SWL24-380-01-WSM-02

Point of Ayr Gas Terminal
Liverpool Bay Project

Groundwater and Surface Water Sampling Methodology

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For: SAIPEM Ltd Saipem House - 12-42 Wood Street Kingston-upon-Thames Surrey KT1 1TG	**Contact:** Name: Mark Green Title: Deputy Construction Manager Telephone: +44 (0) 208 2965043 Email: Mark.Green@saipem.com
By: Stuart Wells Ltd Hargham Road Shropham Norfolk NR17 1DT	**Contact:** Name: Martin Welsford Title: Associate & Technical Manager Mobile: 07552 298 261 Email: martin.welsford@stuartwells.co.uk

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	Name	Position	Signature	Date
Prepared by:	Martin Welsford	Associate & Technical Manager		19.06.2025
Checked by:	David Wright	Managing Director		19.06.2025
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Contents

Appendices

1. Introduction

A pumping test with groundwater remediation will be undertaken at the Point of Ayr Gas Terminal, Talacre, Holywell, CH8 9RD (the Site). This document outlines the methodology for groundwater and surface water quality sampling as part of this scheme.

2. Proposed Pumping Test and Remediation Trial

The pumping test will comprise the drilling and installation of one new groundwater pumping well and seventeen new groundwater monitoring wells (see Table 2). Groundwater shall be abstracted at a constant rate (after equipment and step testing) from PW01 for three days (or until steady state conditions are met) in accordance with BS ISO 14686 (2003) and EN ISO 22282-4 (2021) and the National Resources Wales (NRW) Groundwater Investigation Permit (Document No: TBC). Additionally, surface water will be monitored at three locations and precipitation will be monitored at the pumping well location (see Figure 1).

All abstracted groundwater will be passed through a Granular Activated Carbon (GAC) groundwater treatment system prior to discharge to the firewater pond, where the treated groundwater will be impounded. The treated groundwater will remain impounded until the full laboratory groundwater quality analysis results have been made available (approximately 3 weeks after completion of the pumping test). At which point, an assessment will be made (by the client) in agreement with NRW on whether the treated groundwater can either be; discharged back into the environment or will require additional treatment/removal from Site.

2.1. Proposed Groundwater Monitoring

Groundwater level will be monitored in eighteen groundwater wells (see Appendix 1, Table A1). Water level dataloggers will be installed in all groundwater monitoring points, as well as a barometric datalogger (for atmospheric compensation). All datalogger will be set to record data in accordance with SWL24-380-01-PTS-04.

2.2. Proposed Surface Water and Precipitation Monitoring

Surface water will be monitored at three locations and precipitation will be monitored at the pumping well location (see Figure 1). See details on installations in Appendix 1 (Table A2). Water level dataloggers will be installed in all stilling wells, as well as a barometric datalogger (for atmospheric compensation). All datalogger will be set to record data in accordance with SWL24-380-01-PTS-04. A rain gauge will be utilised to measure precipitation, in accordance with SWL24-380-01-PTS-04.

