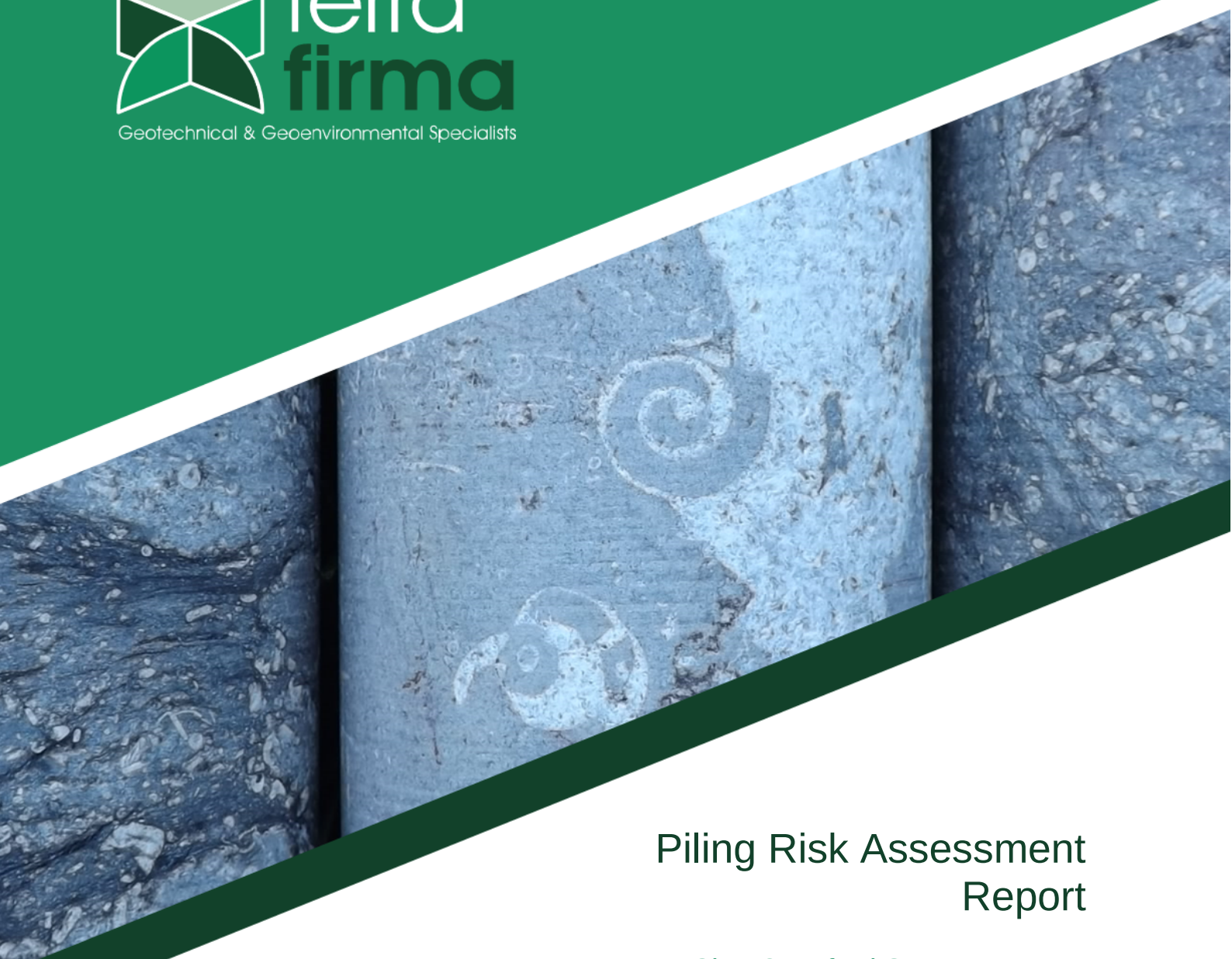




Piling Risk Assessment Report

Site: Crawford Street, Newport

Prepared For: MVR Solutions Limited

Issue Date: January 2025

Job No: 17245/PRA

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SECTION 1 Introduction and Proposed Development

1.1 Introduction

MVR Solutions Limited (the Client) is proposing the residential development of a parcel of land located off Crawford Street, Newport, NP19 7AY. The development is to comprise 30 No. apartments with parking contained within a single three storey building.

