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Remediation Strategy

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Appendix A Technical Note Concerning Vapour Risk & Water Pipes

1 INTRODUCTION

RemedX Limited (RemedX) was contracted by Royal Mail Group (RMG) to complete a Remediation Strategy (RS) for the identified contamination at the Wrexham Delivery Office site, Wrexham, Wales. The RS has been completed based on the previous site investigation works that have been completed for the site to date.

1.1 Objective

The purpose of this RS is to assess and identify the most viable remedial approach for the site and its specific remedial objectives. This will be assessed based on multiple criteria, including cost, time, practicality, technicality, waste and sustainability. It will also include an outline remediation process plan.

1.2 Location and description of the site

The Wrexham Delivery Office site is located on Regent Street, Wrexham, approximately 1 km northwest of Wrexham city centre. To the south of the site is mixed commercial and residential housing, with additional residential properties to the north. To the east and west of the site lie commercial properties. A site location plan is presented in Figure 1.

1.3 History of the site

Limited site history has been supplied for review; however a study of available historical maps has been undertaken for the site to provide some context.

The earliest maps available for the site date back to 1874, showing the site area occupied by agricultural land. This appears to remain the case until mapping dated 1937-1939 shows a building marked "works" occupying the broad location of the current day delivery office. By 1960, the site buildings resemble the current site layout, with mapping in 1963 specifically referring to a sorting office to the west of the site area. The site does not undergo significant change to the current day.

1.4 Summary of previous investigation

It is understood that a Ground Investigation was undertaken by Core Geotechnics Limited, the details of which are contained within their report ref. 21009 dated 20th October 2020. This investigation comprised a desk study, the advancement of four boreholes and geotechnical and chemical testing of recovered samples.

Additionally, a further phase of site investigation has been undertaken at the site by Dunelm, comprising the advancement of three boreholes, MW1, MW2 and MW3, draft logs for which along with the results of groundwater gauging and sampling events conducted on 18th February 2021 for MW1 and MW2, with MW3 sampled on 25th February 2021; 4th March 2021; and 10th March 2021, have been reviewed.

1.5 Limitations

The comments given in this report and the opinions expressed are based on the information made available to RemedX. However, there may be conditions pertaining to the site that have not been revealed by the previous phases of investigation and therefore could not be taken into account for the completion of this RS.

2 CONCEPTUAL SITE MODEL

This section presents the previously established conceptual site model, identifying geology, hydrogeology, sources, pathways and receptors as well as summarising complete contaminant linkages for the site.

2.1 Geology

Based upon intrusive investigations, the site geology can be generally summarised to be as follows:

- 0 – 3-4m bgl - asphalt / engineered surfaces
- 3-4 – 5.80-6m bgl – clayey sandy gravels, some clay evident at the base of MW2 at 5.80m bgl

2.2 Hydrogeology

The hydrogeological conditions are determined by the geological and tectonic structure of the region.

Groundwater gauging has shown there to be a shallow groundwater body present beneath the site in all monitoring wells. The levels appear to be relatively consistent across the site. Generally, groundwater is between 3.5 and 4.0m bgl based on previous monitoring rounds.

Primary groundwater flow direction has been inferred towards the south east. No gradient has yet been calculated and communicated to RemedX.

It should be noted that limited data concerning groundwater flow is available and this inference is subject to change.

2.3 Sources

The following potential sources were identified:

- Potential leak from an underground storage tank or associated pipework.
- Residual contamination in soils surrounding the fuel storage and distribution infrastructure.
- Other potential historic contamination associated with the site use.
- Potential contamination from the highway run off.

It is understood that reference has been made to the presence of an off site petrol filling station as a potential source. Whilst it is understood that such a potential source lies some 60m to the west, based on available data there is presently no hydraulic link between the former petrol filling station and the site, with groundwater requiring a north east flow for such migration to occur.

2.4 Pathways

The following potential pathways were identified:

- Leaching of contaminants sorbed to soils in the unsaturated zone and migration into groundwater
- Migration of dissolved phase contaminants laterally within the groundwater
- Vapours generated from contaminants within the soil
- Vapours generated from contaminants within the groundwater

2.5 Receptors

The following potential receptors were identified:

- Aquifer within the sands and gravels below the site
- Onsite infrastructure and buildings
- Site workers
- River Gwenfro

2.6 Linkages

Based on the findings of the previous site investigations and previous further assessment the following contaminant linkages are confirmed or potentially complete:

- Migration of contaminants from the source/s directly into groundwater.
- Potential lateral migration of impacted groundwater to downgradient offsite receptors.

3 REMEDIATION OPTIONS APPRAISAL

A remediation options appraisal has been undertaken by RemedX to enable the selection of the most feasible remedial options for the residual impacted soils and groundwater at the site. The appraisal takes into consideration multiple criteria including cost, time, practicality, technical, waste and sustainability of the given remediation techniques.

3.1 Remediation objectives

The specific remediation objectives for the site are as follows:

- Removal of primary and secondary sources of contamination
- Protection of off-site receptors to the south and south east of site
- Reduction of dissolved phase concentrations on site to acceptable levels

It is acknowledged that site specific target criteria have yet to be derived for the site in terms of remediation performance. It is proposed that these be developed following the undertaking of the proposed additional works detailed within Section 5.0 of this report.

3.2 Remediation target zones

Throughout redevelopment and remediation works, it is understood that the site will continue to be operated as a Royal Mail delivery office, with vehicular access required to the northern part of the site comprising the vehicle parking and loading area.

Whilst this will restrict access for the site as well as access to the residual contamination and potential plume spread, the remedial works will be designed in such a way as to integrate into the site development and minimise impact to both site operations and remediation programme.

The zone of remedial works is shown on Figure 2 of Appendix A.

3.3 Initial remediation technique selection

Below in Table 1 is a full matrix of remediation techniques that could be utilised. The matrix gives a generalised summary of applicable implantation, target phase, geology and contaminants for each technology. The techniques viable for this site are then selected to be taken forward for detailed assessment.

Table 1: Remediation technology matrix

Remediation technology	Implementation		Target phase				Geology							Contaminants		
	In-situ	Ex-situ	Vapour	NAPL	Aqueous	Sorbed	Gravel >2mm	Sand 0.06-2mm	Silt 2-60um	Clay <2um	Peat	Sedimentary bedrock	Crystalline bedrock	TPH	PAH	Metals
✓ = Applicable, ? = Potential / limited, ✖ = Not applicable.																
Biological breakdown																
Bioremediation	✖	✓	✖	✓	✖	✓	✓	✓	✓	?	?	✖	✖	✓	✓	✖
Monitored natural attenuation (MNA)	✓	✖	✖	✖	✓	?	✓	✓	?	?	?	?	?	✓	✓	?
Enhanced MNA	✓	✖	✖	✖	✓	✓	✓	✓	✓	?	?	?	?	✓	✓	?
Bio venting	✓	✓	✖	✖	✖	✓	✓	✓	?	?	✖	✖	✖	✖	✖	✖
Bio sparging	✓	✖	✖	✖	✓	✓	✓	✓	?	✖	✖	✖	✖	✓	✖	✖
Phytoremediation	✓	✖	✖	✖	✓	✓	✓	✓	✓	✓	✓	✖	✖	✓	✓	✓
Chemical breakdown																
Chemical oxidation	✓	✓	✖	✖	✓	✓	✓	✓	✓	✓	✖	?	?	✖	✖	✖
Chemical reduction	✓	✓	✖	✖	✓	✓	✓	✓	✓	✓	✖	?	?	✓	✓	?
Soil flushing / desorption	✓	✓	✖	✓	?	✓	✓	✓	?	?	✖	?	?	✓	✓	✓
Physical extraction																
LNAPL recovery	✓	✖	✖	✓	✖	✖	✓	✓	✓	?	✖	?	?	✓	✓	✖
Total fluids recovery	✓	✖	✖	✓	✓	?	✓	✓	✓	?	✖	✓	✓	✓	✓	?
Soil vapour extraction (SVE)	✓	✓	✓	✖	✖	✓	✓	✓	?	?	✖	?	?	✓	?	✖
Air sparge SVE	✓	✖	✓	✖	✓	✓	✓	✓	?	✖	✖	✖	✖	✓	?	✖
Dual / multi-phase extraction (DPE / MPE)	✓	✖	✓	✓	✓	✓	✓	✓	?	?	✖	✓	✓	✓	✓	?

Remediation technology	Implementation		Target phase				Geology							Contaminants		
	In-situ	Ex-situ	Vapour	NAPL	Aqueous	Sorbed	Gravel >2mm	Sand 0.06-2mm	Silt 2-60um	Clay <2um	Peat	Sedimentary bedrock	Crystalline bedrock	TPH	PAH	Metals
✓ = Applicable, ? = Potential / limited, ✖ = Not applicable.																
Thermally enhanced extraction	✓	✖	✖	✓	✓	✓	✓	✓	?	?	?	✓	✓	✓	✓	✖
Thermal desorption – low temperature	✖	✓	✖	✖	✖	✓	✖	✓	✓	?	?	✖	✖	✓	✓	?
Soil washing	✖	✓	✖	✖	✖	✓	✓	✓	?	?	?	✖	✖	✓	✓	✓
Excavation – disposal	✖	✓	✖	✖	✖	✓	?	✓	✓	✓	✓	?	?	✓	✓	✓
Thermal destruction																
Thermal conductive heating	✓	✖	✖	✓	✓	✓	✓	✓	✓	✓	?	✓	✓	✓	✓	✖
Thermal desorption – high temperature	✖	✓	✖	✖	✖	✓	✖	✓	✓	?	?	✖	✖	✓	✓	?
Containment																
Solidification / stabilisation	✓	✓	✖	✖	✖	✓	✓	✓	✓	✓	✖	✖	✖	✓	?	✓
Cover systems	✓	✓	✖	✖	✖	✓	✓	✓	✓	✓	✓	✖	✖	✓	✓	✓
Sub surface barriers	✓	✖	✖	✓	✓	✖	✓	✓	✓	✓	✓	✖	✖	✓	✓	✓
Permeable reactive barrier (PRB)	✓	✖	✖	✖	✓	✖	✓	✓	?	?	?	?	?	✓	✓	✓

Upon consideration of the site's specific characteristics, considering cost and sustainability, the following potentially viable options have been selected and taken forward for a detailed assessment:

- Monitored Natural Attenuation (MNA),
- Total Fluids Recovery and
- Dual Phase Extraction (DPE) / Multi Phase Extraction (MPE).

3.4 Discussion of options

The selected remediation techniques from the initial selection are presented below.

3.4.1 Monitored natural attenuation (MNA)

Technology			
Monitored natural attenuation (MNA)			
Applicable Implementation			
In-situ		Ex-situ	
✓		✖	
Applicable Target Phases			
Vapour	NAPL	Aqueous	Sorbed
✖	✖	✓	?
Applicable Geology			
Gravel >2mm	Sand 0.06-2mm	Silt 2-60um	Clay <2um
✓	✓	?	?
Peat	Sedimentary Bedrock	Crystalline Bedrock	
?	?	?	
Applicable Contaminants			
TPH	PAH	Metals	
✓	✓	?	
Description			
Monitored natural attenuation (MNA) consists of a range of naturally occurring in situ physical, chemical, and biological processes that attenuate contaminant concentrations in groundwater to achieve remedial goals within a reasonable timeframe and protect human health and the environment. MNA relies on groundwater data to develop contaminant trends and to evaluate reductions in contaminant concentrations brought about by naturally-occurring destructive mechanisms (e.g., biodegradation and/or chemical/abiotic degradation) and non-destructive mechanisms (e.g., advection, dispersion, dilution via recharge, sorption, and volatilization). While non-destructive mechanisms decrease contaminant concentrations spatially through redistribution (scattering) of the contaminant mass, destructive mechanisms reduce contaminant concentrations through degradation/alteration of the contaminants' chemical composition. Biodegradation is often the predominant (destructive) mechanism to reduce the mass of the contaminants at a site. However, it is noted that the impacts of chemical degradation (or abiotic degradation) mechanisms are becoming better understood and are recognized to contribute more significantly to MNA, under certain site-specific conditions.			

