Final Pre-Construction Water Quality Monitoring Report

DCO Requirement 9

Glyn Rhonwy Pumped Storage

Snowdonia Pumped Hydro

WSP UK limited – June 2023

Report for

Snowdonia Pumped Hydro

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Executive summary

Purpose of this report

This report covers the first two points of the pre-construction water quality monitoring.

Leachate tests have been undertaken as part of the pre-works site investigation. The leachate tests were subject to a separate method statement.

This method statement is based on the principles agreed in the certified WTMP with an amended scope for private water supplies sampling, which are highlighted in this report. All monitoring on water bodies remains unchanged.

Contents

1. Introduction

Requirement 9 of the approved Development Consent Order (DCO) includes the need for a Water Management Plan (WTMP). The WTMP must include a water quality monitoring programme for monitoring prior to the commencement of construction, during construction and post-construction.

This Pre-Construction Water Quality Monitoring Report present the results of pre-construction phase sampling undertaken as outlined in the Pre-Construction Phase Sampling Method Statement (Wood (now WSP), 2022). The method statement was informed by Section 4 of the updated WTMP (dated 5th September 2016).

The following sections outline the methods and procedures implemented as part of this pre-construction sampling programme and present results.

A finalised WTMP will provide details of the construction and post-construction phase monitoring.

1.1 Objectives

The objective of the water quality monitoring programme is to provide water quality data for the scheme from pre-construction, through construction and into post-construction.

The objective of this report is to present and review the data collected by the pre-construction monitoring programme.

1.2 Purpose

Pre-construction phase water quality monitoring is required to:

- Confirm that there have been no changes in the quarry (Q6 Tailpond) water quality since earlier (2012 and 2015) baseline monitoring prior to starting any construction activities; and
- Collate baseline water quality for all relevant water bodies and Private Water Supplies (PWS) that might be affected by construction works for comparison with water quality data collected during and post-construction to allow evaluation of any effects from construction.

2. Background

2.1 Requirement for Monitoring

Section 4 of the WTMP (EN010072-WTMP, 2016) outlines the requirement for pre-construction water quality monitoring, including the identity of relevant water bodies and receptors, to provide a robust baseline for the water environment.

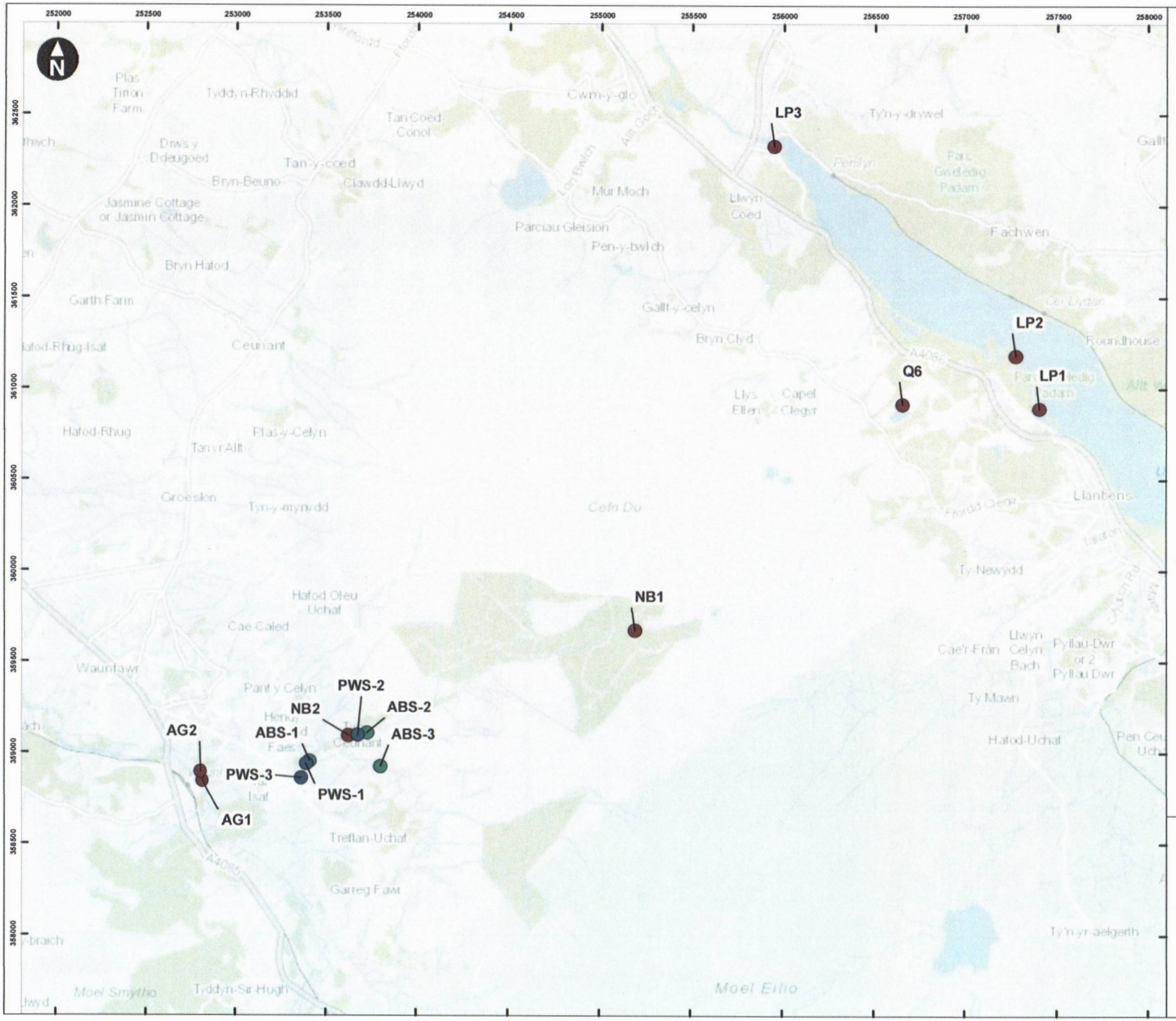
2.2 Monitoring Locations

Monitoring locations and receptor (water body) types are presented in Figure 2.1 and their details tabulated in Table 2.1. Detailed descriptions are provided in the following sections. The sample locations lie in two separate catchments: to the west in the catchment of the Nant y Betws and to the east in the catchment of the Afon Rhythallt.

Table 2.1 Pre-Construction Phase Surface water Sample Locations

Sample Name	Grid Reference	Location	Receptor Description
LP1	SH 57405 60891	Llyn Padarn	Lake
LP2	SH 57276 61180	Llyn Padarn	Lake
LP3	SH 55948 62329	Llyn Padarn	Lake
NB1	SH 55193 59671	Nant y Betws Headwaters	Watercourse
NB2	SH 53624 59094	Nant y Betws (Y Waunfawr)	Watercourse
AG1	SH 52814 58846	Afon Gwyrfai (Upstream)	Watercourse
AG2	SH 52803 58897	Afon Gwyrfai (Downstream)	Watercourse
Q6	SH 56658 60914	Tailpond	Quarry - Waterbody
ABS-1	SH 53413 58953	Ynysoedd, Waenfawr	PWS abstraction point
ABS-2	SH 53725 59108	Tyn y Ceunant, Waenfawr	PWS abstraction point
ABS-3	SH 53806 58926	Tyn y Onnen Caravan Park, Waenfawr	PWS abstraction point
PWS-1	SH 53394 58939	Ynysoedd, Waenfawr	PWS Tap (*Untreated)
PWS-2	SH 53674 59097	Tyn y Ceunant, Waenfawr	PWS Tap
PWS-3	SH 53389 58861	Tyn y Onnen Caravan Park, Waenfawr	PWS Tap

* Water abstracted by PWS Ynysoedd is not used for drinking water and is not currently treated.
PWS = Private Water Supply



Snowdonia Pumped Hydro

Figure 2.1
Water quality monitoring locations and receptor types

February 2023

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Afon Rhythallt (LP1, LP2 and LP3)

Sample location LP1 is in a water sports recreation area of Llyn Padarn, which is frequently used for launching of kayaks and small motorised boats. The shoreline is adjacent to a carpark. Further northwest along the shoreline, sample location LP2 is adjacent to shallow ponds and lagoons that are sometimes used by the public for bathing. Sample location LP3 is at the north-western end of Llyn Padarn adjacent to the Pont Pen-y-llyn bridge, immediately upstream of the outflow from Llyn Padarn to the Afon Rhythallt.

Sample location Q6 is from the water body in an existing quarry close to Llyn Padarn. This quarry will form the tailpond of the scheme.

Afon Gwyrfai (Q1, NB1, NB2, ABS-1 to 3, AG1 and AG2)

A tributary of Afon Gwyrfai, Nant-y-Betws, rises close to the proposed headpond at Q1 and flows westwards to join Afon Gwyrfai at Waunfawr. Two sampling points lie along Nant-y-Betws. The upstream sample location (NB1) is at the headwaters within a forestry plantation, approximately 330 m South of the proposed headpond (Q1). Sample location NB2 is approximately 1.7 km downstream at Waunfawr.

Three PWS take water from Nant-y-Betws or nearby springs. These comprise:

- ABS-1, approximately 250 m downstream of NB2 within a small bifurcation of the Nant-y-Betws, which takes water from the river to supply Ynysoed;
- ABS-2 supplies private residence Tyn-y-Ceunant from Nant-y-Betws and is approximately 115 m east of NB2.
- ABS-3 supplies the Tyn y Onnen Caravan Park and an attached private residence from springs and is approximately 250 m southeast of NB2.

For private water supplies the compliance point for regulatory testing is at the tap after treatment. The PWS taps at Ynysoedd and Tyn y Ceunant are within private residences, whilst the tap at Tyn y Onnen Caravan Park is outside. Ynysoedd does not have treatment and abstracted water is not used as drinking water.

