation of a green link between Great Western Road and southern end of Horton Road
- Provision of appropriate crossing point to access open space.
- Inclusion and expansion of 'Great Western Road Rest Gardens' within the wider redevelopment, to provide a functional area of open space including a Locally Equipped Area for Play
- Implementation of a new strategic cycle and footway linking to city centre and transport hub to the west and new residential development at the Allstone site to the east.
- Creation of a green corridor following proposed walking/cycle route from Horton Road (with links to the Allstone site/Armcroft Park) through sidings towards former Wessex House and railway station.
- Given the likely high density of development and proximity to the site to existing potential sources

of air pollution, all proposals for development should demonstrate their compliance in meeting EU limit values and national objectives for air pollutants. The development must be consistent with the Local Air Quality Action Plan.

1.5 APPROACH TO HRA

The HRA Process

There is no standard methodology or Government guidance (for England) that specifies the format and content of HRA. Table 1.1 below sets out the HRA process followed for this assessment. The methodology was prepared using the following guidance documents:

- European Commission (2001) *Assessment of plans and projects significantly affecting European Sites.*
- Defra, Natural England, Welsh Government Natural Resource Wales joint guidance to competent authorities (24 February 2021) [online] Habitats regulations assessments: protecting a European site - GOV.UK (www.gov.uk)
- DCLG (2006) *Planning for the Protection of European Sites: Appropriate Assessment: Guidance for Regional Spatial Strategies and Local Development Documents*. Department for Communities and Local Government, HMSO, London.
- English Nature (1997-2001) Habitats Regulations Assessment Guidance Notes 1-9, Natural England, Peterborough.
- DTA Publications (2021) The Habitats Regulations Handbook [online]. Available at: http://:www.datapubications.co.uk/handbook .

Table 1.1 Stages of Habitats Regulations Assessment

Stage		Task
Stage 1: Screening	Evidence gathering and consultation	• Determine the project is not directly connected with or necessary to the management of that site. • Identify European sites for consideration • Gather information on relevant European sites, Qualifying features and Conservation Objectives • Gather baseline information on qualifying features of the European sites within the Zone of influence of the Project

Stage		Task
	Screening assessment for Likely Significant Effect	• Identify whether the project is likely to have a significant effect on a European site without avoidance or reduction measures either alone or in-combination with other plans or projects. Where there is no possible risk of a likely significant effect (e.g. due to distance or no identified impact pathways) sites may be screened out of the need for further assessment. • At the screening stage it is not appropriate to take into account measures to avoid or reduce harmful effects of a project on that site following The People Over Wind Sweetman v Coillte Teoranta (April 2018) judgment. • Only measures that constitute part of the project design and are not intended as measures to avoid or reduce effects on European site features are considered at Stage 1 Screening Stage

Stage		Task
Stage 2: Appropriate Assessment	Mitigation Measures	• Where any possible Likely Significant Effects arising from the Project are identified, apply mitigation measure to avoid then reduce effects.
	Ascertain effect on site integrity	• Carry out detailed assessment to show whether an adverse effect on the integrity of the site from the proposal can be ruled out in view of the site's conservation objectives.
	In-combination effects	• Carry out detailed assessment to show whether an adverse effect on the integrity of the site from the proposal can be ruled out in view of the site's conservation objectives.
	Ascertain effect on site integrity	• Conclude no adverse effect on integrity where appropriate mitigation is applied. If an adverse effect cannot be ruled out proceed to assessment of alternative solutions and test for Imperative Reasons of Overriding Public Interest (IROPI) (Stages 3 and 4)

Stage		Task
Stage 3:	Alternative Solutions	- Decide whether there are alternative solutions which would avoid or have a less harmful effect on the European site. - If there are alternative solutions to a potentially damaging plan or project it will need to be changed or refused.
Stage 4:	Imperative Reasons of Overriding Public Interest (IROPI) and Compensatory Measures	- Consider imperative reasons of overriding public interest and secure compensatory measures. Plan or projects may proceed for imperative reasons of overriding public interest if compensatory measures are secured.
		Note: The test for IROPI and requirements for compensation are very high and involve consultation with the Secretary of State. Most projects within the scope of the Habitats Regulations will be unlikely to proceed to stage 3 and 4.

The Shadow Habitats Regulations Assessment Report present the results of Stages 1 and 2 of this process (Screening and Appropriate Assessment) in relation to the proposed development (Section 1.2).

1.6 EVIDENCE GATHERING AND CONSULTATION

A range of information sources have been reviewed in the preparation of this report. Taken together it is considered the following information sources provide a sufficiently detailed baseline and best available information with which to carry out and complete a Habitats Regulations Assessment.

- Enfusion (2019) Gloucester City Plan 2011-2031 Habitats Regulations Assessment Revised Screening and Appropriate Assessment Report
- Footprint Ecology (2019) Habitats Regulations Assessment of the Stroud Local Plan at Draft Plan Consultation Stage
- Darling Associates Architects (April 2022) Great Western Yard Gloucester Pre-Application 2 Design Update Eutopia Homes
- Burton Reid Associates (June 2022) Ecological Impact Assessment Great Western Yard
- Burton Reid Associates (June 2022b) Biodiversity Net Gain Report Great Western Yard

A pre-application meeting took place on 7th February 2022 and GCC provided comments by email on 11th March 2022. Comments included the need for a Shadow Habitats Regulations Assessment - Appropriate Assessment (recreational impact from residential development on European protected sites to include Walmore Common, Cotswold Beechwoods SAC and Severn Estuary SPA and Functional Link to Alney Island.

2 EUROPEAN SITES CONSIDERED

2.1 IDENTIFIED SITES

This section identified the European sites scoped into this assessment (further to pre-application advice from Gloucester City Council) that could be affected by the development and sets out information regarding these sites. Seven sites are scoped into the HRA of the Gloucester City Plan, however two of these sites have been screened out from further assessment (namely Roborough Common SAC (14 km S); Wye Valley and Forest of Dean Bat SA (27 km SW) due to their distance from the development and that no impact pathways have been identified. Further to pre-application advice from Gloucester City Council (GCC) and consistent with the Gloucester City Plan (GCP) HRA the following sites are screened into this assessment.

- Cotswold Beechwoods Special Area of Conservation (SAC)
- Severn Estuary SAC, SPA and Ramsar Site
- Walmore Common Special Protection Area (SPA)

Table 2.1 below details the main characteristics of these Sites.

Table 2.1 Identified European Site Summary Characteristics

Site	Characteristics
Cotswold Beechwoods SAC 5.9 km SE	The Cotswold Beechwoods SAC is the most westerly block of *Asperulo-Fagetum* beech forests in the UK. The woods are structurally varied with blocks of high forest and areas of remnant Beech Coppice. The area is designated as a SAC due to the presence of both *Asperulo-Fagetum* Beech forests and semi-natural dry grasslands and scrubland facies: on calcareous substrates (*Festuco-Brometalia*). The site has a number of vulnerabilities including recreational activities and invasive non-native species.

Site	Characteristics
Severn Estuary SPA/SAC/Ramsar 14 km SW (Functionally Linked Land: Alney Island LNR (1.6km W)	The Severn Estuary SPA/SAC/Ramsar site is the largest coastal plain estuary in the UK with extensive mudflats and sandflats, rocky shore platforms, shingle and islands. Saltmarsh fringes the coast, backed by grazing marsh with freshwater and occasional brackish ditches. The estuary's classic funnel shape, unique in the UK, is a factor causing the Severn to have the second highest tidal range in the world (after the Bay of Fundy in Canada) at more than 12 metres. This tidal regime results in plant and animal communities typical of the extreme physical conditions of strong flows, mobile sediments, changing salinity, high turbidity and heavy scouring. The resultant low diversity invertebrate communities, that frequently include populations of ragworms, lugworms and other invertebrates in high densities, form an important food source for passage and wintering birds. The site is important in the spring and autumn migration periods for waders moving along the west coast of Europe, as well as in winter for large numbers of water birds including swans, geese, ducks and waders. These bird populations are regarded as internationally important. The Severn Estuary SPA/SAC/Ramsar has a number of vulnerabilities including changes in abiotic conditions, changes in hydraulic conditions and industrial activities.
Walmore Common SPA 9.6km WSW	Walmore Common is located 10km South-West of Gloucester. The site is a wetland overlying peat providing a variety of habitats including improved neutral grassland, unimproved marshy grassland and open water ditches. The site is an important location for Bewick's Swan Cygnus columbianus bewickii. The site has a number of vulnerabilities including recreational activities and changes in biotic conditions.

2.2 CONSERVATION OBJECTIVES

Specific Conservation Objectives for each of the European sites are presented in Appendix I of the Gloucester City Plan Pre-Submission HRA Screening and Appropriate Assessment report. For each site the over-arching objectives are to:

Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the Favourable Conservation Status of each of its Qualifying Features, by maintaining or restoring:

- The extent and distribution of qualifying natural habitats and habitats of qualifying species;
- The structure and function (including typical species) of qualifying natural habitats;
- The structure and function of habitats of qualifying species;
- The supporting processes on which qualifying natural habitats and habitats of qualifying species rely;
- The populations of qualifying species; and
- The distribution of qualifying species within the site.

