Ground Source Heat Pump System Design

52 Avenue Road,

London,

NW8 6HP

for

52 Avenue Road Ltd

Private & Confidential

Version 4.1

24 October 2023

GeniusEnergyLab

Contents

1. Introduction

We have pleasure in providing the Ground Source Heat Pump System Design for the following project,

Project Number	15176596
Customer Name	52 Avenue Road Ltd.
Project Address	52 Avenue Road, London, NW8 6HP
Building Type & Number	12 Residences, Communal Area
Building Load Schedule & Date	V1 31/03/2023 V2 16/05/2023
Hourly Loads Totals on Ambient Loop	
Peak Heating Load	115.7 kW
Annual Heating Load	428,291 kWh
Peak Cooling Load	87 kW
Annual Cooling Load	103,100 kWh
Borehole Geometry	Vertical
Borehole Layout	Plotted Arrays
Heat Pump Manufacturer	Carrier
Heat Pump Model	3 X 30WG 60
Version Notes	V1.0 Issue for Comment V2.0 Design Refinement V3.0 COP Data Added V4.0 Comments Addressed V4.1 Maintenance schedule added
Author	Ellis Laird Design Engineer el@geniusenergylab.com
Reviewer	Chris Davidson – BSc ARCS AIOP CGD (IGSHPA & AEE) Chairman & Technical Director cd@geniusenergylab.com
Ground Loop Modelling Period	*20 years (MCS Minimum)*
Contains British Geological Survey materials © UKRI 2022	
The Service Agreement published at https://www.geniusenergylab.com/serviceagreement applies to this document	
Note: *Any estimations regarding building loads provided by Genius Energy Lab are to be used as a guide only, it is the client's responsibility to provide accurate load information in order for a design to be warranted.*	

2. General Requirements

2.1 Roles & Responsibilities

Organisation or Individual	Role
TBC	Client Name
TBC	Main Contractor
Max O'Brien	Project Manager
Chris Davidson, GeniusEnergy*Lab*	Ground Source System Designer
Duncan Rae, GeniusEnergy*Lab*	Geological Lead
Emily Proud, GeniusEnergy*Lab*	Engineering Lead
GLDesign Version 10 Premier Edition	Ground Loop Design Software & Provider
As Appointed by Main Contractor	Drilling Contractor
As appointed by Main Contractor	Sub-Contractor (Internal Works)

2.2 Quality & Standards

During the design and installation of this project all responsible parties shall observe the most up to date versions of the following quality and standards publications which are specifically applicable to ground source heat pump installations and the project:

Publishing Body	Reference & Title
Environment Agency	Environmental good practice guide for ground source heating and cooling
IGSHPA	General Code of practice for closed loop installations
Microgeneration Certification Scheme (MCS)	MIS 3005: Heat Pump Systems
GSHPA	Vertical Borehole Standard
BDA	Code of Safe Drilling Practice
	Guidance on Managing the Risk of Hazardous Gases when Drilling or Piling Near Coal

Further publications and standards such as, but not limited to, those pertaining to Health & Safety, Risk Assessments, Method Statements and general on-site work will be applicable and are not excluded by this statement.

3. Geology

3.1 Summary of Anticipated Geology

GeniusEnergy*Lab* has made the following desktop assessment of the anticipated geological conditions at the site. As ever actual conditions can and will vary from those predicted and significant variances should be reported to the designer as soon as possible to assess the need for redesign.