Advantages	Limitations
• Less generation or transfer of remediation waste; • Less intrusive as few surface structures are required; • Can be used in conjunction with, or after other remediation methods; • Overall cost likely to be lower than many active remediation technologies.	• Requires extensive site investigation; • Requires a long term commitment to monitoring and a contingency plan (and funds) if the contaminants or groundwater do not behave as predicted; • Requires significant depth of understanding of local geology and hydrogeology; • Subsurface conditions may change over time and may result in renewed mobility of previously stabilised contaminants.
Site Specific Application	
This could be a potentially viable option should excavation remove suitable mass of contamination. However, any presence of Light Non Aqueous Phase Liquids (LNAPL) will likely hinder the feasibility of applying MNA. In addition, if off site migration continues to occur an assessment on whether suitable attenuation is occurring to avoid the need of actively controlling groundwater. It is possible the removal of the primary source and bulk of the contaminant mass via the previous excavation works may mean that contaminant levels are reduced across the site to the point that MNA and natural degradation of the residual contamination is sufficient to protect off site receptors. Site appears to have reasonable hydraulic flux in the sub surface and as such there is likely to be high potential for continued aerobic degradation. The high hydraulic flux could also mean the contamination is mobilised off site towards receptors before being degraded, however. Likely to be required in all situations to demonstrate compliance with remediation objectives.	

3.4.2 Total fluids recovery

Technology			
Total fluids recovery			
Applicable Implementation			
In-situ		Ex-situ	
✓		✗	
Applicable Target Phases			
Vapour	NAPL	Aqueous	Sorbed
✗	✓	✓	?
Applicable Geologies			
Gravel >2mm	Sand 0.06-2mm	Silt 2-60um	Clay <2um
✓	✓	✓	?
Peat	Sedimentary Bedrock	Crystalline Bedrock	
✗	✓	✓	
Applicable Contaminants			
TPH	PAH	Metals	
✓	✓	?	
Description			
Total fluids recovery is performed using one or more pumps in a well or trench to recover LNAPL and groundwater. A pump is placed at a specified depth beneath the groundwater/LNAPL interface. A pumping rate is set sufficiently high to create a groundwater cone of depression, which provides a gradient to induce the flow of LNAPL into the well or trench. The pump can be used to recover LNAPL and groundwater in a single stream, or a second pump can be placed at a shallow interval to recover LNAPL (and some water). Total fluids recovery systems generate a large volume of water that must be treated and disposed at the surface. However, the greater driving force creates a localized depression in the water table that can result in a greater volume of LNAPL recovered in a shorter period. Above ground treatment can take the following forms; • Air stripping: VOCs in groundwater are transferred from the dissolved phase to the vapour phase by air bubbles. The contaminated air rises to the water surface where vapours are drawn off and treated; • Carbon adsorption: adsorption of dissolved organic contaminants on to granular activated carbon (GAC); • Filters: mechanical separation based on removing particulate material from water; • Membrane filtration: filtration using semi-permeable membrane on the basis of different molecular size. Can be used to treat inorganic and organic compounds; • Ion exchange: contaminant ions are removed from water as they are exchanged with non-contaminant ions in the exchange resin; • Reverse osmosis: low concentrations of inorganic contaminants may be removed through this separation mechanism; • Chemical oxidation: ozone, hydrogen peroxide and ultraviolet light may be used to degrade contaminants by oxidation;			

Technology	
Total fluids recovery	
- Precipitation: dissolved contaminants are transformed into insoluble compounds which may be less toxic, or easier to treat or remove; - Neutralisation: chemical reaction to amend the pH of a solution; - Biodegradation: sand/gravel filters are colonised with microorganisms to promote biodegradation of organic compounds in water; Total fluids recovery systems generally are used when substantial LNAPL remains at a site. They also are used when it is desirable to prevent migration of the LNAPL or the associated dissolved phase plume since the cone of depression also creates a groundwater capture zone. Groundwater modelling using site-specific data should be performed to determine the extraction flowrate needed to establish the desired capture zone and to design an appropriate number and spacing of recovery wells.	
Advantages	Limitations
- Removal of contaminants and the risk they pose from the site; - Able to also gain hydraulic control of an area; - Can be inexpensive depending on the surface treatment required.	- Limited by the structure of the soil, degree of saturation, pore connectivity and porosity; - Effectiveness can be hindered by a strong water table for in-situ; - Recovery with drawdown can smear contamination across less contaminated zones; - Susceptible to contaminant rebound after pumping stops.
Site Specific Application	
This approach would achieve targeting of any LNAPL and dissolved phase organic contamination across the target areas. Based on the theoretical hydrogeological conditions, it would be able to achieve a cone of depression with drawdown which would be used for hydraulic containment of contamination and prevent further migration off site. this approach is a relatively low maintenance active approach. Extracted liquids would require processing on site. Impacted soils in the subsurface would not be targeted. However, it is a robust proven technique. Logistically it would have to be installed and operated to ensure there were no issues associated with harsh weather conditions.	

3.4.3 Dual / multi-phase extraction (DPE/MPE)

Technology			
Dual / multi-phase extraction (DPE/MPE)			
Applicable Implementation			
In-situ		Ex-situ	
✓		✗	
Applicable Target Phases			
Vapour	NAPL	Aqueous	Sorbed
✓	✓	✓	✓
Applicable Geology			
Gravel >2mm	Sand 0.06-2mm	Silt 2-60um	Clay <2um
✓	✓	?	?
Peat	Sedimentary Bedrock	Crystalline Bedrock	
✗	✓	✓	
Applicable Contaminants			
TPH	PAH	Metals	
✓	✓	?	
Description			
DPE/MPE are two very similar techniques that combine the effects of a liquid extraction system with a SVE system. With DPE, pump and treat is used to dewater a target smear zone and once exposed a vacuum is then applied to the newly exposed unsaturated zone to further remove contamination in the vapour phase. MPE is similar to DPE, except both waste streams are extracted together from 1 extraction lance using a vacuum. This dewateres the target smear zone and once exposed the vacuum is then applied to the newly exposed unsaturated zone to further remove contamination in the vapour phase, as well as stripping vapours from the groundwater. The waste streams are then treated separately for both DPE and MPE. MPE initially requires the liquid and vapour steams to be separated using knockout vessel. Then in both methods via sand and carbon for liquids and via a carbon filter for vapours. There are many other liquid treatment stages that can be added to a water treatment plant depending on the contaminants. The advantages of DPE is that it is better for handling LNAPL as it reduces hazards associated with process safety that occur with LNAPL and MPE. DPE is also better suited if there is higher hydraulic conductivity and more water to process. The value of DPE decreases with reduced requirement for liquid recovery. DPE is a more complex and involved installation with additional pumps installed and associated pipework runs. MPE is a simpler system with less installation requirements and is more suited to tighter geologies, however, struggles with increasing depths below 10m.			

Advantages	Limitations
• Can be cost effective; • Can treat many organic compounds across all phases, including LNAPL (DPE); • MPE has simpler installation requirements; • Minimal site disturbance for in-situ.	• Limited by the structure of the soil, degree of saturation, pore connectivity and porosity for in-situ; • Neither are simple to operate; • Effectiveness can be hindered by high hydraulic conductivity for in-situ; • Verification of treatment can be difficult; • Not applicable to inorganic compounds due to their low volatility; • MPE has limited depth due to vacuum capacity.
Site Specific Application	
Most involved system being a combination of total fluids removal and SVE. But would effectively target LNAPL and dissolved phase contamination across the area and be suited to the geology and contamination. Also gives the benefit of hydraulic control. However it has the same drawbacks of total fluid recovery of potential issues with sub zero temperatures and freezing of extracted water during treatment at certain times of the year. Very effective solution which could see duration of operation reduced, but also most costly and complex to install and operate. Would also require network of extraction wells installed. MPE would be best suited for to the geology and hydrogeology and contamination profile observed.	

3.5 Conclusions from options appraisal

Based on the remedial options appraisal assessment the most feasible technique for achieving the remedial objectives for the site is considered to be DPE/MPE. This is a robust system that will actively treat soils and groundwater providing more assurance in achieving the remedial targets set out for the site. It is well suited to the geology and hydrogeology which has demonstrated itself to not have as high hydraulic conductivity as first expected, likely associated with higher fines content in the moraine sand geology.

The MPE is used to lower the water table and expose the smear zone to airflow and vacuum hence increasing hydrocarbon mass transfer and removal in the vapour phase. The system should be robust enough to handle fluctuating water levels based on seasons and effectively sustain hydraulic control and dewatering. The system, once installed, will be able to operate without any disruption to existing site operations.

Based on the above, there are merits in considering simpler alternatives to achieve the MPE effect without the need of installing and operating a full scale MPE system. RemedX considers the LNAPL and contaminant mass recovery utilising vacuum tankers or mobile vacuum units through Vacuum Extraction Removal (VER) events could therefore be considered. It is much simpler to instigate, however it will likely have limitations in terms of radius of influence and rate that mass is removed thus limiting the ability to reach remedial targets or prolonging the timescales to achieve objectives.

MNA has been discounted largely on the basis of the very limited site investigation, though additional investigation, data assessment and refinement of the remedial model would likely reduce the overall requirement for and scope of remediation works, albeit at additional cost. These costs however, are likely to offset against the overall cost of any remedial scheme implemented at the site.

Whilst dig and dump presents programme benefits in terms of removing the majority of contaminated soil and mass from the site via excavation and removal to landfill quickly, the potential for expansive excavation to interfere with site operations, cost implications from landfill tax and uncertainties regarding extent and nature of contamination given the limited site investigation data have discounted this option.

4 PROPOSED REMEDIATION STRATEGY

Based on the remediation options appraisal assessment, MPE is presenting as the most technically viable methodology for the site at this current stage.

4.1 Overview

The system will require the network of wells and trenches install for the extraction pipework. Being MPE, waste streams of liquids and vapour are both extracted via vacuum down the same line and there is no requirement for air supply with MPE which makes the installation simpler. These will feed into the extraction and treatment plant which will require positioning on site somewhere suitable to not interfere with ongoing site use. It will be ideally located close to a potential discharge location (combined/foul sewer).

The active remediation works to be undertaken at the site can be broadly split into 3 phases of works, designed to progress construction at the site, which are outlined below. This strategy presents these three phases as:

- Phase 1: Removal of existing underground storage tanks and removal of any grossly impacted soils
- Phase 2: Installation and operation of DPE/MPE system
- Phase 3: Post remediation monitoring and validation

It should be noted that the removal of the underground storage tanks will be undertaken by others, with specific methodologies pertaining to tank removal, environmental sampling and validation the responsibility of those chosen to undertake the work.

4.2 Phase 1: Removal of underground storage tanks

These works will be carried by others, being outside of the RemedX scope, however the broad methodology to be employed is as follows.

The underground storage tanks (USTs), associated pipework and any encountered grossly impacted soils represent a potential ongoing source of contamination to the site. The USTs, associated pipework and any grossly impacted soils will be removed from the site.

Validation soil samples will then be obtained from the sides, walls and the base of the excavation(s), which fulfil an agreed analysis criteria, to be agreed by others.