2.3 PRESSURES AND THREATS

Significant effects on European sites are often associated with disturbance and increased emissions from increased traffic arising from new development, and this can often be associated with increased recreational pressures. Natural England has also advised during consultation of the Regulation 18 consultation city plan HRA report that there is growing awareness for growth across Stroud District, Tewkesbury Borough, Gloucester City and Cotswold District to result in additional recreational pressures on the Cotswold Beechwoods SAC which are evidenced through visitor surveys and addressed through strategic mitigation measures in the emerging joint local planning authority mitigation strategy.

Table 2.2 sets out Pressures and Threats to each European site identified within the Site Improvement Plans as set out in the Gloucester City Plan Pre-Submission HRA (Enfusion 2019).

Table 2.2 Pressures and Threats to European sites

Potential effects	Potential impact types	Relevant to Application Site
Habitat and species fragmentation	Direct land take, removal of green/connecting corridors/ supporting habitat, changes to sediment patterns (rivers and coastal locations) Introduction of invasive species (predation)	No
Disturbance	Increased recreational activity (population increase)	Yes
Disturbance	Noise and light pollution (from development and increased traffic)	No
Changes to hydrological regime/water levels	Increased abstraction levels (new housing) Increased hardstanding non-permeable surfaces/ accelerated run-off Laying pipes/cables (surface & ground) Topography alteration	No
Changes in air quality	Increased traffic movements Increased emissions from buildings	Yes

3 STAGE 1: HRA SCREENING ASSESSMENT

3.1 SCOPE

This section presents a Screening of Likely Significant Effects of the development against the Conservation Objectives of the European Sites. The aims of the screening are to:

- Screen out impacts that would not have a Likely Significant Effect (LSE) and do not require further assessment
- Screen in impacts where there would be an LSE either alone or in-combination with other projects so that impacts can be assessed further i.e. subject to Appropriate Assessment.

The approach to considering mitigation measures at Stage 1 screening is in accordance with the European Court Judgment *The People Over Wind, Sweetman v Coillte Teoranta* (April 2018) judgment C-323/17 12 April 2018, where by it is not appropriate at screening stage to take account of the measures intended to avoid or reduce the harmful effects of the project on that site.

The delivery of integral development measure to control the quality and quantity of surface water discharges and the provision of an appropriate sewerage system are considered to be independent of HRA considerations and therefore considered within the Stage 1 Screening. No other measures are considered in the screening of LSE.

The screening assessment is based upon the evidence and justification of findings included within the Gloucester City Plan Pre-Submission Habitats Regulations Assessment (Enfusion, 2019).

3.2 SCREENING ASSESSMENT - COTSWOLD BEECHWOODS SAC

Air Quality

The GCP 2016-2033 Pre-Submission HRA (Enfusion 2019) states that the Cotswold Beechwoods SAC is sensitive to changes in air quality and the A46 is within 200 m of the SAC. The GCP Pre-Submission HRA considers that proposed development has the potential to increase traffic with the potential for short-range atmospheric pollution. This assessment is based on the 200m distance criteria advised by Natural England's internal guidance on the assessment of road traffic emissions under the Habitats Regulations (Natural England 2018). Taking account of the local size of the development and distance from the SAC, the GCP Pre-Submission HRA considers it is unlikely that there will be Likely Significant Effects as a result of developments alone. However, the GCP Pre-Submission HRA (Enfusion 2019) identifies there is uncertainty for in-combination effects from two allocations (SA01 and SA15) both of which are within 3km of the Site and neither of which include the Application Site. Given the Application Site has not been identified as an allocation with uncertainty for in-combination effects (the site allocation is 5.9km from the SAC) (based upon GCP Pre-Submission HRA screening assessment findings, LSE on Air Quality from the development are therefore considered unlikely.

Water Quality/Levels

The GCP Pre-Submission HRA (Enfusion 2019) states that Cotswold Beechwoods SAC is not considered sensitive to impacts associated with water quality/levels (Enfusion 2019).

Habitat Loss/fragmentation

Cotswold Beechwoods SAC is sensitive to loss or fragmentation of habitat, However the development will not involve any land take of habitat, including supporting habitat and therefore LSE due to impacts associated with habitat loss and fragmentation as a result of the development are screened out from further assessment.

Recreational Disturbance

The Cotswold Beechwoods SAC is sensitive to recreational disturbance (Enfusion 2019). The GCP Pre-Submission HRA considers it is unlikely there will be a significant increase in recreational activity from individual site allocations due to their local size. However, the GCP HRA identifies there is potential for individual site policies to act in combination with other plans, specifically Stroud Local Plan Review.

Given the relatively large size of the development (c 300 new residential units) a Likely Significant Effect from recreational disturbance in combination with other developments within the GCP and Stroud Local Plan Review area is considered and therefore an appropriate assessment of these effects on the integrity of the European site in view of the Site's Conservation Objectives is required (Section 4).

3.3 SCREENING ASSESSMENT - SEVERN ESTUARY SAC/SPA/RAMSAR

Functionally Linked Land

Severn Estuary SAC/SPA/Ramsar site is 14km SW of the Site. However, SPA/Ramsar birds continue to use the estuary and river beyond the designation. Natural England advises the river is functionally linked to the designated site and the life and productivity of the SPA birds (Enfusion 2019). It is the corridor that they use for migrations and to reach land such as Ashleworth Ham. Alney Island Local Nature Reserve (LNR) lies 1.6km to the west of the proposed development and is designated for its coastal and floodplain grazing marsh, ponds, ditch, lowland meadows, wet woodland and reedbed habitats (Burton Reid 2022a). Alney Island is thought to be a key wetland and stepping stone along the river (Enfusion 2019) and as such provides a functional link to the SPA/Ramsar.

Air Quality

Alney Island LNR is more than 200m from the proposed development and therefore no pathways for short range atmospheric pollution are considered to result in LSE alone. This assessment is based on the 200m distance criteria advised by Natural England's internal guidance on the assessment of road traffic emissions under the Habitats Regulations (Natural England 2018). No impact pathways for potential in-combination effects on air quality are identified within the GCP Pre-Submission HRA from the development site allocation on land functionally linked to the Severn Estuary SAC/SPA/Ramsar. LSE on Air Quality from the development are considered unlikely.

Water Quality/Levels

Although the designated Severn Estuary SAC/SPA/Ramsar site lies 8km outside the GCP plan area the GCP Pre-Submission HRA identifies there are many water courses within the Gloucester area that eventually flow into the River Severn and therefore there are pathways for potential LSEs on water quality. LSE's on water are considered by the GCP Plan HRA for allocations within the Water Framework Directive (WFD) Drinking Water Protected Area (surface water) with a risk of pollution and the need to protect water quality with potential for LSE's alone and in-combination (Enfusion 2019). Other allocations are considered unlikely to cause LSE alone due to their distance from functionally linked land and are outside the WFD Protection Zone (Enfusion 2019).

The development site itself is not identified by the GCP Pre-Submission HRA as an allocation with potential to cause LSE due to changes in water quality/levels.. , There is some uncertainty identified by the GCP Pre-Submission HRA about potential LSE's on water quality in combination. LSE's on water quality/levels are therefore screened in for further assessment and therefore an appropriate assessment of these effects on the integrity of the European site in view of the Site's Conservation Objectives is required (Section 4).

Habitat loss/fragmentation

The proposed development will not result in loss or fragmentation through land take and given the distance of the proposed development from Alney Island LNR, the site allocation is not identified within the plan HRA as an allocation having potential LSE on supporting habitat. LSE from loss or fragmentation of habitat are therefore screened out from further assessment.

Recreational Disturbance

The GCP Pre-Submission HRA identifies there is growing awareness of the potential for recreational pressures to impact on the Severn Estuary SAC/SPA/Ramsar site, particularly on bird populations. Alney Island, immediately adjacent to the west of the GCP area is thought to be a key wetland and stepping stone along the river. Therefore recreational impacts on the river and supporting habitats such as Alney Island have the potential for adverse effects on the European site (Enfusion, 2019).The GCP Pre-Submission HRA screening assessment considers that a significant increase in recreational activity on functionally linked land and water from developments alone are unlikely given their distance. However the HRA has concluded there is uncertainty with regard to the potential for in-combination effects from recreational disturbance from developments within the GCP plan area and within neighbouring authorities in particular Forest of Dean and Stroud Local Plan Review area (Enfusion 2019).

Given the relatively large size of the development (c 300 new residential units) a Likely Significant Effect from recreational disturbance in combination with other developments is considered and therefore an appropriate assessment of these effects on site integrity in view of the Site's Conservation Objectives is required (Section 4).

3.4 SCREENING ASSESSMENT - WALMORE COMMON SPA

Walmore Common SPA is located 9.6km WSW of the Application Site. The site is designated for overwintering Bewick's Swan. No LSE are considered from the development alone due to the distance of the SPA from the proposed development. However, some potential for LSEs in combination with other developments with regard to changes in air quality, increases in recreational disturbance and water levels/quality are considered. Therefore an appropriate assessment of these effects on site integrity in view of the Site's Conservation Objectives is required (Section 4).