Formation	Classification	Conductivity W/mK	Thickness m	Depth bgl m
London Clay Formation	Slightly calcareous, silty to very silty CLAY, clayey silt and sometimes silt, with some layers of sandy clay.	1.8	73	73
Lambeth Group	CLAY, some silty or sandy, with some sands and gravels	2.2	14	87
Thanet Sand	Homogeneous, bioturbated, glauconitic silty fine-grained SAND with sandy silt,	2.1	3	90
Chalk Group	CHALK with Flints	1.7	180	270
Gault Formation and Upper Greensand	SAND and SANDSTONE, fine-grained, silt, glauconitic, shelly. CLAY or MUDSTONE, glauconitic in part, with a sandy base.	2.4	52	322

Notes	
Local Borehole Records to Depth	213 m
Site Height Relative to Datum	45 m OD
Confidence in Geological Assessment	Very Good

3.2 Groundwater Assessment & Classification

Local records indicate the following groundwater conditions are likely at the project location,

Anticipated Groundwater Depth	70 m
Expected Rest Water Level	70 m
Risk of Artesian Conditions	Low
Notes on Artesian Conditions	No artesian conditions plotted on regional groundwater level map
Source Protection Zone	Yes - Zone II
Surface Aquifer Classification	None
Bedrock Aquifer Classification	Principal
Aquifer Vulnerability	Low
Soluble Rock Risk	No
Drilling Requirements	None
Confidence in Groundwater Assessment	Excellent

3.3 Estimated Thermal Properties

By comparing the expected ground conditions with tabulated values, we have arrived at the following estimated Thermal Properties,

Quantity	Estimated Value
Thermal Conductivity	1.80 $W \cdot mK^{-1}$ to 195m
Thermal Diffusivity	0.09 $m^2 \cdot day^{-1}$
Undisturbed Ground Temperature	11.3 °C
Conductivity Test	Required

3.4 Mines & Coal Authority Permissions

A search of the available records has indicated that the site has the following mining history and requirements,

Historic Mining Activity & Type	None
Coal Authority Reporting Area	No
Historic Coal Mining	No
Likely Depth to Seams	N/A
Development High Risk Area	No
Proximity to Mine Access	None
Historic Surface Works	None
Notes	None

3.5 Other Hazards

A search of the available records has indicated that the site may be subject to the following hazards,

Hazard Type	
Unexploded Ordnance Risk	Moderate
Notes	A UXO Survey is recommended

3.6 Barriers to Construction

With the information available and the analysis undertaken there appear to be no Geological or Hydro-Geological barriers to construction at the required depths.

3.7 EA Licencing

According to 'The Environment Agency's approach to groundwater protection', February 2018 Version 1.2, closed loop systems are not regulated and do not require a permit. There is no requirement to discuss this closed loop system with the EA.

4. Closed Ground Loop Design

4.1 Borehole Specification

Array Ref	Properties	No of Bores	Depth	Min Spacing	U-Tube
A1	Residence 1 to 12, Communal Areas	30	195 m	6 m, As Per "4.4 Borehole Illustration Schematics"	Single 40mm
Total Borehole Requirement			5,850 m		

