

Pile Design Contamination Risk Assessment

Site: Land at Greenbooth Road and Edenfield Road, Norden

Reference:16-465-R6

Date: January 2024



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QUALITY ASSURANCE

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DRAWINGS LIST

16-465-001 – Site Location Plan
16-465-002 – Proposed Development Plan
16-465-006 – Depth of Made Ground Plan
16-465-012 – Depth to Bedrock Plan
16-465-040 – Groundwater Flow Plan



1. INTRODUCTION

1.1. BACKGROUND

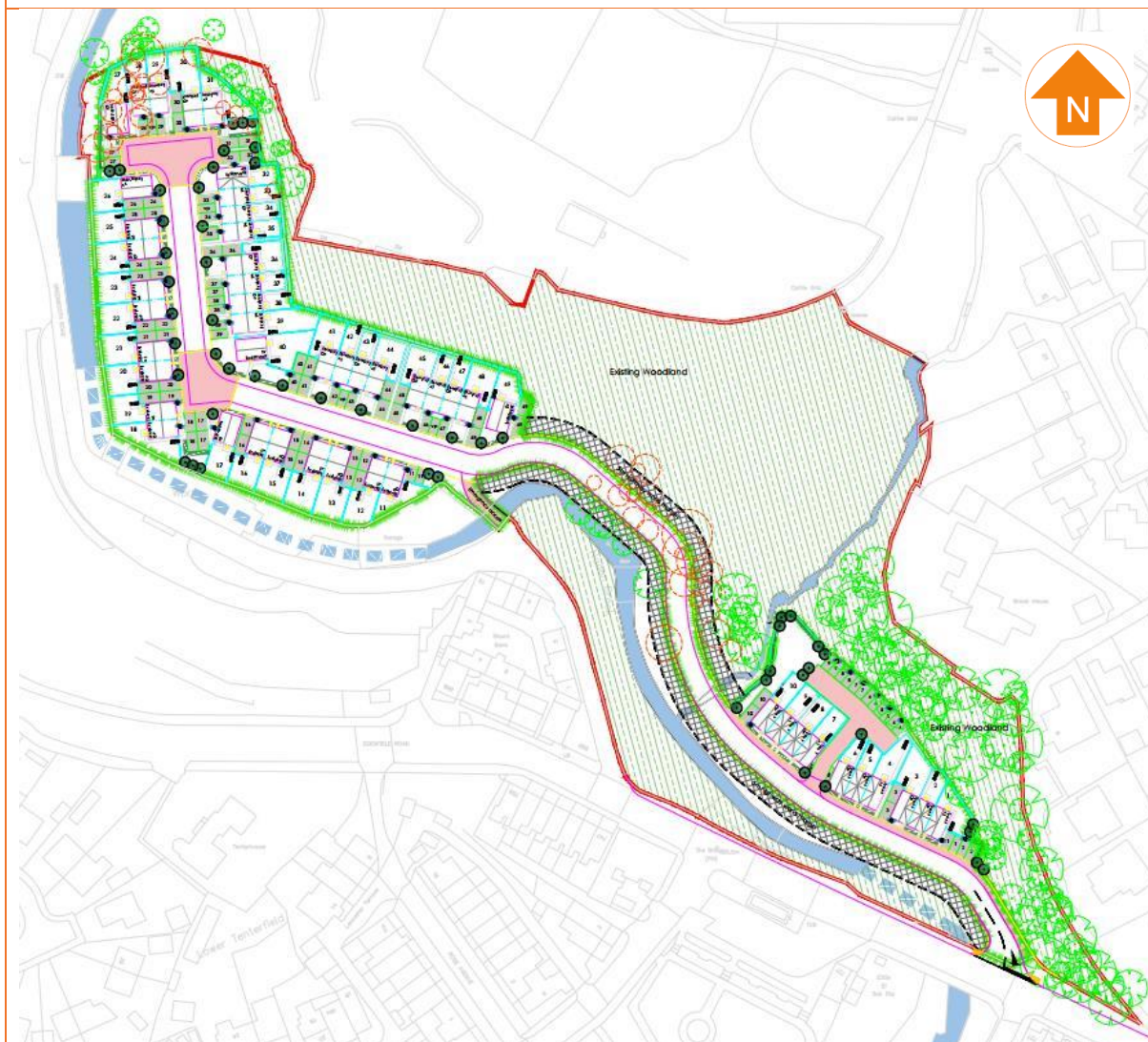
E3P has been instructed by Stonebond Properties Ltd to undertake a contamination risk assessment for penetrative foundation systems, which is referred to as a Contamination Piling Risk Assessment, for a proposed low-rise residential development at the site located to the north of Greenbooth Road and Edenfield Road, Norden, Rochdale.

1.2. PROPOSED DEVELOPMENT

Stonebond Properties Ltd intends to construct a low-rise residential development comprising 49 residential dwellings with associated gardens, estate roads, infrastructure, and a connecting bridge.

A snapshot of the proposed development layout is indicated in Figure 1.1 below, with the full drawing presented as Drawing 16-465-002 in Appendix III.

FIGURE 1.1 SNAPSHOT OF PROPOSED DEVELOPMENT



1.3. SCHEME BACKGROUND

E3P has been provided with the following correspondence from Rochdale Metropolitan Borough Council in relation to their Statutory Consultation to the planning application 20/01170/OUT:

"Piling or any other foundation designs using penetrative methods can result in risks to potable supplies from, for example, pollution / turbidity, risk of mobilising contamination, drilling through different aquifers, and creating preferential pathways. Thus, it should be demonstrated that any proposed piling will not result in contamination of groundwater".

1.4. SCOPE OF WORKS

E3P has prepared this Contamination Piling Risk Assessment in due consideration of the Regulatory Authorities requirement to demonstrate that the proposed construction works will not present any unacceptable risk to controlled waters of the wider environ.

The report has been prepared with due regard to the following Environment Agency guidance:

- ✚ Piling and Penetrative Ground Improvement Methods on Land Affected by Contamination: Guidance on Pollution Prevention. NC/99/73;
- ✚ Piling into Contaminated Sites.

1.5. PREVIOUS WORKS

The following phases of Geoenvironmental investigations have previously been carried out at the site:

- ✚ Encia Consulting Limited – Geoenvironmental Appraisal – Land at Greenbooth Road, Norden; Report Ref: 7112/1, dated June 2006, prepared for Countryside Properties Ltd;
- ✚ LK Consult – Geoenvironmental Risk Assessment, Land at Greenbooth Road, Norden; Report Ref: CL602-LKC 20 1618-01, dated September 2020, prepared for Norden Developments Ltd;
- ✚ E3P – Phase I Geoenvironmental Site Assessment, Land at Greenbooth Road and Edenfield Road, Norden; Report Ref: 16-465-R1-1, dated December 2022, prepared for Stonebond Properties Ltd;
- ✚ E3P – Phase II Geoenvironmental Site Assessment, Land at Greenbooth Road and Edenfield, Road, Norden; Report Ref 16-465-R2-3, dated August 2023, prepared for Stonebond Properties Ltd; and
- ✚ E3P – Remediation and Enabling Works Strategy, Land at Greenbooth Road and Edenfield, Road, Norden; Report Ref 16-465-R4-1, dated September 2023, prepared for Stonebond Properties Ltd.

These reports have been used to form the basis of this Piling Risk Assessment.

1.6. CONFIDENTIALITY

E3P has prepared this report solely for the use of the client and those parties with whom a warranty agreement has been executed, or with whom an assignment has been agreed. Should any third party wish to use or rely upon the contents of the report, written approval must be sought from E3P; a charge may be levied against such approval.



2. GROUNDWATER CONTAMINATION RISK ASSESSMENT

2.1. SITE DESCRIPTION

The subject site is an irregularly shaped disused parcel of land located to the north of Greenbooth Road and Edenfield Road, Norden Rochdale.

Hardstanding comprises over half the land cover, but the site can be split into two distinct areas: the former Tack Lea Works (Woodhouse Mills) area occupying the northern and central portions of the site and the former Shepherd Mill area in the east and south-eastern part of the site.

The site is predominantly old industrial land with five structures present in the centre of the Tack Lea Works area. The structures comprised an old boiler house, a coal hopper, a vehicle spray workshop, a coal bunker, and a gas substation. Concrete and brick-lined structures, believed to be historical filter tanks and reservoirs are also present within an area of semi-mature woodland in the eastern section of the Tack Lea Works area. No structures were identified within the Shepherd Mill area.

An earthen bund approximately 1 m in width and height is located to the immediate west of the old boiler house and bisects the Tack Lea Works area from northeast to southwest.

Naden Brook enters from the northwest and generally flows in a south/southeast direction, adjacent to the site's western and southern boundary along Greenbooth Road. Woodhouse Lane Brook enters the site from the north and flows south separating the Tack Lea Works area and Shepherd Mill area before entering Naden Brook.

The south of the site has been artificially raised and levelled where previous industrial mills were located.

2.2. GROUND CONDITIONS

MADE GROUND

Made Ground deposits were encountered within all exploratory hole locations to depths ranging between 0.00 m and 5.80 m bgl. However, in 23 locations in the Tack Lea Works area and 13 locations in the Sheppard Mill area, the full thickness of Made Ground could not be proven due to significant concrete and brick obstructions and basement features, which are indicative of relict foundations from the former buildings. The five hand pit locations within the eastern section of the Tack Lea Works area were all terminated within Made Ground.

In all locations except WS101 and WS103 (central section of the Tack Lea Works area), concrete was encountered to a maximum proven depth of 0.68 m bgl (WS104). The concrete often contained rebar. In WS101 and WS103, dark brown clay with occasional rootlets (reworked topsoil) was encountered.

In the majority of locations, the concrete was underlain by brown sandy gravel with gravels of sandstone, mudstone, limestone, concrete, and brick. In two locations in the Tack Lea Works area (TP118, and TP120) and one location in the Sheppard Mill area (TP121) a brown gravelly sand was encountered.

In five locations in the Tack Lea Works area (WS101, WS102, WS103, WS107 and WSS14) and three locations in the Sheppard Mill area (WS119, WS122 and WS124) a brown gravelly clay was encountered underneath the sandy gravel.

In one location within the Tack Lea Works area (TP113), a dark brown blackish slightly clayey slightly gravelly silt and a white sandy silt was encountered.



Frequent fragments of ceramic, glass, wood, and metal were encountered within the Made Ground. Ash was also encountered in one location within the Tack Lea Works area (WS115) and one location in the Sheppard Mill area (WS123). Intact empty plastic bottles of fabric softener were also encountered in one location within the Tack Lea Works area (TP114).