Two sample locations are on the Afon Gwyrfai adjacent to the Snowdonia Parc Campsite (AG1) and Gorsaf Waunfawr Railway Station (AG2) respectively. Sample location AG1 is approximately 50 m upstream of the confluence with Nant-y-Betws, whilst AG2 is approximately 5 m downstream of the confluence, within the mixing zone.

As described in the WTMP (2016) and as revised following consultation with GCC (Gwynedd County Council) on 10th August 2022, Table 2.2 details the pre-construction water quality sampling schedule from May 2022 to April 2023. The amended sampling schedule comprises:

- Sampling of the PWS abstraction points (not the tap) over a 6-month period from November 2022 to April 2023 and analysis for the same surface water suite as other samples from Nant y Betws; and
- Sampling of the tap at each PWS on two occasions. Sampling to be undertaken by an Environmental health Officer from GCC, who is accredited under the Drinking Water Inspectorate scheme. These samples were taken in November 2022 and April 2023. Analysis was to drinking water standards and comprised a suite of analysis relevant to the site setting and the possible effects of the scheme.

Prior to this sampling programme, which commenced in 2022, water quality sampling of Q6 was undertaken in July 2012 and in 2015 by ENSIS Ltd to a scope agreed between AECOM and NRW. This report compares the various water quality data sets in Section 5.3.

Table 2.2 Surface Water and PWS Sample Schedule – May 2022 to April 2023

Sample Location ID	Sample Location Name	Sample Schedule	No. of visits	No. Samples Scheduled (Inc of Duplicates)
LP1	Llyn Padarn	Monthly (May 22 - Apr 23)	12	13
LP2	Llyn Padarn	Monthly (May 22 - Apr 23)	12	13
LP3	Llyn Padarn	Monthly (May 22 - Apr 23)	12	13
NB1	Nant y Betws Headwaters	Monthly (May 22 - Apr 23)	11	13
NB2	Nant y Betws (Y Waunfawr)	Monthly (May 22 - Apr 23)	12	13
AG1	Afon Gwyrfai (Upstream)	Monthly (May 22 - Apr 23)	12	13
AG2	Afon Gwyrfai (Downstream)	Monthly (May 22 - Apr 23)	12	13
Q6	Quarry 6 (Tail Pond)	Monthly (May 22 - Apr 23)	11 (no access October 2022)	13
ABS-1	Ynysoedd PWS Abstraction Point	Monthly (Nov 22 - Apr 23)	6	7
ABS-2	Tyn y Ceunant PWS Abstraction Point	Monthly (Nov 22 - Apr 23)	6	7
ABS-3	Tyn y Onnen PWS Abstraction Point	Monthly (Nov 22 - Apr 23)	6	7
PWS-1	PWS Ynysoedd	Twice (Nov 22 & Apr 23)	2	2
PWS-2	PWS Tyn y Ceunant	Twice (Nov 22 & Apr 23)	2	3
PWS-3	PWS Tyn y Onnen Caravan Park	Twice (Nov 22 & Apr 23)	2	3

PWS = Private Water Supply.

2.3 Measurement and Analytical requirements

Field Measurements

The Pre-Construction Water Monitoring Method Statement required field measurements to be taken at each location sampled on each monitoring visit. Field measurements were required for pH, electrical conductivity, turbidity, dissolved oxygen and temperature.

Laboratory Analysis

The Pre-Construction Water Monitoring Method Statement set out the analytical requirements for samples. Two surface water analysis suites have been used: one for most sample locations and a more comprehensive suite for Q6. The analysis suite is set out in Appendix A1.

The surface water suite was used for private water supplies at the point of abstraction. For samples from consumers taps a suite of analysis based on the requirements of the Private Water Supplies (Wales) Regulations 2017 was used.

3. Methodology

3.1 Monitoring Schedule

Between May 2022 and April 2023, 12 monitoring visits at an approximately monthly frequency took place as follows:

- 30th to 31st May 2022
- 27th to 28th June 2022
- 25th July 2022
- 22nd August 2022
- 26th September 2022
- 24th October 2022
- 21 to 22nd November 2022
- 12th December 2022
- 23rd January 2023
- 20th February 2023
- 20th March 2023
- 24th April 2023.

Table 2.2 details the locations sampled for the pre-construction monitoring.

3.2 Monitoring and Sampling

Field Measurements

Sampling of surface waters was conducted using a 5 m telescopic scoop to retrieve water samples, which were decanted into a sample cell attached to a multimeter. The multimeter was calibrated prior to sampling and recorded the following parameters:

- pH
- Turbidity (Nephelometric Turbidity units)
- Conductivity (µS/cm)
- Dissolved oxygen (% and mg/l)
- Temperature (°C)

The sample cell and probe of the multimeter was rinsed 3 times using the same water source being sampled, prior to being filled to record parameters. Readings were allowed to stabilise before recording the results.

Sample Collection – surface water

Samples for laboratory analysis were collected using the telescopic scoop and decanted into a clean bucket. The bucket was rinsed 3 times using the same water source being sampled, prior to collection of sample volume.

Laboratory-supplied containers were filled from the bucket, then labelled and packed into cool boxes with frozen cooling blocks to maintain low temperatures. One duplicate sample was collected per monitoring round. The duplicate sample location is varied for each round to ensure that each sample location is scheduled for duplicate analysis at least once during the sampling programme. The duplicate sample was assigned a sample ID (LL1) that maintained anonymity. Ice packs were replenished in the cool boxes and samples were transported within 24 hours to a cold-storage collection point, registered and then sent via same day courier to the laboratory.

Sample collection – Private Water Supplies (PWS)

Samples taken at the point of abstraction were taken in the same way as other surface water samples.

Samples collected at consumers taps were taken by suitably accredited Environmental Officers from Cyngor Gwynedd Council (CGC), under the supervision of WSP and in accordance with the requirements of the Private Water Supply (Wales) Regulations 2017. This includes sterilisation of the sampling point.

Laboratory Analysis

Chemical analysis of the water samples was conducted by ALS Laboratories UK Limited, which is UKAS Accredited. As described in the WTMP (2016), the Pre-Construction Phase Sampling Method Statement (2022) and following consultation with GCC (2022), chemical analysis of the sample locations was undertaken for one of three testing suites as follows:

1. General surface water (all surface water locations and private water supplies at the point of abstraction).
2. Q6 (quarry tailpond), which comprised the general suite plus additional chemical determinands
3. Private Water Supplies at consumers taps.

The analysis suites and sample locations are summarised in Appendix A1.

4. Results

4.1 Field Measurements

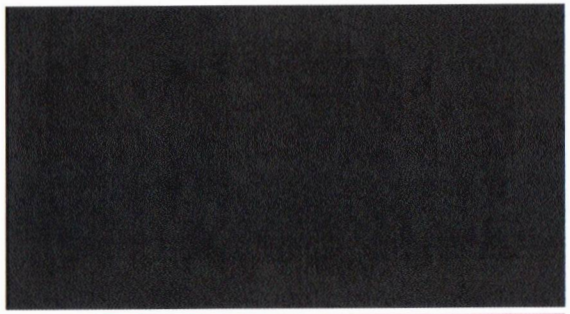
The results of field measurements are presented in Table 4.1.

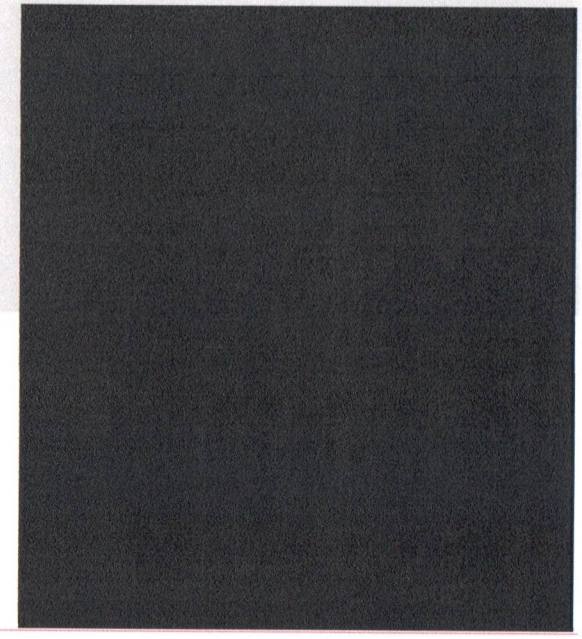
Table 4.1 Summary of Field Measurements (May 2022 to April 2023)

Location ID	Parameter	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
LP1	pH	7.66	6.69	6.69	6.68	6.66	6.54	6.44	6.41	6.65	6.69	6.53	7.44
	Turbidity (NTU)	0.91	0.79	0	0	0.57	0	0.15	0	0	0	0	0
	Conductivity (µS/cm)	41.5	65.6	56.3	53.4	54.1	55	58.3	52.7	64.8	58.3	57.1	47.9
	Dissolved Oxygen (%)	42	94.9	94.9	91.7	90.1	86.5	87.7	89.9	94.6	101.5	102.2	107.7
	Dissolved Oxygen (mg/l)	4.29	8.79	8.92	8.41	9	9.15	9.92	10.4	11.38	12.06	11.76	11.92
	T (°C)	15	19.1	18.3	19.5	15.5	12.8	9.9	8.7	7.3	7.9	9.2	10.8
LP2	pH	7.27	6.41	7	6.61	6.6	6.71	6.39	6.31	6.91	7.12	6.58	6.69
	Turbidity (NTU)	0.69	0.22	0	0	0	0	0.27	0	0	0	0	0
	Conductivity (µS/cm)	40.2	61.4	66.1	52.8	53.9	66.5	51.3	52.6	50.5	51.1	45.9	48.1
	Dissolved Oxygen (%)	36.3	68.1	79.6	89.4	83.7	83.7	88.83	85.3	89.1	102.5	104.7	104.6
	Dissolved Oxygen (mg/l)	3.82	6.48	7.38	8.3	8.44	8.72	9.86	9.84	10.83	12.11	12.28	11.71
	T (°C)	13.9	17.8	19	19	15	13.5	10.5	9.1	6.9	8.1	8.4	10.3
LP3	pH	7.38	6.89	7.2	7.5	7.29	7.31	6.35	7.35	6.86	7.5	7.36	7.18
	Turbidity (NTU)	1.21	0.12	-0.48	0.66	0	0	0	0	0.36	0	0	0
	Conductivity (µS/cm)	41.2	59.9	54.6	52.7	54.2	52	48.2	49.9	45	47.7	47.1	48.8
	Dissolved Oxygen (%)	45.5	98.7	99	104.4	85.7	101.8	96.2	99	104.5	110.3	106.7	102.3