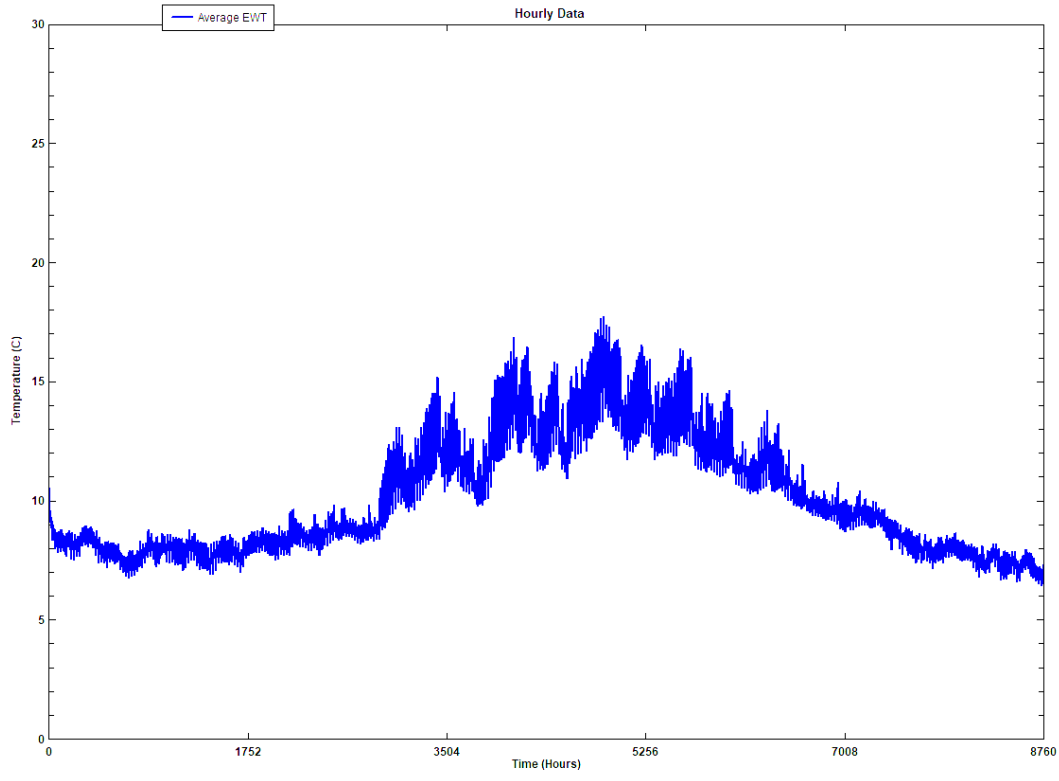
Global Requirements

- All bores to be minimum diameter to allow pipe placement
- All bores to be finished with a thermally enhanced grout
- Minimum conductivity of grout material to be 1.78 $W \cdot mK^{-1}$

Ambient System Design Temperatures – Values in Italics are Design Points

Heat Pump Source	*EWT 0.0 °C*	LWT -3.7°C
Heat Pump Load for Heating	EWT 15.0°C	*LWT 20.0°C*
Heat Pump Load for Cooling	EWT 25.0°C	*LWT 20.0°C*

Hourly EWT Temperature Over a Year



4.2 System Hydraulic Design

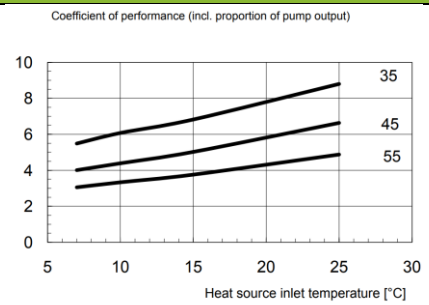
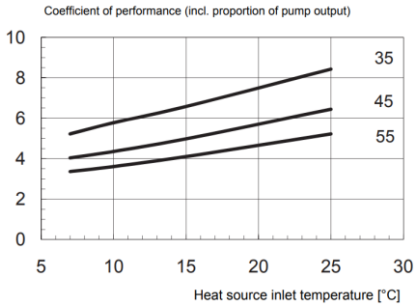
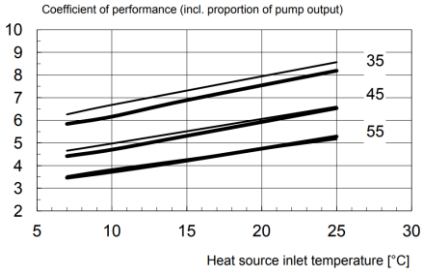
Array Ref	Configuration	Properties	Pressure Drop	
			Evaporator	Condenser
A1	Manifold	Residence 1 to 12, Communal Areas	180.5 kPa	155.5 kPa
Pipework Breakdown				
Borehole		PE100 SDR11 - 40 / 32.3		
Borehole to Sub Manifolds				
Sub Manifold to Main Manifold in Main Plant Room		PE100 SD11 - 125 / 102.2		
Runs to Heat Pumps		PE100 SDR11 - 63 / 50.9		
Anti-Freeze Requirements				
Fluid		Propylene Glycol		
Concentration		22%		
Approximate Ground Loop Volume		13,100 litres		
Approximate Anti-Freeze Requirement		3,000 litres		