3.5 SCREENING ASSESSMENT - OVERALL

Table 3.1 summarises the results of the screening assessment overall as follows:

Table 3.1 Potential Likely Significant Effects on European Sites – Overall Screening Results

(A = LSE Alone; IC= LSE In Combination)

European site	Potential Likely Significant Effect (LSE)							
	Air Quality		**Disturbance**		**Water levels & Quality**		**Habitat Loss & Fragmentation**	
Alone/In Combination	**A**	**IC**	**A**	**IC**	**A**	**IC**	**A**	**IC**
Cotswold Beechwoods SAC	No	?	No	?	No	No	No	No
Severn Estuary SAC/SPA/Ramsar	No	No	No	?	No	No	No	No
Walmore Common SPA	No	?	No	?	No	?	No	No

No = No further assessment required

? = Uncertain – precautionary approach taken and further assessment required

3.6 NEED FOR APPROPRIATE ASSESSMENT

The HRA Screening Assessment of the proposed development at Great Western Yard has identified uncertainty with regard to potential for LSE as follows

- **Cotswold Beechwoods SAC** as a result of changes to air quality and increased recreational disturbance in combination with similar development;
- **Severn Estuary SAC/SPA/Ramsar** as a result of increased recreational disturbance on land functionally linked at Alney Island LNR in-combination with similar development;
- **Walmore Common SPA** as a result of changes in air quality, increased recreational disturbance and changes to water level and quality in-combination with similar development.

Based on the precautionary approach these effects will be considered in more detail through appropriate assessment (Section 4).

4 APPROPRIATE ASSESSMENT

4.1 ASSESSMENT OF EFFECTS – AIR QUALITY EFFECTS

Effects

The GCP Pre-Submission HRA (Enfusion 2019) has found there is uncertainty with regard to the potential for LSE in-combination with similar developments within the plan area and neighbouring authorities (Stroud District and Cotswold District). The Cotswold Beechwoods SAC beechwoods and grasslands are both sensitive to emissions, and critical loads for nitrogen from vehicle exhausts are being exceeded (Enfusion 2019). The Site Improvement Plan identifies air pollution and the impacts of atmospheric nitrogen as a pressure (Enfusion 2019). Whilst the Severn Estuary SAC/SPA/Ramsar is vulnerable to nitrogen deposition, the GCP Pre-Submission HRA found that critical loads for nitrogen are not being exceeded at this site for features that have critical loadings (Enfusion 2019). A small proportion of Walmore Common SPA site lies within 200m of the A48, however critical load information is not available for the habitats of Bewick's Swan for which the site is designated. The SPA is almost 10km from the proposed development and the GCP Pre-Submission HRA considers proposed individual developments within the city urban area are not within 5km of the SPA and proposed individual developments would not result in significant increased traffic due to their location and size. However, the HRA identifies there is potential for allocations to act in combination with other plans and projects, including those of neighbouring authorities.

The GCP HRA identifies that sites within central Gloucester are 6-7km from the A46 and M5. Residents in these developments are more likely to be employed in the main centre of Gloucester and less likely to use these routes to commute. As regards recreational travel it considered unlikely that residents living in the city centre would travel to Beechwoods for regular walking/dog walking activities.

Policy safeguards are in place within the GCP and require air quality assessments where appropriate with further mitigation measures required where appropriate to protect the environment from air pollution. Policy SA05 requires for the allocation site that development must demonstrate compliance in meeting EU limit values and national objectives for air pollutants and must be consistent with the Local Air Quality Action Plan.

GCP Policy G2 Sustainable Transport encourages the use of cycling/walking and public transport to reduce emissions. The development's city centre location close to Gloucester train station also means there is good access for residents to services and facilities through sustainable transport modes such that use of private vehicles is less likely.

Proposed measures

The following measures incorporated into the scheme design (Darling Associates Architects, April 2022) to encourage sustainable travel:

- Scheme layout focussing on a series of character areas with green routes;
- A hierarchy of public and private amenity zones are provided with a green edge to provide a green spine route through the entire site;
- layout creates sheltered pedestrian zones, a network of paths through the site providing cycle and pedestrian routes away from the main road;
- Residential blocks designed with the following features:
    - Individual car and cycle parking;
    - Shared surfaces to promote pedestrian dominance;
    - Streets accessed via a single access to reduce number of cars that use streets;
    - Pedestrian route linking townhouses together and to the village green;
    - Cycle Parking Strategy providing cycle parking for each apartment block including long and short stay cycle spaces;
    - External cycle stands for visitors and additional secure visitor cycle storage;
    - Each terrace house has individual secure cycle storage in front of the property.

Residual effects

Provided site specific policy safeguards are in place it is considered unlikely there would be an adverse effect caused by changes in air quality on the integrity of Cotswold Beechwoods SAC, Severn Estuary SAC/SPA/Ramsar and Walmore Common SPA.

4.2 ASSESSMENT OF EFFECTS – RECREATIONAL DISTURBANCE

Effects

There is some uncertainty with regard to the potential for likely significant effects in combination (specifically with the emerging Stroud Local Plan Review) at the Cotswold Beechwoods SAC through increased recreational disturbance as a result of new development. The majority of the SAC is open access land for people on foot (especially dog walkers) with a network of footpaths including the Cotswold Way National Trail, bridleways open to horse and bike riders. The Site Improvement Plan identifies that public access/disturbance is a priority threat as public use of the Beechwoods has grown considerably in recent years and damage is becoming more widespread (Enfusion 2019).

A particular increase has been in the use of mountain bikes and horseriding which use the woods beyond the limited network of bridleways. This has created numerous additional trackways, increasing the erosion of ground flora and potentially risk of water erosion. Additionally dog walking has increased especially at Cooper's Hill where car parking is available (Enfusion 2019).

Without appropriate mitigation it is considered any net increase in dwellings within a 5km (consistent with Stroud Local Plan Review HRA (Footprint Ecology 2019)) could result in an in-combination adverse effect on Cotswold Beechwoods SAC grassland and beech woods.

Visitor surveys in relation to the Severn Estuary Mitigation Strategy suggest distance travelled from home by visitors as 7.7 km (Enfusion 2019). Whilst the designated sites are 14km from the proposed development, Alney Island LNR functionally linked land is less than 2km from the development and therefore without mitigation there is a potential adverse effect from recreational disturbance in-combination with other development.

Proposed measures

A joint mitigation strategy for Cotswold Beechwood SAC has been prepared by Stroud District Council which sets out priorities for green infrastructure and developer contributions for site management. The Strategy puts in place policy hooks and financial mechanisms to allow appropriate mitigation to happen to ensure that in-combination effects of residential developments will not adversely effect the integrity of Cotswold Beechwoods SAC as a result of increases in recreational disturbance. A developer contribution per residential dwelling may be payable as required by the local planning authority on formal adoption of the joint mitigation strategy for Cotswold Beechwoods SAC expected during 2022. Existing policy safeguards JCS SD9 Biodiversity, INF3 Green Infrastructure and GCP policy E8 Cotswold Beechwoods SAC also include site specific requirements that ensure access to appropriate recreation facilities.

The HRA screening assessment for the GCP Pre-Submission HRA (Enfusion, 2019) concluded there is some uncertainty with regard to potential likely significant effects in combination including plans/projects from neighbouring authorities at the Severn Estuary SAC/SPA/Ramsar through increased recreational disturbance arising from proposed new development. NE has suggested an interim approach to inform assessments for planning applications with a similar approach for the Cotswold Beechwoods SAC.

NE has advised GCC that the neighbouring authorities, Stroud DC and Forest of Dean DC, have undertaken visitor surveys and developed recreation mitigation strategies. The Severn Estuary Mitigation Strategy from Stroud DC (December 2017) identifies the distance travelled from home by visitors as 7.7 km thus identifying a zone of influence for the Stroud area for use in HRAs. The GCP Plan area is 8km from the designated estuary area and therefore applying a similar zone of influence it seems unlikely proposed development within the GCP would lead to significant effects. However, the GCP HRA identifies that there is a growing awareness of the potential for recreational pressures to impact on the site, particularly on bird populations for which the SPA/Ramsar are designated. Recreational impacts on the functionally linked river and supporting sites including Alney Island (1.6 km W) therefore have the potential for adverse effects on the European site.

The GCP Pre-Submission HRA (Enfusion 2019) concludes that revised Policy E2 Biodiversity requires that there will be no adverse effects on integrity of internationally designated sites – alone or in-combination.

During pre-application discussions, GCC (email 15 June 2022) advised an interim approach to the assessment of effects until strategic mitigation measures are formally adopted would entail an analysis of other recreation opportunities in reasonably accessible locations to the site, considered in the context of accessibility of protected sites.

Access to recreational opportunities to be incorporated both on-site and existing opportunities within walking distance are set out below.

The Design Strategy for the proposed development provides the following specific measures to provide for recreational access on-site or within close proximity to the proposed development (Darling Associates Architects, April 2022).

- Pocket Parks – There is a range of communal amenity space which is accessible to all and located across the site providing a green route on site.
- External Communal Amenity – Open terraces offer landscape areas with covered areas to shelter residents from the elements allowing them to enjoy fresh air
- Interactive Spaces – A range of external play spaces is provided within the proposed scheme.
- Private amenity – Balconies are provided in all blocks of apartments for all units.
- The provision of a 0.3 ha open space area 'The Green'
- Provision of green shared pedestrian route 'Sidings Walk'
- Provision of landscape amenity area 'Avenue'

In addition to on-site public open green space, the following open spaces are accessible within proximity to the proposed development (Darling Associates Architects, April 2022):

- Sebert Street play area (1km walk)
- Armscroft Park (0.7km walk)
- Gloucester Park (1.4km walk)
- Coney Hill Park (1.3km walk)
- Spa Ground Park (1.4km walk)

Residual Effects

With the above proposed mitigation measures in place including provision of on-site public open greenspace, links to nearby green space taken together with strategic mitigation payments consistent with the emerging joint mitigation strategy it is considered unlikely there would be an adverse effect on the integrity of Cotswold Beechwoods SAC, Severn Estuary SAC/SPA/Ramsar and Walmore Common SPA is unlikely from recreational disturbance effects from the development in-combination with other developments.