TFW Group Limited (hereafter referred to as Terra Firma) has previously completed a geotechnical and geo-environmental investigation of the site (Report Reference 021224-17245-4 dated December 2024).

Based on the findings of the site investigation it was recommended that a piled foundation be used for the new development.

The Piling Risk Assessment Report has been prepared to achieve the following objectives:

1. Present an overview of the proposed piling methodology
2. Identify the source-pathway-receptor linkages associated with piling works in accordance with the five Scenarios detailed in Environment Agency Guidance for piling in contaminated land.
3. Undertake hazard assessment and risk estimation of the identified potential environmental consequences
4. Determine the requirement for mitigation measures and/or environmental monitoring

MVR Solutions Limited, has requested that a Piling Risk Assessment is undertaken for the development. This report shall not be relied upon or transferred to any other parties without the express written authorisation of Terra Firma.

A king post retaining wall will be used at the east boundary of the site.

If an unauthorised third party comes into possession of this report, they rely on it at their peril and the authors owe them no duty of care and skill. The report represents the findings and opinions of experienced geo-environmental and geotechnical consultants. Terra Firma does not provide legal advice and the advice of lawyers may be required. Any subsurface geological profiles, contamination and other plots are generalised by necessity and have been based on the information found at the locations of the exploratory holes and depths sampled and tested.

1.2 Quality Assurance

The quality and environmental aspects of the assessment comply with Terra Firma business management system which is UKAS Accredited to ISO 9001:2015 and ISO 14001:2015 standards.

SECTION 2 Review of Geotechnical and Geo-environmental Site Investigation

2.1 Geology and Ground Conditions

The site is underlain by rocks of the St Maughan's Formation. Superficial tidal flat deposits above possible river terrace deposits overlie the solid geology. Made ground overlies the natural soils.

The site investigation completed on site comprised windowless sampling and rotary percussive boreholes. The ground conditions encountered can in general be summarised as shown in **Table 2.1**.

Table 2.1 Summary of Typical Ground Conditions

Depth (m)			Thickness (m)	Stratum
0.0	-	1.05/5.2	1.05/5.2	MADE GROUND: Loose dark grey silty angular fine to coarse GRAVEL of slag, ceramics, wood, coal ash and glass.
1.05/5.2	-	9.3/15.0	6.0/11.5	TIDAL FLAT DEPOSITS Various layers of superficial strata including soft light greyish blue silty CLAY , and/or soft dark brown fibrous PEAT with occasional plant fragments and very strong organic odour.
9.3/15.0	-	>12.0/16.2	Absent/>2.7	POSSIBLE RIVER TERRACE DEPOSITS. Brownish red mottled grey clayey gravelly SAND /silty sandy GRAVEL . Gravel is angular siltstone and siltstone lithorelicts.
16.0/17.7	-	>21.0/23.9	Unproven	ST. MAUGHAN'S FORMATION Various interbedded layers of extremely weak to strong reddish grey MUDSTONE , strong greyish brown mottled grey SILTSTONE , weak to medium strong reddish brown and grey SANDSTONE and extremely weak to medium strong reddish brown and grey CONGLOMERATE . Occasional bands of residual mudstone up to 1.25m in thickness.

2.2 Hydrology and Hydrogeology

The St Maughan's Formation bedrock beneath the site is classified as a Secondary A aquifer. Superficial deposits beneath the site have an aquifer designation of unproductive strata. However, this may not consider the more permeable river terrace deposits that lie beneath the tidal flat deposits.