In the Tack Lea Works area, Made Ground deposits were generally encountered between 1.00 m and 2.00 m bgl, with shallower deposits (< 1.00 m bgl) located along the northern boundary (i.e. closer to the valley edge). Deeper Made Ground deposits, ranging between 2.00 m and 5.80 m bgl, were encountered in the northwest part of the site (associated with the infilled sandstone quarry), the central part of the site (associated with infilled reservoirs) and the eastern part of the site (associated with the filter tanks, reservoirs and historical landfill).

In the Sheppard Mill area, Made Ground deposits were generally encountered between 2.00 m and 5.10 m bgl, with shallower deposits (< 1.00 m bgl) located along the northern boundary (i.e. closer to the valley edge). The deepest Made Ground deposits were encountered along the southern boundary associated with the former buildings and infilled reservoirs.

The E3P Depth of Made Ground Plan is presented as Drawing 16-465-006 in Appendix III.

DRIFT

Drift deposits were encountered within twenty-nine exploratory hole locations between depths of 0.50 m and 15.00 m bgl. Both granular and cohesive drift deposits were encountered, which generally comprised a loose to dense brown clayey to sandy GRAVEL overlying a brown gravelly CLAY with gravels of mudstone and sandstone. The strength of CLAY varied from soft to very stiff.

Drift deposits were noted to be shallower (between 1.00 m and 2.50 m thick) along the northern parts of the Tack Lea Works area and Sheppard Mill area (i.e. closer to the valley edge). Deeper drift deposits (between 7.70 m and 11.00 m thick) were noted to be present along the western and southern boundaries of the Tack Lea Works area and the southern boundary of the Sheppard Mill area (i.e. towards the centre of the valley).

In seven locations across the Tack Lea Works area (TP130, WS102, WS103, WS105, WS107, WS111 and WS114) and two locations within the Sheppard Mill area (WS119 and WS120), a loose to dense brown clayey GRAVEL was encountered with gravels of sandstone and mudstone.

In four locations located across the Tack Lea Works area (WS114, TP130, CP101 and CP102) and two locations located across the Sheppard Mill area (WS120 and CP103), a loose to dense brown sandy GRAVEL was encountered.

In two locations located along the northern and southern boundaries of the Tack Lea Works area (RB101 and RB103), and two locations located along the southern boundary of the Sheppard Mill Area (TB104 and RB105), a brown fine to medium SAND & GRAVEL was encountered.

In TP103 (south-western boundary of the Tack Lea Works area), a brown gravelly SAND was encountered with gravels of sandstone and mudstone.

SOLID

The solid bedrock geology was encountered within five exploratory hole locations. Shallow bedrock was encountered between 1.60 m and 2.90 m bgl along the northern part of the Tack Lea Works area (i.e. closer to the valley edge). Along the southern boundaries of the Tack Lea Works area and Sheppard Mill area (i.e. towards the centre of the valley), deep bedrock was encountered between 11.60 m and 13.80 m bgl. The bedrock generally comprised of a greyish brown SANDSTONE. Outcrops of bedrock were also noted to be present in the northwest part of the Tack Lea works area and along the northern boundaries of the Tack Lea Works area and Sheppard Mill area.



In the Encia Consulting 2006 Report, shallow bedrock of sandstone was encountered in the central and western sections of the Tack Lea Works area at depths typically <2.00 m bgl. To the east of the former Tack Lea Mill Buildings and in the Sheppard Mill area, bedrock was found to be deeper and was encountered at depths ranging between 4.30 m and 5.00 m bgl. To the north of the Tack Lea Works area and Sheppard Mill area, bedrock can be seen outcropping in the valley and hillsides.

The E3P Depth of Bedrock Plan is presented as Drawing 16-465-012 in Appendix III.

GROUNDWATER

Perched groundwater was encountered during the ground investigation in one location in the Tack Lea Works area at 1.50 m bgl. Groundwater was encountered between 1.40–3.90 m bgl during the ground investigation, with deep groundwater encountered in one location within the Sheppard Mill area at 12.10 m bgl. During the monitoring, groundwater levels were recorded between 0.59 m and 4.89 m bgl.

The E3P Groundwater Flow Plan is presented as Drawing 16-465-040 in Appendix III.

2.3. TIER 2 CONTROLLED WATERS RISK ASSESSMENT

The site sensitivity with respect to controlled waters is summarised within Table 2.1.

TABLE 2.1 CONTROLLED WATERS SENSITIVITY PROFILE

RISK PROFILE	DISCUSSION	SENSITIVITY RATING
Groundwater Source Protection Zone or Drinking Water Safeguard Zone	The site is not located within a groundwater Source Protection Zone.	Low
Distance to the Closest Groundwater Abstraction Point	No groundwater abstractions points identified within a 1 km radius of the Site.	Low
Aquifer Classification in Superficial Drift Deposits	Superficial deposits (Glacial Till) are classified by the EA as a Secondary Undifferentiated aquifer.	Low
Aquifer Classification in Bedrock	The solid strata underlying the site are classified as a Secondary A Aquifer (Rough Rock - Sandstone).	Moderate
Viability for Anthropogenic Soil in Direct Contact with Aquifer (Drift or Bedrock)	Variable Made Ground up to 5.80 m bgl overlying cohesive drift deposits up to 15.00 m bgl, so limited viability for direct contact with the bedrock aquifer.	Low
Is the Site Located Within 50 m of a Surface Watercourse?	Woodhouse Lane Brook is recorded in the centre of the site and runs north to south. Naden Brook is located along the western and southern boundaries of the site. Naden Brook is classified by the EA as a Statutory Main River. Culverted water courses and springs associated with the former mill buildings are also believed to be present on-site, though these were not identified during the ground investigation. During the site walkover, a spring was identified in the far northwest part of the Tack Lea works area within an area of outcropping bedrock.	High



SUMMARY

The ICSM developed within the context of the site setting has only identified a single viable pollutant risk, which would be the lateral migration of potentially mobile phase-soluble contaminants towards Woodhouse Lane Brook and Naden Brook as well as the culverted watercourses and springs located on-site.

The overall sensitivity of the underlying Secondary A Aquifer within the Rough Rock is reduced given the presence of low permeability cohesive drift deposits across the site, which will inhibit vertical migration, and the absence of any groundwater abstraction; thus, the potential for the creation of a complete pollutant linkage is reduced.

To further refine the ICSM, E3P has undertaken an initial qualitative assessment of the soil data analysis to assess the potential for a source of separate-phase or dissolved-phase contamination originating from either a defined on-site source or from impacted soils. This assessment is summarised in Table 2.2.

TABLE 2.2 QUALITATIVE RISK TO CONTROLLED WATERS FROM SOIL ANALYTICAL RESULTS

BTEX > 1 mg/kg	The soil data analysis has identified concentrations of VOCs above 1 mg/kg in one location within the Sheppard Mill area (WS19).
Total VOC > 1 mg/kg	
Total SVOC > 1 mg/kg	The soil data analysis has identified concentrations of SVOCs above 1 mg/kg in seven locations within the Sheppard Mill area (WS117, WS122, TP122, TP123, TP126, WS19 and WS25).
C5-C10 > 5 mg/kg	All concentrations are below the laboratory LOD
C10-C12 > 10 mg/kg	All concentrations are below or slightly exceeding the laboratory LOD.
C12-C16 > 50 mg/kg	The soil data analysis has identified concentrations of TPH C12-C16 above 50 mg/kg in one location within the Tack Lea Works area (TP116), and four locations within the Sheppard Mill area (WS122, TP122, BH10 and WS19).
Phenols > 2 mg/kg	All concentrations are below or slightly exceeding the laboratory LOD.
Naphthalene > 2 mg/kg	Concentrations of naphthalene above 2 mg/kg have been recorded in one location within the Tack Lea Works area (WS12), and nine locations within the Sheppard Mill area (WS117, WS122, TP122, TP123, TP126, WS19, WS21, WS22 and WS25).
Total PAH > 10 mg/kg	Total concentrations of low-solubility PAH compounds greater than 10 mg/kg have been recorded in three locations within the Tack Lea Works area (TP116, WS10 and WS12), and eight locations within the Sheppard Mill area (WS117, TP122, TP123, TP126, BH10, WS19, WS22 and WS24), with a maximum concentration recorded in TP123 at 334.80 mg/kg.
PCB > 1 mg/kg	No potential sources of PCB have been identified.
Heavy metals > 500 mg/kg	Concentrations of heavy metals above 500 mg/kg have been recorded in four locations within the Tack Lea Works area (TP113, TP116, WS5 and WS9), and one location in the Sheppard Mill area (TP126).

In due consideration of the ICSM, which has identified a potential pollutant linkage associated with the migration towards the local watercourses (Woodhouse Lane Brook and Naden Brook), E3P has undertaken a Tier 2 controlled waters risk assessment. The Tier 2 assessment has included a comparison of leachate analysis, groundwater samples and surface water samples to Environmental Quality Standards (EQS) in the first instance, and, in absence of an EQS screening value, to Drinking Water Standards (DWS).



The assessment has been completed with information from the Phase II investigation data.

These are presented in Tables 2.3 to 2.5.

TABLE 2.3 COMPARISON OF LEACHATE ANALYSIS WITH TIER 2 SCREENING LEVELS

DETERMINAND	UNIT	EQS SCREENING VALUE ^{1, 2, 3}		DWS _{3,4,5}	N	MC	LOC. OF EX	ASSESSMENT
		AA	MAC					
Arsenic	µg/l	50	–	10	4	25	-	No Further Action
Cadmium	µg/l	0.08	0.45	5	4	<0.08	-	No Further Action
Chromium (VI)	µg/l	3.4	–	–	4	32	TP108 0.70 m	Further Assessment
Chromium (III)	µg/l	4.7	–	50	4	62	TP108 0.70 m	Further Assessment
Copper (hardness)	µg/l	1–28	–	2000	4	26	TP108 0.70 m TP115 0.80 m TP126 0.90 m RB105 11.60 m	Further Assessment
Total Cyanide	µg/l	1	–	50	4	5.5	TP126 0.90 m	Further Assessment
Lead	µg/l	1.2	14	10	4	15	TP126 0.90 m	Further Assessment
Mercury	µg/l	–	0.07	1.0	4	<0.50	-	No Further Action
Nickel	µg/l	4	34	20	4	2.2	-	No Further Action
Selenium	µg/l	–	–	10	4	<4.0	-	No Further Action
Zinc (hardness)	µg/l	8–125	–	–	4	18	TP126 0.90 m	Further Assessment
pH	6–9				4	10.3-11.1	TP108 0.70 m TP115 0.80 m	Further Assessment
PAH								
Naphthalene	µg/l	2	130	10*	4	<0.01	-	No Further Action
Anthracene	µg/l	0.1	0.1		4	<0.01	-	No Further Action
Benzo[b]fluoranthene	µg/l	1.7–4	0.017		4	<0.01	-	No Further Action
Benzo[k]fluoranthene	µg/l	1.7–4	0.017		4	<0.01	-	No Further Action
Benzo(a)pyrene	µg/l	1.7–4	0.27		4	<0.01	-	No Further Action
Fluoranthene	µg/l	0.0063	0.12		4	<0.01	-	No Further Action
Benzo(ghi)perylene	µg/l	1.7–4	8.2–3		4	<0.01	-	No Further Action
TPH-Aromatic								
TPH C5-C6 (benzene)	µg/l	10	50	1	4	<1.0	-	No Further Action
TPH C6-C8 (toluene)	µg/l	50	–	700	4	<1.0	-	No Further Action