4.3 Closed Ground Loop Heat Pump Selection

Quantity	Value
Evaporator Side	
Peak Flow Rate	6.2 l/s
Pressure Drop	185 kPa
Refrigerant	R-410A
Condenser Side	
Peak Flow Rate	5.6 l/s
Pressure Drop	160 kPa
Refrigerant	R-410A
Provisional Selection	Value
Make	Carrier
Model	30WG 60
Quantity	3

4.4 Coefficient of Performances

4.4.1 Individual COP and SEER

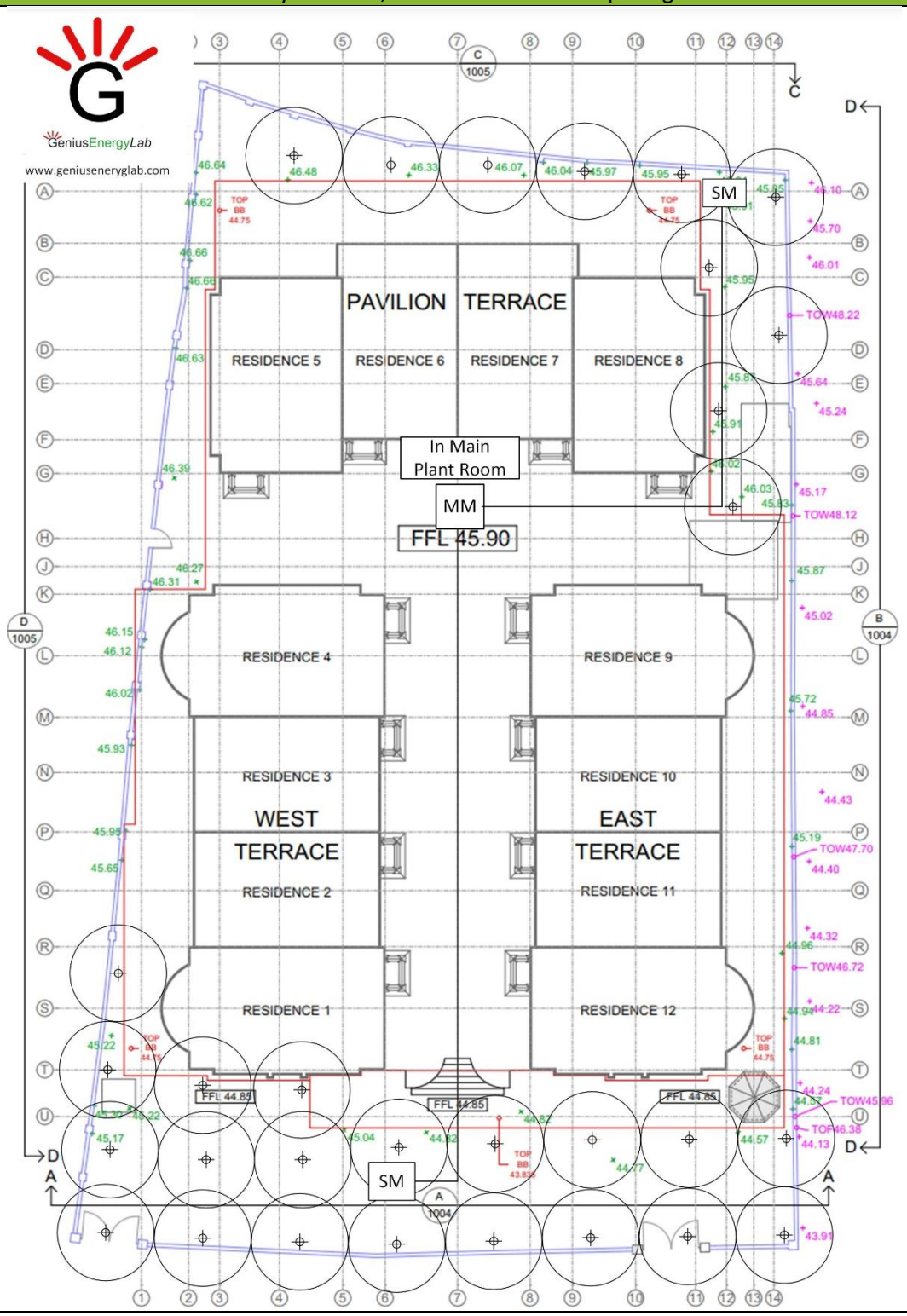
Estimated COP of Specified Heat Pumps at 20 °C EWT				
Heat Pump	LWT	Service	Estimated COP	COP Graph
WI 14TU	45 °C	House Heating	5.9	
	65 °C	House Hot Water	3.0	
WI 18TU	65 °C	Communal Hot Water	3.8	
WI 65TU	50 °C	Communal Heating/Pool Heating	5.2	
SEER of Specified VRF				
RWEYQ14T9		House Cooling	8.5	
RWEYQ1079		Communal Cooling	7.9	
Ambient Loop COP from Design Software				
Heating			6.4	
Cooling			9.1	