Groundwater inflows were typically identified within the made ground/shallow tidal flat deposits at 3.0m depth, and within the possible river terrace gravels at 9.5m. Groundwater monitoring wells were subsequently installed to allow groundwater depth to be recorded, and groundwater samples to be taken.

The head of the groundwater recorded in the shallow and deeper wells were essentially the same. Groundwater head within the shallow wells varied between 5.20m to 6.31m, and 5.58m and 6.21m above Ordnance Datum in the deeper wells. The groundwater bodies are therefore one and the same, however the impermeable tidal flat deposits separate the two permeable layers.

The groundwater is likely to be in hydraulic continuity with the River Usk, the banks of which lie at around 4-5m AOD and 160m to the west.

Groundwater is expected to flow to the southwest and towards the River Usk.

The site does not situate within a groundwater source protection zone, of surface water or groundwater safeguard zone.

There are no groundwater abstraction points within the local area.

2.3 Human Health and Environmental Risk Assessment

During site investigation works both site soils and groundwater were sampled and chemically analysed.

Table 2.2 Contaminants of Concern in Soils

Location	Depth	Contaminant	Source
SA1	0.9	Naphthalene, Fluorene, Phenanthrene, Fluoranthene, Pyrene, Benzo[a]anthracene, Chrysene, Benzo[b]fluoranthene, Benzo[k]fluoranthene, Benzo[a]pyrene, Indeno(1,2,3-c,d)Pyrene, Dibenz(a,h)Anthracene	S2 -Past site use (depot, car sales, vehicle maintenance).
WS01	0.5	Arsenic, Naphthalene, Phenanthrene, Fluoranthene, Benzo[a]anthracene, Chrysene, Benzo[b]fluoranthene, Benzo[a]pyrene, Indeno(1,2,3-c,d)Pyrene, Dibenz(a,h)Anthracene	
WS02	0.6	Naphthalene, Benzo[a]anthracene, Chrysene, Benzo[b]fluoranthene, Benzo[a]pyrene, Indeno(1,2,3-c,d)Pyrene, Dibenz(a,h)Anthracene	
WS03	0.6	Naphthalene, Fluorene, Phenanthrene, Fluoranthene, Pyrene, Benzo[a]anthracene, Chrysene, Benzo[b]fluoranthene, Benzo[k]fluoranthene, Benzo[a]pyrene, Indeno(1,2,3-c,d)Pyrene, Dibenz(a,h)Anthracene, Benzo[g,h,i]perylene	
WS04	0.6	Naphthalene, Phenanthrene, Benzo[a]anthracene, Chrysene, Benzo[b]fluoranthene, Benzo[a]pyrene, Indeno(1,2,3-c,d)Pyrene, Dibenz(a,h)Anthracene	
WS05	0.4	Lead, Naphthalene, Benzo[a]anthracene, Chrysene, Benzo[b]fluoranthene, Benzo[a]pyrene, Dibenz(a,h)Anthracene	
WS06	0.7	Naphthalene, Benzo[a]anthracene, Chrysene, Benzo[b]fluoranthene, Benzo[a]pyrene, Indeno(1,2,3-c,d)Pyrene, Dibenz(a,h)Anthracene	
WS07	0.4	Lead, Naphthalene, Benzo[a]anthracene, Chrysene, Benzo[b]fluoranthene, Benzo[a]pyrene, Indeno(1,2,3-c,d)Pyrene, Dibenz(a,h)Anthracene	
WS08	1.5	Benzo[a]anthracene, Benzo[b]fluoranthene, Benzo[a]pyrene, Dibenz(a,h)Anthracene	
WS09	0.5	Lead, Naphthalene, Benzo[a]anthracene, Chrysene, Benzo[b]fluoranthene, Benzo[a]pyrene, Dibenz(a,h)Anthracene	

Several contaminants were identified at levels above their respective threshold in both the shallow and deeper groundwater.