	Dissolved Oxygen (mg/l)	4.67	9.56	9.61	9.71	8.73	10.79	10.86	12.36	12.92	13.04	12.35	11.47
	T (°C)	15.1	16.9	16.8	18.9	14.5	12.7	10	5.9	6.3	8.1	8.8	10.3
NB1	pH	6.63	5.96	5.91	5.85	6.19	6.1	5.92	N/A	6.37	6.32	6.18	6.3
	Turbidity (NTU)	2.6	0.7	0.4	-0.32	-0.13	-0.41	0.26	N/A	0	0	0	0
	Conductivity (µS/cm)	33.9	63.6	57.7	58.8	52.4	54.2	48.9	N/A	52	55.6	48.6	51.1
	Dissolved Oxygen (%)	48.8	89	87.3	86.5	87.6	89	85.3	N/A	93.6	92.2	94.4	95.7
	Dissolved Oxygen (mg/l)	5.61	9.6	9.31	9.02	9.7	9.8	10.2	N/A	11.38	10.87	11.02	11.13
	T (°C)	9.8	12	12.4	13.3	10.7	11	7.6	N/A	6.9	8.2	8.6	8.7
NB2	pH	7.71	7.25	6.94	7.02	6.84	6.79	6.26	6.6	6.82	6.84	6.51	6.67
	Turbidity (NTU)	0.52	-0.38	-0.19	-0.58	0.01	-0.48	3.7	-0.3	0	0	0	0
	Conductivity (µS/cm)	42.3	86.5	84.7	93.5	72.5	78	53.9	102.4	76	88.1	56.9	77.2
	Dissolved Oxygen (%)	100.6	97.5	97.3	97.2	97.4	97.3	96.2	96.8	101.4	100.9	99.1	99.4
	Dissolved Oxygen (mg/l)	11.31	10.59	10.12	9.85	10.69	10.6	11.6	12.75	12.38	11.69	11.37	11.15
	T (°C)	9.9	11.7	13.6	14.8	11.2	11.5	7.3	3.8	6.7	8.9	9.3	10.2
AG1	pH	6.99	6.47	6.9	6.95	6.7	6.39	5.86	6.3	6.2	6.65	6.11	6.27
	Turbidity (NTU)	0.55	-0.12	0.56	-0.58	-0.41	0.12	-0.03	-0.52	0	0	0	0
	Conductivity (µS/cm)	38	48.5	51.5	52.3	51.4	49.8	49.5	58	49.7	48.6	44.4	51.6
	Dissolved Oxygen (%)	48.2	92.9	99.9	104.4	100.6	99.2	92.4	100.2	104.5	106.8	104.6	114.3
	Dissolved Oxygen (mg/l)	5.22	9.6	9.91	10.11	10.61	10.67	10.77	12.9	12.74	12.5	12.22	12.88

	T (°C)	12.8	13.9	15.8	16.9	13	12.1	8.6	4.7	6.9	8.5	8.6	10.1
AG2	pH	6.81	6.31	6.6	6.63	6.46	6.16	5.86	6.01	6.17	6.34	6.05	6.27
	Turbidity (NTU)	0.67	0	0	0	0	0	0.14	0	0	0	0	0
	Conductivity (µS/cm)	36.6	48.3	51.1	52	51.1	48.5	49.5	57.2	49.3	48.2	43.7	51.9
	Dissolved Oxygen (%)	34.6	93.2	100.3	106.1	101.1	99.9	93.5	100.1	105.1	107.6	104.6	113.2
	Dissolved Oxygen (mg/l)	3.71	9.61	9.91	10.21	10.61	10.74	10.82	13.04	12.85	12.59	12.26	12.78
	T (°C)	12	14	16	17.2	13.1	12.1	8.9	4.2	6.7	8.5	8.4	10
Q6	pH	8.01	7.93	7.59	7.69	7.72	7.5	N/A	7.31	7.5	7.54	7.4	7.79
	Turbidity (NTU)	1.01	3.25	0	0	0	0	N/A	0	0	0	0	0
	Conductivity (µS/cm)	117	174.2	173.7	176.8	177.2	178.5	N/A	176.5	162.9	165.1	163.9	164.1
	Dissolved Oxygen (%)	43.8	101.7	96.4	94.6	95.7	95.6	N/A	89.6	96.8	103.7	102.8	105.1
	Dissolved Oxygen (mg/l)	4.62	9.94	9.36	9.03	9.86	10.33	N/A	10.67	11.82	12.43	12.23	12.01
	T (°C)	13.4	16.4	16.7	17.5	14	11.8	N/A	7.7	6.7	7.5	7.7	9.4
ABS-1	pH												
	Turbidity (NTU)												
	Conductivity (µS/cm)												
	Dissolved Oxygen (%)												
	Dissolved Oxygen (mg/l)												
	T (°C)												



ABS-2	pH	
	Turbidity (NTU)	
	Conductivity (µS/cm)	
	Dissolved Oxygen (%)	
	Dissolved Oxygen (mg/l)	
	T (°C)	
ABS-3	pH	
	Turbidity (NTU)	
	Conductivity (µS/cm)	
	Dissolved Oxygen (%)	
	Dissolved Oxygen (mg/l)	
	T (°C)	

4.2 Surface Water Quality

The laboratory results for the May 2022 to April 2023 are presented in Appendix A2.

4.3 Results from Previous Water Quality Monitoring

Water quality monitoring conducted at Q6 in 2012 and 2015 are tabulated in Appendix A3.

4.4 Results from analysis of Private Water Supply (drinking water)

The laboratory results from analysis of drinking water samples collected from Private Water Supplies (PWS) are presented in Appendix A4.

The purpose of testing PWS is solely for the collection of baseline water quality data. WSP will not provide any comment or consultation to individual PWS regarding the analytical results of drinking water samples.

Laboratory results have been communicated to individual PWS by Cyngor Gwynedd Council and guidance offered regarding any results failing Drinking Water Standards (DWS).

5. Discussion of Results

5.1 Surface Water Quality Monitoring

Field Measurements

The following observations are made on the field parameters:

- pH values ranged from 5.3 to 8.0, which indicates weakly acidic to slightly alkaline conditions. The lowest pH values were recorded at [redacted] (Figure 5.1) and low values were consistently found along Nant y Betws. The low values at [redacted] are within expected values of surface waters discharged from moorland environments, reflecting weak acidic conditions. The highest value was at Q6, and pH was consistently higher at Q6 than elsewhere (Figure 5.1).
- Conductivity values were low compared to typical UK waters and indicate limited dissolved solids are present. These low values are likely to reflect the absence of soluble minerals and /or limited interaction with bedrock. Although low, conductivity was typically three times higher at Q6 than at most other sample locations (Figure 5.2). Values at Q6 ranged from 117 µS cm-1 to 179 µS cm-1, but 10 out of the 11 monthly values fall within 160 µS cm-1 – 180 µS cm-1 range. The higher conductivity values at Q6 indicate increased total dissolved solids, suggesting that water has encountered more soluble minerals. Conductivity values at [redacted] were notably higher than other abstraction point samples (range 117.5 to 139.2 µS cm-1). There are no obvious reasons for this. Conductivity for the other sample locations ranged from 34 to 104 µS cm-1, with a mean value of 57 µS cm-1. These values are consistent with those expected from largely rainfall-derived freshwater within rivers and lakes in a hard rock area and indicate limited soil:water interaction.
- Turbidity values were low (<5 NTU) or zero indicating low suspended solids in the waters sampled.
- Dissolved oxygen (DO) values were generally close to saturation indicating well-oxygenated water.
- Consistently low values of DO and conductivity in May 2022 (see Section 5.2) are likely to indicate instrument error.