4.3 Site constraints

Prior to commencing the works a site visit will be required to confirm any site constraints specifically relevant to the remedial methodology and proposed field works. Currently the following site constraints have been noted for this site:

- The site is still an operational delivery and sorting office. The designation and segregation of target work locations will have to be carefully considered and executed to ensure no incidents occur in relation to site use, public access and critical use areas within the site.

- It is assumed that a suitable power supply to run the system will be made available for these works. If one is not available there will be the requirement to source a new connection or run the system using generators for the duration of the works. This however is not recommended given the associated costs, carbon footprint and operational issues.
- Future works will have to minimise disruption to ongoing site activities. Wells and trenching will need to be installed in such a way to minimise the impact on ongoing site operations.
- It is unknown if a water supply is available on site. Water supply will be required to commission the water treatment plant system when installed.
- Discharge location. It is unknown if there is a suitable discharge location for the extracted liquids to be discharged to post treatment. This will be essential for this works to be able to proceed. It has been assumed a suitable discharge location with sufficient capacity is available.

4.4 Installation requirements

The specific number and spacing of remediation wells would be best determined by pilot testing works but for the purposes of this proposal a total of 8 installations for the MPE system have been assumed based on a radius of 4m per extraction well. It should be noted that this provisional design could be changed based upon the results of any agreed pilot testing works. Figure 2 shows the proposed well installation layouts.

New remediation wells should be installed in 110mm diameter PVC or HDPE pipes, screened from 1.5m to 6m bgl, targeting the residual smear zone.

All wells will be installed within manhole chambers to allow for connection with below ground pipework and installation of extraction lances. All of the extraction and distribution pipework will be installed in trenches so as not to impact upon the ongoing operation of the site.

The existing monitoring wells on site will be utilised for ongoing groundwater monitoring.

4.5 Full scale equipment

The Equipment required for these works are as follows:

- Basic hand tools for conducting maintenance and connections
- Photo Ionisation Detector (PID) for monitoring VOCs
- Interface probe for measuring water levels / LNAPL in wells
- Anemometers for measuring air velocity
- Thermometer for measuring temperature
- Vacuum gauges for measuring vacuum at well heads and system
- Data loggers for monitoring groundwater levels inside wells
- Vapour sampling pumps and kit
- Water sample bottles

- MPE container comprising:
 - 2 x vacuum pumps
 - Knock out separation vessel
 - System control panel
 - Safety controls
 - Dilution control
- 10m³/hr Water treatment plant (WTP) comprising:
 - Oil/water separator
 - Buffer tank with forwarding pump
 - Sand filter unit (BI50)
 - Aqueous phase carbon vessel units (2 x BI50)
 - LNAPL storage tank
- Vapour phase carbon vessel units (2 x BI25)
- Pipework infrastructure and manifold

4.6 Remedial works methodology

The key tasks involve in the remediation works for this site are highlighted in this section.

4.6.1 HAZOP

A HAZOP will be completed during design stage to assess process safety and identify all safety devices and measures require for the safe operation of the system

4.6.2 Installation of new wells for systems

The new wells will need to be installed in the target remediation zones. This will be done using the most suitable drilling method for the geology present. Installations will be profiled with a PID to allow for targeted removal during the extraction works. Arisings will be collected up and arranged for disposal to a suitable licensed facility. Wells will need to be installed in chambers with surface cover access due to the existing site use. Wells will be suitably developed once installed, ready for use.

4.6.3 Baseline groundwater sampling and gauging

The baseline GW sampling round will be collected from all wells installed to the groundwater, new and old, once they have been installed and have had a chance to settle. A selection of wells providing suitable coverage of the site has been assumed for these works. Sampling will be completing using a bladder pump (or similar) and low flow cell due to the depth of the groundwater. Samples will be analysed for TPH CWG (to include BTEX), PAH and metals in line with existing testing. This will inform the baseline conditions for the remediation works.

4.6.4 Installation and commissioning of systems

This phase of the work will involve delivery of the plant to site prior to setting it up in position, building the bund, connecting all plant, testing and commissioning before finally starting the system operation.

4.6.5 System operation and maintenance

The operation and maintenance will take place initially on a weekly basis and will be split into two types of visit. They are as follows:

- Operation and optimisation visits – this will involve a day visit to conduct basic system checks of the plant and wells, check lance inlets and record system and well data which will then allow for re-optimisation of the system if required. These will be initially completed on a weekly basis then moved to fortnight visits.
- Maintenance and service visits – this will involve a two day visit to conduct all that would be completed on a normal operation visit, but also additional plant servicing and maintenance which requires more involved tools and knowledge. This visit will be conducted on a monthly basis.

4.6.6 Quarterly remediation groundwater sampling

Groundwater sampling of applicable wells to be decided based on baseline conditions will be completed on a quarterly basis during operation of the plant. The groundwater abstraction plant be switched off and groundwater levels allowed to settle prior to completing the sampling. Sampling will be completed using a peristaltic pump and low flow cell due to the depth of the groundwater. These samples should be analysed for TPH CWG. The data will then be used to help further direct extraction and optimisation of the system.

4.6.7 Decommissioning of plant

For this part of the works the equipment will be turned off and isolated to allow for it to be dismantled, cleaned and packed up ready for transport off site back. Wastes media and sludges will be removed from site and transported to a suitable disposal facility.

4.6.8 Post remediation groundwater sampling

Groundwater sampling of applicable wells will be completed on a monthly basis post remediation works, for a period to be agreed with the regulatory authorities. Sampling will be completed using a bladder pump and low flow cell due to the depth of the groundwater. These samples should be analysed for TPH CWG (to include BTEX). The data will then be used to help further delineate residual contamination and demonstrate continued attenuation of concentrations and meeting of remediation targets.

4.6.9 Validation

Following completion of the active works, a validation report detailing the works undertaken, remediation performance, data and post remediation monitoring regime will be produced to demonstrate compliance with the agreed remediation strategy and successful achievement of the target criteria.

4.7 Groundwater monitoring and sampling

The groundwater sampling analysis will be used to assess the progress of the job throughout the works and inform areas to target for the MPE extraction system as well as inform on duration to run the system for. It is recommended that a full groundwater sampling round is completed prior to works commencing to create a baseline data set. For the purposes of this scoping, it has been assumed to include 4 wells, and will be made up of a cross section of the new and existing installations to give good coverage of the site.

Allowance should also be made for monthly monitoring of wells post completion of remediation works. This is to allow for validation of the remediation targets.

The sampling should be completed using low flow sampling methods with a peristaltic style pump and assessed for water quality parameters (pH, dissolved oxygen (DO), oxidation-reduction potential (ORP), conductivity, temperature) via a suitable water multi parameter probe.

The water samples should be sent to an accredited laboratory for the following analysis:

- TPH CWG (to include BTEX), PAH and metals.

4.8 Regulatory Context

MPE would require a mobile treatment plant license as well as a discharge consent for processing and discharge the water to foul sewer. The system should not need an abstraction license for pumping the water from the ground.

Waste would have to be handled by appropriate handlers, spent carbon etc is considered a hazardous waste substance.

Wastes should be disposed of to a suitably licensed facility.

4.9 Unexpected Contamination

It may be the case that the remediation strategy requires amendment and update should additional sources be discovered during the phases of work proposed. In this event, consultation with the regulatory authorities will be sought to ensure compliance with the agreed and updated strategy.

5 ADDITIONAL WORKS

In addition to the proposed active remediation works, it should be noted that all stakeholders acknowledge that, despite the conclusions drawn in earlier sections of this report, the conceptual site model for the site concerning groundwater in particular to be limited in terms of available data.

It is therefore proposed that as the active remediation works progress that in order to further inform the design and implementation of the proposed DPE/MPE system, supplementary site investigation is undertaken.

5.1 Phase 1a: Supplementary intrusive site investigation

It is proposed that a supplementary intrusive site investigation is undertaken to better delineate the remaining contamination across the site by installing additional monitoring wells. The scope of the works will include the following:

- 6 shallow boreholes will be installed to a provisional final depth of approximately 6 metre below ground level (m bgl). Figure 3 shows the proposed shallow borehole locations.
- 1 deeper borehole will be installed to confirm the depth to the aquitard and establish the extent, or lack of, vertical migration of contamination. Figure 3 shows the proposed deeper borehole location.
- Groundwater sampling will be collected from the 7 new monitoring wells once they have been installed and have had a chance to settle; and the 3 existing monitoring wells already established on the site. Sampling will be completed using a bladder pump (or similar) and low flow cell due to the depth of the groundwater. Samples will be analysed for TPH CWG (to include BTEX), PAH and metals in line with existing testing.
- Three rounds of groundwater sampling will be completed over a period of three months at the 10 monitoring wells.

5.2 Water supply pipes

It is understood that concern has been raised with respect to the potential impact of hydrocarbons on water supply pipes both present and to be installed at the site.

Whilst this is outside the scope of this strategy and the works proposed to be conducted by RemedX, it is understood that a technical note, ref. 100404109 Issue B dated 27th May 2021, has been issued by Mott MacDonald in relation to water quality and vapour risk.

This technical note is provided in Appendix A, for reference.

5.3 Data analysis and refinement of conceptual site model

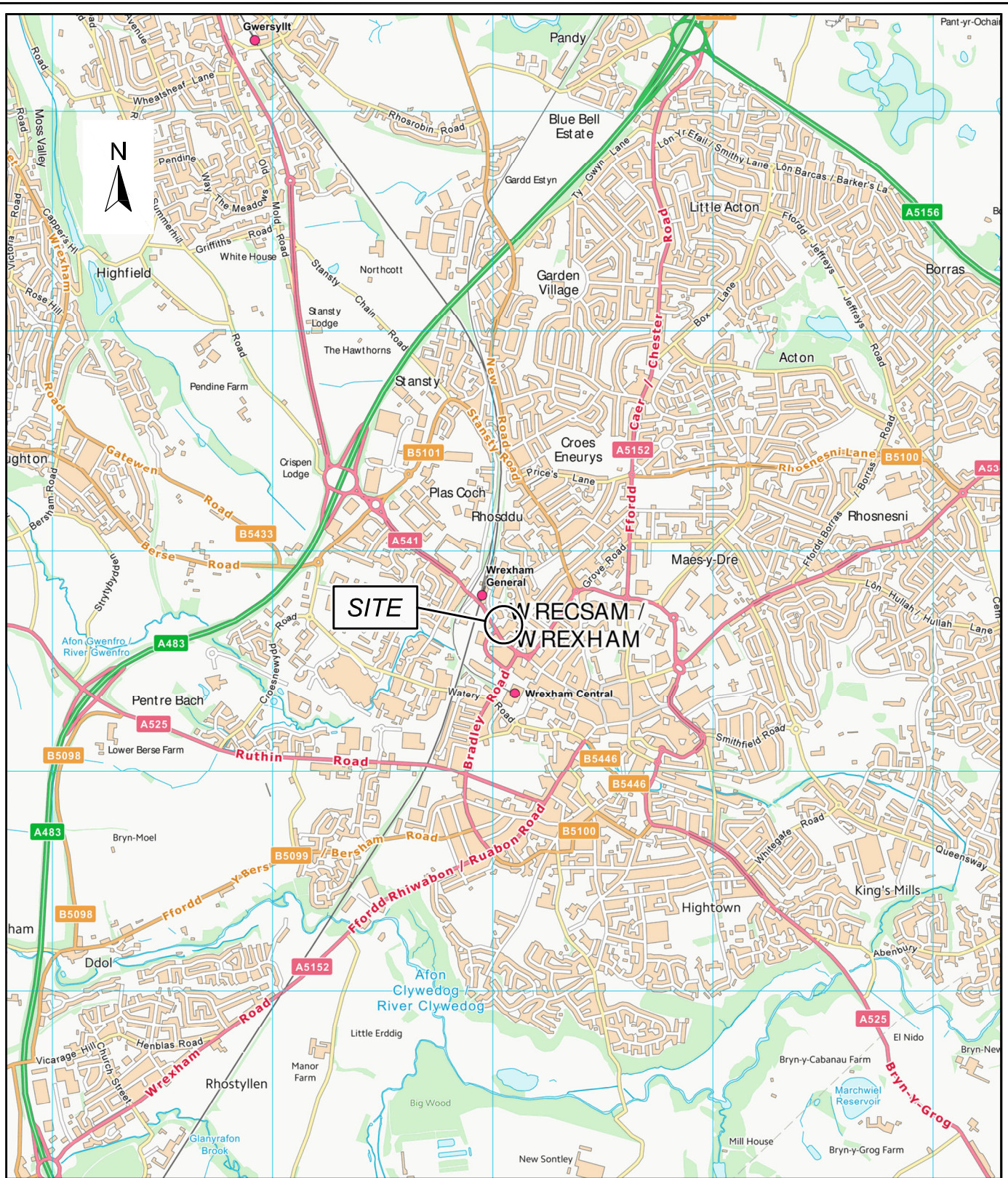
Following receipt of each round of groundwater analysis, it is proposed that a data review be undertaken to further inform both the conceptual site model and refine the proposed remedial approach to better target the residual groundwater contamination identified at the site, together with any additionally identified sources.