Table 2.2 Summary of Chemical Exceedances in Groundwater

Location	Depth	Contaminant	Source
BH03 (shallow)	3.0-6.0m	Copper, Zinc, Aliphatic TPH >C16-C21, Aliphatic TPH >C21-C35, Aliphatic TPH >C35-C44, Dimethylphthalate, Carbazole, Di-N-Butyl Phthalate, Acenaphthene, Fluorene, Phenanthrene, Anthracene, Fluoranthene, Pyrene	S2 -Past site use (depot, car sales, vehicle maintenance).
BH04 (Deep)	8.0-12.0m	Copper, Zinc, Carbazole, Acenaphthene, Fluorene, Phenanthrene, Anthracene, Fluoranthene, Pyrene	S2 -Past site use (depot, car sales, vehicle maintenance).
BH05 (Shallow)	3.0-6.0m	Copper, Zinc, Naphthalene	S2 -Past site use (depot, car sales, vehicle maintenance).
BH06 (Deep)	8.0-12.0m	Copper, Zinc	S2 -Past site use (depot, car sales, vehicle maintenance).
BH07 (Deep)	8.0-12.0m	Copper, Zinc, Di-N-Butyl Phthalate	S2 -Past site use (depot, car sales, vehicle maintenance).
BH08 (Shallow)	3.0-6.0m	Copper, Aliphatic TPH >C16-C21, Aliphatic TPH >C21-C35, Aliphatic TPH >C35-C44, Aromatic TPH >C16-C21, 2-Methylnaphthalene, Dibenzofuran, Carbazole, Di-N-Butyl Phthalate, Naphthalene, Acenaphthene, Fluorene, Phenanthrene, Anthracene, Fluoranthene, Pyrene	S2 -Past site use (depot, car sales, vehicle maintenance).

Contaminants identified in both the soil and groundwater are typically representative of a site previously occupied by a depot, and car sales and maintenance garage.

To protect future site users from the identified contamination it was recommended that the site will need to be capped.

It is considered that the wider aquatic environment is at a very low risk from the site. It is therefore considered that a Level 3 Groundwater Assessment is not necessary. However, a Piling Risk Assessment should be carried out prior to the installation of piles to assess and manage the potential risks of contaminating controlled waters through the introduction of new migration pathways into the deeper groundwater body. This may lead to further rounds of groundwater monitoring, samples taken and assessment. Groundwater monitoring before and after the piling may also be required.

With regards to ground gas, the site has been classified as 'gas characteristic situation 1' in accordance with Table 8.5 of CIRIA Report C665 and gas protection measures are not necessary in the new development.

SECTION 3 Piling Risk Assessment

3.1 General

Due to the presence of deposits of compressible clay and made ground it was considered that shallow foundations would present an unacceptable risk of settlement and deep piled foundations were recommended.

Due to the proximity to a railway and restricted access, it is understood that 200mm diameter steel cased, bottom driven piles will be used, to reduce vibrations occurring from traditional driven piles.

Piles will be driven into bedrock within the extremely weak to strong reddish grey MUDSTONE, strong greyish brown mottled grey SILTSTONE, weak to medium strong reddish brown and grey SANDSTONE and extremely weak to medium strong reddish brown and grey CONGLOMERATE, at depths ranging from 16.5m to 20.2m below existing ground level is used.

Piling should be carried out in accordance with NRW guidance and regulations.

3.2 Piling Application and Installation

Bottom driven steel piles are quick, cost-effective, low-energy driven displacement piles. Suitable for most ground conditions and ideal for poor ground conditions and contaminated soils. This method is one of the most environmentally friendly piling systems as it requires much less concrete than other solutions and does not produce any spoil.

The pile is formed by first driving a closed ended starter casing into the ground using an internal drop hammer weight, driving onto a dry concrete plug. The drop hammer weight is lifted and dropped repetitively which drives onto the plug allowing the casing to be driven into the ground. Subsequent casing sections are added as the pile is driven to depth. Casings are joined by a full but non-structural fillet weld as the installation proceeds. The pile is driven to a predetermined set or design depth. Once the required depth is reached the casing is then filled with concrete or grout with pile reinforcement introduced to complete pile formation.