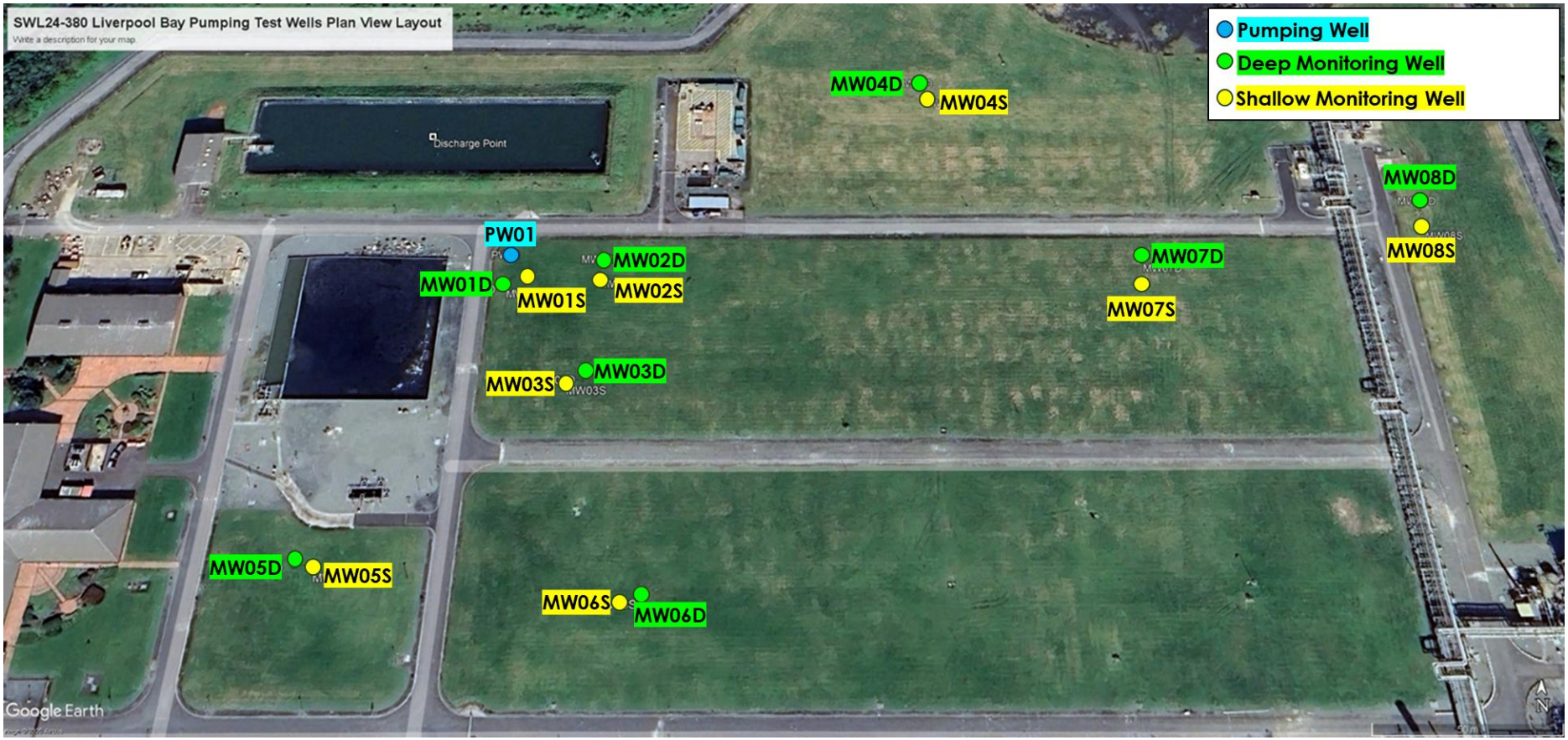

Figure 1: Indicative pumping test wells plan view layout map

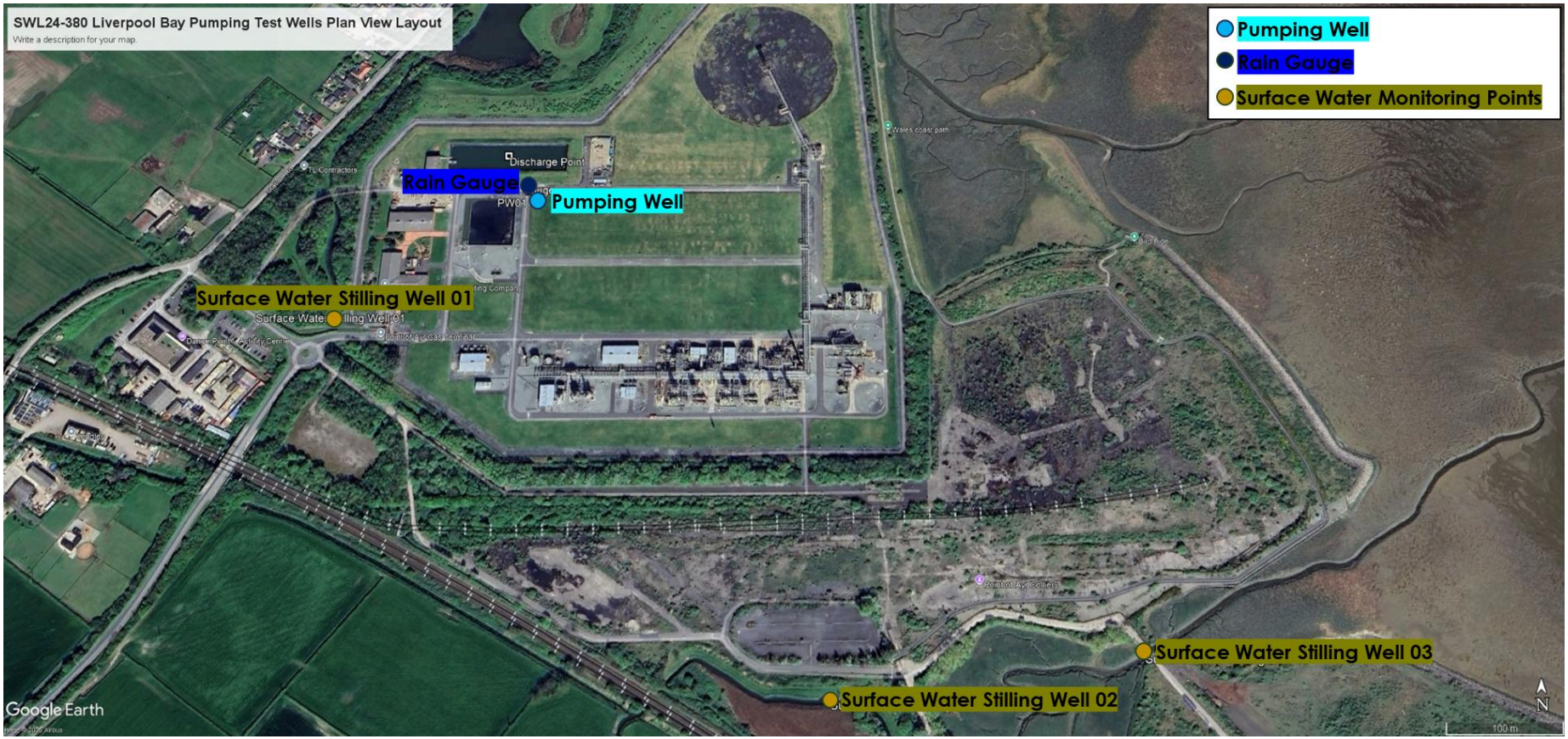

Figure 2: Indicative pumping test surface and rainwater monitoring points plan view layout

3. PFAS and PFOS/PFOA Remediation Targets

There is no generic target for PFAS and PFOS/PFOA in groundwater remediation for the following reasons:

- Reaching a robust, demonstrable and economically viable treatment target needs to be considered on a site-by-site basis, with supporting data provided by bench-scale/pilot treatment trials in conjunction with risk assessment (DQRA); and
- Targets are site-specific, risk-based and relate to the site sensitivity.

At this stage, an appropriate and achievable target of 100ng/l PFOS / PFOA is proposed for this Site to NRW. This is because:

- This is closely aligned with findings of ERM's DQRA, which suggested a maximum permissible PFOS concentration in the site surface water discharge of 0.12ug/l (120ng/l). The 100ng/l target therefore offers further betterment;
- Based on the findings of the proposed treatability trial, it may be possible to achieve a lower PFOS / PFOA / Total PFAS target, without substantially enhancing the specification / costs of the treatment system. However, we would need the trial data to assess this reliably;
- PFOS and PFOA are more readily sorbed to GAC than other PFAS compounds; and
- If PFOS / PFOA are the only consent parameters, then a moderate discharge consent limit of 100ng/l PFOS/PFOA is readily achievable using a GAC approach.