It is considered likely that a Detailed Quantitative Risk Assessment (DQRA) will be required to agree risk based target criteria for the purpose of determining the remedial

end point, with this work to be undertaken (by others) following completion of the additional works proposed within Section 5.0 of this report.

At each stage of the process, consultation with the regulatory authorities will be undertaken to ensure compliance with the approved RS and planning conditions.

FIGURES



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Client

Royal Mail Group

Project Title

Wrexham DO Rem Strat

Drawing Title

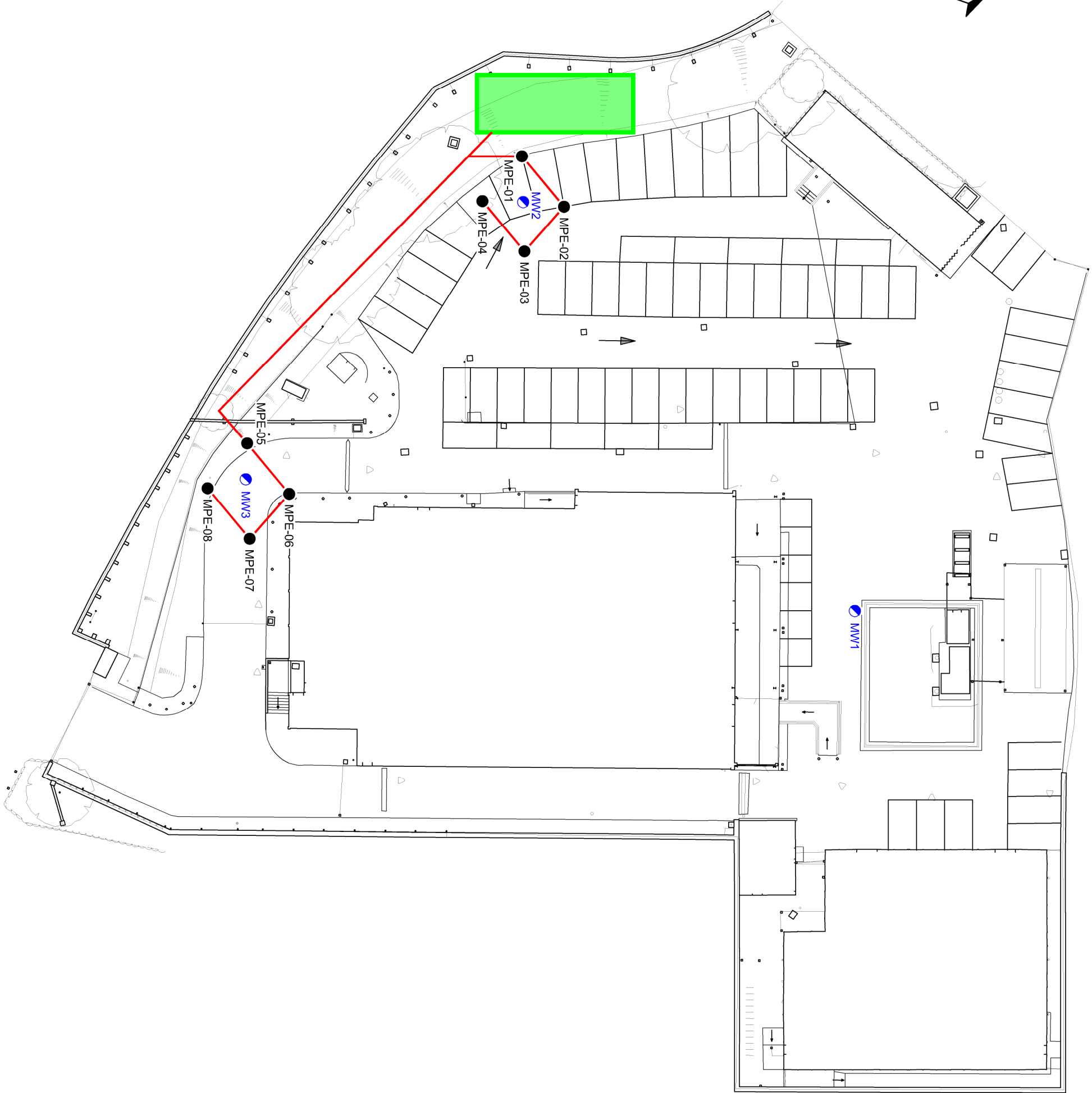
Site Location Map

Rev	Drawn	Date	Checked	Date	Approved	Date
00	MW	27.05.21	SC	27.05.21	PF	27.05.21
Dimensions		Scale		Original Size		
m		1:25,000		A4		

Project Number	Grid Ref
170995	SJ 330 506



Drawing Number
Figure 1



LEGEND

- Monitoring Well Location
- MPE Well
- Pipework
- MPE Treatment Area

00	27.05.2021	-	MW	SC	PF
Rev.	Date	Amendment	Drawn	Chkd.	Appd.

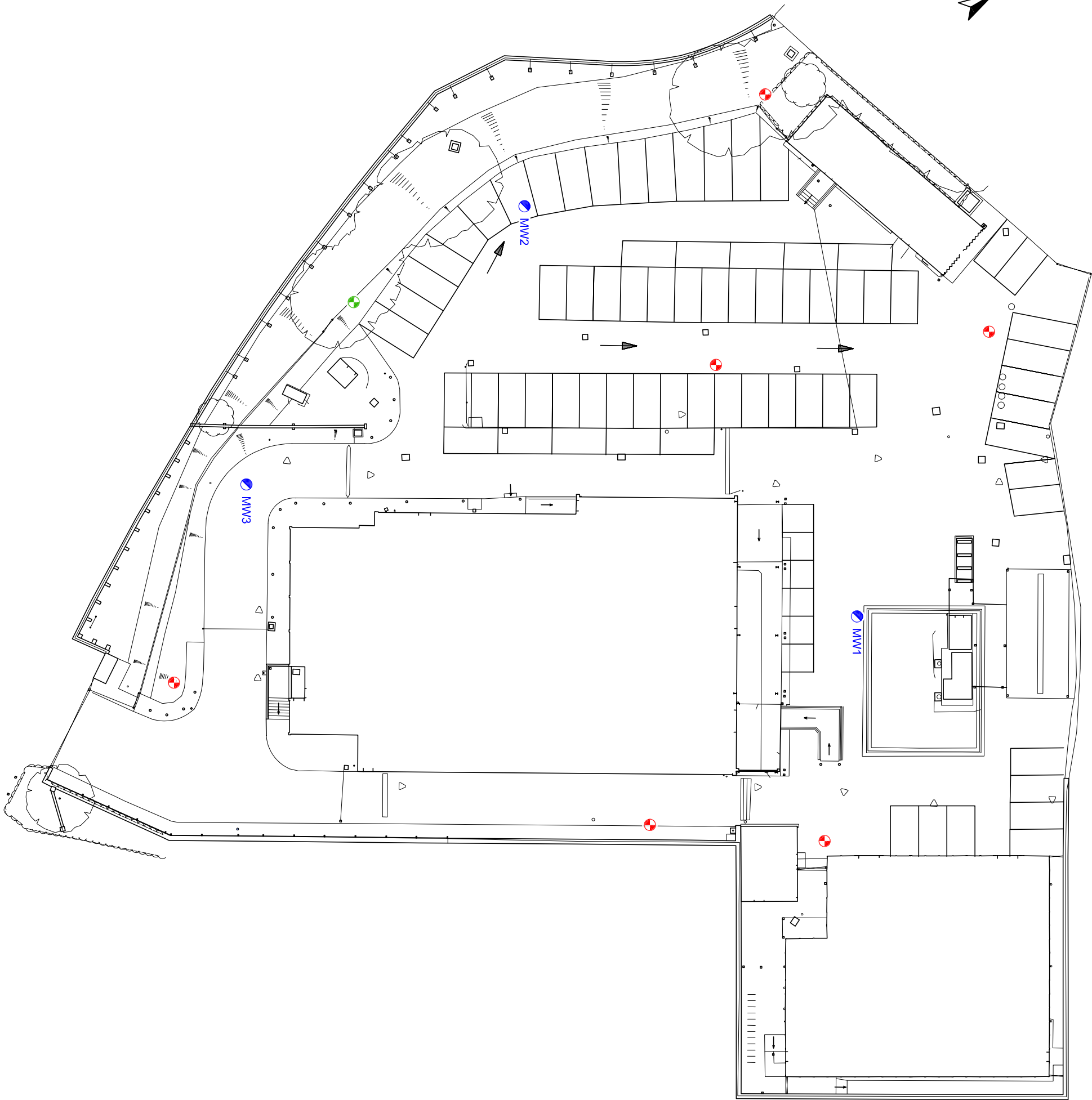


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Client	
Project Title	Wrexham DO Rem Strat

Drawing Title	Proposed Remediation Layout Plan				
Drawn	Date	Checked	Date	Approved	Date
MW	27.05.21	SC	27.05.21	PF	27.05.21
Dimensions	m	Scale	NTS	Original Size	A3
Project Number	170995	Drawing Number	Figure 2		
Drawing File	170995 - Fig 2 - rev 00 - PRLP	Rev	00		



LEGEND

- Monitoring Well Location
- Shallow Borehole Location
- Deep Borehole Location

00	11.05.2021	-	MW	SC	PF
Rev.	Date	Amendment	Drawn	Chkd.	Appd.



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Royal Mail Group

Wrexham DO Rem Strat

Proposed Supplementary
Site Investigation Locations Plan

Drawn	Date	Checked	Date	Approved	Date
MW	11.05.21	SC	11.05.21	PF	27.05.21
Dimensions	m	Scale	NTS	Original Size	A3
Project Number	170995	Drawing Number	Figure 3	Rev	00
Drawing File	170995 - Fig 3 - rev 00 - PSSILP				

APPENDIX A

Project:	Wrexham Delivery Office		
Our reference:	100404109 Issue B ¹	Your reference:	
Prepared by:	C Williams	Date:	27 May 2021
Approved by:	A Simpson	Checked by:	V Sin
Subject:	Review of human health risks from vapour inhalation		

1 Introduction

Plans have been submitted to Wrexham Council for alterations to the existing Post Office at Regent Street in Wrexham. Planning permission has been granted but is subject to pre-commencement planning conditions relating to contamination present within the underlying ground. This Note addresses the potential for risks to human health to arise from inhalation of vapours arising from petroleum hydrocarbon contamination of the underlying sediments and groundwater. This Note has been prepared as a supplement to "Discharge of planning conditions relating to contaminated land" prepared by Mott MacDonald in February 2021 and should be read in conjunction with that report which presents the background to the project which is not repeated here.