DETERMINAND	UNIT	EQS SCREENING VALUE ^{1, 2, 3}		DWS _{3,4,5}	N	MC	LOC. OF EX	ASSESSMENT
		AA	MAC					
TPH C8-C10 (xylene)	µg/l	20	–	300	4	<1.0	-	No Further Action
TPH C10-C12 (naphthalene)	µg/l	30	–	500	4	22	RB105 11.60 m	Further Assessment
TPH C12-C16	µg/l	2	130	90 ⁵	4	<10	-	No Further Action
TPH C16-C35	µg/l	50#	50#	90 ⁵	4	<10	-	No Further Action
TPH Aliphatic ⁵								
TPH C5-C6	µg/l	–	–	15000	4	<1.0	-	No Further Action
TPH C6-C8	µg/l	–	–	15000	4	<1.0	-	No Further Action
TPH C8-C10	µg/l	–	–	300	4	<1.0	-	No Further Action
TPH C10-C12	µg/l	–	–	300	4	<1.0	-	No Further Action
TPH C12-C16	µg/l	–	–	300	4	<10	-	No Further Action
TPH C16 – C21	µg/l	–	–	300**	4	<10	-	No Further Action
TPH C21-C35	µg/l	–	–	300**	4	<10	-	No Further Action
VOC								
Tetrachloroethylene	µg/l	0.4	–	10	-	<3.0	-	No Further Action
Trichloroethylene	µg/l	10	–	10	-	<3.0	-	No Further Action
Trichlorobenzene	µg/l	0.4	–	–	-	<3.0	-	No Further Action
Trichloromethane	µg/l	2.5	–	–	-	<3.0	-	No Further Action
Dichloromethane	µg/l	20	–	200	-	<3.0	-	No Further Action
Carbon Tetrachloride	µg/l	12	–	3	-	<3.0	-	No Further Action
Vinyl Chloride	µg/l	–	–	0.3	-	<3.0	-	No Further Action

TABLE 2.4 COMPARISON OF GROUNDWATER ANALYSIS WITH TIER 2 SCREENING LEVELS

DETERMINAND	UNIT	EQS SCREENING VALUE ^{1, 2, 3}		DWS _{3,4,5}	N	MC	LOC. OF EX	ASSESSMENT
		AA	MAC					
Arsenic	µg/l	50	–	10	23	0.74	-	No Further Action
Cadmium	µg/l	0.08	0.45	5	23	0.08	-	No Further Action
Chromium (VI)	µg/l	3.4	–	–	23	<5.0	-	No Further Action
Chromium (III)	µg/l	4.7	–	50	23	2.5	-	No Further Action
Copper (hardness)	µg/l	1–28	–	2000	23	7.2	CP101 (29/11/22, 18/07/23) CP103 (22/06/23,	Further Assessment



DETERMINAND	UNIT	EQS SCREENING VALUE ^{1, 2, 3}		DWS _{3,4,5}	N	MC	LOC. OF EX	ASSESSMENT
		AA	MAC					
							18/07/23) RB103 (22/06/23) RB102 (05/07/23, 18/07/23) RB105 (05/07/23, 18/07/23) RB101 (18/07/23)	
Total Cyanide	µg/l	1	–	50	23	<1.0	-	No Further Action
Lead	µg/l	1.2	14	10	23	0.6	-	No Further Action
Mercury	µg/l	–	0.07	1.0	23	<0.05	-	No Further Action
Nickel	µg/l	4	34	20	23	8.8	RB102 (05/07/23)	Further Assessment
Selenium	µg/l	–	–	10	23	1.9	-	No Further Action
Zinc (hardness)	µg/l	8–125	–	–	23	13	RB105 (05/07/23)	Further Assessment
pH	6–9				23	7.7- 8.1	-	No Further Action
PAH								
Naphthalene	µg/l	2	130	10*	23	<0.01	-	No Further Action
Anthracene	µg/l	0.1	0.1		23	<0.01	-	No Further Action
Benzo[b]fluoranthene	µg/l	1.7–4	0.017		23	<0.01	-	No Further Action
Benzo[k]fluoranthene	µg/l	1.7–4	0.017		23	<0.01	-	No Further Action
Benzo(a)pyrene	µg/l	1.7–4	0.27		23	<0.01	-	No Further Action
Fluoranthene	µg/l	0.0063	0.12		23	0.51	CP103 (29/11/22)	Further Assessment
Benzo(ghi)perylene	µg/l	1.7–4	8.2– 3		23	<0.01	-	No Further Action
TPH-Aromatic								
TPH C5-C6 (benzene)	µg/l	10	50	1	23	<1.0	-	No Further Action
TPH C6-C8 (toluene)	µg/l	50	–	700	23	<1.0	-	No Further Action
TPH C8-C10 (xylene)	µg/l	20	–	300	23	<1.0	-	No Further Action
TPH C10-C12 (naphthalene)	µg/l	30	–	500	23	<10	-	No Further Action
TPH C12-C16	µg/l	2	130	90 ⁵	23	<10	-	No Further Action



DETERMINAND	UNIT	EQS SCREENING VALUE ^{1, 2, 3}		DWS _{3,4,5}	N	MC	LOC. OF EX	ASSESSMENT
		AA	MAC					
TPH C16-C35	µg/l	50#	50#	90 ⁵	23	<10	-	No Further Action
TPH Aliphatic⁵								
TPH C5-C6	µg/l	-	-	15000	23	<1.0	-	No Further Action
TPH C6-C8	µg/l	-	-	15000	23	<1.0	-	No Further Action
TPH C8-C10	µg/l	-	-	300	23	<1.0	-	No Further Action
TPH C10-C12	µg/l	-	-	300	23	<1.0	-	No Further Action
TPH C12-C16	µg/l	-	-	300	23	<10	-	No Further Action
TPH C16 – C21	µg/l	-	-	300**	23	<10	-	No Further Action
TPH C21-C35	µg/l	-	-	300**	23	<10	-	No Further Action
VOC								
Tetrachloroethylene	µg/l	0.4	-	10	23	<3.0	-	No Further Action
Trichloroethylene	µg/l	10	-	10	23	<3.0	-	No Further Action
Trichlorobenzene	µg/l	0.4	-	-	23	<3.0	-	No Further Action
Trichloromethane	µg/l	2.5	-	-	23	<3.0	-	No Further Action
Dichloromethane	µg/l	20	-	200	23	<3.0	-	No Further Action
Carbon Tetrachloride	µg/l	12	-	3	23	<3.0	-	No Further Action
Vinyl Chloride	µg/l	-	-	0.3	23	<3.0	-	No Further Action

TABLE 2.5 COMPARISON OF SURFACE WATER ANALYSIS WITH TIER 2 SCREENING LEVELS

DETERMINAND	UNIT	EQS SCREENING VALUE ^{1, 2, 3}		DWS _{3,4,5}	N	MC	LOC. OF EX	ASSESSMENT
		AA	MAC					
Arsenic	µg/l	50	-	10	23	0.63	-	No Further Action
Cadmium	µg/l	0.08	0.45	5	23	0.11	Naden Brook (U) – 18/07/23	Further Assessment
Chromium (VI)	µg/l	3.4	-	-	23	<5.0	-	No Further Action
Chromium (III)	µg/l	4.7	-	50	23	0.7	-	No Further Action
Copper (hardness)	µg/l	1–28	-	2000	23	9.4	Woodhouse Lane Brook (U + D) – 29/11/22, 22/06/23, 05/07/23, 18/07/23 Naden Brook (U, M and D) – 29/11/22,	Further Assessment



DETERMINAND	UNIT	EQS SCREENING VALUE ^{1, 2, 3}		DWS _{3,4,5}	N	MC	LOC. OF EX	ASSESSMENT
		AA	MAC					
							22/06/23, 05/07/23 Spring – 22/06/23, 05/07/23 (U, M) – 18/07/23	
Total Cyanide	µg/l	1	–	50	23	1.0	-	No Further Action
Lead	µg/l	1.2	14	10	23	0.5	-	No Further Action
Mercury	µg/l	–	0.07	1.0	23	<0.05	-	No Further Action
Nickel	µg/l	4	34	20	23	6	Naden Brook (U) – 05/07/23	Further Assessment
Selenium	µg/l	–	–	10	23	0.7	-	No Further Action
Zinc (hardness)	µg/l	8–125	–	–	23	11	Woodhouse Lane Brook (U) – 29/11/22 (D) – 05/07/23 Naden Brook (D) – 05/07/23	Further Assessment
pH	6–9				23	7.7- 7.9	-	No Further Action
PAH								
Naphthalene	µg/l	2	130	10*	23	<0.01	-	No Further Action
Anthracene	µg/l	0.1	0.1		23	0.16	Woodhouse Lane Brook (D) – 29/11/22	Further Assessment
Benzo[b]fluoranthene	µg/l	1.7–4	0.017		23	0.44	Woodhouse Lane Brook (D) – 29/11/22	Further Assessment
Benzo[k]fluoranthene	µg/l	1.7–4	0.017		23	0.16	Woodhouse Lane Brook (D) – 29/11/22	Further Assessment
Benzo(a)pyrene	µg/l	1.7–4	0.27		23	0.3	Woodhouse Lane Brook (D) – 29/11/22	Further Assessment
Fluoranthene	µg/l	0.0063	0.12		23	<0.01	-	No Further Action
Benzo(ghi)perylene	µg/l	1.7–4	8.2– 3		23	0.83	Woodhouse Lane	Further Assessment



DETERMINAND	UNIT	EQS SCREENING VALUE ^{1, 2, 3}		DWS _{3,4,5}	N	MC	LOC. OF EX	ASSESSMENT
		AA	MAC					
							Brook (D) – 29/11/22	
TPH-Aromatic								
TPH C5-C6 (benzene)	µg/l	10	50	1	23	<1.0	-	No Further Action
TPH C6-C8 (toluene)	µg/l	50	–	700	23	<1.0	-	No Further Action
TPH C8-C10 (xylene)	µg/l	20	–	300	23	<1.0	-	No Further Action
TPH C10-C12 (naphthalene)	µg/l	30	–	500	23	<10	-	No Further Action
TPH C12-C16	µg/l	2	130	90 ⁵	23	<10	-	No Further Action
TPH C16-C35	µg/l	50#	50#	90 ⁵	23	<10	-	No Further Action
TPH Aliphatic⁵								
TPH C5-C6	µg/l	–	–	15000	23	<1.0	-	No Further Action
TPH C6-C8	µg/l	–	–	15000	23	<1.0	-	No Further Action
TPH C8-C10	µg/l	–	–	300	23	<1.0	-	No Further Action
TPH C10-C12	µg/l	–	–	300	23	<1.0	-	No Further Action
TPH C12-C16	µg/l	–	–	300	23	<10	-	No Further Action
TPH C16 – C21	µg/l	–	–	300**	23	<10	-	No Further Action
TPH C21-C35	µg/l	–	–	300**	23	<10	-	No Further Action
VOC								
Tetrachloroethylene	µg/l	0.4	–	10	23	<3.0	-	No Further Action
Trichloroethylene	µg/l	10	–	10	23	<3.0	-	No Further Action
Trichlorobenzene	µg/l	0.4	–	–	23	<3.0	-	No Further Action
Trichloromethane	µg/l	2.5	–	–	23	<3.0	-	No Further Action
Dichloromethane	µg/l	20	–	200	23	<3.0	-	No Further Action
Carbon Tetrachloride	µg/l	12	–	3	23	<3.0	-	No Further Action
Vinyl Chloride	µg/l	–	–	0.3	23	<3.0	-	No Further Action

Notes

Solubility < 0.01 µg/l.