4.3 ASSESSMENT OF EFFECTS – WATER QUALITY/LEVELS

The GCP Pre-Submission HRA (Enfusion 2019) confirms that JCS Policy SD3 Sustainable Drainage & Construction requires development to use water efficiently and not cause harm to water quality. GCP Policy G7 Water efficiency promotes sustainable use of water; GCP Policy E6 Flooding, Sustainable Drainage & Watercourses promotes more sustainable management of water, which the GCP Pre-Submission HRA considers will positively affect water quality and levels. The GCP HRA concludes there is integrated/embedded policy to provide mitigation to ensure there will be no adverse effects on Severn Estuary SAC/SPA/Ramsar site in respect of water quality/levels – alone or in-combination (Enfusion, 2019).

Potential effects on water quality/levels on Walmore Common SPA were screened out of the GCP site allocations by the GCP Pre-Submission HRA since no pathways for impacts on surface water runoff or water quality at the site were identified. Whilst the River Severn is functionally linked to the wetlands of the SPA, including land at Alney Island LNR, it is unlikely that the proposed developments would have any significant effects due to its size and distance from the site. There is also embedded mitigation through policies described above.

Proposed measures

Site specific measures to mitigate effects on water quality/levels include:

- A Construction Environmental Management Plan (CEMP) will be conditioned and produced prior to construction to prevent pollution discharge from the development site.
- SuDS features have been designed into the landscape strategy and are to be detailed within the scheme's Drainage Strategy. Proposed features include swales, rain gardens and SuDs planting (Darling Associates Architects, April 2022).

Residual Effects

With proposed mitigation measures and provided additional policy safeguards (JCS Policy SD3, GCP Policy SD3, GCP Policy E6) are in place including a Construction Environmental Management Plan and Drainage Strategy it is considered unlikely there would be an adverse effect on the integrity of Cotswold Beechwoods SAC, Severn Estuary SAC/SPA/Ramsar and Walmore Common SPA is unlikely from changes in water quality/levels as a result of the development alone or in-combination with other developments.

5 CONCLUSIONS

With proposed mitigation measures taken together with additional strategic mitigation and policy safeguards in place, including provision of green infrastructure, access links to nearby public green space, an appropriate drainage strategy and Construction Environmental Management Plan together with any additional strategic mitigation payments imposed by the competent authority, it is considered an adverse effect is unlikely as a result of the development on the integrity of Walmore Common SPA, Cotswold Beechwoods SAC and Severn Estuary SAC, SPA and Ramsar Site, alone or in combination with other plans or projects.

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Statement of Community Involvement

Great Western Yard

Polity

1. Introduction and background

1.1 Polity Communications Ltd ('Polity') was appointed by Eutopia Homes (Gloucester) Ltd ('Eutopia') to coordinate and implement pre-application community consultation and involvement relating to new proposals at Great Western Yard, Great Western Road, Gloucester.

1.2 Polity is a community involvement consultancy which specialises in regeneration and the built environment and has worked with on a number of similar projects at various locations nationwide. We act as a third party facilitator, acting as a 'bridge' between applicants and the local community, using various communications methods to engage with and involve residents, civic groups, businesses, elected representatives and other relevant stakeholders.

1.3 The application site falls within the Kingsholm & Wotton ward of Gloucester City Council ('GCC') which is also the Local Planning Authority.

1.4 GCC is in the latter stages of the adoption of its new Local Plan, the Gloucester City Plan ('GCP'). Following examination hearing sessions during May/June 2021, the Inspector's 'post hearing letter' was received in August 2021, setting out her initial findings. This concludes the GCP is legally compliant, has met the duty to cooperate, but unsound. However, it but can be made sound with 'Main Modifications'.

1.5 The Main Modifications have been published and are currently the subject of statutory consultation which ended on the 4th July 2022. There is a Main Modification which relates to Great Western Yard within the Site Allocations section of the GCP (SA05). This proposes to increase the number of new homes allocated to Great Western Yard from approximately 200 to 300. The emerging proposals which were presented by Eutopia and its design team during the pre-application consultation on Great Western Yard were based on the Main Modification proposal of approximately 300 new homes.

1.6 The site extends to approximately 7.78 acres (3.14 ha) gross and comprises disused rail sidings, parking and commercial premises. The site is flat in gradient in keeping with the surrounding area which is generally level.

1.7 The land is situated in a mixed-use area comprising residential, healthcare and commercial uses. The Gloucestershire Royal Hospital is situated to the north, Pullman Court business centre to the west and circa 1900's Victorian terraced properties adjoin the site to the north. Approximately 260m to the west is the Gloucester Railway Station and the railway line forms a part of the southern boundary of the site.

1.8 Within the site is a single storey former engine shed which has been structurally assessed and found to be in a poor and dangerous condition. A separate heritage assessment has also concluded that the buildings do not have any heritage value and they do not feature on any local listing.

1.9 The precise details of the proposed development at the site are set out in the Planning Statement which forms part of the planning submission and the formal description is:

Residential development of up to 315 dwellings with associated landscaping, parking, open space and ancillary works including demolition of existing buildings.

1.10 In broad terms, the proposals for Great Western Yard are for a residential development comprising some 87 new townhouses with 228 apartments in four separate blocks ranging in size from one to three bedrooms. There will be significant internal and external amenity space included to provide an attractive living environment for all new residents.

1.11 The heights of the new buildings range from two to five-storeys with the tallest buildings being located at the north western and south eastern ends of the linear Great Western Yard site. The heights, location and orientation of the proposed buildings have been chosen to ensure that there are no unacceptable amenity impacts on the nearest terraced properties on Great Western Road.

1.12 Affordable housing provision seeks to be policy compliant subject to financial viability.

1.13 The proposed development will provide low car living and encourage sustainable transportation (walking and cycling). 440 cycle spaces will be provided for the apartment blocks and each town house will have cycle parking. Six car club spaces will also be provided so that residents can have easy access to vehicles on a casual basis. In terms of car parking spaces, each of the 87 townhouses will have a dedicated car parking space and 58 will be provided for the apartments.

1.14 Aside from encouraging less reliance on use of the private car, the completed development will also have a variety of sustainable features aimed at reducing carbon emissions and meeting the need to address the climate emergency.

2. Community involvement programme – principles

Guidance on involving the community in pre-application proposals

2.1 Eutopia and its Design Team reviewed Gloucester City Council's Statement of Community Involvement (2015) to ensure that the Council's expectations were met in terms of pre-application community involvement.

2.2 Section 4 of GCC's Statement of Community Involvement sets out the recommended process to be followed in terms of engagement with a range of stakeholders and interested parties. This states that:

> *For major developments, Gloucester City Council strongly encourages applicants before the application is submitted to arrange a public meeting or exhibition at a suitable location such as a local hall in close proximity to the application site, in order to allow the proposal to be more fully understood by the local community prior to submission.*

2.3 At the point of the planning submission, applicants are also encouraged by GCC to:

> *Submit a brief statement as part of the application submission outlining how the results of the Pre-application Consultation Exercise have been taken into account in the final application documentation.*

2.4 Increased emphasis has been placed at national level on early engagement in the planning process in order to allow feedback to be fully taken on board before planning applications are finalised. This was a key guiding principle of the Localism Act (2011), and the importance of front-loaded community involvement is reinforced by the most recent iteration of the National Planning Policy Framework (July 2021), which states at paragraph 39:

> *Early engagement has significant potential to improve the efficiency and effectiveness of the planning application system for all parties. Good quality pre-application discussion enables better coordination between public and private resources and improved outcomes for the community.*

The approach followed by Eutopia

2.5 Eutopia and its design team is fully committed to appropriate non-statutory community involvement in all its development activities and has a track record of good practice in this regard with planning applications in a number of Local Planning Authorities.

2.6 Over the years of working on development and regeneration projects, Polity has developed community involvement programmes which seek to involve residents, businesses, civic groups and other community stakeholders using a variety of methods and channels. These include briefing meetings with community-based groups, design workshops, briefing meetings with elected representatives, public exhibitions, use of social media, the press & broadcast media and the use of websites and other digital media.

2.7 Polity formulated a programme in conjunction with Eutopia and its design team which had the objective of meeting best practice in pre-application consultation as well as responding to GCC's Statement of Community Involvement.

2.8 The programme was both physical and virtual in nature as COVID-19 restrictions on public gatherings had been relaxed prior to the commencement of the programme.

2.9 The community involvement programme sought to ensure that prior to the finalisation of any planning application proposals residents, businesses, civic groups, political representatives and other stakeholders could:

- have access at an early stage to clear information about the proposals and the design process leading to the planning application;
- put forward their own ideas and feel confident that there was a process for listening to, recording and considering feedback; and
- comment on the design and content of proposals prior to submission and receive appropriate responses from the design team.

2.10 The process followed, feedback received and the responses from the design team are described in the following sections.

3. Community involvement programme – activities

Briefing of elected representatives

3.1 The first stage of the pre-application community involvement process was to engage with local elected representatives and this was undertaken by means of site visits on 7th April 2022. The first was with the Leader of the Council, Cllr Richard Cook who was accompanied by GCC's recently appointed Director of Place, David Oakhill and the second was with the local councillors for Kingsholm and Wotton ward, Cllrs Angela Conder and Jeremy Hilton.