Figure 5.1 pH Field Measurements May 2022 to April 2023

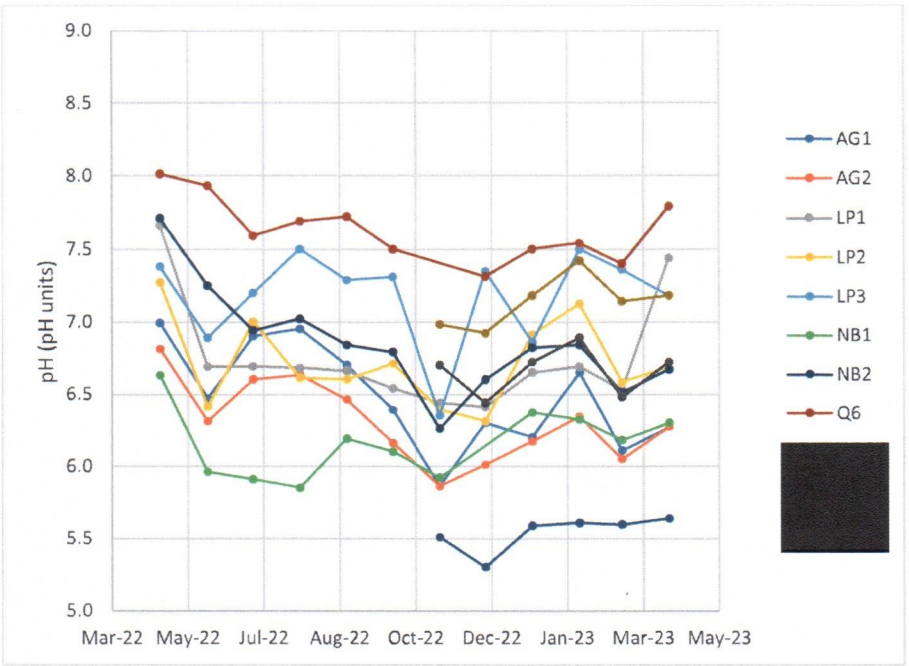
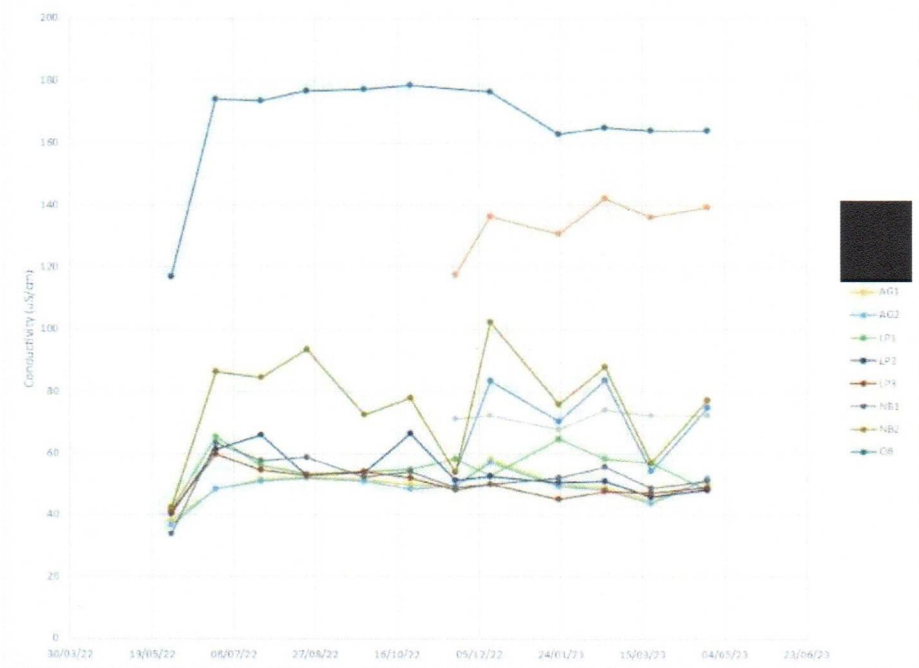


Figure 5.2 Conductivity (EC) Field Measurements May 2022 to April 2023

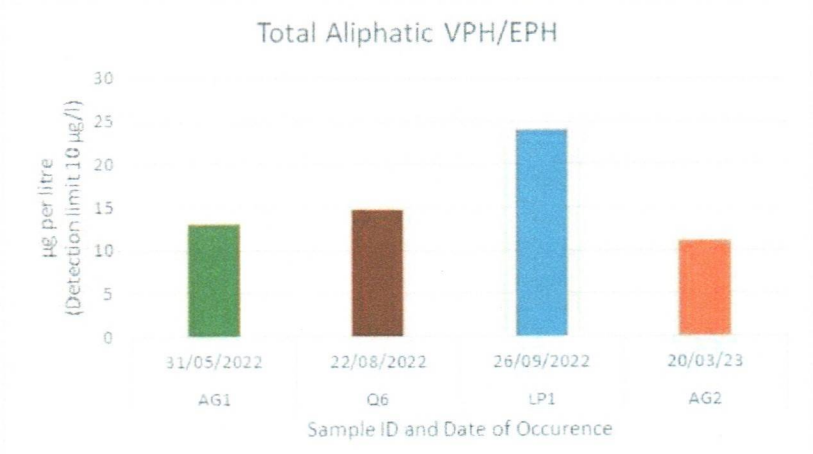


5.2 Laboratory Analysis

The following observations are made from reviewing the water quality data from samples analysed in the laboratory:

- There is agreement between laboratory results for conductivity and pH field parameters, except for May 2022, where field parameter values appear to be under-reported. This suggests field instrument error in May 2022, and the laboratory results are, therefore, to be regarded as a more accurate reflection of water quality conditions for these parameters in May 2022.
- The majority of organic chemical determinands were not detected, indicating that these determinands are either not present, or that concentrations were below the limit of detection.
- Minor detections of hydrocarbons (Aliphatic VPH/EPH >C5 - C44) slightly above detection limits occurred on four separate occasions (See Figure 5.3) at four different locations (AG1, AG2, LP1 and Q6). Groundworks for resurfacing a carpark adjacent to LP1 was coincident with detection, and may represent a source of VPH/EPH. However, groundworks were active during the October sampling, when VPH/EPH was not detected. Sample location AG1 on Afon Gwyrfai is next to a camping and caravan park close to vehicles, whilst agricultural land is found along the northern riverbank. AG2 is on the Afon Gwyrfai next to Gorsaf Waunfawr Railway Station. Q6 is the tail pond and is isolated from other water bodies, but it is occasionally visited by trespassers and there is HGV traffic on roads adjacent to the quarry, which is a possible source of dust and hydrocarbon contamination.

Figure 5.3 Detections of Aliphatic VPH/EPH (Total)



- Naphthalene and phenanthrene were found at 0.016 and 0.017 µg/l slightly above the detection limit of 0.010 µg/l at LP3 in October 2022. LP3 is next to the Pont Pen-y-llyn bridge linking the southern and northern areas of Llyn Padarn with national roads connecting to local urban settlements of Caernarfon to the Northwest and Bangor to the North.
- Dissolved copper, nickel, selenium and chromium were consistently below their detection limit, with minor exceptions. Chromium was present in all samples at Q6 at up to 1.2 µg/l.

- Dissolved iron was either below or slightly above the detection limit of 20 µg/l except for NB1 and NB2, which have mean concentrations of 183 µg/l and 173 µg/l respectively. Concentrations were variable, ranging from 55 µg/l to 420 µg/l.
- Dissolved lead was generally below the detection limit except in NB1 and NB2 where lead was present in all samples at up to 0.5 µg/l.
- Arsenic was present at low concentrations of up to 36 µg/l in most samples. Concentrations were highest at Q6, where they were an order of magnitude higher than in other samples.

5.3 Comparison with 2015 Q6 Tailpond Water Quality data

The scope of analytical testing for the 2022-2023 baseline water quality monitoring as described in the WTMP (2016) and varied following consultation with GCC, differs slightly from water quality sampling at Q6 conducted in 2012 and 2015 by ENSIS Ltd (scope agreed between AECOM and NRW). Where comparative analyses are available, minimum, maximum and mean values are tabulated in Table 5.1.

Table 5.1 Summary Comparison of Q6 Water Quality between 2015 and 2022

		Q6 May to August 2015 N = 11			Q6 2022/23 N = 11		
Analytical Parameter	**Units**	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean***
pH	pH units	6.8	8.3	7.59	7.5	8.1	7.9
Conductivity	µS/cm	160	190	182	150	165	158
Antimony (dissolved)	µg/l	1.5	3.1	1.8	<1.3	<1.3	<1.3
Arsenic (dissolved)	µg/l	2.68	5.52	3.53	3.00	3.60	3.18
Boron (dissolved)	µg/l	12.0	64.0	21.1	<56	<56	<56
Cadmium (dissolved)	µg/l	0.02	0.08	0.03	<0.02	<0.02	<0.02
Chromium (dissolved)	µg/l	1.0	2.6	1.4	0.80	1.20	1.05
Copper (dissolved)	µg/l	3.8	9.00	6.51	<4.00	<4.00	<4.00
Iron (dissolved)	µg/l	<4.00	120	20	<20.00	<20.00	<20.00
Lead (dissolved)	µg/l	0.2	2.8	0.49	<0.3	<0.3	<0.3
Manganese (dissolved)	µg/l	1.1	8.4	3.5	0.74	3.30	1.01
Mercury (dissolved)	µg/l	0.05	0.21	0.06	<0.01	0.02	0.02
Nickel (dissolved)	µg/l	0.5	1.1	0.6	<1.00	<1.00	<1.00
Selenium (dissolved)	µg/l	0.6	2.8	1.0	<1.2	<1.2	<1.2
Zinc (dissolved)	µg/l	1	6.6	2.5	<5.0	5.1	5.1

< denotes concentrations below minimum detectable limits. *of detects

The WFD Compliance Appraisal (AECOM, 2015) found that the 2015 water quality analysis at Q6 was similar to the water quality analysis reported in 2012.

The comparison in Table 5.1 indicates that there has not been any significant change in water quality at Q6 since 2015. For nearly all detected substances, the 2022/23 results are lower than earlier results. There are, however, subtle differences in detection limits between some analytical parameters, but where 2022 detection limits are higher than those in 2015, they are broadly comparable with 2015 mean values or below maximum values.