The load from the proposed structure(s) will be carried by a number of closely spaced piles with the load being distributed by the pile cap.

3.3 Potential Pollution Linkages

The Environment Agency publication 'Piling and Penetrative Ground Improvement Methods on Land Affected by Contamination: Guidance on Pollution Prevention (2001)' was consulted.

The Environment Agency has identified six possible pollution linkages (scenarios):

- **Pollution scenario 1:** Creation of preferential pathways through a low permeability layer (aquitard), to allow potential contamination of an aquifer.
- **Pollution scenario 2:** Creation of preferential pathways, through a low permeability surface layer to allow upward migration of landfill gas, soil gas or contaminant vapours to the surface.
- **Pollution scenario 3:** Direct contact of site workers and others with contaminated soil arisings which have been brought to the surface.
- **Pollution scenario 4:** Direct contact of the piles or engineered structures with contaminated soil or leachate causing degradation of pile materials.

- **Pollution Scenario 5:** The driving of solid contaminants down into an aquifer during pile driving
- **Pollution Scenario 6:** Contamination of groundwater and nearby surface waters by concrete, cement paste or grout.

These scenarios are assessed below in the following sub-sections.

3.3.1 Pollution Scenario 1

Creation of preferential pathways through a low permeability layer (aquitard), to allow potential contamination of an aquifer.

The site investigation concluded that the presence and depth of shallow groundwater located within the made ground or at the top of the tidal flat deposits was consistent and possibly in hydraulic continuity with the River Usk.

The shallow groundwater and the deeper groundwater are separated by tidal flat deposits, which act as an aquitard, confining shallow groundwater within the made ground above and preventing transmission to the intermittent river terrace deposits below the tidal flat deposits. Disturbance of the aquitard (via piling) has the potential to create a migration pathway, assuming that a downward hydraulic gradient exists between the shallow water and the deeper groundwater.

Aquitards, which are typically layers of low-permeability materials like clay and silt, act as barriers that prevent or slow the movement of water between aquifers. If a pile breaches this layer, it could create a continuous path, allowing water to bypass the natural barrier.

The tidal flat deposits beneath the site mostly comprising soft clay has sufficient thickness and is of low shear strength and therefore will deform with the pile during installation and 'close up' around the pile shaft after installation. Due to the propensity of cohesive soils to remould around piles, the cohesive soils should maintain their properties. A tight seal will be formed with the surrounding soft clay once set, preventing migration in the long term.

The closed ended steel pile will be filled with a steel reinforcement cage and concrete. A pathway through the pile will not exist.

It is considered that there is negligible risk of a preferential pathway from the shallow groundwater into the deeper groundwater developing in the long term.

To confirm the piling does not create a temporary preferential pathway from the shallow groundwater body, and through the tidal flat deposits (aquitard) and therefore a deterioration to the deeper groundwater body, it is recommended that further groundwater monitoring is carried out prior to and then during the piling at weekly intervals. If noticeable deterioration to the deeper groundwater body is detected, additional mitigation measures can be taken to prevent any further pathways and deterioration being created.

3.3.2 Pollution Scenario 2

Creation of preferential pathways, through a low permeability surface layer to allow upward migration of landfill gas, soil gas or contaminant vapours to the surface.

The study site has been placed within Gas Characteristic Situation CS1. There is not considered to be a significant source of gas or hydrocarbon vapours.

3.3.3 Pollution Scenario 3

Direct contact of site workers and others with contaminated soil arisings which have been brought to the surface.

Driven piles will not create arisings and site construction workers are therefore not deemed to be at risk from soil contamination.

3.3.4 Pollution Scenario 4

Direct contact of the piles or engineered structures with contaminated soil or leachate causing degradation of pile materials and consequential secondary effects are to increase the potential for contaminant migration.

Provided the concrete used for the piles is the correct class there is negligible risk of pile degradation and consequential increase in pile permeability, void formation, creation of contaminant migration pathways and obviously structural performance/safety.