Ground investigations at the Wrexham Sorting Office undertaken by Core Geotechnics detected the presence of petroleum hydrocarbons within the underlying ground and groundwater. The source of this contamination is an underground fuel storage tank. This tank was used to store diesel fuel for use in mail delivery vehicles and was decommissioned in 2007. Further borehole installations were specified by Mott McDonald along the western site boundary to obtain groundwater samples for analysis.

2 Conceptual Site Model

The proposed development is an extension to the main sorting office to replace an existing building which will be demolished. The ground conditions beneath the site comprise several metres of granular Made Ground used to form a regulation layer over the natural glaciofluvial deposits (sands and gravels). The bedrock geology comprises the Etruria Formation which comprises mudstones. This stratum has not been encountered during any ground investigation. Groundwater is present within the glaciofluvial deposits and flow is towards the south-southeast to the River Gwenfro which is culverted beneath Wrexham centre.

This Note discusses risks arising from vapour inhalation within the proposed development and also considers the existing development which will remain in occupation. Vapours from volatile compounds can be generated from soil bound contamination and also from contaminants dissolved in groundwater or forming an immiscible layer on top of the groundwater (free product). These vapours can then migrate upwards and

¹ Issue B Covering assessment of risks to water supply pipe

enter buildings through gaps in foundations such as service entries. The contaminant linkage being considered is:

Fuel leaks from the UST (S2) → Vapour inhalation (P1) → Occupants of the development (R1)

The conceptual model for the site is discussed in detail in the main report (Section 2.1.1).

Not all hydrocarbon contaminants will be relevant when considering vapour inhalation pathways. The degree to which a chemical can enter the vapour phase is governed by its physico-chemical properties and the properties of the soil matrix. The CIRIA VOC Handbook² considers a substance to be volatile if its air-water partition coefficient (K_{aw}) is greater than 4×10^{-4} .

Additionally, risks to water supply pipes are considered. Where water pipes come into contact with hydrocarbon contaminated soils or are placed below the water table and groundwater is contaminated with hydrocarbons the hydrocarbons can permeate through the pipe and taint the supply. The permeation of hydrocarbons affects polyethylene (PE) and poly vinyl chloride (PVC) pipe materials. It is understood that the water supply to the site is provided by a high-density PE pipe.

² CIRIA C682 The VOCs Handbook. Investigating, assessing and managing risks from inhalation of VOCs at land affected by contamination.

3 Data Review

3.1 Soil

Core Geotechnics submitted soil samples for laboratory analysis for a range of contaminants including petroleum hydrocarbons. The results are summarised in Table 3.1. The Generic Assessment Criteria (GAC) selected are for a commercial end use. Criteria for a sandy loam soil with 1% soil organic matter have been chosen as a conservative assessment. Where analysis is not speciated and described as gasoline range (GRO), diesel range (DRO) or oil the lowest criteria of those speciated fractions included has been adopted. So, for DRO which covers the range C10 to C24 the lowest GAC is 9700mg/kg for Aliphatic C10-C12.

Table 3.1: Summary of Soil Quality

	Unit	GAC	WS01	WS01	WS02	WS02	WS03	WS03	WS03	WS03	WS04	WS04	WS04
		Depth (m)	0.3-0.6	0.8	0.5-0.8	0.9-1.0	0.6-1.0	1.5	3.0-4.0	4.0-5.0	0.6-0.7	0.8	2.7
Aliphatic EC 5-6	mg/kg	3200							<0.1				<0.01
Aliphatic EC >6-8	mg/kg	7800							11				<0.01
Aliphatic EC >8-10	mg/kg	2000							18				<0.01
Aliphatic EC >10-12	mg/kg	9700							390				<1.5
Aliphatic EC >12-16	mg/kg	59000							950				<1.2
Aliphatic EC >16-35	mg/kg	1600000							1260				<4.9
Aromatic EC 5-7	mg/kg	26000							0.02				<0.01
Aromatic EC >7-8	mg/kg	56000							5.7				<0.01
Aromatic EC >8-10	mg/kg	3500							57				<0.01
Aromatic EC >10-12	mg/kg	16000							59				<0.9
Aromatic EC >12-16	mg/kg	36000							240				<0.5
Aromatic EC >16-21	mg/kg	28000							290				<0.6
Aromatic EC >21-35	mg/kg	28000							84				<1.4
C05-C10 GRO	mg/kg	2000	0.2	<0.1	0.1		<0.1	<0.1			0.1		
C10-C24 DRO	mg/kg	9700	22	<10	390		<10	<10			<10		
C24-C40 Oil	mg/kg	28000	45	<10	390		<10	<10			<10		

	Unit	GAC	WS01	WS01	WS02	WS02	WS03	WS03	WS03	WS03	WS04	WS04	WS04
Acenaphthene	mg/kg	84000			1.7						<0.1	<0.1	
Acenaphthylene	mg/kg	83000			0.2						<0.1	<0.1	
Fluorene	mg/kg	63000			1.5						<0.1	<0.1	
Naphthalene	mg/kg	190	0.2	<0.1	0.1	<0.1	<0.1	<0.1			<0.1	<0.1	

None of the soil bound concentrations are present above thresholds protective of human health for a commercial end use. These generic thresholds are derived using the CLEA model³ which includes vapour inhalation.

3.2 Groundwater

Groundwater samples were obtained by Core Geotechnics from three boreholes during their ground investigation in September 2020. Three sets of samples have subsequently been obtained from the MW-Series monitoring wells constructed in February 2021 (Lab results are appended). The GAC used are those published by SoBRA⁴ for a commercial end use.

Table 3.2: Summary of Groundwater Quality

		Date	08/09/20	21/09/20	21/09/20	18/02/21	18/02/21	25/02/21	04/03/21	04/03/21	04/03/21	10/03/21	10/03/21	10/03/21
			WS04	WS01	WS02	MW1	MW2	MW3	MW1	MW2	MW3	MW1	MW2	MW3
GACgwap	Units													
Petroleum Hydrocarbons														
Aliphatic C5-C6	190,000	µg/l	<0.1	<0.1	<0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Aliphatic C6-C8	150,000	µg/l	<0.1	<0.1	<0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Aliphatic C8-C10	5700	µg/l	<0.1	<0.1	<0.1	< 0.1	64	< 0.1	< 0.1	< 0.1	320	< 0.1	< 0.1	< 0.1
Aliphatic C10-C12	3600	µg/l	170	<1.0	<1.0	< 1.0	3200	< 1.0	< 1.0	< 10.0	98	< 1.0	61	1200
Aromatic C5-C7	20,000,000	µg/l	<0.1	<0.1	<0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Aromatic C7-C8	21,000,000	µg/l	<0.1	<0.1	<0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1

³ Environment Agency Updated technical background to the CLEA model Science Report SCO50021/SR3

⁴ Society for Brownfield Risk Assessment Development of Generic Assessment Criteria for Assessing Vapour Risks to Human Health from Volatile Contaminants in Groundwater Ver 1.0 February 2017

			Date	08/09/20	21/09/20	21/09/20	18/02/21	18/02/21	25/02/21	04/03/21	04/03/21	04/03/21	10/03/21	10/03/21	10/03/21
				WS04	WS01	WS02	MW1	MW2	MW3	MW1	MW2	MW3	MW1	MW2	MW3
Aromatic C8-C10	190,000	µg/l		<0.1	<0.1	<0.1	< 0.1	93	< 0.1	< 0.1	< 0.1	340	< 0.1	< 0.1	< 0.1
Aromatic C10-C12	660,000	µg/l		8.8	<1.0	<1.0	< 1.0	1300	< 1.0	< 1.0	< 10.0	20	< 1.0	170	340
Aromatic C12-C16	3,700,000	µg/l		190	<1.0	<1.0	< 1.0	5600	< 1.0	< 1.0	98	640	< 1.0	940	2800
PAHs															
Naphthalene	23,000	µg/l				<0.1	< 0.05	< 0.50	3.7	< 0.05	< 0.50	0.81	< 0.05	< 0.05	< 0.05
Acenaphthylene	20,000,000	µg/l				<0.1	< 0.01	0.55	0.13	< 0.01	< 0.10	< 0.10	< 0.01	< 0.01	< 0.01
Acenaphthene	15,000,000	µg/l				0.01	< 0.01	0.95	0.22	< 0.01	< 0.10	< 0.10	< 0.01	< 0.01	< 0.01
Fluorene	18,000,000	µg/l				0.03	< 0.01	0.28	0.27	< 0.01	0.51	< 0.10	< 0.01	< 0.01	< 0.01

No concentrations exceed their assessment criterion.

4 Discussion

4.1 Vapour Risk

Ground investigations have indicated the presence of petroleum hydrocarbons within subsurface soils and as a dissolved phase in groundwater at the Wrexham Sorting Office. The proposed development of the site will comprise a new extension to an existing building. The development will be isolated from the underlying contamination by the floor slab and existing hard surfaced car park areas and so direct contact with any residual contamination will not be possible. However, there remains a risk that volatile components of the hydrocarbons present could enter the vapour phase from contamination sorbed onto soil particles and from dissolved phase in groundwater.

Soil bound concentrations of contaminants have been assessed against GAC derived using the CLEA model for a commercial end use. These criteria include the indoor and outdoor vapour inhalation pathway as well as other exposure pathways (direct contact and ingestion) and so provide a further level of conservatism. No soil bound concentrations of any volatile compound were found at concentrations in excess of their assessment criterion and it is considered that soil bound concentrations of contaminants do not present a significant risk to human health from the vapour inhalation pathway.

Dissolved phase concentrations of contaminants have been assessed against GAC_{gwvap} derived using the CLEA model for a commercial end use. These criteria include the indoor and outdoor vapour inhalation pathway. No dissolved phase concentrations of any volatile compound in groundwater were found at concentrations in excess of their assessment criterion and it is considered that dissolved phase concentrations of contaminants do not present a significant risk to human health from the vapour inhalation pathway.

4.2 Water Supply

The mains supply to the suite enters from the road and follows the access road down towards the main building (Figure 4.1).

Figure 4.1: Water Supply



Source: Extract from services drawing

The pipe is laid at a depth of 900mm below surface. Borehole MW3 is located on the bend in the access road and shows groundwater is some 2.8m below ground level. The supply pipe is approximately 1.9m above the water table and so would not be expected to come into contact with contaminated groundwater.

5 Conclusions

No further remedial action is required with regards to risks associated with vapour inhalation.

There are no risks associated with the existing water supply pipe from permeation of hydrocarbons.

A. Lab Results for Monitoring Wells MW1-3



Certificate of Analysis

Certificate Number 21-04829

Issued: 11-Mar-21

Client Dunelm Geotechnical & Environmental Ltd
Chambers Business Centre
Chapel Road
Oldham
OL8 4QQ

Our Reference 21-04829

Client Reference M948

Order No NW8082M948RB

Contract Title Wrexham Delivery Office

Description 3 Water samples.

Date Received 08-Mar-21

Date Started 08-Mar-21

Date Completed 11-Mar-21

Test Procedures Identified by prefix DETSn (details on request).

Notes Opinions and interpretations are outside the laboratory's scope of ISO 17025 accreditation. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced except in full, without the prior written approval of the laboratory.