3.2 The format of the site visits was to walk the land concerned and talk through the emerging design proposals. Questions were invited along with feedback. We also discussed with ward councillors whether there were any specific civic groups or residents' associations which we should approach. The only group we identified was the Gloucester Civic Trust, who were contacted with an offer of a briefing.

Wider public engagement - consultation catchment, community letter and media coverage

3.3 Publicity for the physical and virtual consultation activities was by means of a letter (**see Appendix A**) that was hand delivered door to door by Polity's dedicated street delivery team on 21st May 2022 within an identified catchment area around the site (**see Appendix B**).

3.4 This catchment was selected by assessing the site and its locality by a visit and walk round. It was defined in such a way as to exceed the statutory neighbour notification requirements for planning applications by Local Planning Authorities. Some 800 letters were distributed to business premises and residential addresses. The Gloucester Royal Hospital was also contacted with an offer of a briefing.

3.5 Apart from signposting a website (see below), the letter also included contact information so residents and businesses could ask questions of the development team.

3.6 The details of a local 'drop in' session and how to register for an online presentation (webinar) were prominently featured. The elected members who had been briefed in April were also sent a copy of the community letter along with the two councillors representing the neighboring Elmbridge ward as some residents in that ward resided within the delivery catchment.

3.7 In addition, a news release was drafted (**see Appendix C**) and sent out to the following media outlets on 26th May 2022:

- Gloucestershire Live;
- Cotswold Journal;
- The Wilts & Gloucestershire Standard;
- Glosnews;
- The Forester;
- Gloucestershire Echo ;
- Stroud News;
- Gloucester Citizen;
- Cotswold Times;
- Gloucestershire Gazette;
- Cotswold Life; and
- Gloucestershire Review.

Website

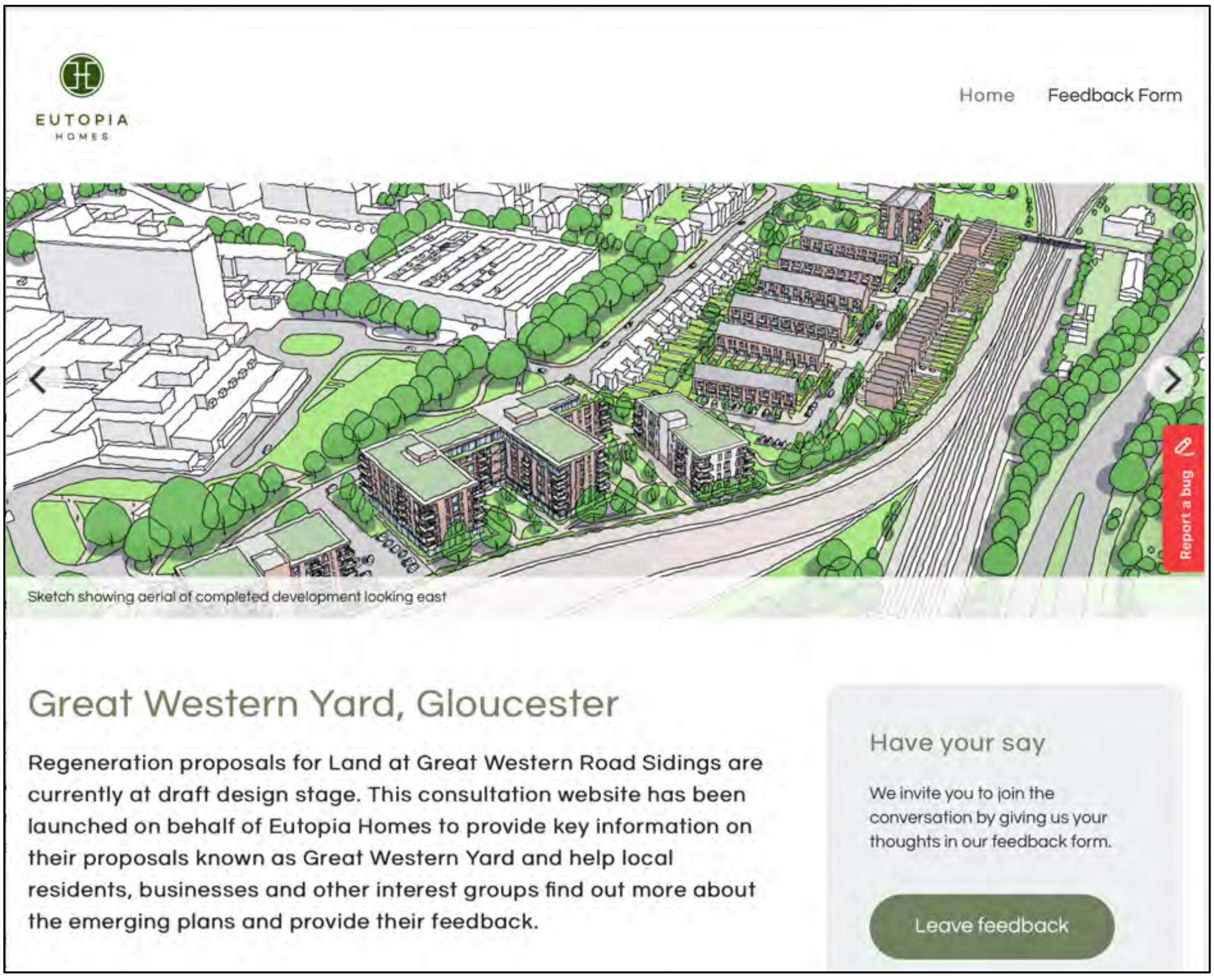
3.8 A dedicated website www.greatesternyard.info was launched on 21st May 2022 to coincide with the delivery of the community letter. This contained a downloadable presentation which had been produced by the architects. A clickable link was also provided to pre-register for the webinar.

3.9 The website contained an online contact form which invited users to submit questions and comments. One comment was received via the website.

3.10 Google Analytics reveals that there were 568 views of the website from 383 users between 21st May and 30th June 2022 including 72 downloads of the architects' presentation.

Drop in session

3.11 A drop in session was held from 4pm to 7pm on Monday 29th May 2022 at the Irish Club on Horton Road, immediately adjacent to the eastern boundary of the site. This was held in the ground floor hall and had level access to ensure that people with disabilities or restricted mobility could attend.



Great Western Yard, Gloucester

Regeneration proposals for Land at Great Western Road Sidings are currently at draft design stage. This consultation website has been launched on behalf of Eutopia Homes to provide key information on their proposals known as Great Western Yard and help local residents, businesses and other interest groups find out more about the emerging plans and provide their feedback.

Have your say

We invite you to join the conversation by giving us your thoughts in our feedback form.

Screenshot of dedicated website

3.12 Two Polity representatives were present and key visuals were displayed on A1 boards (**see Appendix D**) to assist visitors with their understanding of the draft proposals. Questions were answered and feedback noted which is set out in Section 4 below.

3.13 There were seven visitors to the event which included Richard Graham MP and Cllr Anne Radley who represents the neighbouring Elmbridge ward.

Webinar

3.14 An online live presentation via the Zoom platform of the emerging proposals was publicised via the community letter with pre-registration via the website. This was held on Thursday 31st May at 1830 and was attended by six people in addition to the Eutopia representatives. The webinar involved an on-screen presentation by the architects, Q&A's and the opportunity to provide feedback via video/audio.

3.15 The questions and other comments which resulted from the webinar and the responses from Eutopia and its design team are set out in Section 4 below.

Conclusions

3.16 The pre-application community involvement programme was a combination of engagement with elected representatives, the delivery of a community letter to a wide catchment around the site signposting the dedicated website and webinar as well as a physical event.

3.17 We received a diverse range of comments and feedback through these channels although we feel that the locational characteristics of the site plus its long-standing identification as a prime regeneration site did not elicit significant interest from the surrounding community. However, those that did participate in the programme offered very helpful and interesting feedback which has been considered by Eutopia and its design team.

3.18 The following section focuses on the key issues highlighted in the feedback received and gives the responses of Eutopia and its design team.

4. Key issues emerging from the programme

4.1 The table below shows the key issues and comments raised during the community involvement programme. These were gathered from the drop in session, comments received via the website and from the discussions which took place during the webinar.

4.2 The responses provided seek to demonstrate how the finalised proposals have been influenced by the community feedback received or explain why it is not possible to implement any suggestions received.

Key issue/comment	Response
Is the hospital happy with the access arrangements?	The Hospital have been engaged as part of the consultation process and the access proposals will be shared with them for comment. It is worth noting that the proposed access arrangements are not significantly different from the existing site access points.
Will the traffic generated impact on the operation of the hospital?	The traffic generation associated with the development is forecast to be low, as the proposed apartments will have a very low level of car parking. Furthermore, the site currently generates traffic through existing commercial uses and there are therefore already patterns of vehicle movement associated with the site. The proposed development traffic is not expected to impact on the operation of the hospital.
Traffic generally in the area is difficult and this is particularly the case when the level crossing barrier comes down on a frequent basis.	The traffic generation associated with the development is forecast to be low given the low number of car parking spaces within the site and the highly accessible location of the site. The number of additional vehicle trips that could be expected to use Horton Road has been considered and this is expected to be around 10-20 trips per hour at the busiest times. This is around one vehicle per 3-6 minutes at these busiest times, which is not expected to result in any notable change to any queues that form as a result of the level crossing being down.