Laboratory soil chemical tests on samples from the site revealed a total sulphate content of between 450mg/kg and 2000mg/kg and pH levels of between 8.3 and 9.8.

Groundwater sulphate levels ranged between 12mg/l and 160mg/l at a pH of between 7.1 to 8.1.

When these results are compared with Table C2 of BRE Digest 1:2005, it indicates that all buried concrete should most likely as a minimum conform to DS-1, AC-1.

It should also be noted that the steel casing will provide some protection for the concrete.

3.2.5 Pollution Scenario 5

The driving of solid contaminants down into an aquifer during pile driving

Driven displacement piles may drag down contaminated materials as the strata are penetrated. The drag down may occur along the pile shaft through friction or by pushing material in front of the pile shoe.

Academic research has been carried out by Hayman *et al* (1993), Boutwell *et al* (2000) and the Federation of Piling Specialists (2000) with regards to the potential impact of displacement piling on the 'drag down' of contaminated soils. The studies conclude that whilst the downward movement of soil due to frictional drag can occur along the pile shaft, it is limited both horizontally and vertically. In addition, the vertical contaminant migration along the pile-soil interface is, in most cases, insignificant.

Material dragged down by shaft friction is unlikely to be displaced more than a few centimetres and Boutwell (2000) calculated that at most a few kilograms of soil may be pushed ahead of the pile shoe. Boutwell (2000) also suggested that the potential drag down of material can be mitigated by using a conical pile shoe.

Soil displacement during pile installation will therefore occur generally in a radial horizontal direction meaning there will be very little downwards vertical movement of the soil under the toe of the pile.

The risk of contaminating the groundwater within the St Maughan's Group or river terrace deposits from contaminated soils is therefore deemed to be negligible.

3.3.5 Pollution Scenario 6

Contamination of groundwater and nearby surface waters by concrete, cement paste or grout.

Whilst the steel piles will be filled with concrete, the piles are closed ended and will therefore be contained within the steel casing. Consequently, there is no risk to the aquatic environment via this scenario.

SECTION 4 Recommendations and Mitigation Measures

Due to the presence of a consistent shallow groundwater body in the made ground, there is a small potential risk of creating a preferential pathway for perched groundwater to migrate to the underlying deep groundwater during the piling.

To confirm that suitable mitigation measures are incorporated into the piling to prevent this occurring, groundwater will be monitored from the three existing dedicated deep groundwater and three shallow groundwater monitoring stations on weekly intervals during the piling. Three further monitoring visits should be carried out following the cessation of piling works on a fortnightly basis. This is intended to demonstrate that there is no change in chemical content of the underlying groundwater body. Piling is expected to take three weeks.

The existing wells are presented on **Figure 4.1**.