AA – Annual average.

MAC – Maximum admissible concentration.

L – Leachate

GW - Groundwater

* Sum of The specified compounds are benzo[b]fluoranthene (CAS 205-99-2), benzo[k]fluoranthene (CAS 207-08-9), benzo[g,h,i]perylene (CAS 191-24-2) and indeno[1,2,3-c,d]pyrene (CAS 193-39-5)

1. The Water Environment (Water Framework Directive) (England and Wales) (Amendment) Regulations (2015)



2. Directive establishing a framework for Community action in the field of water policy (Water Framework Directive)
3. Council Directive on pollution caused by certain dangerous substances discharged into the aquatic environment of the Community (Dangerous Substances Directive) - List II substances
4. Council Directive on the quality of water intended for human consumption (Drinking Water Directive)
5. WHO Guidelines for Drinking Water Quality. Third edition (2004)

CONTROLLED WATERS RISK ASSESSMENT AND MITIGATION

This comparison indicates that the data exceeds the EQS values for the following inorganic compounds:

- ✳ Cadmium (Surface Water – Naden Brook U);
- ✳ Chromium (VI) (Leachate – TP108 at 0.70 m);
- ✳ Chromium (III) (Leachate – TP108 at 0.70 m);
- ✳ Copper (Leachate – TP108 at 0.70 m, TP115 at 0.80 m, TP126 at 0.90 m, RB105 at 11.60 m, ;Groundwater - CP101, CP103, RB101, RB102, RB103, RB105, Surface Water - Woodhouse Lane U + D and Naden Brook U, M and D, Spring);
- ✳ Cyanide (Leachate – TP115 at 0.80 m, RB105 at 11.60 m);
- ✳ Lead (Leachate – TP115 at 0.80 m and TP126 at 0.90 m);
- ✳ Nickel (Groundwater - RB102, Surface Water – Naden Brook U)
- ✳ Zinc (Leachate – TP126 at 0.90 m; Surface Water - Woodhouse Lane U, Naden Brook D Groundwater – RB105);
- ✳ pH (Leachate – TP108 at 0.70 m and TP115 at 0.80 m);
- ✳ Anthracene (Surface Water - Woodhouse Lane D);
- ✳ Benzo(b)fluoranthene (Surface Water - Woodhouse Lane D);
- ✳ Benzo(k)fluoranthene (Surface Water - Woodhouse Lane D);
- ✳ Benzo(a)pyrene (Surface Water - Woodhouse Lane D);
- ✳ Fluoranthene (Groundwater - CP103; Surface Water - Woodhouse Lane D); and
- ✳ TPH C10-C12 Aromatic (Leachate – RB105 at 11.60 m).

Encia Consulting identified the following exceedances of the EQS within the subject site boundary:

- ✳ Chromium (III) (Leachate – BH2 at 0.50 m, WS8 at 0.40 m, WS9 at 0.50 m and WS11 at 0.60 m; Groundwater – BH10, BH12, WS4, WS5, WS12 and WS19; Surface Water – W1, W3, W4 and W5);
- ✳ Copper (Leachate – BH2 at 0.50 m, HP1 at 0.50 m, WS6 at 1.00 m, WS8 at 0.40 m, WS9 at 0.50 m, WS11 at 0.60 m, WS12 at 0.70 m, WS17A at 4.80 m, WS19 at 0.90 m, WS20 at 0.60 m, WS21 at 0.50 m and WS25 at 0.70 m; Groundwater – BH10 and WS12; Surface Water – W1, W3, W4);
- ✳ Lead (Leachate – HP1 at 0.50 m, WS4 at 0.50 m, WS6 at 1.00 m, WS11 at 0.60 m, WS19 at 0.90 m, WS20 at 0.60 m and WS25 at 0.70 m);



- ✳ Nickel (Leachate – WS21 at 0.50 m)
- ✳ Zinc (Leachate – BH2 at 0.50 m, HP1 at 0.50m, WS4 at 0.50 m, WS8 at 0.40 m, WS9 at 0.50 m, WS11 at 0.60 m, WS12 at 0.70 m, WS19 at 0.90 m and WS20 at 0.60m; Groundwater – BH10, BH12, WS4, WS5, WS12 and WS19; Surface Water – W1, W3, W4 and W5);
- ✳ Naphthalene (Leachate – WS21 at 0.50 m; Groundwater – WS19);
- ✳ Anthracene (Leachate – WS19 at 0.90 m, WS21 at 0.50m and WS25 at 0.70 m; Groundwater – BH12 and WS19);
- ✳ Benzo(b)fluoranthene (Leachate – WS21 at 0.50 m; Groundwater – BH12, WS4 and WS12; Surface Water – W4);
- ✳ Benzo(k)fluoranthene (Leachate – WS21 at 0.50 m; Groundwater – BH12, WS4 and WS12; Surface Water – W4);
- ✳ Benzo(a)pyrene (Leachate – WS21 at 0.50 m; Groundwater – BH12, WS4 and WS12; Surface Water – W4);
- ✳ Indeno(123cd)pyrene (Leachate – WS21 at 0.50 m; Groundwater – BH12, WS4 and WS12; Surface Water – W4);
- ✳ Fluoranthene (Leachate – WS4 at 0.50 m, WS8 at 0.40 m, WS9 at 0.50 m, WS12 at 0.70 m, WS17A at 4.80 m, WS19 at 0.90 m, WS20 at 0.60 m, WS21 at 0.50 m and WS25 at 0.70 m; Groundwater – BH10, BH12, WS4, WS12 and WS19; Surface Water – W4);
- ✳ m&p-xylene (Groundwater – WS19);
- ✳ o-xylene (Groundwater – BH12 and WS19);
- ✳ TPH Aromatics C8-C10, C10-C12, C12-C16, C16-C21 and C21-C35 (Groundwater – BH12 and WS19);
- ✳ TPH Aliphatic C8-C10 (Groundwater – BH12) (Screened against DWS in absence of EQS value);
- ✳ TPH Aliphatic C10-C12 (Groundwater – BH12 and WS19) (Screened against DWS in absence of EQS value); and,
- ✳ TPH Aliphatic C12-C16 (Groundwater – BH12) (Screened against DWS in absence of EQS value).

Note – Leachate sample WS21 underwent 25 times dilution and Water sample WS19 underwent 200 times dilution for PAH analysis.

M-BAT ASSESSMENT

Due to exceedances of the EQS for copper, nickel and zinc, an m-BAT assessment has been completed to assess the bioavailability of the metals with respect to surface water receptors (Naden Brook, Woodhouse Lane Brook and the on-site spring). The chemical values from the surface water analysis have been input into the assessment.

It is noted that E3P has been unable to undertake an m-BAT assessment on the Encia surface water sample data due to incomplete testing parameters (i.e., DOC and Ca).

Where the Risk Characterisation Ratio (RCR) is greater than 1, this indicates the bioavailable concentration is above the EQS and the receptor is therefore at risk.



The m-BAT assessment has confirmed that no exceedances of the RCR have been identified within surface water samples taken from Woodhouse Lane Brook, Naden Brook and the on-site spring, and as such, the concentrations of copper, nickel and zinc identified within these samples are not considered to be bioavailable.

Furthermore, this assessment is considered to be conservative given that several concentrations of copper, nickel and zinc within the surface water samples are greater than concentrations encountered within groundwater.

In light of the above assessment, E3P does not consider the site to pose an unacceptable level of risk to surface waters for copper, nickel and zinc. It should also be noted that the proposed development will largely encapsulate the site, thus limiting the potential for infiltration and therefore leaching potential.

Further analysis of Naden Brook and Woodhouse Lane Brook should be undertaken as groundworks progress, to ensure no future mobilisation of contaminants is caused, which may pose a risk to the surface watercourses.

DISCUSSION OF CONTROLLED WATERS RISK ASSESSMENT

Historically, the site has been subjected to extensive infilling and a number of industrial uses including a bleaching and dyeing mill, filter beds/tanks and infilled reservoirs. Chemical by-products of manufacturing processes and compounds within the Made Ground may have subsequently leached down into the underlying ground and contaminated groundwater both within Made Ground and natural drift deposits.

The Tier 2 controlled waters risk assessment identified exceedances of the EQS for heavy metals (cadmium, chromium (III), copper, nickel and zinc), non-volatile PAHs (anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno(123cd)pyrene, and fluoranthene) and naphthalene in both the leachate and dissolved phases (during the Encia investigation).

Exceedances of the EQS for chromium (VI), cyanide, lead and pH were also identified in the leachate phase only.

Exceedances of the EQS for TPHs (m&p-xylene, o-xylene, TPH Aromatic C8-C35 and Aliphatic C8-C16) were also identified in the dissolved phase within groundwater samples taken by Encia in the Sheppard Mill area (BH12 and WS19). An elevated concentration of TPH C10-C12 Aromatic was identified in the leachate sample from RB105 at 11.60 m (also located in the Sheppard Mill area). No TPH impact has been identified in the groundwater in RB102 where the monitoring well is installed in the sandstone bedrock.

No significant concentrations of VOCs or SVOCs were identified within samples submitted for analysis.

PFAS/PFOS testing on groundwater and surface water samples had no detections above the laboratory LOD.