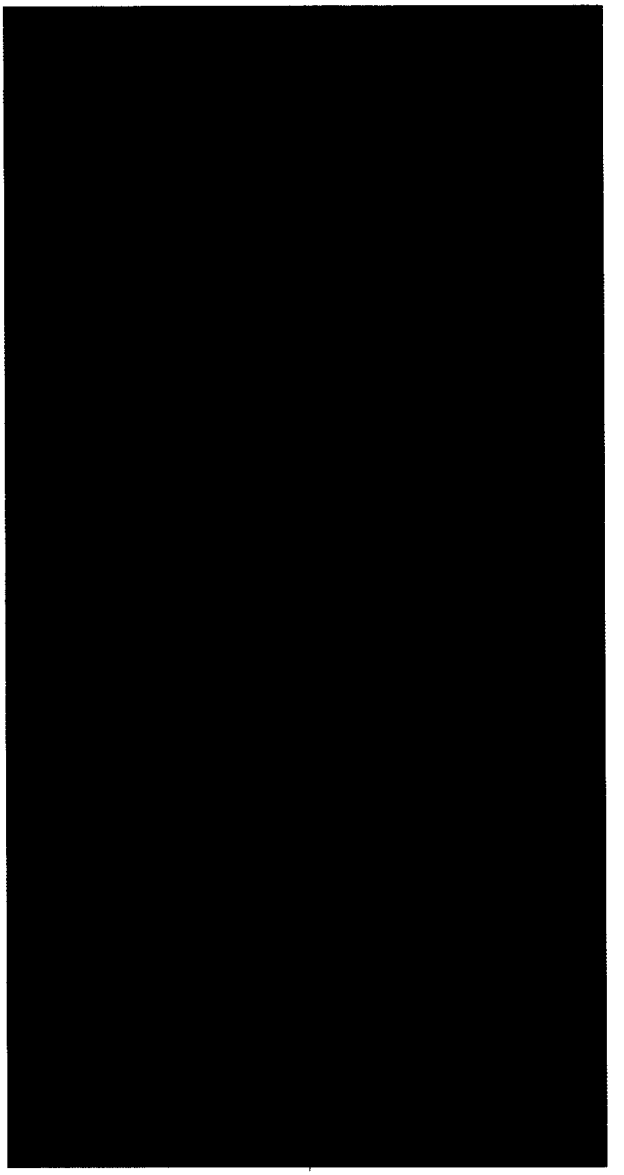
5.4 Analysis of drinking water from Private Water Supplies

The results of the analysis of drinking water samples taken at consumers taps in November 2022 and April 2023 have been compared to Drinking Water Standards (DWS) in Table 5.2. The compliance point for drinking water standards is the tap. [redacted]

Table 5.2 Comparison of PWS Results against Drinking Water Standards

Parameter	Units	DWS	[redacted]
Date			
TVC 37C 2 day	cfu/ml	no abnormal change	
TVC 22C 3 day	cfu/ml	no abnormal change	
Total Coliform presump	cfu/100ml	0	
Total Coliforms confirmed	cfu/100ml	0	
E. coli presumptive	cfu/100ml	0	
Escherichia coli confirmed	cfu/100ml	0	
Clostridium Perfringens, Conf	cfu/100ml	0	
Antimony, Total as Sb	µg/l	5	
Arsenic, Total as As	µg/l	10	
Cadmium, Total as Cd	µg/l	5	

Manganese, Total as Mn	µg/l	50
Chromium, Total as Cr	µg/l	50
Copper, Total as Cu	µg/l	2000
Lead, Total as Pb	µg/l	10
Nickel, Total as Ni	µg/l	20
Selenium, Total as Se	µg/l	10
Zinc, Total as Zn	µg/l	n/a
Hydrogen ion (pH)	pH units	>6<9
Conductivity	µS/cm	2500
Colour	mg/l Pt/Co	20
Nitrite as NO2	mg/l	0.5
Nitrate as NO3	mg/l	50
Total Oxidised Nitrogen as NO3	mg/l	
Fluoride, Total as F	µg/l	1.5
Mercury, Total as Hg	µg/l	1
Benzene	µg/l	1



PWS = Private Water Supply, DWS = drinking water standard
Values in bold exceed the DWS.

6. Conclusion

A 12-month programme of pre-construction water quality testing has been undertaken around the proposed scheme including sampling of surface waters in the tail pond, Llyn Padarn, Afon Gwyrfai and Nant y Betws. Three private water supplies were also tested at the abstraction point of their source. Additional sampling of the private water supplies at the tap was undertaken on two occasions. The testing programme included both field measurement and laboratory analysis.

The programme was undertaken to provide a pre-construction water quality baseline against which any impacts of the scheme on water quality during and post construction could be evaluated.

Water quality was generally good, and water showed minimal mineralisation indicating limited interaction between recharge and rocks. Water quality at Q6 was slightly different to elsewhere marked by higher concentrations of dissolved arsenic and chromium.

Minor pollution by hydrocarbons was found in a small number of samples from four different locations.

The assessment has found that the 2022/23 results are consistent with earlier results from 2012 and 2015.

References

AECOM (2012) Water quality sampling at four locations around Q6 and Q7 for range of physico-chemical, metal, and major ion parameters;

AECOM (2015) WFD Compliance Appraisal, DCO Appendix 9.1 Water Framework Directive Assessment;

AECOM (2016) Outline Water Management Plan, EN010072;

Wood plc (2022) Pre-Construction Phase Sampling Method Statement;

Appendix A 1
Water Quality Sampling Analysis Suites

Group	Suites / Determinands	Method Description	Matrix (Accreditation)	Reporting Limit	
Surface Water Analysis Suite	BOD + ATU (5 day)	WAS001 BOD in	SU(Y)	1	mg/l
	TOC (Filtered)	WAS005 TOC in		0.7	mg/l
Applicable to Sample locations LP1, LP2, Lp3, NB1, NB2, AG1 & AG2	Total Suspended Solids	WAS006 Suspended Solids in Water by Gravimetry	SU(Y)	1.0	mg/l
	Mercury, Filtered as Hg	WAS013 Mercury in	SU(Y)	0.00001	mg/l
	Mercury, Total as Hg	WAS013 Mercury in Water by CV-AFS	SU(Y)	0.00001	mg/l
	Alkalinity as CaCO3	WAS025 Alkalinity in	SU(Y)	2.3	mg/l
	Conductivity- Electrical 20C	WAS039 pH/ EC in Water by Electrode	SU(Y)	30	uS/cm
	pH	WAS039 pH/ EC in Water by Electrode	SU(Y)	1	pH units
	COD (Total)	WAS040 COD in	SU(Y)	11	mg/l
	Turbidity	WAS066 Turbidity in Water by Turbidimetry	SU(Y)	1.4	NTU
	Antimony, filter as Sb (mg/l)	WAS076 ICPMS	SU(Y)	0.0013	mg/l
	Antimony, total as Sb (mg/l)	WAS076 ICPMS	SU(Y)	0.0016	mg/l
	Arsenic, filter as As (mg/l)	WAS076 ICPMS	SU(Y)	0.0002	mg/l
	Arsenic, total as As (mg/l)	WAS076 ICPMS	SU(Y)	0.00024	mg/l
	Boron, filter as B (mg/l)	WAS076 ICPMS	SU(Y)	0.056	mg/l
	Boron, total as B (mg/l)	WAS076 ICPMS	SU(Y)	0.06	mg/l
	Cadmium, filter as Cd (mg/l)	WAS076 ICPMS	SU(Y)	0.00002	mg/l
	Cadmium, total as Cd (mg/l)	WAS076 ICPMS	SU(Y)	0.00007	mg/l
	Chromium, filter as Cr (mg/l)	WAS076 ICPMS	SU(Y)	0.0002	mg/l
	Chromium, total as Cr (mg/l)	WAS076 ICPMS	SU(Y)	0.00051	mg/l
	Copper, filter as Cu (mg/l)	WAS076 ICPMS	SU(Y)	0.004	mg/l
	Copper, total as Cu (mg/l)	WAS076 ICPMS	SU(Y)	0.0018	mg/l
	Iron, filter as Fe (mg/l)	WAS076 ICPMS	SU(Y)	0.02	mg/l
	Iron, total as Fe (mg/l)	WAS076 ICPMS	SU(Y)	0.025	mg/l
	Lead, filter as Pb (mg/l)	WAS076 ICPMS	SU(Y)	0.0003	mg/l
	Lead, total as Pb (mg/l)	WAS076 ICPMS	SU(Y)	0.0003	mg/l
	Manganese, filter as Mn (mg/l)	WAS076 ICPMS	SU(Y)	0.0002	mg/l
	Manganese, total as Mn (mg/l)	WAS076 ICPMS	SU(Y)	0.0017	mg/l
	Nickel, filter as Ni (mg/l)	WAS076 ICPMS	SU(Y)	0.001	mg/l
	Nickel, total as Ni (mg/l)	WAS076 ICPMS	SU(Y)	0.001	mg/l
	Selenium, filter as Se (mg/l)	WAS076 ICPMS	SU(Y)	0.0012	mg/l
	Selenium, total as Se (mg/l)	WAS076 ICPMS	SU(Y)	0.0006	mg/l
	Zinc, filter as Zn (mg/l)	WAS076 ICPMS	SU(Y)	0.005	mg/l
	Zinc, total as Zn (mg/l)	WAS076 ICPMS	SU(Y)	0.006	mg/l
	PAHs (16)				
	Acenaphthene	GEO81 PAH (EPA)	SU(Y)	0.01	ug/l
	Acenaphthylene	GEO81 PAH (EPA)	SU(Y)	0.01	ug/l
	Anthracene	GEO81 PAH (EPA)	SU(Y)	0.01	ug/l
	Benzo(a)anthracene	GEO81 PAH (EPA)	SU(Y)	0.01	ug/l
	Benzo(a)pyrene	GEO81 PAH (EPA)	SU(Y)	0.01	ug/l
	Benzo(b)fluoranthene	GEO81 PAH (EPA)	SU(Y)	0.01	ug/l
	Benzo(ghi)perylene	GEO81 PAH (EPA)	SU(Y)	0.01	ug/l
	Benzo(k)fluoranthene	GEO81 PAH (EPA)	SU(Y)	0.01	ug/l
	Chrysene	GEO81 PAH (EPA)	SU(Y)	0.01	ug/l
	Dibenzo(ah)anthracene	GEO81 PAH (EPA)	SU(Y)	0.01	ug/l
	Fluoranthene	GEO81 PAH (EPA)	SU(Y)	0.01	ug/l
	Fluorene	GEO81 PAH (EPA)	SU(Y)	0.01	ug/l
	Indeno(123cd)pyrene	GEO81 PAH (EPA)	SU(Y)	0.01	ug/l
	Naphthalene	GEO81 PAH (EPA)	SU(Y)	0.01	ug/l
	PAH, Total of 16	GEO81 PAH (EPA)		0.01	ug/l
	Phenanthrene	GEO81 PAH (EPA)	SU(Y)	0.01	ug/l
	Pyrene	GEO81 PAH (EPA)	SU(Y)	0.01	ug/l
	VPH/EPH combined (Ali/Aro)				
	Aliphatic EPH >C10 - C12	GEO46 EPH in water by GC-FID	DW(Y)	10	ug/l
	Aliphatic EPH >C10 - C44	GEO46 EPH in water by GC-FID	DW(Y)	10	ug/l
	Aliphatic EPH >C12 - C16	GEO46 EPH in water by GC-FID	DW(Y)	10	ug/l
	Aliphatic EPH >C16 - C35	GEO46 EPH in water by GC-FID		10	ug/l
	Aliphatic EPH >C35 - C44	GEO46 EPH in water by GC-FID		10	ug/l
	Aliphatic VPH >C5 - C10	GEO45 VPH in water by GC-FID & GCMS	SU(Y)	10	ug/l
	Aliphatic VPH >C5 - C6	GEO45 VPH in water by GC-FID & GCMS	SU(Y)	10	ug/l
	Aliphatic VPH >C6 - C8	GEO45 VPH in water	SU(Y)	10	ug/l
	Aliphatic VPH >C8 - 10	GEO45 VPH in water	SU(Y)	10	ug/l
	Aliphatic VPH/EPH >C5 - C44	GEO45/GEO46		10	ug/l
	Aromatic EPH >C10 - C12	GEO46 EPH in water by GC-FID	DW(Y)	10	ug/l
	Aromatic EPH >C10 - C44	GEO46 EPH in water by GC-FID	DW(Y)	10	ug/l
	Aromatic EPH >C12 - C16	GEO46 EPH in water	DW(Y)	10	ug/l
	Aromatic EPH >C16 - C21	GEO46 EPH in water by GC-FID	DW(Y)	10	ug/l
	Aromatic EPH >C21 - C35	GEO46 EPH in water by GC-FID		10	ug/l
	Aromatic EPH >C35 - C44	GEO46 EPH in water by GC-FID		10	ug/l
	Aromatic VPH >C5 - C10	GEO45 VPH in water by GC-FID & GCMS	SU(Y)	10	ug/l
	Aromatic VPH >C5 - C7	GEO45 VPH in water by GC-FID & GCMS	SU(Y)	10	ug/l
	Aromatic VPH >C7 - C8	GEO45 VPH in water by GC-FID & GCMS	SU(Y)	10	ug/l
	Aromatic VPH >C8 - C10	GEO45 VPH in water	SU(Y)	10	ug/l
	Aromatic VPH/EPH >C5 - C44	GEO45/GEO46		10	ug/l
	EPH >C10 - C44	GEO46 EPH in water	DW(Y)	10	ug/l
	VPH >C5 - C10	GEO45 VPH in water by GC-FID & GCMS	SU(Y)	10	ug/l
	VPH/EPH >C5 - C44	GEO45/GEO46		10	ug/l