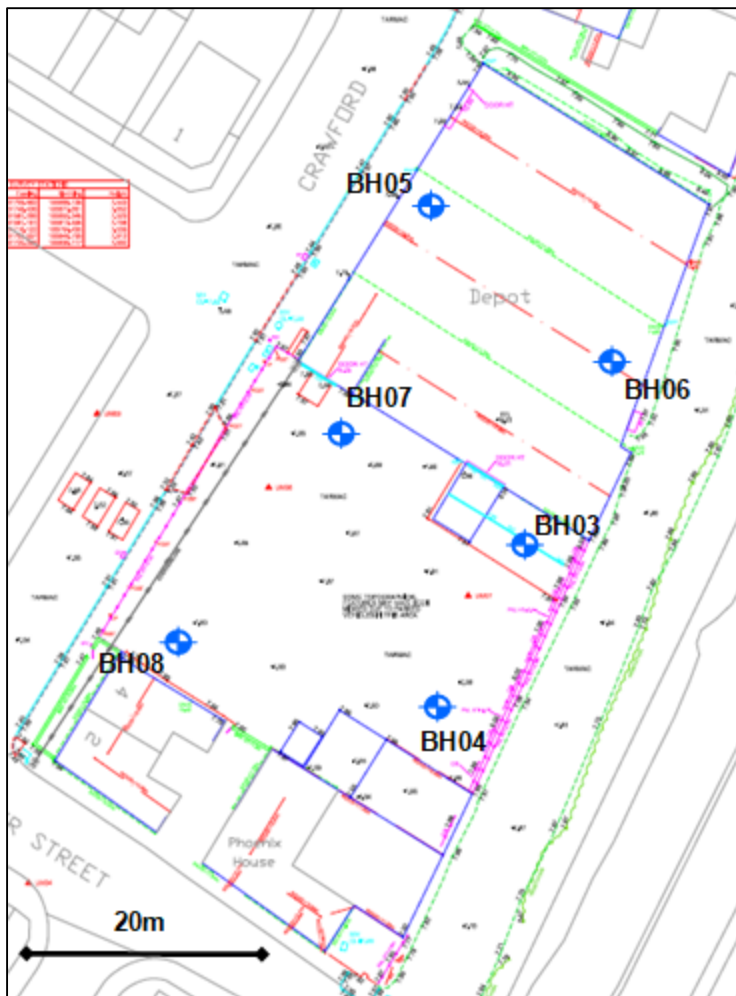


Figure 4.1 Groundwater Monitoring Well Locations

Three complete rounds of groundwater testing have already been performed and are discussed in the geotechnical and geoenvironmental report (Reference 240125-17245-5 dated January 2025). The baseline results are summarised in **Tables 4.1 to 4.5**.

Seventeen groundwater samples were collected from boreholes BH03 to BH08 over three rounds of groundwater monitoring. A sample could not be retrieved from BH08 on the third visit due to roofing materials having been placed over the monitoring stations.

Table 4.1 Summary of Groundwater Chemical Test Results – Inorganics

Determinand	Threshold Value (µg/l)	Source	Measured Concentrations (µg/l)		Number of Exceedances
			Minimum	Maximum	
Arsenic	50	WFD2	1.5	120	1
Cadmium	0.08	WFD1	<0.08	<0.11	BLDL
Chromium	4.7	WFD2	<0.5	6.1	5
Copper	1.0	WFD2	0.66	1.8	12
Lead	1.2	WFD1	<0.5	<0.5	0
Mercury	0.07	WFD3	<0.01	<0.05	0
Nickel	4	WFD1	<0.5	7.4	5
Selenium	10	DWD	<0.5	0.71	0
Zinc	10.9	WFD2	5.8	20	9
Cyanide, Total	1.0	WFD2	<5	<50	BLDL
Sulphide	-	-	<5	51	-
Sulphate (mg/l)	400	BRE	<1.0	160	0
pH	-	-	7.1	8.3	-
BOD (mg/l)	-	-	4.6	12.0	-
COD (mg/l)	-	-	12	90	-
Electrical Conductivity (uS/cm)	-	-	920	9200	-
Hardness (mg/l)	-	-	250	1400	-

Notes:

WFD1 - Water Framework Directive – Inland Surface Waters (AA)

WFD2 - Water Framework Directive – Freshwater (Long Term Mean)

WFD3 - Water Framework Directive – Inland Surface Waters (MAC)

DWD – Drinking Water Directive

BRE – British Research Establishment

- No available guideline

* Conservative threshold for Chromium VI used

BLDL - Below laboratory detection limit

ALDL - Above laboratory detection limit

Table 4.2 Summary of Groundwater Chemical Test Results – Organics

Determinand	Threshold Value (µg/l)	Source	Measured Concentrations(µg/l)		Number of Exceedances
			Minimum	Maximum	
Naphthalene	2	WFD1	<0.01	4.3	2
Acenaphthylene	-	-	<0.01	<0.01	BLDL
Acenaphthene	-	-	<0.01	4.5	5
Fluorene	-	-	<0.01	2.7	5
Phenanthrene	-	-	<0.01	5.6	5
Anthracene	0.1	WFD1	<0.01	1.4	4
Fluoranthene	0.0063	WFD1	<0.01	8.2	5
Pyrene	-	-	<0.01	6.2	5
Benzo(a)anthracene	-	-	<0.01	<0.01	BLDL
Chrysene	-	-	<0.01	<0.01	BLDL
Benzo(b)fluoranthene	0.017	WFD3	<0.01	<0.01	0
Benzo(k)fluoranthene	0.017	WFD3	<0.01	<0.01	0
Benzo(a)pyrene	0.00017	WFD1	<0.01	<0.01	BLDL
Indeno(123cd)pyrene	-	-	<0.01	<0.01	BLDL