4. Proposed Groundwater Quality Sampling and Monitoring

All abstracted groundwater quality will be monitored at the abstraction point (PW01 wellhead) prior to the GAC system, and post-treatment (at discharge point prior to the firewater pound) to establish treatment performance and aid any future groundwater treatment assessment. As part of the pumping test, in-situ groundwater quality samples will be taken from all new groundwater monitoring wells (deep and shallow) across the Site as well as three surface water points, at various stages in the testing (see Figure 1, 2 and Table 2).

This groundwater quality sampling and laboratory testing will primarily be undertaken to establish the extent of PFAS contamination at the Site. An initial round of groundwater and surface water samples will be undertaken upon installation of monitoring points, these results will need to be reviewed by NRW prior to any groundwater pumping at the Site (see Table 2).

The final groundwater quality sampling requirements shall be finalised after full consultation with NRW and acquisition of the GIC. The proposed schedule of groundwater monitoring from surface and groundwater points is outlined in Table 2.

4.1. General Sampling Guidance and Standards

All groundwater quality samples will be undertaken in accordance with general guidance outlined in BS ISO 5667-11 (2009) and all surface water samples will be undertaken in accordance with general guidance in BS ISO 5667-6 (2014).

Table 1: Proposed groundwater quality sampling schedule for the pumping test phase of works

Location ID	Sampling Phase										
	Install	Pre-Test	*Duplicate Sample	Equipment Test	Step-Test	**Duplicate Sample	Constant Rate (1hr)	Constant Rate (24hr)	Constant Rate (48hr)	Constant Rate (72hr)	Post-Constant Rate
PW01	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
PWMW01	✓	✓		✓	✓		✓	✓	✓	✓	✓
MW01D	✓	✓									✓
MW01S	✓	✓									✓
MW02D	✓	✓									✓
MW02S	✓	✓									✓
MW03D	✓	✓									✓
MW03S	✓	✓									✓
MW05D	✓	✓									✓
MW05S	✓	✓									✓
MW06D	✓	✓									✓
MW06S	✓	✓									✓
MW04D	✓	✓									✓
MW04S	✓	✓									✓
MW07D	✓	✓									✓
MW07S	✓	✓									✓
MW08D	✓	✓									✓
MW08S	✓	✓									✓
Surface Water Stilling Well 01	✓	✓									✓
Surface Water Stilling Well 02	✓	✓									✓
Surface Water Stilling Well 03	✓	✓									✓
Discharge Point				✓	✓		✓	✓	✓	✓	✓
*Deionised Water Sample							✓			✓	

NOTES: *Duplicate sample to be taken from PW01 at the same time as Pre-Test sample. **Duplicate sample to be taken from PW01 at the same time as Step-Test sample.
***A deionised water sample of known quality to be taken at the same time as the Constant Rate (1hr) and Constant Rate (72hr).

4.2. Proposed Groundwater Quality Sampling Suite

Groundwater and surface water samples shall be sent to an UKAS accredited off-site laboratory and tested for components outlined in Table 2. The full PFAS testing suite is outlined in Appendix 2.

Table 2: Summary of groundwater quality sample testing suite

Indicative Stuart Wells Groundwater Quality Sampling Suite			
pH	Dissolved Oxygen	Antimony	Lead (dissolved)
Total dissolved solids	Conductivity	Sulphate	Arsenic
Magnesium	Total suspended solids	Alkalinity	Chloride
Barium	Manganese	Iron (dissolved)	Hardness
Nitrate	Boron	Molybdenum	Zinc
BOD	Nitrite	Cadmium	Nickel
TPH/PAH	COD	Phosphate	Chromium
Selenium	Sodium	Ammoniacal Nitrogen	Copper
*PFAS	*PFOS/PFOA	Total Organic Carbon	

NOTES: *Full PFAS and PFOS/PFOA testing suite included in Appendix 2.