4.4.2 Combined COP and SEER

Estimated Combined COP of Specified Heat Pumps and GSHP			
Heat Pump	LWT	Service	Combined COP of Two Systems
WI 14TU	45 °C	House Heating	4.2
	65 °C	House Hot Water	3.0
WI 18TU	65 °C	Communal Hot Water	3.4
WI 65TU	50 °C	Communal Heating/ Communal Pool Heating	3.9
Estimated Combined SEER of Specified VRF and GSHP			
RWEYQ14T9		House Cooling	4.4
RWEYQ1079		Communal Cooling	4.2

4.5 Borehole Illustration Schematics

Array Ref – A1, 30 Boreholes at 6m Spacing



MM: Main Manifold
SM: Sub Manifold

5. Drilling Oversight

5.1 Inspection of Drilling Logs

Drilling logs will be kept by the Drilling Contractor in compliance with the standards noted in section 2 above. These will be provided to the Main Contractors Project Manager and Ground Source System Designer as requested in printed type format. These logs will be used to highlight any risk of variation as required to satisfy the Ground Source System Designer that the system design as outlined above is valid. Upon discovery of any significant variation from the first borehole subsequent drill logs may be requested in a similar manner. If at any time during the drilling operation the drilling contractor believes that successful completion to specified depth is at risk or if any other significant situation should arise the Main Contractor Project Manager will be notified immediately.

5.2 Inspection of Grout Specification

Upon request by the Main Contractor Project Manager the Drilling Contractor will provide a representative sample of the thermally enhanced grout as being used in the actual installation. This sample may be used to physically test the thermal conductivity of the grout mix being employed to verify it meets or exceeds the specification above.

5.3 Soil Sample Inspection

In some circumstances the Main Contractor Project Manager may request the Drilling Contractor to provide representative samples of soil, drilling arisings or samples to verify the drilling log samples above.

5.4 Grout & Sample Analysis

Analysis of soil samples and / or grout samples will be carried out to the appropriate standards by the Main Contractor or Ground Source System Designer.

6. Maintenance

6.1 Typical Maintenance Schedule:

Annually

- Professional Inspection: A qualified technician perform a comprehensive system inspection.
- Update Software: Update control system software, if applicable.
- Piping Integrity: Inspect the integrity of all pipes, connections and insulation.
- Air Venting: Ensure no air has entered the system.
- Performance Review: Compile and analyse the year's recorded performance metrics to identify any trends or irregularities.
- Regulatory Checks: Ensure that the system complies with any updated local or national regulations.