Approved By

Adam Fenwick
Contracts Manager



2139

Summary of Chemical Analysis

Water Samples

Our Ref 21-04829

Client Ref M948

Contract Title Wrexham Delivery Office

Lab No	1813573	1813574	1813575
Sample ID	MW1	MW2	MW3
Depth			
Other ID			
Sample Type	EW	EW	EW
Sampling Date	04/03/2021	04/03/2021	04/03/2021
Sampling Time	n/s	n/s	n/s

Test	Method	LOD	Units			
Metals						
Arsenic, Dissolved	DETSC 2306	0.16	ug/l	0.45	0.65	1.1
Boron, Dissolved	DETSC 2306*	12	ug/l	13	63	34
Cadmium, Dissolved	DETSC 2306	0.03	ug/l	< 0.03	0.09	0.13
Calcium, Dissolved	DETSC 2306	0.09	mg/l	60	98	62
Chromium, Dissolved	DETSC 2306	0.25	ug/l	0.74	0.32	0.33
Copper, Dissolved	DETSC 2306	0.4	ug/l	2.9	1.5	2.6
Manganese, Dissolved	DETSC 2306	0.22	ug/l	34	140	1100
Mercury, Dissolved	DETSC 2306	0.01	ug/l	< 0.01	< 0.01	< 0.01
Nickel, Dissolved	DETSC 2306	0.5	ug/l	1.0	1.4	1.5
Zinc, Dissolved	DETSC 2306	1.3	ug/l	1.6	4.4	5.1
Inorganics						
pH	DETSC 2008		pH	6.9	6.9	7.2
Dissolved Organic Carbon	DETSC 2085	2	mg/l	4.4	< 2.0	4.3
Petroleum Hydrocarbons						
Aliphatic C5-C6	DETSC 3322	0.1	ug/l	< 0.1	< 0.1	< 0.1
Aliphatic C6-C8	DETSC 3322	0.1	ug/l	< 0.1	< 0.1	< 0.1
Aliphatic C8-C10	DETSC 3322	0.1	ug/l	< 0.1	< 0.1	320
Aliphatic C10-C12	DETSC 3072*	1	ug/l	< 1.0	< 10.0	98
Aliphatic C10-C44	DETSC 3072*	1	ug/l	< 1.0	410	4000
Aliphatic C12-C16	DETSC 3072*	1	ug/l	< 1.0	180	1600
Aliphatic C16-C21	DETSC 3072*	1	ug/l	< 1.0	180	1900
Aliphatic C21-C35	DETSC 3072*	1	ug/l	< 1.0	42	390
Aliphatic C35-C44	DETSC 3072*	1	ug/l	< 1.0	< 10.0	< 10.0
Aromatic C5-C7	DETSC 3322	0.1	ug/l	< 0.1	< 0.1	< 0.1
Aromatic C7-C8	DETSC 3322	0.1	ug/l	< 0.1	< 0.1	< 0.1
Aromatic C8-C10	DETSC 3322	0.1	ug/l	< 0.1	< 0.1	340
Aromatic C10-C12	DETSC 3072*	1	ug/l	< 1.0	< 10.0	20
Aromatic C12-C16	DETSC 3072*	1	ug/l	< 1.0	98	640
Aromatic C16-C21	DETSC 3072*	1	ug/l	< 1.0	210	1300
Aromatic C21-C35	DETSC 3072*	1	ug/l	< 1.0	85	610
Aromatic C35-C44	DETSC 3072*	1	ug/l	< 1.0	< 10.0	< 10.0
Aromatic C10-C44	DETSC 3072*	1	ug/l	< 1.0	390	2600
Ali/Aro C10-C44	DETSC 3072*	1	ug/l	< 1.0	800	6600
PAHs						
Naphthalene	DETSC 3304	0.05	ug/l	< 0.05	< 0.50	0.81
Acenaphthylene	DETSC 3304	0.01	ug/l	< 0.01	< 0.10	< 0.10
Acenaphthene	DETSC 3304	0.01	ug/l	< 0.01	< 0.10	< 0.10
Fluorene	DETSC 3304	0.01	ug/l	< 0.01	0.51	< 0.10
Phenanthrene	DETSC 3304	0.01	ug/l	< 0.01	0.17	0.78
Anthracene	DETSC 3304	0.01	ug/l	0.01	0.16	0.70
Fluoranthene	DETSC 3304	0.01	ug/l	0.08	0.14	0.65

Summary of Chemical Analysis

Water Samples

Our Ref 21-04829

Client Ref M948

Contract Title Wrexham Delivery Office

Lab No	1813573	1813574	1813575
Sample ID	MW1	MW2	MW3
Depth			
Other ID			
Sample Type	EW	EW	EW
Sampling Date	04/03/2021	04/03/2021	04/03/2021
Sampling Time	n/s	n/s	n/s

Test	Method	LOD	Units			
Pyrene	DETSC 3304	0.01	ug/l	0.09	0.19	0.46
Benzo(a)anthracene	DETSC 3304	0.01	ug/l	0.02	< 0.10	0.16
Chrysene	DETSC 3304	0.01	ug/l	0.02	0.14	0.29
Benzo(b)fluoranthene	DETSC 3304	0.01	ug/l	0.03	0.18	0.18
Benzo(k)fluoranthene	DETSC 3304	0.01	ug/l	0.01	0.14	0.16
Benzo(a)pyrene	DETSC 3304	0.01	ug/l	0.02	< 0.10	< 0.10
Indeno(1,2,3-c,d)pyrene	DETSC 3304	0.01	ug/l	0.01	< 0.10	< 0.10
Dibenzo(a,h)anthracene	DETSC 3304	0.01	ug/l	< 0.01	< 0.10	< 0.10
Benzo(g,h,i)perylene	DETSC 3304	0.01	ug/l	0.02	< 0.10	< 0.10
PAH Total	DETSC 3304	0.2	ug/l	0.36	< 2.00	4.2

Information in Support of the Analytical Results

Our Ref 21-04829
Client Ref M948
Contract Wrexham Delivery Office

Containers Received & Deviating Samples

Lab No	Sample ID	Date		Containers Received	Holding time exceeded for tests	Inappropriate container for tests
		Sampled				
1813573	MW1 WATER	04/03/21		GB 1L, GV	pH/Cond/TDS (1 days)	
1813574	MW2 WATER	04/03/21		GV, PB 1L	pH/Cond/TDS (1 days)	
1813575	MW3 WATER	04/03/21		GV, PB 1L	pH/Cond/TDS (1 days)	

Key: G-Glass B-Bottle V-Vial P-Plastic

DETS cannot be held responsible for the integrity of samples received whereby the laboratory did not undertake the sampling. In this instance samples received may be deviating. Deviating Sample criteria are based on British and International standards and laboratory trials in conjunction with the UKAS note 'Guidance on Deviating Samples'. All samples received are listed above. However, those samples that have additional comments in relation to hold time, inappropriate containers etc are deviating due to the reasons stated. This means that the analysis is accredited where applicable, but results may be compromised due to sample deviations. If no sampled date (soils) or date+time (waters) has been supplied then samples are deviating. However, if you are able to supply a sampled date (and time for waters) this will prevent samples being reported as deviating where specific hold times are not exceeded and where the container supplied is suitable.

Disposal

From the issue date of this test certificate, samples will be held for the following times prior to disposal :-
Soils - 1 month, Liquids - 2 weeks, Asbestos (test portion) - 6 months

End of Report



Certificate of Analysis

Certificate Number 21-05249

Issued: 17-Mar-21

Client Dunelm Geotechnical & Environmental Ltd
Chambers Business Centre
Chapel Road
Oldham
OL8 4QQ

Our Reference 21-05249

Client Reference M948

Order No NW8082M948RB

Contract Title Wrexham Delivery Office

Description 3 Water samples.

Date Received 12-Mar-21

Date Started 12-Mar-21

Date Completed 17-Mar-21

Test Procedures Identified by prefix DETSn (details on request).

Notes Opinions and interpretations are outside the laboratory's scope of ISO 17025 accreditation. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced except in full, without the prior written approval of the laboratory.

Approved By

Adam Fenwick
Contracts Manager



Summary of Chemical Analysis

Water Samples

Our Ref 21-05249

Client Ref M948

Contract Title Wrexham Delivery Office

Lab No	1816220	1816221	1816222
Sample ID	MW1	MW2	MW3
Depth			
Other ID			
Sample Type	WATER	WATER	WATER
Sampling Date	10/03/2021	10/03/2021	10/03/2021
Sampling Time	n/s	n/s	n/s

Test	Method	LOD	Units			
Metals						
Arsenic, Dissolved	DETSC 2306	0.16	ug/l	0.61	0.57	2.3
Boron, Dissolved	DETSC 2306*	12	ug/l	38	55	39
Cadmium, Dissolved	DETSC 2306	0.03	ug/l	0.05	0.11	0.61
Calcium, Dissolved	DETSC 2306	0.09	mg/l	79	110	130
Chromium, Dissolved	DETSC 2306	0.25	ug/l	2.5	1.1	1.0
Copper, Dissolved	DETSC 2306	0.4	ug/l	4.0	3.8	6.3
Manganese, Dissolved	DETSC 2306	0.22	ug/l	42	150	1100
Mercury, Dissolved	DETSC 2306	0.01	ug/l	< 0.01	< 0.01	0.01
Nickel, Dissolved	DETSC 2306	0.5	ug/l	1.3	2.5	2.5
Zinc, Dissolved	DETSC 2306	1.3	ug/l	3.5	6.4	9.4
Inorganics						
pH	DETSC 2008		pH	7.7	7.7	7.5
Dissolved Organic Carbon	DETSC 2085	2	mg/l	6.0	2.1	3.2
Petroleum Hydrocarbons						
Aliphatic C5-C6	DETSC 3322	0.1	ug/l	< 0.1	< 0.1	< 0.1
Aliphatic C6-C8	DETSC 3322	0.1	ug/l	< 0.1	< 0.1	< 0.1
Aliphatic C8-C10	DETSC 3322	0.1	ug/l	< 0.1	< 0.1	< 0.1
Aliphatic C10-C12	DETSC 3072*	1	ug/l	< 1.0	61	1200
Aliphatic C10-C44	DETSC 3072*	1	ug/l	< 1.0	750	16000
Aliphatic C12-C16	DETSC 3072*	1	ug/l	< 1.0	310	6400
Aliphatic C16-C21	DETSC 3072*	1	ug/l	< 1.0	320	6400
Aliphatic C21-C35	DETSC 3072*	1	ug/l	< 1.0	58	1700
Aliphatic C35-C44	DETSC 3072*	1	ug/l	< 1.0	< 1.0	< 1.0
Aromatic C5-C7	DETSC 3322	0.1	ug/l	< 0.1	< 0.1	< 0.1
Aromatic C7-C8	DETSC 3322	0.1	ug/l	< 0.1	< 0.1	< 0.1
Aromatic C8-C10	DETSC 3322	0.1	ug/l	< 0.1	< 0.1	< 0.1
Aromatic C10-C12	DETSC 3072*	1	ug/l	< 1.0	170	340
Aromatic C12-C16	DETSC 3072*	1	ug/l	< 1.0	940	2800
Aromatic C16-C21	DETSC 3072*	1	ug/l	6.3	1200	4900
Aromatic C21-C35	DETSC 3072*	1	ug/l	1.7	290	1800
Aromatic C35-C44	DETSC 3072*	1	ug/l	< 1.0	< 1.0	2.7
Aromatic C10-C44	DETSC 3072*	1	ug/l	8.2	2600	9800
Ali/Aro C10-C44	DETSC 3072*	1	ug/l	8.2	3300	26000
PAHs						
Naphthalene	DETSC 3304	0.05	ug/l	< 0.05	< 0.05	< 0.05
Acenaphthylene	DETSC 3304	0.01	ug/l	< 0.01	< 0.01	< 0.01
Acenaphthene	DETSC 3304	0.01	ug/l	< 0.01	< 0.01	< 0.01
Fluorene	DETSC 3304	0.01	ug/l	< 0.01	< 0.01	< 0.01
Phenanthrene	DETSC 3304	0.01	ug/l	0.02	< 0.01	< 0.01
Anthracene	DETSC 3304	0.01	ug/l	< 0.01	< 0.01	< 0.01
Fluoranthene	DETSC 3304	0.01	ug/l	0.09	< 0.01	< 0.01
Pyrene	DETSC 3304	0.01	ug/l	0.11	< 0.01	< 0.01