4.3. Competency of Those Collecting Samples

All personnel involved in the collection of groundwater and surface water samples on Site must demonstrate a range of technical and procedural competencies to ensure reliable and accurate groundwater and surface water samples are collected in compliance with regulatory standards (outlined in Section 4.1). The key competencies are:

- **Site Risk Awareness**: All personnel will be SAIPEM inducted and be aware of the site-specific risks at the Point of Ayr. The ability to assess and respond to site-specific hazards, including contaminated land, deep excavations, and moving plant or machinery.
- **Training and Skills**: Operatives will be adequately trained and suitably experienced in groundwater and surface water sampling.
- **Understanding of Sampling Protocols and Standards**: All personnel will have been briefed on and have knowledge of standard operating procedures (outlined in Section 6.1), including sampling techniques, equipment use, and sample preservation methods.
- **Equipment Handling**: Operatives will be proficient in the correct use, decontamination, and calibration of sampling equipment (e.g., bailers, pumps, and water level dip meters).
- **Hydrogeological Awareness**: Operatives will have a basic understanding of groundwater flow, surface water, and site hydrology in order to differentiate between groundwater and surface water sampling.
- **Sample Integrity**: Operatives will be properly trained in and competent in sample labelling, handling, storage, and chain-of-custody documentation to maintain sample integrity from field to lab.
- **Regulatory Knowledge**: Familiarity with environmental regulations, permits, and reporting requirements relevant to the construction project and receiving environment.

4.4. Task Specific Personal Protective Equipment

For all individual groundwater and surface water quality samples, task specific PPE in the form of; PFAS free disposable overalls and PFAS free nitrile gloves will be utilised. After each sampling event, PFAS free disposable overalls and PFAS free nitrile gloves will be disposed of.

4.5. Cross-Contamination Prevention

All groundwater and surface water samples shall be collected in a way that limits cross-contamination of samples. All groundwater and surface water samples shall be acquired from individual monitoring points with new equipment at each monitoring point, for each sample. The Operative undertaking the sampling shall not utilise any equipment that knowingly contaminates groundwater or surface water quality samples with PFAS or any other contaminant.

4.6. Process for Sample Collection

Groundwater sampling shall be undertaken in accordance with standards and guidance outlined in Section 4.1. The general process for groundwater sample collection shall comprise the following:

1. Arrival at the sampling location, and deployment of suitable PFAS free task specific PPE (disposable overalls, nitrile gloves) and sampling equipment (disposable bailer or disposable tubing at wellhead);
2. The source of groundwater or surface water is identified. Samples will either be obtained from the pumping well, monitoring well or stilling well;
3. The groundwater or surface water sample shall be collected, and transfer to sample bottles will be undertaken without cross-contamination (in accordance with Section 4.5);
4. During the transfer of groundwater and surface water to sampling bottles and containers, the following must be considered;
    - **a)** All transfer shall be undertaken away from other site activities, to prevent unintentional contamination.
    - **b)** Sample bottles and containers shall be placed on a lipped tray to act as drip tray and contain any spillages.
    - **c)** When filling the bottles and containers, carefully fill to level equal to top of bottle, without leaving any headspace.
    - **d)** Any spillage onto the drip tray should be diluted further by adding potable water and then mopped up using paper towels.
    - **e)** Upon completion of filling sampling bottles and containers, the operative shall check sample bottles for damage and ensure the lid is securely sealed.
    - **f)** If sample bottles are damaged or have evidence of leakage, keep within the cool box (to prevent any contaminant spread) and contact laboratory to arrange collection and replacement bottles.
5. Once all required sampling bottles and containers have been filled, the sampling bottled will be labelled using a biro pen and the relevant chain of custody paperwork completed. All sample bottles and paperwork are placed within the cool box in an upright position, protected with bubble wrap etc and the laboratory contacted to arrange collection;
6. Once the sampling has been completed, Stuart Wells will dispose of overalls and nitrile gloves. Prior to any other sampling

4.6.1. Purging of Groundwater Abstraction and Monitoring Wells

In order to ensure that groundwater quality samples are representative of the aquifer conditions, purging and development of pumping and monitoring wells shall be undertaken prior to any groundwater sampling.

Monitoring and pumping wells will be developed by low-flow groundwater purging. Individual wells shall be purged for either 3 to 5 well volumes (to be calculated by the Pumping Test Contractor) or 3 hours, whichever is shortest (in accordance with BS ISO 5667-11:2009). Purging will be undertaken using a 12V whale pump, that is flushed with Decom 90 prior to reuse. All abstracted water during development will be stored in prior to discharge through the GAC treatment system at the end of the pumping test.