Secondary A Aquifer (Bedrock)

The site is underlain by mixed geology, with cohesive clay and granular sand and gravel across the site. The granular deposits will afford less protection to the underlying Secondary A aquifer in the bedrock, whereas clay deposits have been identified in excess of 5.00 m in areas, which will restrict the migration of contaminants.

Also, the proposed development will create hardstanding cover across the site, thus reducing the amount of infiltration generated. This will, in turn, reduce the number of contaminants present in leachate off the site and reduce the risk further to the underlying aquifer and on-site stream.



The sensitivity of the aquifer is further reduced given that the site is not located within a groundwater source protection zone and that no active groundwater abstraction points are located within a 1 km radius of the site. The closest active potable abstraction point is a surface water abstraction point located 498 m northwest of the site. It is noted that this abstraction point is located upstream of the site. As such, the underlying Secondary A Aquifer is deemed to be at a low risk from on-site contamination.

Surface Water Receptor

A comparison of surface water samples from Naden Brook and Woodhouse Lane Brook to the Tier 2 assessment criteria has shown exceedances for copper within all samples upstream and downstream of the site. Exceedances for copper were also identified in the samples from the on-site spring on two occasions.

As a result of this, it can be said that the presence of copper cannot be attributed to the site, due to the presence of this within upstream samples. The m-BAT assessment has also shown that within surface water samples taken by E3P, copper, nickel and zinc are not considered to be bioavailable.

The exceedances relating to zinc in the surface water samples are marginal, of 11 µg/l when compared to the EQS value of 10.9 µg/l. Elevated concentrations of cadmium and nickel were only identified in the upstream sample from Naden Brook, suggesting that the contamination may be related to an off-site source.

Concentrations of chromium (III) were found to be in exceedance of the EQS within leachate samples taken by E3P and leachate, groundwater and surface water samples taken by Encia. Chromium (III) is generally considered to be of low solubility and mobility. However, concentrations were noted to be significantly elevated within groundwater and surface water samples (417-444 µg/l) when compared to leachate samples (14-132 µg/l). It is also noted that the elevated concentrations were present within Encia's surface water samples both upstream and downstream of the site (419-444 µg/l). As such, there is the potential that the chromium (III) contamination within the groundwater (on-site) and surface water is migrating from a currently unknown off-site source through the site and into the surface water receptors. However, given the site's history as a dyeing mill (where chromium (III) was actively used in certain dyeing agents), and the fact that concentrations within groundwater and surface water samples are similar, there is the possibility that the chromium (III) contamination is coming from site, and laterally migrating into the surface water courses, thus causing a detrimental impact on the surface water receptors. No exceedances were identified for chromium (III) during the four rounds of groundwater and surface water sampling completed by E3P, therefore there is considered to be a low risk to controlled waters.

The other contaminants of concern, non-volatile PAHs, were identified within the chemical testing in surface water samples taken downstream of Woodhouse Lane Brook (E3P, Woodhouse Lane Downstream) and Naden Brook (Encia, W4). However, concentrations of PAHs were identified to be less than the limit of detection in all surface water samples during the second, third and fourth rounds of monitoring. This suggests that there is no significant impact associated with non-volatile PAHs.

It is also noted that mobile contaminants identified within the soils and groundwater (PAHs, naphthalene and TPHs) have the potential to migrate laterally towards the surface water receptors as a result of the high permeability strata present beneath the site. The cohesive strata that is present beneath the site may also act as an impermeable barrier and channel mobile contaminants towards the surface water receptors. Given no elevated concentrations of naphthalene have been identified in leachate, groundwater or surface water samples taken by E3P, there does not appear to be a complete pollutant linkage. Although an elevated concentration of TPH C10-C12 Aromatic was identified in the leachate sample from RB105 at 11.60 m, no elevated TPH concentrations were recorded in groundwater and surface water samples taken by E3P. Where leachate analysis has been undertaken, this can overstate the risk and is not wholly representative of the site characterisation.



Conclusions & Recommendations

Though the risk to the underlying bedrock Secondary A aquifer is considered to be low, the risk to the surface water receptors is considered to be high, due to the presence of impacted soils within close proximity of surface water features, and the presence of high permeability strata in areas beneath the site which would afford the lateral and vertical migration of contaminants.

The groundwater flow plan (Drawing 16-465-040, Appendix III) suggests that groundwater is flowing towards the central sector of the site from the north and southeast.

Widespread naphthalene and TPH contamination has been identified in the soil analysis, with the majority of the impact noted within the Sheppard Mill area of the site. Thus, the source of the contaminants cannot be attributed to one area or point source and the majority of the contamination is considered present on a site wide basis.

During the remediation and enabling works phase, the removal of the hardstanding currently present across the site may induce infiltration and potential mobilisation of contaminants present within the soils and groundwater directly into the surface water receptors. However, the areas of low permeability clay soils will act to inhibit migration.

The controlled waters risk assessment completed by E3P has not identified any significant impact within the groundwater or surface water samples. The data suggests that there is no complete pollutant linkage and the identified contamination within the soils is not likely to be mobile.

It will be necessary to instigate a watching brief during Remediation and Enabling Works to ensure that it can be demonstrated that all material that remains in-situ is suitable for retention.

Surface water sampling is also recommended throughout the Remediation and Enabling Works to ensure that the water quality of the surface water features is not altered.

Based on the above, there is considered to be no significant level of risk to the controlled water receptors. However, due to the presence of heavy metals and non-volatile PAHs within groundwater, careful consideration as to the risks to site operatives and the possible requirement to pretreat the water will be required.



3. PILE DESIGN CONTAMINATION RISK ASSESSMENT

3.1. PILE DESIGN

Upon completion of the enabling works, it is anticipated that the final foundation solution will be a combination of:

- ✳ Vibro Stone Columns (VSC) that will ensure a uniform ABP in the order of 100 kN/m² for the construction of a doubly reinforced strip footing at ~600 mm below remediated ground level (1050 mm below FFL);
- ✳ Shallow strip foundations, where viable, bearing on localised areas of firm to very stiff clays, medium dense sands and shallow bedrock;
- ✳ Mass trench fill bearing on localised areas of firm to very stiff clays, medium dense sands and shallow bedrock;
- ✳ Piled foundations may be required where deep Made Ground and soft clays have been encountered; and for plots which span the historical sandstone quarry and associated high wall in the north-western section of the Tack Lea Works area; and
- ✳ Raft foundations may be required where obstructions cannot be removed.

3.2. CONTAMINATION RISK ASSESSMENT

The purpose of the risk assessment is to ensure that the proposed ground disturbance/foundation method will not have an adverse impact by creating new pathways for the migration of contamination, considering the protection both of water resources and human health.

The piling risk assessment considers six pollution scenarios based on the site setting and ground investigation findings. These are discussed in Table 3.1.

TABLE 3.1 POTENTIAL POLLUTION SCENARIO

GENERIC POLLUTION SCENARIO	RISK	SITE CONSIDERATIONS
Creation of preferential pathways associated with potentially soluble phase compounds within the perched aquifer	LOW	VSC may create a granular permeable layer that has the potential to create a pathway within the upper stratum for soluble phase compounds to migrate through to the underlying secondary A aquifers. Extensive testing of soils throughout the identified contaminant source areas has concluded that the majority of soils pose no risk to receptors when compared to GACs. Any soils with contaminant concentrations in exceedance of GACs will be remediated or removed and placed in an area of reduced sensitivity, thus removing the primary source. Sampling of the adjacent watercourses has also confirmed no direct pollutant linkage from the site, even with the presence of granular drift deposits beneath the majority of the site that may provide a preferential migration pathway. The addition of stone columns is therefore unlikely to significantly increase permeability or migration potential.



GENERIC POLLUTION SCENARIO	RISK	SITE CONSIDERATIONS
Creation of preferential pathways associated with potentially soluble phase compounds within the perched aquifer <i>Continued...</i>	LOW	A 5 m development easement will be maintained from adjacent watercourses, and VSC columns will be installed no closer than 6.15 m from the watercourse, thus reducing the potential for creating new preferential pathway between the aquifers and surface water features.
Creation of preferential pathways, through a low permeability surface layer, to allow upward migration of landfill gas, soil gas or contaminant vapors to the surface	LOW	The site has been assessed as Characteristic Situation 2 therefore appropriate gas protection measures will be installed in the proposed development protecting end users of the site.
Direct contact of site workers and others with contaminated soil arisings that have been brought to the surface.	LOW	The use of VSC and/or, driven piles would not generate any return materials to the surface.
Direct contact with the pile and potentially contaminated soil and leachable compounds	LOW	Stone columns would not be susceptible to degradation. For piled foundations, concrete in contact with Made Ground will be specified to a recognized standard according to the pH and sulphate concentrations recorded in the E3P site investigation.
The driving of solid contaminants down into the aquifer during piling	LOW	Ground improvement using VSC, and precast concrete driven pile are displacement methods, which result in increased soil density and lateral compaction, rather than downward. There is a small potential for soils in contact with the sides and base to be dragged down slightly before being displaced. However, document EA NC/99/73 concludes that there are no recorded cases of this occurring. Extensive testing of soils throughout the identified contaminant source areas has concluded that the majority of soils pose no risk to receptors when compared to GACs. Any soils with contaminant concentrations in exceedance of GACs will be remediated or removed and placed in an area of reduced sensitivity, thus removing the primary source. Therefore, on the basis that identified contaminant sources areas within the Made Ground will be remediated or removed; and with the piling method only likely to result in minimal vertical displacement of soils through the underlying drift, the risk is considered to be low.
Contamination of groundwater and, subsequently, surface waters by concrete, cement paste or grout	LOW	Ground improvement using VSC to construct reinforced strip footing foundations is currently the predominant proposed foundation solution. This method does not utilise liquid cement or grout and therefore poses no risk. Similarly, driven piles if adopted, would not introduce liquid cement or grout.



4. CONCLUSION

The Piling Risk Assessment has determined that based on the ground and groundwater conditions within the Made Ground and underlying drift strata, the use of VSC or piled foundations through Made Ground and bearing within the underlying drift will pose a low risk to controlled waters.

END OF REPORT



APPENDIX I

LIMITATIONS

GENERAL

1. This report and any associated works (together comprising the "Services") were compiled and carried out by E3P for the client (as present in Section 1) under the E3P "Terms of Business" or with those parties with whom a warranty agreement has been executed, or with whom an assignment has been agreed and outlined in the body of the report.
2. Unless explicitly agreed otherwise, in writing, this report has been prepared under E3P Standard Terms and Business as included within our proposal to the Client.
3. Project-specific appointment documents may be agreed upon at our discretion and a charge may be levied for both the time to review and finalise appointment documents and also for associated changes to the appointment terms. E3P reserves the right to amend the fee should any changes to the appointment terms create an increased risk to E3P.
4. The report needs to be considered in light of the proposal and associated limitations of scope. The report needs to be read in full and isolated sections cannot be used without full reference to other elements of the report and any previous works referenced within the report.