Summary of Chemical Analysis

Water Samples

Our Ref 21-05249

Client Ref M948

Contract Title Wrexham Delivery Office

Lab No	1816220	1816221	1816222
Sample ID	MW1	MW2	MW3
Depth			
Other ID			
Sample Type	WATER	WATER	WATER
Sampling Date	10/03/2021	10/03/2021	10/03/2021
Sampling Time	n/s	n/s	n/s

Test	Method	LOD	Units			
Benzo(a)anthracene	DETSC 3304	0.01	ug/l	0.02	< 0.01	< 0.01
Chrysene	DETSC 3304	0.01	ug/l	0.02	< 0.01	< 0.01
Benzo(b)fluoranthene	DETSC 3304	0.01	ug/l	< 0.01	< 0.01	< 0.01
Benzo(k)fluoranthene	DETSC 3304	0.01	ug/l	< 0.01	< 0.01	< 0.01
Benzo(a)pyrene	DETSC 3304	0.01	ug/l	< 0.01	< 0.01	< 0.01
Indeno(1,2,3-c,d)pyrene	DETSC 3304	0.01	ug/l	< 0.01	< 0.01	< 0.01
Dibenzo(a,h)anthracene	DETSC 3304	0.01	ug/l	< 0.01	< 0.01	< 0.01
Benzo(g,h,i)perylene	DETSC 3304	0.01	ug/l	< 0.01	< 0.01	< 0.01
PAH Total	DETSC 3304	0.2	ug/l	0.27	< 0.20	< 0.20

Information in Support of the Analytical Results

Our Ref 21-05249
 Client Ref M948
 Contract Wrexham Delivery Office

Containers Received & Deviating Samples

Lab No	Sample ID	Date		Holding time exceeded for tests	Inappropriate container for tests
		Sampled	Containers Received		
1816220	MW1 WATER	10/03/21	GB 1L, GV, PB 1L	pH/Cond/TDS (1 days)	
1816221	MW2 WATER	10/03/21	GB 1L, GV, PB 1L	pH/Cond/TDS (1 days)	
1816222	MW3 WATER	10/03/21	GB 1L, GV, PB 1L	pH/Cond/TDS (1 days)	

Key: G-Glass P-Plastic B-Bottle V-Vial

DETS cannot be held responsible for the integrity of samples received whereby the laboratory did not undertake the sampling. In this instance samples received may be deviating. Deviating Sample criteria are based on British and International standards and laboratory trials in conjunction with the UKAS note 'Guidance on Deviating Samples'. All samples received are listed above. However, those samples that have additional comments in relation to hold time, inappropriate containers etc are deviating due to the reasons stated. This means that the analysis is accredited where applicable, but results may be compromised due to sample deviations. If no sampled date (soils) or date+time (waters) has been supplied then samples are deviating. However, if you are able to supply a sampled date (and time for waters) this will prevent samples being reported as deviating where specific hold times are not exceeded and where the container supplied is suitable.

Disposal

From the issue date of this test certificate, samples will be held for the following times prior to disposal :-

Soils - 1 month, Liquids - 2 weeks, Asbestos (test portion) - 6 months

End of Report



Certificate of Analysis

Certificate Number 21-04246

Issued: 04-Mar-21

Client Dunelm Geotechnical & Environmental Ltd
Chambers Business Centre
Chapel Road
Oldham
OL8 4QQ

Our Reference 21-04246

Client Reference M948

Order No NW8082M948RB

Contract Title Wrexham Delivery Office

Description One Water sample.

Date Received 01-Mar-21

Date Started 01-Mar-21

Date Completed 04-Mar-21

Test Procedures Identified by prefix DETSn (details on request).

Notes Opinions and interpretations are outside the laboratory's scope of ISO 17025 accreditation. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced except in full, without the prior written approval of the laboratory.

Approved By

Adam Fenwick
Contracts Manager



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Summary of Chemical Analysis

Water Samples

Our Ref 21-04246

Client Ref M948

Contract Title Wrexham Delivery Office

Lab No	1808926
Sample ID	MW3
Depth	6.00
Other ID	
Sample Type	EW
Sampling Date	25/02/2021
Sampling Time	n/s

Test	Method	LOD	Units	
Metals				
Arsenic, Dissolved	DETSC 2306	0.16	ug/l	0.59
Boron, Dissolved	DETSC 2306*	12	ug/l	46
Cadmium, Dissolved	DETSC 2306	0.03	ug/l	0.32
Calcium, Dissolved	DETSC 2306	0.09	mg/l	91
Chromium, Dissolved	DETSC 2306	0.25	ug/l	0.52
Copper, Dissolved	DETSC 2306	0.4	ug/l	2.8
Manganese, Dissolved	DETSC 2306	0.22	ug/l	1700
Mercury, Dissolved	DETSC 2306	0.01	ug/l	0.02
Nickel, Dissolved	DETSC 2306	0.5	ug/l	2.9
Zinc, Dissolved	DETSC 2306	1.3	ug/l	15
Inorganics				
pH	DETSC 2008		pH	7.3
Dissolved Organic Carbon	DETSC 2085	2	mg/l	4.3
Petroleum Hydrocarbons				
Aliphatic C5-C6	DETSC 3322	0.1	ug/l	< 0.1
Aliphatic C6-C8	DETSC 3322	0.1	ug/l	< 0.1
Aliphatic C8-C10	DETSC 3322	0.1	ug/l	< 0.1
Aliphatic C10-C12	DETSC 3072*	1	ug/l	< 1.0
Aliphatic C10-C44	DETSC 3072*	1	ug/l	< 1.0
Aliphatic C12-C16	DETSC 3072*	1	ug/l	< 1.0
Aliphatic C16-C21	DETSC 3072*	1	ug/l	< 1.0
Aliphatic C21-C35	DETSC 3072*	1	ug/l	< 1.0
Aliphatic C35-C44	DETSC 3072*	1	ug/l	< 1.0
Aromatic C5-C7	DETSC 3322	0.1	ug/l	< 0.1
Aromatic C7-C8	DETSC 3322	0.1	ug/l	< 0.1
Aromatic C8-C10	DETSC 3322	0.1	ug/l	< 0.1
Aromatic C10-C12	DETSC 3072*	1	ug/l	< 1.0
Aromatic C12-C16	DETSC 3072*	1	ug/l	< 1.0
Aromatic C16-C21	DETSC 3072*	1	ug/l	< 1.0
Aromatic C21-C35	DETSC 3072*	1	ug/l	< 1.0
Aromatic C35-C44	DETSC 3072*	1	ug/l	< 1.0
Aromatic C10-C44	DETSC 3072*	1	ug/l	< 1.0
Ali/Aro C10-C44	DETSC 3072*	1	ug/l	< 1.0
PAHs				
Naphthalene	DETSC 3304	0.05	ug/l	3.7
Acenaphthylene	DETSC 3304	0.01	ug/l	0.13
Acenaphthene	DETSC 3304	0.01	ug/l	0.22
Fluorene	DETSC 3304	0.01	ug/l	0.27
Phenanthrene	DETSC 3304	0.01	ug/l	0.28
Anthracene	DETSC 3304	0.01	ug/l	0.04
Fluoranthene	DETSC 3304	0.01	ug/l	0.07

Summary of Chemical Analysis

Water Samples

Our Ref 21-04246

Client Ref M948

Contract Title Wrexham Delivery Office

Lab No	1808926
Sample ID	MW3
Depth	6.00
Other ID	
Sample Type	EW
Sampling Date	25/02/2021
Sampling Time	n/s

Test	Method	LOD	Units	
Pyrene	DETSC 3304	0.01	ug/l	0.04
Benzo(a)anthracene	DETSC 3304	0.01	ug/l	< 0.01
Chrysene	DETSC 3304	0.01	ug/l	< 0.01
Benzo(b)fluoranthene	DETSC 3304	0.01	ug/l	< 0.01
Benzo(k)fluoranthene	DETSC 3304	0.01	ug/l	< 0.01
Benzo(a)pyrene	DETSC 3304	0.01	ug/l	< 0.01
Indeno(1,2,3-c,d)pyrene	DETSC 3304	0.01	ug/l	< 0.01
Dibenzo(a,h)anthracene	DETSC 3304	0.01	ug/l	< 0.01
Benzo(g,h,i)perylene	DETSC 3304	0.01	ug/l	< 0.01
PAH Total	DETSC 3304	0.2	ug/l	4.8

Information in Support of the Analytical Results

Our Ref 21-04246
Client Ref M948
Contract Wrexham Delivery Office

Containers Received & Deviating Samples

Lab No	Sample ID	Date		Containers Received	Holding time exceeded for tests	Inappropriate container for tests
		Sampled				
1808926	MW3 6.00 WATER	25/02/21		GB 1L, GV, PB 1L	pH/Cond/TDS (1 days)	
Key: G-Glass P-Plastic B-Bottle V-Vial DETS cannot be held responsible for the integrity of samples received whereby the laboratory did not undertake the sampling. In this instance samples received may be deviating. Deviating Sample criteria are based on British and International standards and laboratory trials in conjunction with the UKAS note 'Guidance on Deviating Samples'. All samples received are listed above. However, those samples that have additional comments in relation to hold time, inappropriate containers etc are deviating due to the reasons stated. This means that the analysis is accredited where applicable, but results may be compromised due to sample deviations. If no sampled date (soils) or date+time (waters) has been supplied then samples are deviating. However, if you are able to supply a sampled date (and time for waters) this will prevent samples being reported as deviating where specific hold times are not exceeded and where the container supplied is suitable.						

Disposal

From the issue date of this test certificate, samples will be held for the following times prior to disposal :- Soils - 1 month, Liquids - 2 weeks, Asbestos (test portion) - 6 months

End of Report



Certificate of Analysis

Certificate Number 21-03799

Issued: 01-Mar-21

Client Dunelm Geotechnical & Environmental Ltd
Chambers Business Centre
Chapel Road
Oldham
OL8 4QQ

Our Reference 21-03799

Client Reference M948

Order No NW8082M948RB

Contract Title Wrexham Delivery Office

Description 2 Water samples.

Date Received 23-Feb-21

Date Started 23-Feb-21

Date Completed 01-Mar-21

Test Procedures Identified by prefix DETSn (details on request).

Notes Opinions and interpretations are outside the laboratory's scope of ISO 17025 accreditation. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced except in full, without the prior written approval of the laboratory.