4.6.2. Collection of Quality Samples: Groundwater Pumping Well

The install and pre-test groundwater quality sample (as outlined in Table 1) shall be obtained immediately after purging/development (as outlined in Section 6.6) and shall be collected utilising a PFAS free disposable bailer directly from the well liner (and in accordance with Section 4.6). Thereafter, an electric submersible borehole pump shall be installed into the pumping well (from the equipment test sample onwards) on suitable riser pipe, with a suitable wellhead and sample tap.

For each individual groundwater sample, the sample tap shall be attached with a disposable tube, to allow abstracted groundwater to be easily directed into sample bottles. After each use, the disposable tube attached to the sample tap shall be disposed of. The sample tap shall also be utilised to collect abstracted groundwater to allow the monitoring of in-field groundwater quality parameters.

All sampled groundwater will be transferred (abiding with Section 4.6) from the disposable bailer to the suitable sampling bottles and containers. Individual sample bottles and containers shall be individually labelled as appropriate and a chain of custody (containing full details on the sampling process) undertaken to ensure the correct analysis is performed and there is no confusion between samples at the laboratory. These samples shall then be stored at a suitable temperature (in a cool boxes) for transfer to a UKAS accredited (to the ISO/IEC 17025) laboratory (TBC) within 24hrs of sample collection.

4.6.3. Collection of Quality Samples: Monitoring Well

All groundwater quality samples (in accordance with Table 1) shall be collected utilising a PFAS free disposable bailer directly from the well liner (and in accordance with Section 4.6).

All sampled groundwater will be transferred (abiding with Section 4.6) from the disposable bailer to the suitable sampling bottles and containers. Individual sample bottles and containers shall be individually labelled as appropriate and a chain of custody (containing full details on the sampling process) undertaken to ensure the correct analysis is performed and there is no confusion between samples at the laboratory. These samples shall then be stored at a suitable temperature (in a cool boxes) for transfer to a UKAS accredited (to the ISO/IEC 17025) laboratory (TBC) within 24hrs of sample collection.

4.6.4. Collection of Quality Samples: Stilling Well

All groundwater quality samples (in accordance with Table 1) shall be collected utilising a PFAS free disposable bailer directly from the stilling well liner (and in accordance with Section 4.6).

All sampled surface water will be transferred (abiding with Section 4.6) from the disposable bailer to the suitable sampling bottles and containers. Individual sample bottles and containers shall be individually labelled as appropriate and a chain of custody (containing full details on the sampling process) undertaken to ensure the correct analysis is performed and there is no confusion between samples at the laboratory. These samples shall then be stored at a suitable temperature (in a cool boxes) for transfer to a UKAS accredited (to the ISO/IEC 17025) laboratory (TBC) within 24hrs of sample collection.

4.7. Quality Assurance Sampling

For quality assurance purposes, four additional samples shall be taken (see Table 1). The samples are to be taken at the following periods:

- **Duplicate Samples:** Taken from PW01 during the pre-test sample and the step-test; and
- **Deionised Water Samples:** To be sent to the lab at the same time as the Constant Rate (1hr) and Constant Rate (72hr).

5. References

BS ISO 5667-11:2009. Water quality – Sampling. Part 11: Guidance on sampling of groundwaters. British Standards Institution, London.

BS ISO 5667-6:2014. Water quality – Sampling. Part 6: Guidance on sampling of rivers and streams. British Standards Institution, London.