PHASE 1 GEOENVIRONMENTAL AND PRELIMINARY RISK ASSESSMENTS

5. Coverage: This section covers reports with the following titles or combination of titles: Phase 1; Desktop Study; Geoenvironmental Assessment; Development Appraisal; Preliminary Environmental Risk Assessment; Constraints Report; Due Diligence Report; Geotechnical Development Review; Environmental Statement; Environmental Chapter; Baseline Environmental Assessment; Project Scope Summary Report (PSSR), Program Environmental Impact Report (PEIR), Geotechnical Development Risk Register; Agricultural Land Assessment; Mineral Safeguarding Assessment; Desk Top Coal Mining Risk Assessment; Hydrogeological Appraisal; Construction Environmental Management Plan; and Site Water Management Plan.
6. The works undertaken to prepare this report comprised a study of available and easily documented information from a variety of sources (including the Client), together with (where appropriate) a brief walkover inspection of the Site and correspondence with relevant authorities and other interested parties. Due to the short timescales associated with these projects' responses may not have been received from all parties. E3P cannot be held responsible for any disclosures that are provided post-production of our report and will not automatically update our report.
7. The opinions given in this report have been dictated by the finite data on which they are based and are relevant only for the purpose for which the report was commissioned. The information reviewed should not be considered exhaustive and has been accepted in good faith as providing true and representative data pertaining to site conditions. Should additional information become available which may affect the opinions expressed in this report, E3P reserves the right to review such information and, if warranted, to modify the opinions accordingly.
8. It should be noted that any risks identified in this report are perceived risks based on the information reviewed. Actual risks can only be assessed following intrusive investigations of the site.



9. Where mention has been made to the identification of Japanese Knotweed and other invasive plant species and asbestos or asbestos-containing materials, this is for indicative purposes only and does not constitute or replace full and proper surveys completed by suitably qualified and experienced specialists in these fields.
10. E3P does not warrant work/data undertaken/provided by others.

INTRUSIVE INVESTIGATION REPORTS

11. Coverage: The following report titles (or combination) may cover this category of work: Geoenviromental Site Investigation; Geotechnical Assessment; GIR (Ground Investigation Reports); Preliminary Environmental And Geotechnical Risk Assessment; Preliminary Summary; Coal Mining Risk Assessment, Ground Gas Addendum; and Geotechnical Risk Register.
12. The investigation has been undertaken to provide information concerning either:
 - I. The type and degree of contamination present at the site in order to allow a generic quantitative risk assessment to be undertaken; or
 - II. Information on the soil properties present at the site to allow for geotechnical development constraints to be considered.
13. The scope of the investigation was selected on the basis of the specific development and land use scenario proposed by the Client and may be inappropriate to another form of development or scheme. If the development layout was not known at the time of the investigation the report findings may need revisiting once the development layout is confirmed.
14. Unless otherwise specified in the scope of works, any site drawing(s) provided in this report is (are) not meant to be an accurate base plan but is (are) used to present the general relative locations of features on, and surrounding, the site. Features (intrusive and sample locations etc) annotated on site plans are not drawn to scale but are centred over the approximate location. Such features should not be used for setting out and should be considered indicative only.
15. For contamination purposes, the objectives of the investigation are limited to establishing the risks associated with potential contamination sources with the potential to cause harm to human health, building materials, the environment (including adjacent land), or controlled waters.
16. For geotechnical investigations, the purpose is to broadly consider potential development constraints associated with the physical property of the soils underlying the site within the context of the proposed future or continued use of the site, as stated within the report.
17. The amount of exploratory work, soil property testing and chemical testing undertaken has necessarily been restricted by various factors which may include accessibility, the presence of services; existing buildings; current site usage or short timescales. The exploratory holes completed assess only a small percentage of the area in relation to the overall size of the Site, and as such can only provide a general indication of conditions.



18. The number of sampling points and the methods of sampling and testing do not preclude the possible existence of contamination where concentrations may be significantly higher than those actually encountered or ground conditions that vary from those identified. In addition, there may be exceptional ground conditions elsewhere on the site which have not been disclosed by this investigation and which have therefore not been taken into account in this report.
19. The inspection, testing and monitoring records relate specifically to the investigation points and the timeframe that the works were undertaken. They will also be limited by the techniques employed. As part of this assessment, E3P has used reasonable skill and care to extrapolate conditions between these points based on assumptions to develop our interpretation and conclusions.
20. The assumption made in forming our conclusions is that the ground and groundwater conditions (both chemically and physically) are the same as have been encountered during the works undertaken at the specific points of investigation and at the time of the investigation.
21. Conditions can change between investigation points both spatially and over time and these interpretations should therefore be considered indicative. The assessment of extreme weather events and their impact on ground conditions is not within the scope of E3P's work.
22. The risk assessment and opinions provided are based on currently available guidance relating to acceptable contamination concentrations; no liability can be accepted for the retrospective effects of any future changes or amendments to these values. Specific assumptions associated with the risk assessment process have been outlined within the body or associated appendix of the report.
23. Additional investigations may be required in order to satisfy relevant planning conditions or to resolve any engineering and environmental issues.
24. Where soil contamination concentrations recorded as part of this investigation are used for commentary on the potential waste classification of soils for disposal purposes, these should be classed as indicative only. Due consideration should be given to the variability of contaminant concentrations taken from targeted samples versus bulk excavated soils and the potential variability of contaminant concentrations between sampling locations. Where major waste disposal operations are considered, targeted waste classification investigations should be designed, and the waste classification and any subsequent disposal option agreed upon with licenced subcontractors and/or the relevant regulators.
25. The results of the asbestos testing are factually reported, and interpretation is given as to how this relates to the previous use of the site, the types of ground encountered and site conceptualisation. This does not however constitute a formal asbestos assessment. These results should be treated cautiously and should not be relied upon to provide detailed and representative information on the delineation, type and extent of bulk ACMs and/or trace loose asbestos fibres within the soil matrix at the site.
26. If costs have been included in relation to additional site works, and/or site remediation works these must be considered as indicative only and must be confirmed by a qualified quantity surveyor.



EUROCODE 7: GEOTECHNICAL DESIGN

27. On 1st April 2010, BS EN 1997-1:2004 (Eurocode 7: Geotechnical Design – Part 1) became the mandatory baseline standard for geotechnical ground investigations.
28. In terms of geotechnical design for foundations, slopes, retaining walls and earthworks, EC7 sets guidance on design procedures including specific guidance on the numbers and spacings of boreholes for geotechnical design, there are limits to methods of ground investigation and the quality of data obtained and there are also prescriptive methods of assessing soil strengths and methods of design. Unless otherwise explicitly stated, the work has not been undertaken in accordance with EC7. A standard geotechnical interpretative report will not meet the requirements of the Geotechnical Design Report (GDR) under Eurocode 7. The GDR can only be prepared following confirmation of all structural loads and serviceability requirements. The report is likely to represent a Ground Investigation Report (GIR) under the Eurocode 7 guidance.

DETAILED QUANTITATIVE RISK ASSESSMENTS AND REMEDIATION AND ENABLING WORK STRATEGY REPORTS

29. These reports build upon previous report versions and associated notes. The scope of the investigation, further testing and monitoring and associated risk assessments were selected based on the specific development and land use scenario proposed by the Client and may not be appropriate to another form of development or scheme layout. The risk assessment and opinions provided are based on currently available approaches in the generation of Site Specific Assessment Criteria relating to contamination concentrations and are not considered to represent a risk in a specific land use scenario to a specific receptor. No liability can be accepted for the retrospective effects of any future changes or amendments to these values, associated models or associated guidance.
30. The outputs of the Detailed Quantitative Risk Assessments are based upon the manipulation of standard risk assessment models. These are our interpretation of the risk assessment criteria.
31. Before adoption on-site, assessment criteria will need to be discussed and agreed upon with the Regulatory Authorities prior to adoption on site. The regulatory discussion and engagement process may result in an alternative interpretation being determined and agreed. The process and timescales associated with the Regulatory Authority engagement are not within the control of E3P. All costs and programmes presented as a result of this process should be validated by a quantity surveyor and should be presumed to be indicative.
32. E3P does not accept liability for any subcontract work that has not been completed in strict accordance with an approved E3P Remediation and Enabling Works Strategy.

GEOTECHNICAL DESIGN REPORT (GDR)

33. The GDR can only be prepared following confirmation of all structural loads and serviceability requirements. All the relevant information needs to be provided to allow for a GDR to be produced.



MONITORING (INCLUDING REMEDIATION MONITORING REPORTS AND BUILD PHASE MITIGATION)

34. These reports are factual and comprise monitoring, normally groundwater and ground gas and data provided by contractors as part of earthworks or remedial works.
35. The data is presented and will be compared with assessment criteria.



APPENDIX II

GLOSSARY

TERMS

ACM	Asbestos-containing material	MMP	Materials management plan
ADS	Acoustic design statement	ND	Not detected
AST	Above-ground storage tank	NDP	Nuclear density probe
BGS	British Geological Survey	NMP	Noise management plan
BSI	British Standards Institute	NPSE	Noise policy statement for England
BTEX	Benzene, toluene, ethylbenzene, xylenes	NR	Not recorded
CA	Coal Authority	PAH	Polycyclic aromatic hydrocarbon
CBR	California bearing ratio	PCB	Polychlorinated biphenyl
CIEH	Chartered Institute of Environmental Health	PI	Plasticity index
CIRIA	Construction Industry Research Association	PID	Photo ionisation detector
CLEA	Contaminated land exposure assessment	POS	Public open space
CML	Council of Mortgage Lenders	PPE	Personnel protective equipment
CoC	Contaminants of concern	ProPG	Professional practice guidance
CSM	Conceptual site model	QA	Quality assurance
DNAPL	Dense non-aqueous phase liquid (chlorinated solvents, PCB)	SGV	Soil guideline value
DWS	Drinking water standard	SPH	Separate-phase hydrocarbon
EA	Environment Agency	SPT	Standard penetration test
EQS	Environmental quality standard	SVOC	Semi-volatile organic compound
FFL	Finished floor level	TPH	Total and speciated petroleum hydrocarbon
GAC	General assessment criteria	TPH CWG	Total Petroleum Hydrocarbon (Criteria Working Group)
GL	Ground level	UKWIR	United Kingdom Water Infrastructure Risk
GSV	Gas screening value	UST	Underground storage tank
HCV	Health criteria value	VCC	Vibro-concrete column
ICSM	Initial conceptual site model	VOC	Volatile organic compound
LEL	Lower explosive limit	VRSC	Vibro-replacement stone columns
LMRL	Lower method reporting limit	VSC	Vibro-stone columns
LNAPL	Light non-aqueous phase liquid (petrol, diesel, kerosene)	WHO	World Health Organisation
MCV	Moisture condition value	WRAP	Waste and Resources Action Programme
MIBK	Methyl isobutyl ketone	WTE	Water table elevation