Access by car to this site is poor. The level crossing delays access to/from the south and towards the city centre there is the difficulty in turning onto London Rd if right turners are waiting to turn, this problem is especially bad in the traffic peaks. In addition, when the level crossing gates are down it causes long queues on Horton Rd. affecting traffic from the north. Queues also form on Great Western Rd as traffic queues ready to turn right to go south. This impedes quick access to the hospital A &E for ambulances at these times.	The development seeks to capitalise upon the highly accessible location and it is expected that a very high proportion of trips will be by active travel modes. The low car parking levels within the site will help to constrain vehicle trips to and from the site. The effect of development traffic upon the local junctions and at the level crossing has been considered and found to be negligible. The proposals are not expected to change the existing character of the surrounding highway network.
Additional traffic from your development will exacerbate existing traffic problems.	The traffic generation associated with the development is forecast to be low given the low number of car parking spaces within the site and the highly accessible location of the site. The proposals are not expected to change the existing character of the surrounding highway network.
To reduce traffic generation from your development it would be sensible to make the whole or part of the development car free. This would be appropriate as the site is close to good public transport in the form of the rail and bus stations and the facilities of the city centre are within easy cycle and walking distance.	The development is proposed as a 'low car' scheme due to its sustainable location. The car parking ratio is 0.47 across the proposal as a whole. This is considered to be an appropriate provision. Generous cycle parking is provided to promote sustainable travel choices along with car club spaces to help facilitate low levels of car ownership amongst residents.
What parking will be provided?	145 car parking spaces will be provided.
Given each house will have one parking space, there is very little provision for the apartments.	The principle of low-car development and car-free development in sustainable locations such as this is supported by the Council and the Local Highway Authority. It is also consistent with national policy that seeks to prioritise active travel modes over car travel. Car ownership data for the local area shows that apartment households have a lower level of car ownership than houses, which shows that it is appropriate to provide different car parking levels for the two different types of dwelling. There are also six car club spaces proposed within the site to provide easy access to a car if required for residents without a car parking space.

Will visitors' spaces be provided? If so, how will these be controlled?	It is anticipated that the site will be covered by a new controlled parking zone (CPZ) which will manage the use of on-street spaces within the site, ensuring these can be used by visitors to properties within the site but restricting the use of those spaces to people not associated with the properties on the site.
On-street parking can be an issue locally and is often at a premium. Concern that the new development will exacerbate this.	The new residents at the proposed development will not be able to apply for parking permits for streets outside the site and will therefore not be able to park on-street where there is controlled parking.
Could traffic calming measures on Great Western Road be required?	It is not proposed to provide traffic calming on Great Western Road as part of the proposed development.
Should double yellow lines feature around the hospital access/egress to ensure that there is no on-street car parking?	Great Western Road is already subject to parking restrictions being within a controlled parking zone. It is not proposed to change the traffic regulation orders at the hospital access/ egress as part of this development.
Is there a need for a mini roundabout on Great Western Road at the main exit from the hospital?	The proposed access arrangements to serve the development are priority junction arrangements, which are appropriate for the scale of the proposals.
When the air ambulance is using the hospital's helicopter pad, traffic becomes worse, and the access to hospital must be shut which creates a tailback of cars entering hospital.	The traffic generation associated with the development is forecast to be low, as the proposed apartments will have a very low level of car parking within the site and the highly accessible location of the site ensures a high proportion of trips can be undertaken by sustainable modes. The proposals are not expected to change the character of the existing highway network.
There is a lack of shops in the area, is there any space for a retail unit? The nearest foodstore is quite some distance away.	There is no retail provision planned on site as the proposal has been designed as a new residential community. Tesco Express on London Road is around 0.4 miles (an 8 minute walk) from the main entrance to the proposed development.
What contact has been made with the hospital?	The relevant senior member of staff at the Royal Gloucester Hospital was approached with the offer of a briefing. A member of staff attended the drop in session and gave some feedback which is set out in this document.

Will there be more local educational and health provision to cover the increased population associated with the development? Could the arrangements for social infrastructure provision be explained in the application documentation so that this is understood locally?	Financial contributions for social infrastructure will be requested by Gloucester City Council once they have had requests from the relevant providers. This will emerge from the Council's own statutory consultation and is expected to be set out in the eventual committee report as heads of terms for a legal agreement (S106).
Affordable housing is required locally.	Agreed. The proposed development will seek to provide a policy compliant level of affordable homes subject to financial viability.
Better that brownfield sites are developed rather than greenfield sites.	This site is a classic brownfield site in a sustainable location and its development will mean that Gloucester City Council will not need to look towards greenfield sites to meet the numbers of new homes provided at Great Western Yard.
What is happening with the existing commercial uses on the site?	All tenants have plans to relocate their businesses.
The Wildlife Trust encourages certain measures to ensure wildlife can thrive. Can these be incorporated? Measures to encourage habitat/ecological diversity welcomed.	The Ecological Assessments submitted with the application demonstrate Biodiversity Net Gain. Mitigation proposed includes the installation of new bird and bat boxes, planting to encourage invertebrates and the use of hedgehog friendly fencing.
Will there be more trees/landscaping than shown along the boundary with the railway line?	There will be more high quality planting at the site but planting along the railway is restricted due to a Network Rail covenant.
Important to ensure that the proposed open space to the eastern side of the site works in conjunction with the Council-owned land just to the north. How will these two elements work together, as combined they could be an important piece of public open space for the new development and the surrounding community? What will be included in the open space within the application site boundary?	Specialist landscape consultants have been appointed to advise on the content of the open space within the site's boundary and the proposals are set out in document which forms part of the planning submission. The design will ensure that there the Council-owned land is connected. Discussions with the Council to ensure that the two pieces of open space work in combination are anticipated.
Why is the proposal presented at the webinar at variance with that featured on the Eutopia Homes website? For example, the website plans show a landscaped buffer along the railway line.	This was an earlier iteration of the scheme. The latest proposal improves upon that.
What part of the development will start first?	This is not yet determined.

There have been issues around noise and dust for residents neighbouring this site to the south east from existing commercial uses. Has this problem been assessed and will it impact on residents in the new development?	Acoustic and Air Quality Assessments have been prepared and are submitted with the application, the reports propose mitigation as part of the proposals where this is considered to be relevant and necessary.
There will be noise from the railway line. What is proposed to mitigate noise impact particularly to those properties closest to the railway line?	The Acoustic report proposes the installation of acoustic fencing where necessary.
Could the existing buildings on the site be retained and re-used? Is there any heritage value in these buildings and has there been any 'push back' from the Council's heritage/conservation officers?	The Engine Shed on the site has been assessed and is structurally unsound. A separate heritage assessment has been made of this unlisted building has been made and found it is of little heritage value. The Council has chosen not to locally list this building.
Not convinced that the proposal optimises the site's potential. Could it be possible to increase the heights of the proposed houses to three storeys?	The heights proposed have been chosen to ensure that the new development is sympathetic in amenity, townscape and sunlight/daylight terms.
Linked to the possibility of increased height for the houses is the provision of family-sized accommodation which could be maximised to meet known local demand.	The proposed development has considered housing need for the City as set out in the Gloucestershire Strategic Housing Market Assessment. The submission includes 124 no. 3 person 2-bed dwellings; 36 no. 4 person 2-bed dwellings; 37 no. 4 person 3-bed dwellings and 19 no. 5 person 3 bed dwellings.
The focus should also be to provide larger sized apartments as well and less one-bedroomed units.	The submitted proposal has 99 1-bed apartments, the remaining 129 apartments comprise a mix of 2 and 3 bed units, therefore only 43% of the proposed apartments and 31% of the whole scheme are 1 bed dwellings.
The climate emergency should be at the front of thinking in all developments. Could the new homes be carbon neutral?	An Energy Statement accompanies the submission which demonstrates the sustainability measures being taken in the construction of the proposal.
Recognised that zero carbon in construction would much more difficult to achieve.	The Energy Statement accompanies the submission which demonstrates the sustainability measures being taken in the construction of the proposal.
The holding of a webinar to invite feedback is an excellent idea.	Noted.

Wanted assurance that height of new properties would not adversely affect the neighbouring existing properties on Great Western Road in terms of amenity and overlooking.	The proposed town houses are located at a minimum distance of 13.5m from the rear elevations of the terraced houses on Great Western Road. They are also oriented so that they are 'side on' and the northern elevations facing the existing terraced properties do not contain windows so there will be no overlooking. The daylight and sunlight impacts have also been assessed and are considered to be acceptable. The height of the nearest apartment block to the existing terraced properties has also been reduced during the pre-application design process.
When is the development likely to commence and how long will the construction programme last? What measures will be taken to minimise construction impacts on neighbours?	Commencement will depend on the approval of the planning application. If a decision is made to approve by the end of 2022, works on site could commence by Q2 2023. The construction programme is expected to be 18-24 months.
How will the neighbours be consulted on construction management issues?	A Construction Management Plan will be provided and this will be shared and discussed with neighbouring residents as appropriate.
Could the layout benefit from the apartment blocks being arranged as a 'curve' to reflect the line of Great Western Avenue?	The scheme as proposed is designed to break up the development and maximise open space as well as arrival space. It creates a well-considered series of spaces and a buffer with the Great West Road. This is seen as the best design solution, although it is acknowledged that there are different options possible for the layout and configuration of the new development.
The proposed Block 'C' is splayed in relation to the other blocks. Wouldn't the layout benefit from the creation of one curved block with the open space behind it?	As above.