Appendix 1

Newly Proposed Pumping and Monitoring Wells

Table A1: Newly proposed pumping and monitoring wells

Borehole No.	Ground Level (mAOD)	Distance From Pumping Well (m)	New or Existing?	Minimum. Finish Drilling Diameter (mm)	Liner Internal Diameter (mm)	Max. Borehole Depth (mbgl)	Response Stratum
PW01	TBC*	N/A	New	300	155	18.5	Tidal Flat Deposits
PWMW01	TBC*	<5	New	150	52	4.5	Tidal Flat Deposits
MW01D	TBC*	10.0	New	150	52	18.5	Tidal Flat Deposits
MW01S	TBC*	10.0	New	150	52	4.5	Tidal Flat Deposits
MW02D	TBC*	30.0	New	150	52	18.5	Tidal Flat Deposits
MW02S	TBC*	30.0	New	150	52	4.5	Tidal Flat Deposits
MW03D	TBC*	50.0	New	150	52	18.5	Tidal Flat Deposits
MW03S	TBC*	50.0	New	150	52	4.5	Tidal Flat Deposits
MW05D	TBC*	113.0	New	150	52	18.5	Tidal Flat Deposits
MW05S	TBC*	113.0	New	150	52	4.5	Tidal Flat Deposits
MW06D	TBC*	121.0	New	150	52	18.5	Tidal Flat Deposits
MW06S	TBC*	121.0	New	150	52	4.5	Tidal Flat Deposits
MW04D	TBC*	150.0	New	150	52	18.5	Tidal Flat Deposits
MW04S	TBC*	150.0	New	150	52	4.5	Tidal Flat Deposits
MW07D	TBC*	200.0	New	150	52	18.5	Tidal Flat Deposits
MW07S	TBC*	200.0	New	150	52	4.5	Tidal Flat Deposits
MW08D	TBC*	292.0	New	150	52	18.5	Tidal Flat Deposits
MW08S	TBC*	292.0	New	150	52	4.5	Tidal Flat Deposits

Table A2: Newly proposed surface and rainwater monitoring points

Monitoring Identification	Distance From Pumping Well (m)	Monitoring
Rain Gauge	0.0	Rainfall
Surface Water Stilling Well 01	226	Surface Water Level
Surface Water Stilling Well 02	565	Surface Water Level
Surface Water Stilling Well 03	717	Surface Water Level

Appendix 2

PFAS and PFOS/PFOA Groundwater Quality Sampling Suite

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PFAS Groundwater Quality Analysis (2025)

PFAS Extended Suite

Matrix	Determinand	Accreditation Status		Methodology	Detection Limit	Unit
Water	Perfluorobutanoic acid	None		LC/MS	0.05	ug/l
Water	Perfluorobutane sulphonate	None		LC/MS	0.05	ug/l
Water	Perfluoropentonic acid	None		LC/MS	0.05	ug/l
Water	Perfluoropentane sulphonate	None		LC/MS	0.05	ug/l
Water	Perfluorohexanoic acid	None		LC/MS	0.05	ug/l
Water	Perfluorohexane sulphonate	None		LC/MS	0.05	ug/l
Water	Perfluoroheptanoic acid	None		LC/MS	0.05	ug/l
Water	Perfluoroheptane sulphonate	None		LC/MS	0.05	ug/l
Water	Perfluorooctanoic acid (PFOA)	None		LC/MS	0.05	ug/l
Water	Perfluorooctane sulphonate (PFOS)	None		LC/MS	0.05	ug/l
Water	Perfluorononanoic acid	None		LC/MS	0.05	ug/l
Water	Perfluorononane sulphonate	None		LC/MS	0.05	ug/l
Water	Perfluorodecanoic acid	None		LC/MS	0.05	ug/l
Water	Perfluorodecane sulphonate	None		LC/MS	0.05	ug/l
Water	Perfluoroundecanoic acid	None		LC/MS	0.05	ug/l
Water	Perfluoroundecane sulphonate	None		LC/MS	0.05	ug/l
Water	Perfluorododecane sulphonate	None		LC/MS	0.05	ug/l
Water	Perfluorododecanoic acid	None		LC/MS	0.05	ug/l
Water	FOSA C8 Sulphonamides	None		LC/MS	0.1	ug/l
Water	NMeFOSA C9 Sulphonamides	None		LC/MS	0.1	ug/l
Water	NEtFOSA C10 Sulphonamides	None		LC/MS	0.1	ug/l
Water	6:2FTA C8 Telomer acids	None		LC/MS	0.1	ug/l
Water	8:2FTA C10 Telomer acids	None		LC/MS	0.1	ug/l
Water	10:2FTA C12 Telomer acids	None		LC/MS	0.1	ug/l
Water	6:2FTUA C8 Telomer unsaturated acids	None		LC/MS	0.1	ug/l
Water	8:2FTUA C10 Telomer unsaturated acids	None		LC/MS	0.1	ug/l
Water	10:2FTUA C12 Telomer unsaturated acids	None		LC/MS	0.1	ug/l
Water	4:2FTS C6 Telomer Sulphonates	None		LC/MS	0.1	ug/l
Water	6:2FTS C8 Telomer Sulphonates	None		LC/MS	0.1	ug/l
Water	8:2FTS C10 Telomer Sulphonates	None		LC/MS	0.1	ug/l