Group	Suites / Determinands	Method Description	Matrix (Accreditation)	Reporting Limit	
Q6 Anayasis Suite **Applicable to sample location Q6 Quarry (Tail pond)**	BOD + ATU (5 day)	WAS001 BOD in Water	SU(Y)	1	mg/l
	TOC (Filtered)	WAS005 TOC in Water by IR		0.7	mg/l
	Total Suspended Solids	WAS006 Suspended Solids in Water by Gravimetry	SU(Y)	1.0	mg/l
	Mercury, Filtered as Hg	WAS013 Mercury in Water by CV-AFS	SU(Y)	0.00001	mg/l
	Mercury, Total as Hg	WAS013 Mercury in Water by CV-AFS	SU(Y)	0.00001	mg/l
	Alkalinity as CaCO3	WAS025 Alkalinity in Water by Titration	SU(Y)	2.3	mg/l
	Nitrate as N	WAS036 Anions by Colorimetry	SU(Y)	0.7	mg/l
	Nitrite as N	WAS036 Anions by Colorimetry	SU(Y)	0.08	mg/l
	Nitrogen, Total Oxidised as N	WAS036 Anions by Colorimetry	SU(Y)	0.7	mg/l
	Phosphate, Ortho as P	WAS036 Anions by Colorimetry	SU(Y)	0.6	mg/l
	Conductivity- Electrical 20C	WAS039 pH/ EC in Water by Electrode	SU(Y)	30	uS/cm
	pH	WAS039 pH/ EC in Water by Electrode	SU(Y)	1	pH units
	COD (Total)	WAS040 COD in Water by Colorimetry	SU(Y)	11	mg/l
	Turbidity	WAS066 Turbidity in	SU(Y)	1.4	NTU
	Antimony, filter as Sb (mg/l)	WAS076 ICPMS Metals	SU(Y)	0.0013	mg/l
	Antimony, total as Sb (mg/l)	WAS076 ICPMS Metals	SU(Y)	0.0016	mg/l
	Arsenic, filter as As (mg/l)	WAS076 ICPMS Metals	SU(Y)	0.0002	mg/l
	Arsenic, total as As (mg/l)	WAS076 ICPMS Metals	SU(Y)	0.00024	mg/l
	Boron, filter as B (mg/l)	WAS076 ICPMS Metals	SU(Y)	0.056	mg/l
	Boron, total as B (mg/l)	WAS076 ICPMS Metals	SU(Y)	0.06	mg/l
	Cadmium, filter as Cd (mg/l)	WAS076 ICPMS Metals	SU(Y)	0.00002	mg/l
	Cadmium, total as Cd (mg/l)	WAS076 ICPMS Metals	SU(Y)	0.00007	mg/l
	Chromium, filter as Cr (mg/l)	WAS076 ICPMS Metals	SU(Y)	0.0002	mg/l
	Chromium, total as Cr (mg/l)	WAS076 ICPMS Metals	SU(Y)	0.00051	mg/l
	Copper, filter as Cu (mg/l)	WAS076 ICPMS Metals	SU(Y)	0.004	mg/l
	Copper, total as Cu (mg/l)	WAS076 ICPMS Metals	SU(Y)	0.0018	mg/l
	Iron, filter as Fe (mg/l)	WAS076 ICPMS Metals	SU(Y)	0.02	mg/l
	Iron, total as Fe (mg/l)	WAS076 ICPMS Metals	SU(Y)	0.025	mg/l
	Lead, filter as Pb (mg/l)	WAS076 ICPMS Metals	SU(Y)	0.0003	mg/l
	Lead, total as Pb (mg/l)	WAS076 ICPMS Metals	SU(Y)	0.0003	mg/l
	Manganese, filter as Mn (mg/l)	WAS076 ICPMS Metals	SU(Y)	0.0002	mg/l
	Manganese, total as Mn (mg/l)	WAS076 ICPMS Metals	SU(Y)	0.0017	mg/l
	Nickel, filter as Ni (mg/l)	WAS076 ICPMS Metals	SU(Y)	0.001	mg/l
	Nickel, total as Ni (mg/l)	WAS076 ICPMS Metals	SU(Y)	0.001	mg/l
	Phosphorus, total as P (mg/l)	WAS076 ICPMS Metals	SU(Y)	0.013	mg/l