5. Conclusions

5.1 The community involvement programme for the emerging proposals at the Great Western Yard was conceived with best practice in mind and with the objective of meeting the expectations of Gloucester City Council as set out in its Statement of Community Involvement.

5.2 The programme employed both face-to-face (physical) and virtual communications channels including a website, a local drop-in event and a webinar which were publicised by a door-to-door letter drop to an identified catchment around the site. Local elected representatives were also notified of the intended programme and we took steps to use the local media to publicise the opportunity for local people and businesses to participate in various pre-application activities.

5.4 All of the comments received during the programme (which extended over an approximate one-month period) have been reviewed by Eutopia and its design team and responses to key issues have been set out in this document.

5.5 We received an extensive range of comments which covered key issues such as height, form, layout, sustainability, transportation, access, parking, public realm/open space, heritage, acoustics, tenures of the proposed properties, landscaping, unit sizes and construction management.

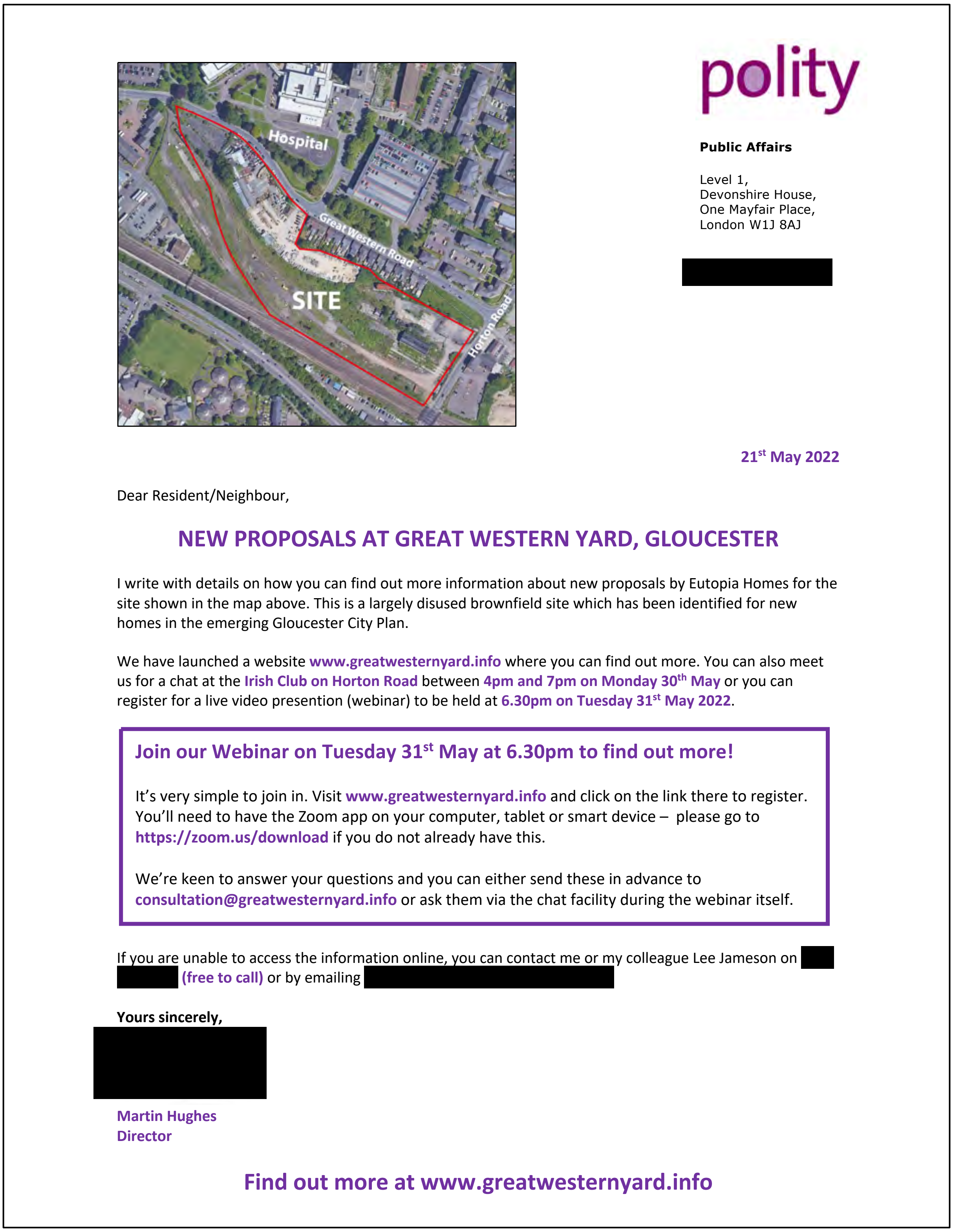
5.6 In terms of responses to the pre-application feedback, the planning application proposals and associated technical reports have sought to:

- Address all issues raised about traffic generation and adopted a 'low-car' approach to minimise traffic movements and promote sustainable transport modes;
- Respond to concerns around on-street car parking off site by indicating that off-site parking permits will not be available to new residents;
- Ensure that the proposed building heights and the configuration of the proposed buildings is such that any impacts on adjacent existing residential properties are minimised;
- Provide a suitable level of family-sized housing meeting identified needs along with a seeking to provide policy compliant level of affordable homes subject to viability;

- Consider the need to find a good solution to the relationship between the proposed new open space and the adjacent Council-owned open space;
- Include measures to minimise noise impacts from the railway line; and
- Develop a clear strategy to create a sustainable and energy efficient development.

5.7 Eutopia, its design team and Polity would like to express their thanks to local people and elected representatives which participated in the community involvement programme. The feedback received was very helpful for the pre-application design process and has informed the final planning submission.

APPENDIX A: Community letter



polity

Public Affairs

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[redacted]

21st May 2022

Dear Resident/Neighbour,

NEW PROPOSALS AT GREAT WESTERN YARD, GLOUCESTER

I write with details on how you can find out more information about new proposals by Eutopia Homes for the site shown in the map above. This is a largely disused brownfield site which has been identified for new homes in the emerging Gloucester City Plan.

We have launched a website **www.greatwesternyard.info** where you can find out more. You can also meet us for a chat at the **Irish Club on Horton Road** between **4pm and 7pm on Monday 30th May** or you can register for a live video presention (webinar) to be held at **6.30pm on Tuesday 31st May 2022**.

Join our Webinar on Tuesday 31st May at 6.30pm to find out more!

It's very simple to join in. Visit **www.greatwesternyard.info** and click on the link there to register. You'll need to have the Zoom app on your computer, tablet or smart device – please go to **https://zoom.us/download** if you do not already have this.

We're keen to answer your questions and you can either send these in advance to **consultation@greatwesternyard.info** or ask them via the chat facility during the webinar itself.

If you are unable to access the information online, you can contact me or my colleague Lee Jameson on [redacted] **(free to call)** or by emailing [redacted]

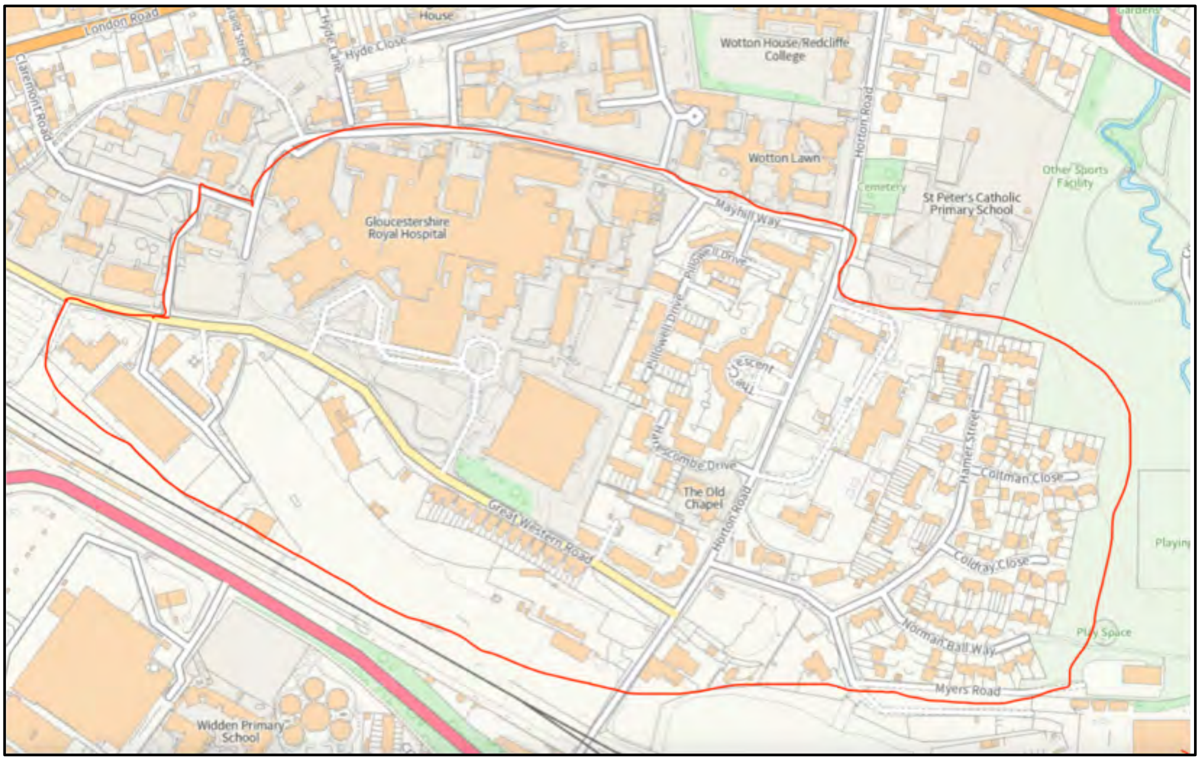
Yours sincerely,

[redacted]