PFOS/PFOA

Matrix	Determinand	Accreditation Status		Methodology	Detection Limit	Unit
Water	Perfluorooctane sulphonate (PFOS)	None		LC/MS	0.05	ug/l
Water	Perfluorooctanoic acid (PFOA)	None		LC/MS	0.05	ug/l

Appendix 3

Stuart Wells Quality Testing Suite

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Standard Groundwater Quality Analysis (2025)

Analysis	Minimum Dectection Limited	Accrediation
pH	1 pH units	U
Conductivity at 25°C	100 µS/cm	U
BOD (5 day)	1 mg O2/l	U
Dissolved Oxygen	0.1 mg O2/l	N
COD (Settled)	5 mg/l	U
Total Alkalinity	2 mg/l	U
Total Suspended Solids	5 mg/l	U
TDS as mg/L	5 mg/l	N
Total Organic Carbon	0.4 mg/l	U
Total Oxidised Nitrogen	0.2 mg/l	U
Nitrate as NO3	0.9 mg/l	U
Nitrite as NO2	0.04 mg/l	U
Ammoniacal Nitrogen as N	0.01 mg/l	U
Orthophosphate as PO4	0.03 mg/l	U
Chloride as Cl	1 mg/l	U
Fluoride as F	0.1 mg/l	U
Aluminium as Al	0.01 mg/l	U
Antimony as Sb	0.001 mg/l	U
Arsenic as As	0.001 mg/l	U
Barium as Ba	0.01 mg/l	U
Boron as B	0.01 mg/l	U
Cadmium as Cd	0.00002 mg/l	U
Calcium as Ca	1 mg/l	U
Total Chromium as Cr	0.001 mg/l	U
Copper as Cu	0.001 mg/l	U
Iron as Fe	0.01 mg/l	U
Lead as Pb	0.0002 mg/l	U
Magnesium as Mg	1 mg/l	U
Manganese as Mn	0.002 mg/l	U
Molybdenum as Mo	0.001 mg/l	U
Nickel as Ni	0.001 mg/l	U
Potassium as K	1 mg/l	U
Selenium as Se	0.001 mg/l	U
Sodium as Na	1 mg/l	U
Total Sulphur as SO4	3 mg/l	U
Zinc as Zn	0.002 mg/l	U
Total Hardness as CaCO3	6.6 mg/l	U
Total TPH >C8-C40 (EH_1D_Total)	0.01 mg/l	U
Acenaphthene	0.01 µg/l	U
Acenaphthylene	0.01 µg/l	U
Anthracene	0.01 µg/l	U
Benzo[a]anthracene	0.01 µg/l	U
Benzo[a]pyrene	0.01 µg/l	U
Benzo[b]fluoranthene	0.01 µg/l	U
Benzo[g,h,i]perylene	0.01 µg/l	U
Benzo[k]fluoranthene	0.01 µg/l	U
Chrysene	0.01 µg/l	U
Dibenzo[a,h]anthracene	0.01 µg/l	U
Fluoranthene	0.01 µg/l	U
Fluorene	0.01 µg/l	U
Indeno[1,2,3-cd]pyrene	0.01 µg/l	U
Naphthalene	0.01 µg/l	U
Phenanthrene	0.01 µg/l	U
Pyrene	0.01 µg/l	U