Group	Suites / Determinands	Method Description	Matrix (Accreditation)	Reporting Limit	
Q6	Selenium, filter as Se (mg/l)	WAS076 ICPMS Metals	SU(Y)	0.0012	mg/l
	Selenium, total as Se (mg/l)	WAS076 ICPMS Metals	SU(Y)	0.0006	mg/l
	Zinc, filter as Zn (mg/l)	WAS076 ICPMS Metals	SU(Y)	0.005	mg/l
	Zinc, total as Zn (mg/l)	WAS076 ICPMS Metals	SU(Y)	0.006	mg/l
	Ammoniacal Nitrogen as N	WAS036 Anions by Colorimetry	SU(Y)	0.41	mg/l
	PAHs (16)				
	Acenaphthene	GEO81 PAH (EPA)	SU(Y)	0.01	ug/l
	Acenaphthylene	GEO81 PAH (EPA)	SU(Y)	0.01	ug/l
	Anthracene	GEO81 PAH (EPA)	SU(Y)	0.01	ug/l
	Benzo(a)anthracene	GEO81 PAH (EPA)	SU(Y)	0.01	ug/l
	Benzo(a)pyrene	GEO81 PAH (EPA)	SU(Y)	0.01	ug/l
	Benzo(b)fluoranthene	GEO81 PAH (EPA)	SU(Y)	0.01	ug/l
	Benzo(ghi)perylene	GEO81 PAH (EPA)	SU(Y)	0.01	ug/l
	Benzo(k)fluoranthene	GEO81 PAH (EPA)	SU(Y)	0.01	ug/l
	Chrysene	GEO81 PAH (EPA)	SU(Y)	0.01	ug/l
	Dibenzo(ah)anthracene	GEO81 PAH (EPA)	SU(Y)	0.01	ug/l
	Fluoranthene	GEO81 PAH (EPA)	SU(Y)	0.01	ug/l
	Fluorene	GEO81 PAH (EPA)	SU(Y)	0.01	ug/l
	Indeno(123cd)pyrene	GEO81 PAH (EPA)	SU(Y)	0.01	ug/l
	Naphthalene	GEO81 PAH (EPA)	SU(Y)	0.01	ug/l
	PAH, Total of 16	GEO81 PAH (EPA)		0.01	ug/l
	Phenanthrene	GEO81 PAH (EPA)	SU(Y)	0.01	ug/l
	Pyrene	GEO81 PAH (EPA)	SU(Y)	0.01	ug/l
	Phenols				
	2,3,4,6-Tetrachlorophenol	SVOCs		0.1	ug/l
	2,3,5,6-Tetrachlorophenol	SVOCs		0.1	ug/l
	2,4,5-Trichlorophenol	SVOCs	SU(Y)	0.1	ug/l
	2,4,6-Trichlorophenol	SVOCs	SU(Y)	0.1	ug/l
	2,4-Dichlorophenol	SVOCs	SU(Y)	0.1	ug/l
	2,4-Dimethylphenol	SVOCs	SU(Y)	0.1	ug/l
	2,4-Dinitrophenol	SVOCs		5	ug/l
	2,6-Dichlorophenol	SVOCs	SU(Y)	0.1	ug/l
	2-Chlorophenol	SVOCs	SU(Y)	0.1	ug/l
	2-Methylphenol	SVOCs	SU(Y)	0.1	ug/l
	2-Nitrophenol	SVOCs	SU(Y)	0.1	ug/l
	3&4-Methylphenol	SVOCs	SU(Y)	0.1	ug/l
	3,5-Dimethylphenol	SVOCs	SU(Y)	0.1	ug/l
	4,6-Dinitro-2-Methylphenol	SVOCs		2	ug/l
	4-Chloro-3-methylphenol	SVOCs	SU(Y)	0.1	ug/l
	4-Chlorophenol	SVOCs	SU(Y)	0.1	ug/l
	4-Nitrophenol	SVOCs	SU(Y)	5	ug/l
	Pentachlorophenol	SVOCs	SU(Y)	1	ug/l
	Phenol	SVOCs	SU(Y)	0.5	ug/l
	SVOCs				
	1,2,4-Trichlorobenzene	SVOCs	SU(Y)	0.1	ug/l
	1,2-Dichlorobenzene	SVOCs	SU(Y)	0.1	ug/l
	1,3-Dichlorobenzene	SVOCs	SU(Y)	0.1	ug/l
	1,4-Dichlorobenzene	SVOCs	SU(Y)	0.1	ug/l
	2,4,5-Trichlorophenol	SVOCs	SU(Y)	0.1	ug/l
	2,4,6-Trichlorophenol	SVOCs	SU(Y)	0.1	ug/l
	2,4-Dichlorophenol	SVOCs	SU(Y)	0.1	ug/l
	2,4-Dimethylphenol	SVOCs	SU(Y)	0.1	ug/l
	2,4-Dinitrotoluene	SVOCs	SU(Y)	1	ug/l
	2,6-Dinitrotoluene	SVOCs	SU(Y)	1	ug/l
	2-Chloronaphthalene	SVOCs	SU(Y)	0.1	ug/l
	2-Chlorophenol	SVOCs	SU(Y)	0.1	ug/l
	2-Methylnaphthalene	SVOCs	SU(Y)	0.1	ug/l
	2-Methylphenol	SVOCs	SU(Y)	0.1	ug/l
	2-Nitrophenol	SVOCs	SU(Y)	0.1	ug/l
	3&4-Methylphenol	SVOCs	SU(Y)	0.1	ug/l
	4-Bromophenyl phenyl ether	SVOCs	SU(Y)	1	ug/l
	4-Chloro-3-methylphenol	SVOCs	SU(Y)	0.1	ug/l
	4-Chlorophenyl phenyl ether	SVOCs	SU(Y)	0.1	ug/l
	4-Nitrophenol	SVOCs	SU(Y)	5	ug/l
	Acenaphthene	SVOCs	SU(Y)	0.1	ug/l
	Acenaphthylene	SVOCs	SU(Y)	0.1	ug/l
	Anthracene	SVOCs	SU(Y)	0.1	ug/l
	Benz(a)anthracene	SVOCs	SU(Y)	0.1	ug/l
	Benzo(a)pyrene	SVOCs	SU(Y)	0.1	ug/l
	Benzo(b)fluoranthene	SVOCs	SU(Y)	0.1	ug/l

Group	Suites / Determinands	Method Description	Matrix (Accreditation)	Reporting Limit	
Q6	Benzo(ghi)perylene	SVOCs	SU(Y)	0.1	ug/l
	Benzo(k)fluoranthene	SVOCs	SU(Y)	0.1	ug/l
	Benzyl butyl phthalate	SVOCs	SU(Y)	1	ug/l
	Bis(2-chloroethoxy)methane	SVOCs	SU(Y)	1	ug/l
	Bis(2-chloroethyl)ether	SVOCs	SU(Y)	1	ug/l
	Bis(2-ethylhexyl)phthalate	SVOCs	SU(Y)	1	ug/l
	Bis(chloroisopropyl)ether	SVOCs	SU(Y)	1	ug/l
	Carbazole	SVOCs	SU(Y)	1	ug/l
	Chrysene	SVOCs	SU(Y)	0.1	ug/l
	Dibenzo(ah)anthracene	SVOCs	SU(Y)	0.1	ug/l
	Dibenzofuran	SVOCs	SU(Y)	0.1	ug/l
	Diethylphthalate	SVOCs	SU(Y)	1	ug/l
	Dimethylphthalate	SVOCs	SU(Y)	1	ug/l
	Di-n-butylphthalate	SVOCs	SU(Y)	5	ug/l
	Di-n-octyl phthalate	SVOCs	SU(Y)	1	ug/l
	Diphenylamine	SVOCs		1	ug/l
	Fluoranthene	SVOCs	SU(Y)	0.1	ug/l
	Fluorene	SVOCs	SU(Y)	0.1	ug/l
	Hexachlorobenzene	SVOCs	SU(Y)	0.1	ug/l
	Hexachlorobutadiene	SVOCs	SU(Y)	0.1	ug/l
	Hexachloroethane	SVOCs	SU(Y)	1	ug/l
	Indeno(1,2,3-cd)Pyrene	SVOCs	SU(Y)	0.1	ug/l
	Isophorone	SVOCs	SU(Y)	1	ug/l
	Naphthalene	SVOCs	SU(Y)	0.1	ug/l
	Nitrobenzene	SVOCs	SU(Y)	1	ug/l
	n-Nitroso-di-n-propylamine	SVOCs	SU(Y)	1	ug/l
	Pentachlorophenol	SVOCs	SU(Y)	1	ug/l
	Phenanthrene	SVOCs	SU(Y)	0.1	ug/l
	Phenol	SVOCs	SU(Y)	0.5	ug/l
	Pyrene	SVOCs	SU(Y)	0.1	ug/l
	VOC HS Waters				
	1,1,1,2-Tetrachloroethane	GEO76 VOC in water	SU(Y)	1	ug/l
	1,1,1-Trichloroethane	GEO76 VOC in water	SU(Y)	1	ug/l
	1,1,2,2-Tetrachloroethane	GEO76 VOC in water	SU(Y)	1	ug/l
	1,1,2-Trichloroethane	GEO76 VOC in water	SU(Y)	1	ug/l
	1,1-Dichloroethane	GEO76 VOC in water	SU(Y)	1	ug/l
	1,1-Dichloroethene	GEO76 VOC in water	SU(Y)	1	ug/l
	1,1-Dichloropropene	GEO76 VOC in water	SU(Y)	1	ug/l
	1,2,3-Trichlorobenzene	GEO76 VOC in water	SU(Y)	1	ug/l
	1,2,3-Trichloropropane	GEO76 VOC in water	SU(Y)	1	ug/l
	1,2,4-Trichlorobenzene	GEO76 VOC in water	SU(Y)	1	ug/l
	1,2,4-Trimethylbenzene	GEO76 VOC in water	SU(Y)	1	ug/l
	1,2-Dibromo-3-chloropropane	GEO76 VOC in water	SU(Y)	2	ug/l
	1,2-Dibromoethane	GEO76 VOC in water	SU(Y)	1	ug/l
	1,2-Dichlorobenzene	GEO76 VOC in water	SU(Y)	1	ug/l
	1,2-Dichloroethane	GEO76 VOC in water	SU(Y)	1	ug/l
	1,2-Dichloropropane	GEO76 VOC in water	SU(Y)	1	ug/l
	1,3,5-Trimethylbenzene	GEO76 VOC in water	SU(Y)	1	ug/l
	1,3-Dichlorobenzene	GEO76 VOC in water	SU(Y)	1	ug/l
	1,3-Dichloropropane	GEO76 VOC in water	SU(Y)	1	ug/l
	1,4-Dichlorobenzene	GEO76 VOC in water	SU(Y)	1	ug/l
	2,2-Dichloropropane	GEO76 VOC in water	SU(Y)	1	ug/l
	2-Chlorotoluene	GEO76 VOC in water	SU(Y)	1	ug/l
	4-Chlorotoluene	GEO76 VOC in water	SU(Y)	1	ug/l
	Benzene	GEO76 VOC in water	SU(Y)	1	ug/l
	Bromobenzene	GEO76 VOC in water	SU(Y)	1	ug/l
	Bromochloromethane	GEO76 VOC in water	SU(Y)	1	ug/l
	Bromodichloromethane	GEO76 VOC in water	SU(Y)	1	ug/l
	Bromoform	GEO76 VOC in water	SU(Y)	1	ug/l
	Bromomethane	GEO76 VOC in water	SU(Y)	1	ug/l
	Carbon Tetrachloride	GEO76 VOC in water	SU(Y)	1	ug/l
	Chlorobenzene	GEO76 VOC in water	SU(Y)	1	ug/l
	Chloroethane	GEO76 VOC in water	SU(Y)	1	ug/l
	Chloroform	GEO76 VOC in water	SU(Y)	1	ug/l
	Chloromethane	GEO76 VOC in water	SU(Y)	2	ug/l
	cis-1,2-Dichloroethene	GEO76 VOC in water	SU(Y)	1	ug/l
	cis-1,3-Dichloropropene	GEO76 VOC in water	SU(Y)	1	ug/l
	Dibromochloromethane	GEO76 VOC in water	SU(Y)	1	ug/l
	Dibromomethane	GEO76 VOC in water	SU(Y)	1	ug/l
	Dichlorodifluoromethane	GEO76 VOC in water		1	ug/l
	Dichloromethane	GEO76 VOC in water	SU(Y)	1	ug/l
	Ethyl Benzene	GEO76 VOC in water	SU(Y)	1	ug/l
	Hexachlorobutadiene	GEO76 VOC in water	SU(Y)	1	ug/l
	Iso-Propylbenzene	GEO76 VOC in water	SU(Y)	1	ug/l
	m&p Xylene	GEO76 VOC in water	SU(Y)	1	ug/l
	MTBE	GEO76 VOC in water	SU(Y)	1	ug/l
	Naphthalene	GEO76 VOC in water	SU(Y)	1	ug/l