Approved By

Adam Fenwick
Contracts Manager



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Summary of Chemical Analysis

Water Samples

Our Ref 21-03799

Client Ref M948

Contract Title Wrexham Delivery Office

Lab No	1806093	1806094
Sample ID	MW1	MW2
Depth	6.00	6.00
Other ID		
Sample Type	EW	EW
Sampling Date	18/02/2021	18/02/2021
Sampling Time	n/s	n/s

Test	Method	LOD	Units		
Metals					
Arsenic, Dissolved	DETSC 2306	0.16	ug/l	< 0.16	0.37
Boron, Dissolved	DETSC 2306*	12	ug/l	< 12	63
Cadmium, Dissolved	DETSC 2306	0.03	ug/l	< 0.03	< 0.03
Calcium, Dissolved	DETSC 2306	0.09	mg/l	68	95
Chromium, Dissolved	DETSC 2306	0.25	ug/l	0.66	< 0.25
Copper, Dissolved	DETSC 2306	0.4	ug/l	1.1	0.6
Manganese, Dissolved	DETSC 2306	0.22	ug/l	99	560
Mercury, Dissolved	DETSC 2306	0.01	ug/l	< 0.01	< 0.01
Nickel, Dissolved	DETSC 2306	0.5	ug/l	< 0.5	1.4
Zinc, Dissolved	DETSC 2306	1.3	ug/l	4.1	4.0
Inorganics					
pH	DETSC 2008		pH	7.5	7.2
Dissolved Organic Carbon	DETSC 2085	2	mg/l	2.3	< 2.0
Petroleum Hydrocarbons					
Aliphatic C5-C6	DETSC 3322	0.1	ug/l	< 0.1	< 0.1
Aliphatic C6-C8	DETSC 3322	0.1	ug/l	< 0.1	< 0.1
Aliphatic C8-C10	DETSC 3322	0.1	ug/l	< 0.1	64
Aliphatic C10-C12	DETSC 3072*	1	ug/l	< 1.0	3200
Aliphatic C10-C44	DETSC 3072*	1	ug/l	< 1.0	22000
Aliphatic C12-C16	DETSC 3072*	1	ug/l	< 1.0	9600
Aliphatic C16-C21	DETSC 3072*	1	ug/l	< 1.0	8100
Aliphatic C21-C35	DETSC 3072*	1	ug/l	33	1400
Aliphatic C35-C44	DETSC 3072*	1	ug/l	< 1.0	< 1.0
Aromatic C5-C7	DETSC 3322	0.1	ug/l	< 0.1	< 0.1
Aromatic C7-C8	DETSC 3322	0.1	ug/l	< 0.1	< 0.1
Aromatic C8-C10	DETSC 3322	0.1	ug/l	< 0.1	93
Aromatic C10-C12	DETSC 3072*	1	ug/l	< 1.0	1300
Aromatic C12-C16	DETSC 3072*	1	ug/l	< 1.0	5600
Aromatic C16-C21	DETSC 3072*	1	ug/l	< 1.0	5800
Aromatic C21-C35	DETSC 3072*	1	ug/l	< 1.0	1100
Aromatic C35-C44	DETSC 3072*	1	ug/l	< 1.0	< 1.0
Aromatic C10-C44	DETSC 3072*	1	ug/l	< 1.0	14000
Ali/Aro C10-C44	DETSC 3072*	1	ug/l	< 1.0	37000
PAHs					
Naphthalene	DETSC 3304	0.05	ug/l	< 0.05	< 0.50
Acenaphthylene	DETSC 3304	0.01	ug/l	< 0.01	0.55
Acenaphthene	DETSC 3304	0.01	ug/l	< 0.01	0.95
Fluorene	DETSC 3304	0.01	ug/l	< 0.01	0.28
Phenanthrene	DETSC 3304	0.01	ug/l	0.01	< 0.10
Anthracene	DETSC 3304	0.01	ug/l	< 0.01	< 0.10
Fluoranthene	DETSC 3304	0.01	ug/l	0.07	0.76

Summary of Chemical Analysis

Water Samples

Our Ref 21-03799

Client Ref M948

Contract Title Wrexham Delivery Office

Lab No	1806093	1806094
Sample ID	MW1	MW2
Depth	6.00	6.00
Other ID		
Sample Type	EW	EW
Sampling Date	18/02/2021	18/02/2021
Sampling Time	n/s	n/s

Test	Method	LOD	Units		
Pyrene	DETSC 3304	0.01	ug/l	0.08	1.3
Benzo(a)anthracene	DETSC 3304	0.01	ug/l	0.03	0.33
Chrysene	DETSC 3304	0.01	ug/l	0.03	0.55
Benzo(b)fluoranthene	DETSC 3304	0.01	ug/l	0.05	0.11
Benzo(k)fluoranthene	DETSC 3304	0.01	ug/l	0.02	< 0.10
Benzo(a)pyrene	DETSC 3304	0.01	ug/l	0.04	< 0.10
Indeno(1,2,3-c,d)pyrene	DETSC 3304	0.01	ug/l	0.04	< 0.10
Dibenzo(a,h)anthracene	DETSC 3304	0.01	ug/l	< 0.01	< 0.10
Benzo(g,h,i)perylene	DETSC 3304	0.01	ug/l	0.05	< 0.10
PAH Total	DETSC 3304	0.2	ug/l	0.46	4.8

Information in Support of the Analytical Results

Our Ref 21-03799
 Client Ref M948
 Contract Wrexham Delivery Office

Containers Received & Deviating Samples

Lab No	Sample ID	Date Sampled	Containers Received	Holding time exceeded for tests	Inappropriate container for tests
1806093	MW1 6.00 WATER	18/02/21	GB 1L, GV, PB 1L	Aliphatics/Aromatics (4 days), pH/Cond/TDS (1 days), PAH MS (4 days)	
1806094	MW2 6.00 WATER	18/02/21	GB 1L, GV, PB 1L	Aliphatics/Aromatics (4 days), pH/Cond/TDS (1 days), PAH MS (4 days)	

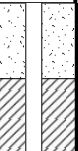
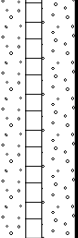
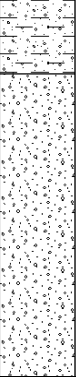
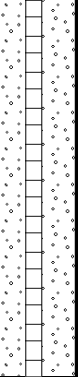
Key: G-Glass P-Plastic B-Bottle V-Vial

DETS cannot be held responsible for the integrity of samples received whereby the laboratory did not undertake the sampling. In this instance samples received may be deviating. Deviating Sample criteria are based on British and International standards and laboratory trials in conjunction with the UKAS note 'Guidance on Deviating Samples'. All samples received are listed above. However, those samples that have additional comments in relation to hold time, inappropriate containers etc are deviating due to the reasons stated. This means that the analysis is accredited where applicable, but results may be compromised due to sample deviations. If no sampled date (soils) or date+time (waters) has been supplied then samples are deviating. However, if you are able to supply a sampled date (and time for waters) this will prevent samples being reported as deviating where specific hold times are not exceeded and where the container supplied is suitable.

Disposal

From the issue date of this test certificate, samples will be held for the following times prior to disposal :-
 Soils - 1 month, Liquids - 2 weeks, Asbestos (test portion) - 6 months

End of Report

				BOREHOLE RECORD				Borehole MW1				
Contract No: M948				Site: Wrexham Delivery Office				GL (m AOD) 82.24		Scale 1:50		
						Easting: 333071.60		Northing: 350684.70				
Client: Bowmer & Kirkland Ltd						Driller: MH		Logged By: JM		Sheet 1 of 1		
Method: Cable Percussive Boring						Checked By: RB		Dates:		18/02/2021 - 19/02/2021		
SAMPLE DETAILS			(Casing) Groundwater	STRATA RECORD Description	Depth (m)	Level (m AOD)	Legend	Well/ Backfill				
Type	Depth From-To (m)	Insitu Testing										
ES	0.50		1 18/02/2021 1700 (0.00) Dry 19/02/2021 0800 (0.00) Dry	MADE GROUND: Black macadam. MADE GROUND: Yellowish brown and light grey sandy gravel with a medium cobble and/or boulder content. Gravel is angular to subangular fine to coarse of sandstone. Cobbles are angular of sandstone.	(0.10) 0.10	82.14						
ES	1.00				(1.40)							
ES	2.00		2	MADE GROUND: Brown slightly clayey sandy gravel. Gravel is angular to subrounded fine to coarse of sandstone, limestone and quartzite.	1.50	80.74						
ES	3.00		3	Very soft brown sandy gravelly CLAY. Gravel is subangular to rounded fine to coarse of sandstone, limestone, siltstone and quartzite. 3.00-4.00m: Slightly oily sheen noted, no odour.	3.00 (1.00)	79.24						
ES	4.00		4	Brown and grey fine to coarse SAND and GRAVEL. Gravel is subangular to rounded fine to medium of sandstone, siltstone, limestone and quartzite.	4.00	78.24						
ES	5.00		5		(2.00)							
ES	6.00		6 19/02/2021 1700 (6.00) 5.50	End of Borehole at 6.00 m	6.00	76.24						
			7									
			8									
			9									
			10									
Ground Water (m)					Chiselling / Hard Strata		Casing Depths		Hole Diameter		General Remarks 1. Hand dug inspection pit to 1.20m.	
Depth Struck (m)	Casing Depth (m)	Water Level	Minutes	Water sealed (m)	From (m)	To (m)	Time (hr)	Diameter (mm)	Depth (m)	Diameter (mm)		Depth (m)
3.50		3.50	0							150		6.00
5.50		5.50	20									
Log last updated 04/03/2021												



Borehole MW2

Site: Wrexham Delivery Office

GL (m AOD)	Scale 1:50
83.56	
Easting:	Northing:
333025.80	350672.40

Driller: MH

Logged By: JM

Sheet 1 of 1

Checked By: RB

Dates:	18/02/2021
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SAMPLE DETAILS			(Casing) Groundwater	STRATA RECORD Description	Depth (m)	Level (m AOD)	Legend	Well/ Backfill
Type	Depth From-To (m)	Insitu Testing						
ES	0.50			MADE GROUND: Black macadam. MADE GROUND: Grey slightly sandy gravel. Gravel is angular to subangular fine to medium of limestone.	(0.10) 0.10 (0.50)	83.46		
ES	1.00		1	MADE GROUND: Brown and grey clayey sandy gravel. Gravel is angular to subrounded fine to coarse of limestone, brick, sandstone and siltstone.	0.60	82.96		
ES	2.00		2		(3.40)			
ES	3.00		3					
ES	4.00		4	Brown slightly clayey sandy GRAVEL. Gravel is subangular to rounded fine to coarse of sandstone, siltstone, limestone and quartzite. <i>At 4.00m: Strong hydrocarbon odour noted. Slightly clayey slightly sandy with low cobble content.</i>	4.00	79.56		
ES	5.00		5		(1.80)			
ES	6.00		6	Firm brown sandy gravelly CLAY. Gravel is subangular to rounded fine to coarse of sandstone, siltstone, limestone and quartzite.	5.80 (0.20) 6.00	77.76 77.56		
			7	End of Borehole at 6.00 m				
			8					
			9					
			10					

Ground Water (m)					Chiselling / Hard Strata			Casing Depths		Hole Diameter		General Remarks
Depth Struck (m)	Casing Depth (m)	Water Level	Minutes	Water sealed (m)	From (m)	To (m)	Time (hr)	Diameter (mm)	Depth (m)	Diameter (mm)	Depth (m)	
4.00	4.00	4.00	20					150	6.00	150	6.00	
5.80	5.80	5.80	0									
Log last updated 04/03/2021												



Borehole MW3

Site: Wrexham Delivery Office

GL (m AOD)	Scale 1:50
83.14	
Easting:	Northing:
333034.40	350636.90

Driller: JT

Logged By: JM

Sheet 1 of 1

Checked By: RB

Dates:	25/02/2021
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Ground Water (m)					Chiselling / Hard Strata			Casing Depths		Hole Diameter		General Remarks
Depth Struck (m)	Casing Depth (m)	Water Level	Minutes	Water sealed (m)	From (m)	To (m)	Time (hr)	Diameter (mm)	Depth (m)	Diameter (mm)	Depth (m)	
3.00	3.00	2.40	20		5.30	5.50	00:45	150	6.00	150	6.00	
Log last updated 04/03/2021												