Land at Greenbooth Road and Edenfield Road, Norden

Pile Design Contamination Risk Assessment

January 2024

m	Metres	ppm	Parts per million
km	Kilometres	mg/m³	Milligram per metre cubed
% v/v	Percent volume in air	m bgl	Metres below ground level
mb	Millibars (atmospheric pressure)	m bcl	Metre below cover level
l/hr	Litres per hour	mAOD	Metres above ordnance datum (sea level)
µg/l	Micrograms per litre (parts per billion)	kN/m²	Kilonewtons per metre squared
ppb	Parts per billion	µm	Micrometre
mg/kg	Milligrams per kilogram (parts per million)		



APPENDIX III

DRAWINGS

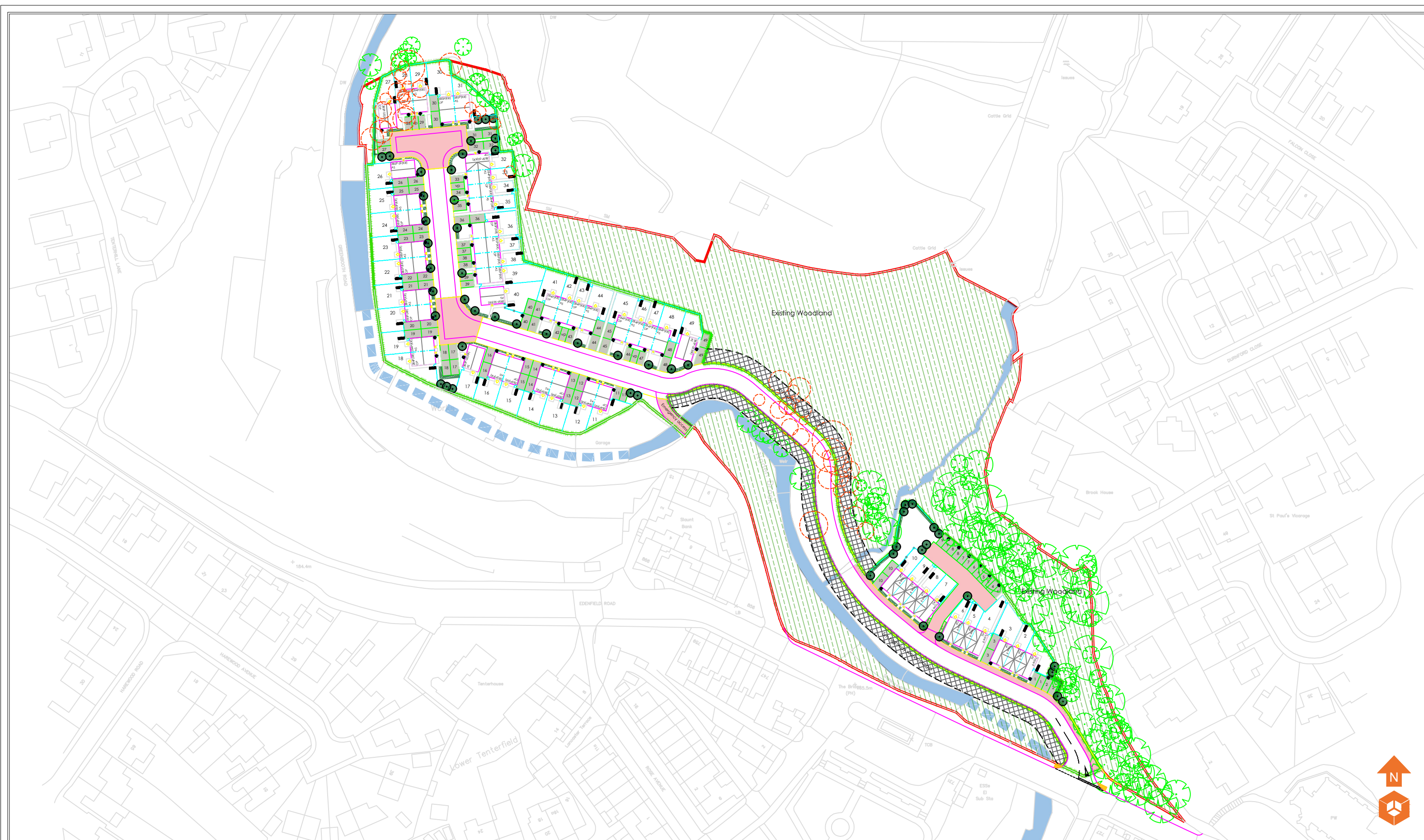
Site Name

Phase I Geoenvironmental Site Assessment

Date

DRAWING 16-465-001 – Site Location Plan





Notes:				

P1	REVC	16.06.2023	OW	MW
P1	REVB	20.03.2023	EB	RJW
P1	REVA	17.11.2022	OW	MD
Phase	Issue	Date	Drawn	Checked

Client:
Stonebond Properties Ltd

Job Title:
Land at Greenbooth Road and Edenfield Road, Norden

Job No:
16-465
Drawing No:
002

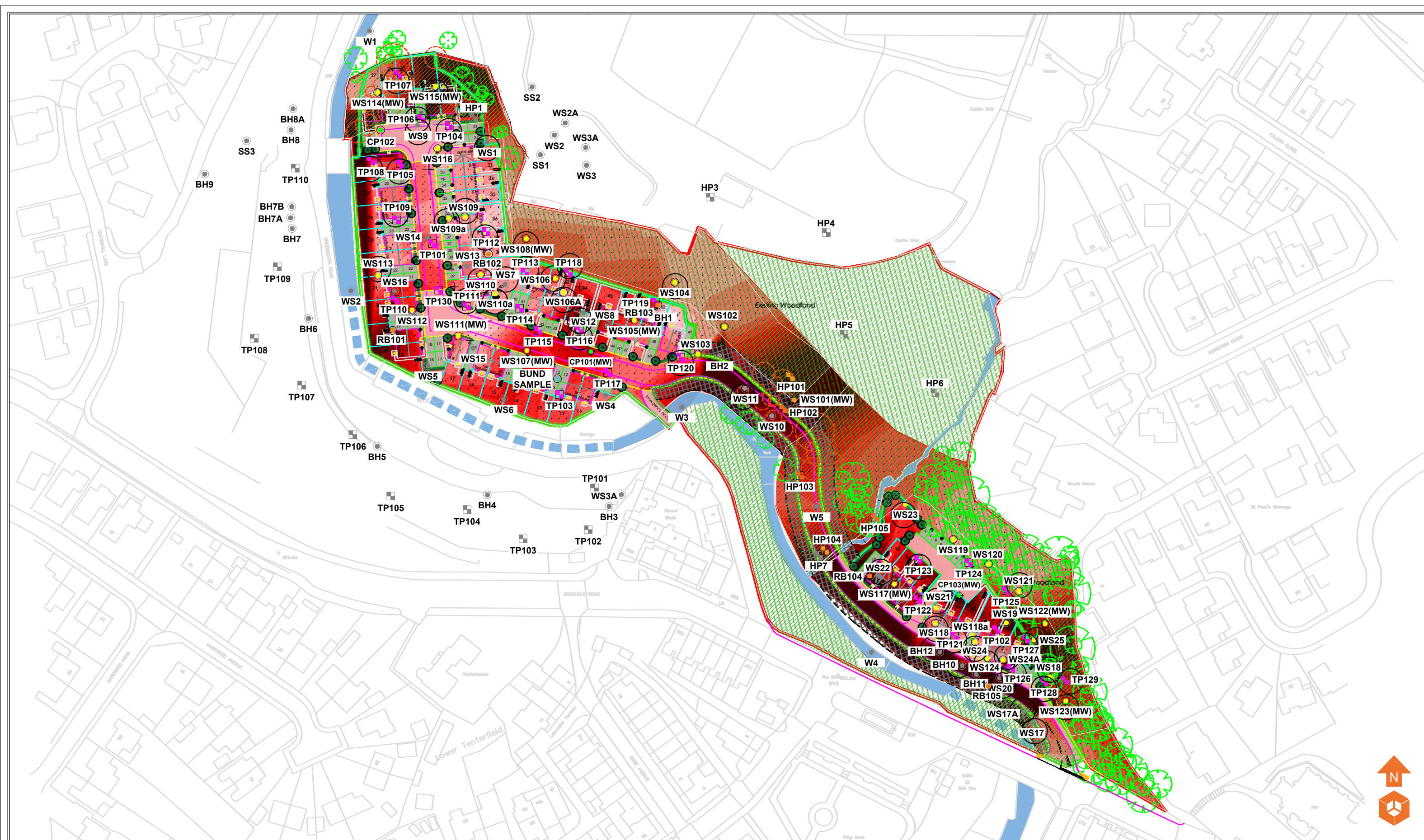
Date:
16.06.2023
Scale:
NTS@ A3

Drawing Title:
Proposed Development Plan



Environmental Engineering
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Taylor Road, Trafford Park
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Location Symbols		Made Ground Depth (m)	
	Approximate Window Sample Probehole Location		Depth of Made Ground 0.00 - 0.99m
	Approximate Trial Pit Location		Depth of Made Ground 1.00 - 1.99m
	Approximate Cable Percussive Borehole Location		Depth of Made Ground 2.00 - 2.99m
	Approximate Hand Dug Pit Location		Depth of Made Ground 3.00 - 3.99m
	Bund Sample Location		Depth of Made Ground 4.00 - 4.99m
	Approximate Hand Dug Pit Location (Enica - April 2006)		Depth of Made Ground >5.00m
	Approximate Trial Pit Location (Enica - April 2006)		Full extent of Made Ground not identified
	Approximate Window Sample Probehole Location (Enica - April 2006)		
	Approximate Borehole Location (Enica - April 2006)		

Notes:

P1	REVD	12.07.2023	OW	MW
P1	REVC	12.04.2023	LM	MW
P1	REVB	16.01.2023	EB	HM
P1	REVA	15.12.2022	LM	HM
Phase	Issue	Date	Drawn	Checked

Client:

Stonebond Properties Ltd

Job Title:

Land at Greenbooth Road and Edenfield Road, Norden

Job No:

16-465

Drawing No:

006

Date:

12.07.2023

Scale:

NTS @ A3

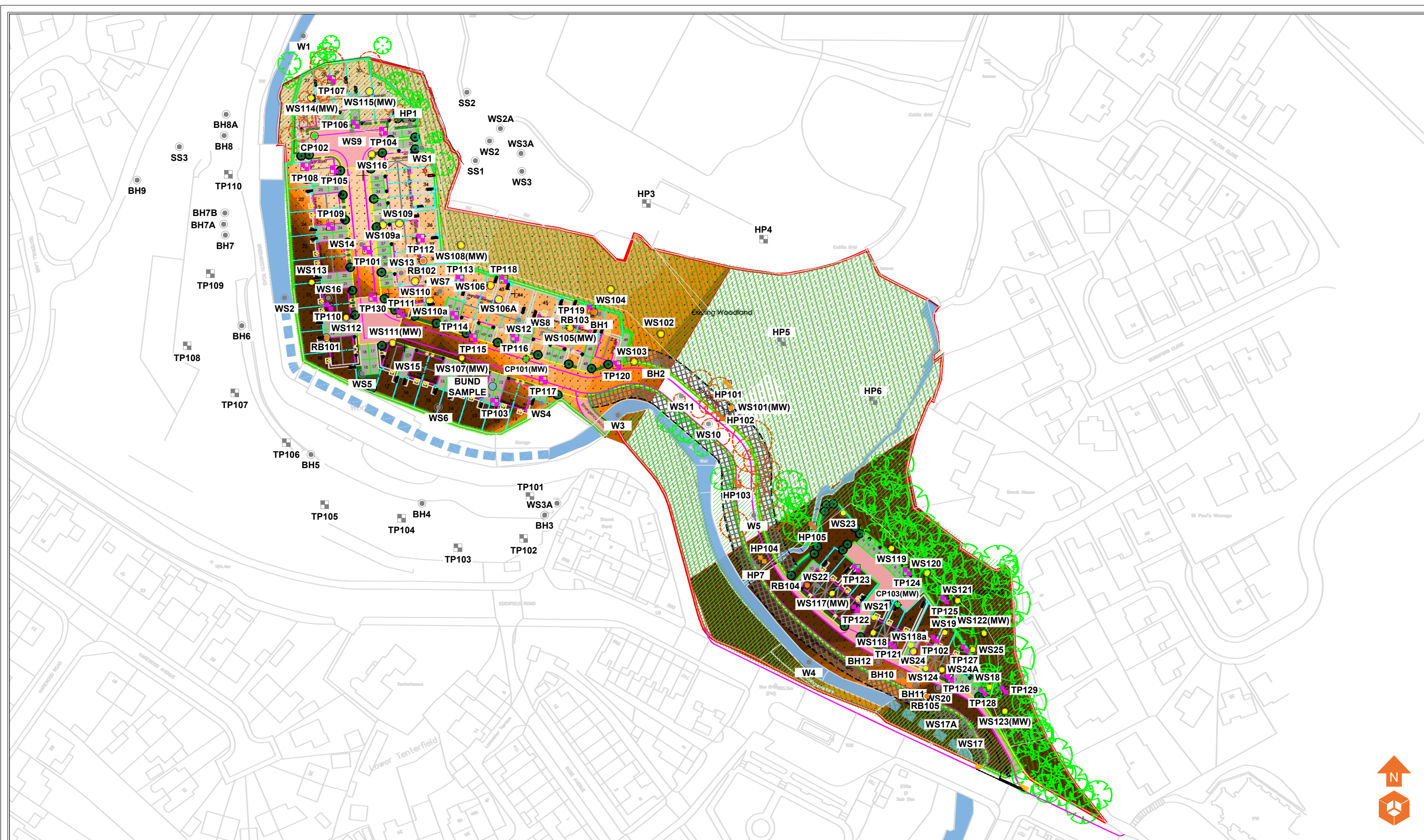
Drawing Title:

Depth of Made Ground Plan



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Location Symbols

- Approximate Window Sample Probehole Location
- Approximate Trial Pit Location
- Approximate Cable Percussive Borehole Location
- Approximate Hand Dug Pit Location
- Bund Sample Location
- Approximate Hand Dug Pit Location (Enica - April 2006)
- Approximate Trial Pit Location (Enica - April 2006)
- Approximate Window Sample Probehole Location (Enica - April 2006)
- Approximate Borehole Location (Enica - April 2006)
- Approximate Rotary Borehole Location

Bedrock Depth (m)

- Depth to Bedrock 0.00 - 0.99m
- Depth to Bedrock 1.00 - 1.99m
- Depth to Bedrock 2.00 - 2.99m
- Depth to Bedrock 3.00 - 3.99m
- Depth to Bedrock 4.00 - 4.99m
- Depth to Bedrock >5.00m

Notes:

P1	REVB	27.07.2023	OW	MW
P1	REVA	12.04.2023	LM	MW
Phase	Issue	Date	Drawn	Checked

Client:

Stonebond Properties
Ltd

Job Title:

Land at Greenbooth Road and
Edenfield Road, Norden

Job No:

16-465

Drawing No:

012

Date:

27.07.2023

Scale:

NTS@ A3

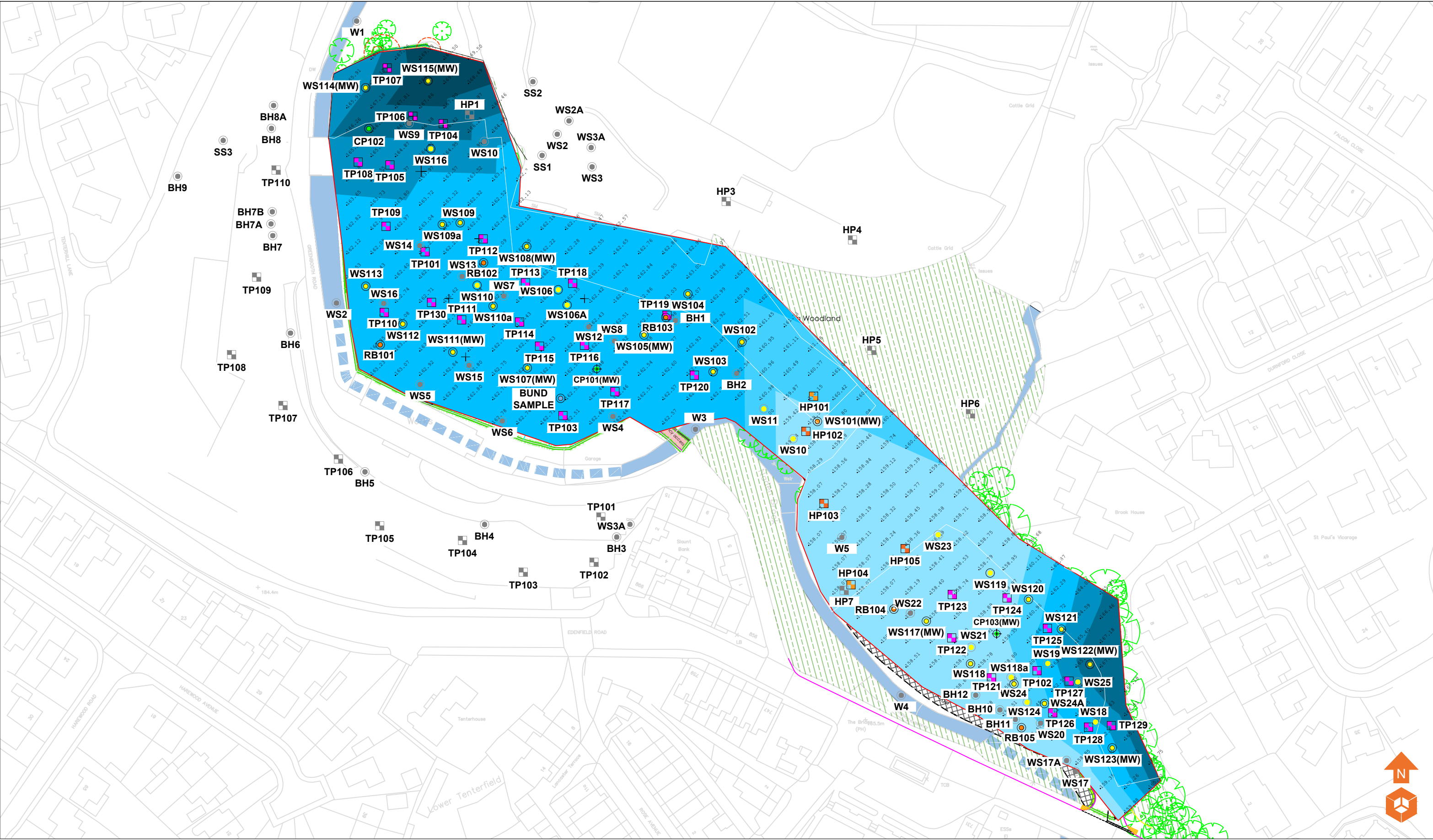
Drawing Title:

Depth to Bedrock Plan



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Location Symbols		Location Symbols		Groundwater Flow Depth		Notes:	Client: Stonebond Properties Ltd	Job No: 16-465	Date: 09.08.2023	 Environmental Engineering Partnership Ltd Taylor Road, Trafford Park Urmston, Manchester, M41 7JQ Tel: 0161 707 9612 E-mail: info@e3p.co.uk Website: www.e3p.co.uk
 WS101	Approximate Window Sample Probehole Location	 HP101	Approximate Hand Dug Pit Location		Depth of <i>Groundwater Flow</i> 158.00 - 159.99m					
 TP101	Approximate Trial Pit Location	 BS101	Bund Sample Location		Depth of <i>Groundwater Flow</i> 160.00 - 161.99m					
 CP101	Approximate Cable Percussive Borehole Location	 HP101	Approximate Hand Dug Pit Location (Enica - April 2006)		Depth of <i>Groundwater Flow</i> 162.00 - 163.99m	P1 REVA 09.08.2023 LM NS	Job Title: Land at Greenbooth Road and Edenfeild Road, Norden	Drawing No: 040	Scale: NTS @ A3	
 RB101	Approximate Rotary Borehole Location	 TP101	Approximate Trial Pit Location (Enica - April 2006)		Depth of <i>Groundwater Flow</i> 164.00 - 165.99m					
 HP101	Approximate Hand Dug Pit Location	 WS101	Approximate Window Sample Probehole Location (Enica - April 2006)		Depth of <i>Groundwater Flow</i> 166.00 - 167.99m					
		 BH101	Approximate Borehole Location (Enica - April 2006)		Depth of <i>Groundwater Flow</i> 168.00m	Phase		Drawing Title: Groundwater Flow Plan		The client must not amend any drawing, design or other intellectual property produced by E3P Ltd without permission in writing from E3P Ltd in advance of any amendments being made. In the event that such written permission is not obtained in advance of the amendments being made, E3P Ltd shall not be liable for any damage and/or losses occurring as a result of the amended drawing, design or intellectual property.
		 RB101	Approximate Rotary Borehole Location			Issue				