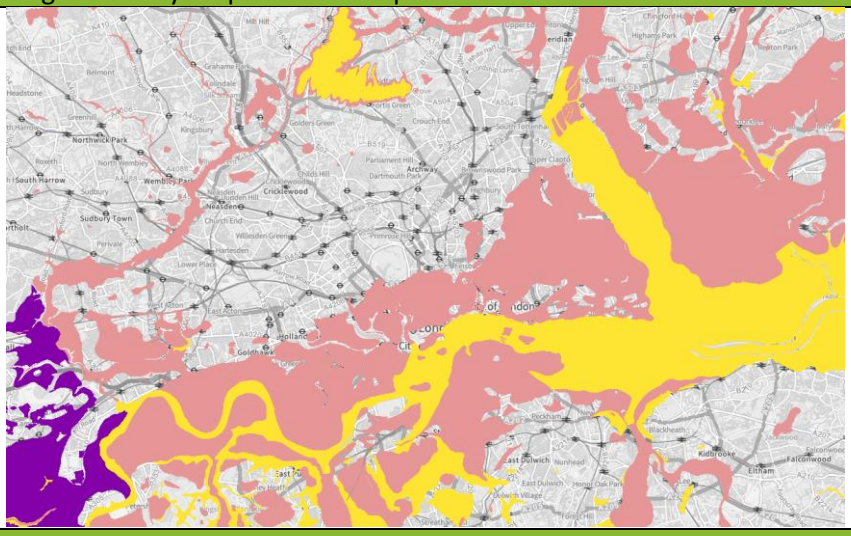
Every 10-15 Years

- Pipe Integrity: Complete a more in-depth inspection, including the underground loops.
- Full System Review: Review system components for long-term wear or possible upgrades.
- Glycol Test: Test antifreeze/heat transfer fluid, as recommended by the manufacturer.

Note that actual maintenance requirements can vary based on manufacturer specifications and local conditions.

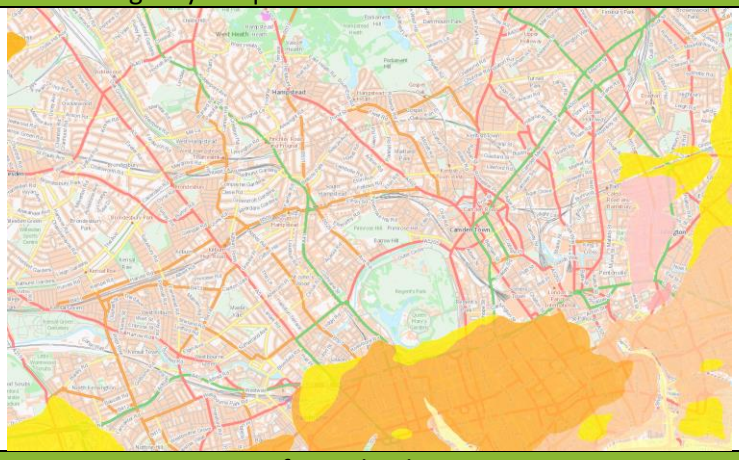
7. Geological Maps & Supporting Evidence

British Geological Survey Map of Area – Superficial Materials



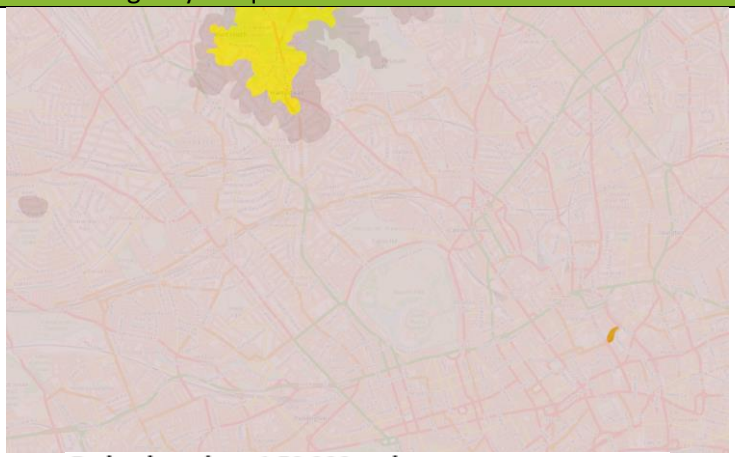
British Geological Survey Map of Area – Bedrock