Martin Hughes
Director

Find out more at www.greatwesternyard.info

APPENDIX B: Consultation catchment for community letter


London Road
Claremont Road
Hyde Lane
Hyde Close
House
Wotton House/Redcliffe College
Wotton Lawn
Horton Road
Gloucestershire Royal Hospital
Mayhill Way
Cemetery
St Peter's Catholic Primary School
Other Sports Facility
Pillowell Drive
The Crescent
Haycombe Drive
The Old Chapel
Great Western Road
Horton Road
Hamer Street
Coltman Close
Coldray Close
Norman Ball Way
Myers Road
Play Space
Playing
Widden Primary School

APPENDIX C: News release and example media coverage

Eutopia Homes propose new homes to regenerate brownfield site in Gloucester

- The proposals are yet to be finalised but aim to regenerate a disused railway depot opposite the Royal Gloucestershire Hospital.
- The planned development will include a mixture of town houses and apartments.
- The latest Gloucester Council Local Plan indicates the site is suitable for around 300 homes.
- Eutopia Homes is keen to transform the site in a manner that benefits the local community and welcomes residents' input on the proposals.

Emerging proposals for the regeneration of a key brownfield site in Gloucester have been revealed by Eutopia Homes and local people are invited to find out more and give their feedback.

The site opposite the Royal Gloucestershire Hospital and adjacent to the railway line is a disused former railway depot and has long been identified for new homes. The latest version of the draft Gloucester City Local Plan indicates that the site is suitable for around 300 new homes.

Eutopia Homes are working with award-winning architects Darling Associates to bring forward a high quality residential development which will feature town houses and apartments.

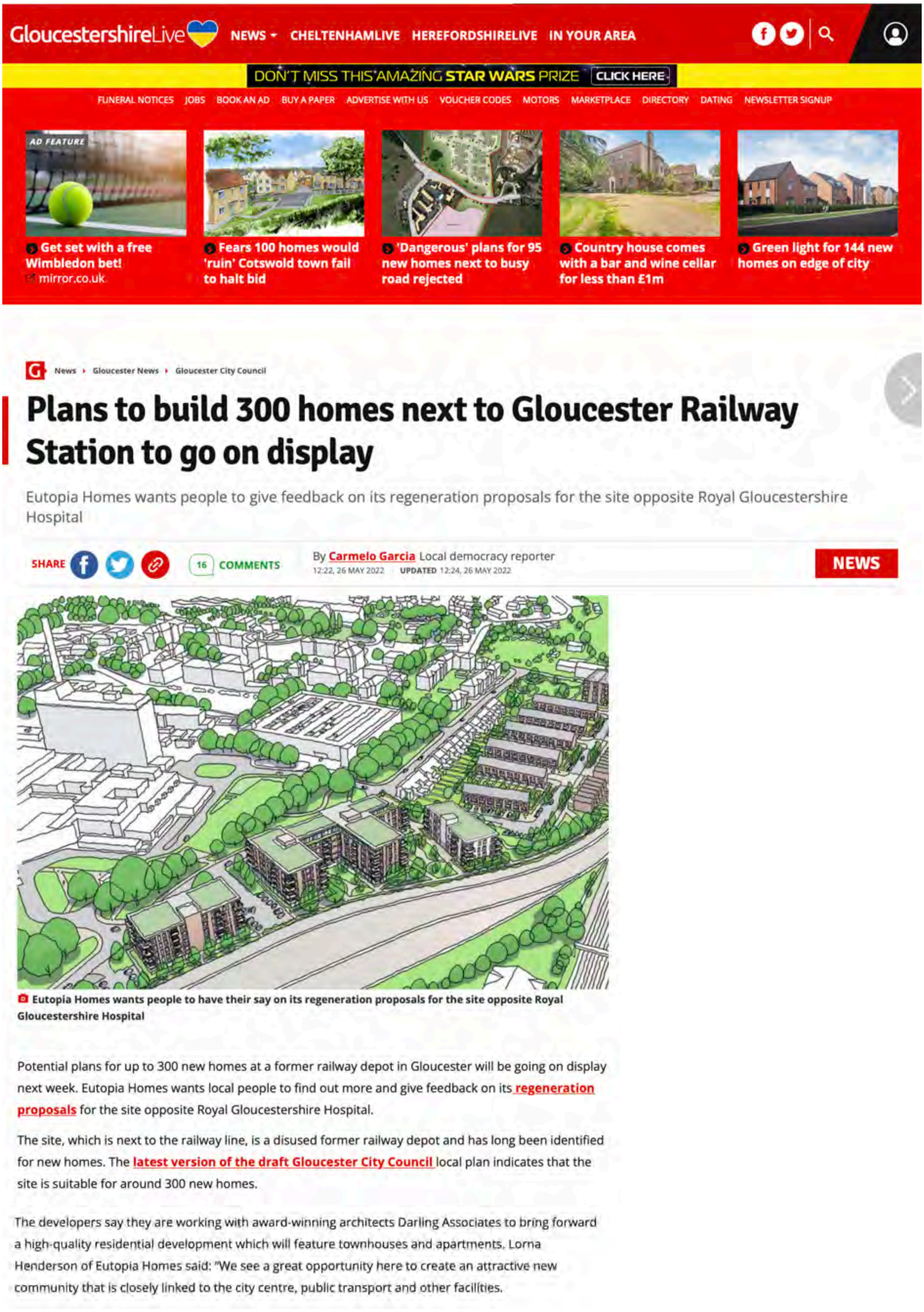
Lorna Henderson of Eutopia Homes said, "We see a great opportunity here to create an attractive new community that is closely linked to the City Centre, public transport and other facilities. The inclusion of green space and landscaping is also very much part of our thinking in transforming the site."
Lorna Henderson of Eutopia Homes added, "We would welcome the views of residents and local groups on the draft plans so that we can consider any feedback before finalising a planning application."

A dedicated website www.greatwesternyard.info has been launched to provide more information and also offer an easy way to give feedback. The website also has details on how to join a live presentation by the architects via Zoom which will be held at 6.30pm on Tuesday 31st May.

Representatives of Eutopia Homes will also be at the Irish Club on Horton Road on Monday 30th May between 4pm and 7pm where anyone interested in the plans for the site can find out more. The Eutopia Homes team can also be contacted free of charge on 0800 246 5890.

ENDS

See over for suggested images (credit: Darling Associates) which can be downloaded at https://we.tl/t-PKuofEU4qv



Plans to build 300 homes next to Gloucester Railway Station to go on display

Eutopia Homes wants people to give feedback on its regeneration proposals for the site opposite Royal Gloucestershire Hospital

By Carmelo Garcia Local democracy reporter
12:22, 26 MAY 2022 UPDATED 12:24, 26 MAY 2022

Eutopia Homes wants people to have their say on its regeneration proposals for the site opposite Royal Gloucestershire Hospital

Potential plans for up to 300 new homes at a former railway depot in Gloucester will be going on display next week. Eutopia Homes wants local people to find out more and give feedback on its regeneration proposals for the site opposite Royal Gloucestershire Hospital.

The site, which is next to the railway line, is a disused former railway depot and has long been identified for new homes. The latest version of the draft Gloucester City Council local plan indicates that the site is suitable for around 300 new homes.

The developers say they are working with award-winning architects Darling Associates to bring forward a high-quality residential development which will feature townhouses and apartments. Lorna Henderson of Eutopia Homes said: "We see a great opportunity here to create an attractive new community that is closely linked to the city centre, public transport and other facilities.

"The inclusion of green space and landscaping is also very much part of our thinking in transforming the site. We would welcome the views of residents and local groups on the draft plans so that we can consider any feedback before finalising a planning application."

The developers have set up a **dedicated website** to provide more information and also offer an easy way to give feedback. The website also has details on how to join a live presentation by the architects via Zoom which will be held at 6.30pm on Tuesday, May 31.

Representatives of Eutopia Homes will also be at the Irish Club on Horton Road on Monday, May 30, between 4pm and 7pm where anyone interested in the plans for the site can find out more. The Eutopia Homes team can also be contacted on [redacted]

The site, which is next to the railway line, is a disused former railway depot and has long been identified for new homes (Image: Eutopia Homes)

Representatives of Eutopia Homes will also be at the Irish Club on Horton Road on May 30 between 4pm and 7pm where anyone interested in the plans for the site can find out more (Image: Eutopia Homes)

APPENDIX D: A1 boards shown at drop in session

Masterplan & Layout

Proposed Layout

Block A
- 43 units
- 64 long stay cycle spaces
- 12 short stay cycle spaces

Block B
- 125 units
- 202 long stay cycle spaces
- 40 short stay cycle spaces

Block C
- 34 units
- 60 long stay cycle spaces
- 10 short stay cycle spaces

Block D
- 26 units
- 52 long stay cycle spaces
- 10 short stay cycle spaces

Apartment parking
- [illegible] general parking spaces
- 5 car club spaces

Townhouses
- [illegible] units
- Car and cycle parking per unit

DA
A

April 2021

EUTOPIA
HOMES