Dibenzo(ah)anthracene	-	-	<0.01	<0.01	BLDL
Benzo(ghi)perylene	0.0082	WFD3	<0.01	<0.01	BLDL
Phenols	7.7	WFD2	<3	<3	0
Notes: WFD1 - Water Framework Directive – Inland Surface Waters (AA) WFD2 - Water Framework Directive – Freshwater (Long Term Mean) WFD3 - Water Framework Directive – Inland Surface Waters (MAC) - No available guideline ALDL - Above laboratory detection limit BLDL - Below laboratory detection limit					

Table 4.3 Summary of Groundwater Chemical Test Results – Petroleum Hydrocarbons

Substance	Threshold Value (ug/l)	Source	Measured Concentrations (ug/l)		Number of Exceedances
			Minimum	Maximum	
Aliphatic					
TPH >C5 – C6 Ali	15000	WFD1	<0.1	<1.0	0
TPH C6 – C8 Ali	15000	WFD1	<0.1	<1.0	0
TPH C8 – C10 Ali	300	WFD1	<0.1	<1.0	0
TPH C10 – C12 Ali	300	WFD1	<0.1	<1.0	0
TPH C12 – C16 Ali	300	WFD1	<0.1	64	0
TPH C16 – C21 Ali	-	-	<0.1	980	4
TPH C21 – C35 Ali	-	-	<0.1	41000	4
TPH C35 – C44 Ali	-	-	<0.1	5000	3
Aromatic					
TPH C5 – C7 Arom	10		<0.1	<1.0	0
TPH C7 – C8 Arom	700		<0.1	<1.0	0
TPH C8 – C10 Arom	300		<0.1	<1.0	0
TPH C10 – C12 Arom	90		<0.1	2.0	0
TPH C12 – C16 Arom	90		<0.1	43	0
TPH C16 – C21 Arom	90		<0.1	97	1
TPH C21 – C35 Arom	90		<0.1	20	0
TPH C35 – C44 Arom	-	-	<0.1	<1.0	-
Notes: PH – Petroleum Hydrocarbon Ali – Aliphatic Arom – Aromatic					

Seventeen samples were tested for a full suite of volatile, semi-volatile organic compounds, BTEX, and MTBE. Noteworthy compounds exceeding laboratory limits of detection are summarised in **Table 5.8**.

Table 4.4 Summary of Groundwater Chemical Test Results – Noteworthy VOC & SVOC

Substance	Measured Concentrations (mg/kg)	
	Minimum	Maximum
2-Methylnaphthalene	<0.0005	0.00081
Dibenzofuran	<0.0005	0.001
Dimethylphthalate	<0.0005	0.0012
Carbazole	<0.0005	0.0019
Di-N-Butyl Phthalate	<0.0005	0.058

Samples should be tested for the contaminants listed in **Table 4.5**.

Table 4.5 Proposed Groundwater Laboratory Analysis

Metals & Metalloids	In-Organics	Organics	Others
Arsenic	Cyanide	Phenols	pH (acidity)
Cadmium	Sulphate	Petroleum Hydrocarbons	Hardness
Chromium III	Sulphide	PAH	Electrical Conductivity
Chromium VI		VOCs	Oxygen Demands
Chromium		SVOCs	
Copper		BTEX	
Lead		MTBE	
Mercury			
Nickel			
Selenium			

A validation report should be presented following the groundwater monitoring.



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