Environment Agency – Aquifer Surface Materials



Principal
Secondary A
Secondary B
Secondary (undifferentiated)
Unknown (lakes and landslip)

Environment Agency – Aquifer Bedrock



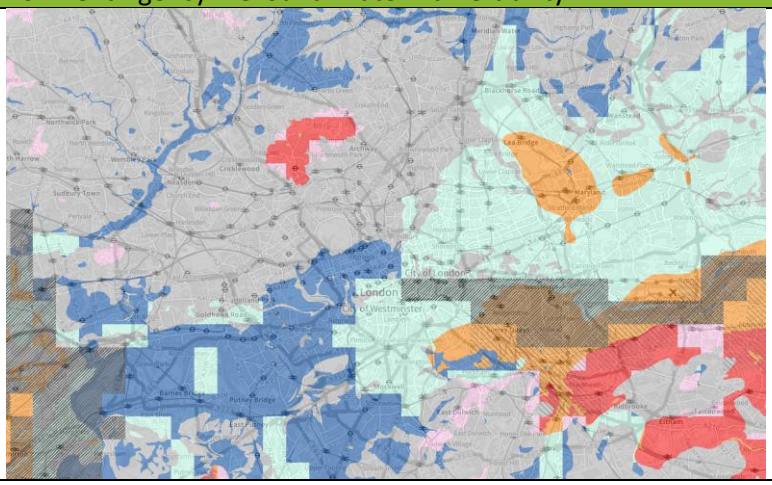
Principal
Secondary A
Secondary B
Secondary (undifferentiated)

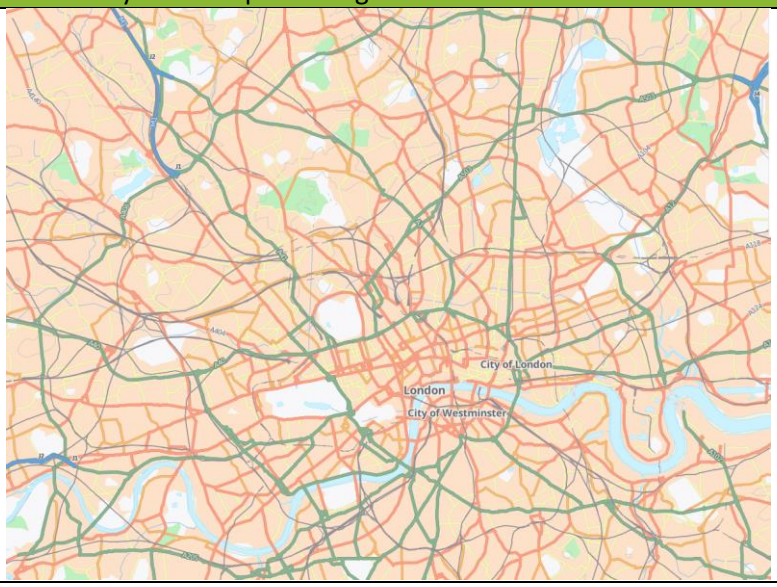
Bedrock geology 1:50,000 scale

LONDON CLAY FORMATION - CLAY, SILT AND SAND
CLAYGATE MEMBER - CLAY, SILT AND SAND
BAGSHOT FORMATION - SAND
LAMBETH GROUP - CLAY, SILT AND SAND

Environnent Agency – Source Protection Zones

Environment Agency – Ground Water Vulnerability



Coal Authority – Reporting Area & Mining Catalogue	
	Black – Reporting Area Green - Mining
Coal Authority – Development High Risk Area	
	Shaded – DHR Area

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Unexploded Ordnance Risk