Group	Suites / Determinands	Method Description	Matrix (Accreditation)	Reporting Limit	
Q6	n-butylbenzene	GEO76 VOC in water	SU(Y)	1	ug/l
	n-propylbenzene	GEO76 VOC in water	SU(Y)	1	ug/l
	o-Xylene	GEO76 VOC in water	SU(Y)	1	ug/l
	p-isopropyltoluene	GEO76 VOC in water	SU(Y)	1	ug/l
	sec-butylbenzene	GEO76 VOC in water	SU(Y)	1	ug/l
	Styrene	GEO76 VOC in water	SU(Y)	1	ug/l
	tert-Butylbenzene	GEO76 VOC in water	SU(Y)	1	ug/l
	Tetra and Trichloroethene	GEO76 VOC in water		1	ug/l
	Tetrachloroethene	GEO76 VOC in water	SU(Y)	1	ug/l
	Toluene	GEO76 VOC in water	SU(Y)	1	ug/l
	Total THM	GEO76 VOC in water		1	ug/l
	trans-1,2-Dichloroethene	GEO76 VOC in water	SU(Y)	1	ug/l
	trans-1,3-Dichloropropene	GEO76 VOC in water	SU(Y)	1	ug/l
	Trichloroethene	GEO76 VOC in water	SU(Y)	1	ug/l
	Trichlorofluoromethane	GEO76 VOC in water	SU(Y)	1	ug/l
	Vinyl Chloride	GEO76 VOC in water	SU(Y)	0.5	ug/l
	Xylene, Total	GEO76 VOC in water		1	ug/l
	VPH/EPH combined (Ali/Aro)				
	Aliphatic EPH >C10 - C12	GEO46 EPH in water by GC-FID	DW(Y)	10	ug/l
	Aliphatic EPH >C10 - C44	GEO46 EPH in water by GC-FID	DW(Y)	10	ug/l
	Aliphatic EPH >C12 - C16	GEO46 EPH in water by GC-FID	DW(Y)	10	ug/l
	Aliphatic EPH >C16 - C35	GEO46 EPH in water by GC-FID		10	ug/l
	Aliphatic EPH >C35 - C44	GEO46 EPH in water by GC-FID		10	ug/l
	Aliphatic VPH >C5 - C10	GEO45 VPH in water by GC-FID & GCMS	SU(Y)	10	ug/l
	Aliphatic VPH >C5 - C6	GEO45 VPH in water by GC-FID & GCMS	SU(Y)	10	ug/l
	Aliphatic VPH >C6 - C8	GEO45 VPH in water by GC-FID & GCMS	SU(Y)	10	ug/l
	Aliphatic VPH >C8 - 10	GEO45 VPH in water	SU(Y)	10	ug/l
	Aliphatic VPH/EPH >C5 - C44	GEO45/GEO46 Headspace GC-FID/GC-FID		10	ug/l
	Aromatic EPH >C10 - C12	GEO46 EPH in water by GC-FID	DW(Y)	10	ug/l
	Aromatic EPH >C10 - C44	GEO46 EPH in water by GC-FID	DW(Y)	10	ug/l
	Aromatic EPH >C12 - C16	GEO46 EPH in water by GC-FID	DW(Y)	10	ug/l
	Aromatic EPH >C16 - C21	GEO46 EPH in water by GC-FID	DW(Y)	10	ug/l
	Aromatic EPH >C21 - C35	GEO46 EPH in water by GC-FID		10	ug/l
	Aromatic EPH >C35 - C44	GEO46 EPH in water by GC-FID		10	ug/l
	Aromatic VPH >C5 - C10	GEO45 VPH in water by GC-FID & GCMS	SU(Y)	10	ug/l
	Aromatic VPH >C5 - C7	GEO45 VPH in water by GC-FID & GCMS	SU(Y)	10	ug/l
	Aromatic VPH >C7 - C8	GEO45 VPH in water by GC-FID & GCMS	SU(Y)	10	ug/l
	Aromatic VPH >C8 - C10	GEO45 VPH in water by GC-FID & GCMS	SU(Y)	10	ug/l
	Aromatic VPH/EPH >C5 - C44	GEO45/GEO46 Headspace GC-FID/GC-FID		10	ug/l
	EPH >C10 - C44	GEO46 EPH in water by GC-FID	DW(Y)	10	ug/l
	VPH >C5 - C10	GEO45 VPH in water by GC-FID & GCMS	SU(Y)	10	ug/l
	VPH/EPH >C5 - C44	GEO45/GEO46 Headspace GC-FID/GC-FID		10	ug/l

Group	Suite / Determinand	Method Description	Matrix (accreditation)	Units	Reporting Limit
PWS Analysis Suite	TVC 37C 2 day	W1	DW(Y)	cfu/ml	0
	TVC 22C 3 day	W1	DW(Y)	cfu/ml	0
Applicable to Sample Locations PWS-1, PWS-2 & PWS-3	Total Coliform presump	W10	DW(Y)	cfu/100ml	0
	Total Coliforms confirmed	W10	DW(Y)	cfu/100ml	0
	E.coli presumptive	W10	DW(Y)	cfu/100ml	0
	Escherichia coli confirmed	W10	DW(Y)	cfu/100ml	0
	Clostridium Perfringens, Conf	W8	DW(Y)	cfu/100ml	0
	Antimony, Total as Sb	WPC15	DW(Y)	ug/l	0.07
	Arsenic, Total as As	WPC15	DW(Y)	ug/l	0.15
	Cadmium, Total as Cd	WPC15	DW(Y)	ug/l	0.03
	Manganese, Total as Mn	WPC12/49	DW(Y)	ug/l	0.85
	Chromium, Total as Cr	WPC15	DW(Y)	ug/l	0.18
	Copper, Total as Cu	WPC15	DW(Y)	ug/l	0.36
	Lead, Total as Pb	WPC15	DW(Y)	ug/l	0.81
	Nickel, Total as Ni	WPC15	DW(Y)	ug/l	0.18
	Selenium, Total as Se	WPC15	DW(Y)	ug/l	0.32
	Zinc, Total as Zn	WPC15	DW(Y)	ug/l	0.6
	Hydrogen ion (pH)	WPC8	DW(Y)	pH units	1
	Conductivity	WPC7	DW(Y)	uS/cm	30
	Colour	WPC13	DW(Y)	mg/l Pt/Co	
	Nitrite as NO2	WPC64	DW(Y)	mg/l	0.003
	Nitrate as NO3	WPC64	DW(Y)	mg/l	2.11
	Total Oxidised Nitrogen as NO3	WPC64	DW(Y)	mg/l	2.13
	Fluoride, Total as F	WPC20	DW(Y)	ug/l	40
	Mercury, Total as Hg	WPC21	DW(Y)	ug/l	0.04
	Benzene	WPC28	DW(Y)	ug/l	0.06
	Benzo(b)fluoranthene	WPC27	DW(Y)	ug/l	0.00039
	Benzo(k)fluoranthene	WPC27	DW(Y)	ug/l	0.00053
	Benzo(ghi)perylene	WPC27	DW(Y)	ug/l	0.00043
	Benzo(a)pyrene	WPC27	DW(Y)	ug/l	0.00057
	Fluoranthene	WPC27	DW(Y)	ug/l	0.00088
	Indeno(1,2,3cd)pyrene	WPC27	DW(Y)	ug/l	0.00079
	Total PAHs 4 Constituents	WPC27	DW(Y)	ug/l	
	Vinyl Chloride	WPC63	DW(Y)	ug/l	0.13
	Boron, Total as B	WPC12/49	DW(Y)	ug/l	
	Clostridium Perfringens, Pres	W8	DW(Y)	cfu/100ml	0
	PAH Total ug/l	WPC27	DW(Y)	ug/l	

Appendix A 2
Laboratory Water Quality Analysis Results - Surface Water Samples

Appendix A 3
Q6 2015 Water Quality Results

Table C4 Water Quality Results from Q6

Sample Reference				Q6-1	Q6-2	Q6-3	Q6-5	Q6-6	Q6-7	Q6-8	Q6-9	Q6-10	Q6-11	Q6-12	Ave	Max	Min
Date Sampled				18/05/2015	18/05/2015	26/05/2015	01/06/2015	08/06/2015	15/06/2015	22/06/2015	06/07/2015	20/07/2015	03/08/2015	17/08/2015			
Analytical Parameter (Soil Analysis)	Units	EQS	LOD	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result			
pH	pH Units	N/A	N/A	7.60	7.70	7.80	7.70	6.80	7.80	8.30	6.8	7.6	7.7	7.70	7.59	8.3	6.8
Electrical Conductivity	µS/cm	N/A	10	190.00	190.00	190.00	190.00	190.00	180.00	180.00	190	180	160	160	182	190	160
Total Cyanide	µg/l	Annual ave. 1 ug/l and MAC 5 ug/l	10	<10.00	<10.00	<10.00	<10.00	<10.00	<10.00	<10.00	<10.00	<10.00	<10.00	<10.00	<10	<10	<10
Sulphate as SO_4	µg/l	400 mg/l (f/w EQS)	45	4950.00	5010.00	4300.00	4120.00	4580.00	4560.00	4950.00	4740	4590	4620	4240	4605	5010	4120
Chloride	mg/l	250 mg/l (f/w EQS)	0.15	7.50	6.90	32.00	9.80	10.00	10.00	9.80	8.3	13	11	11.00	11.75	32	6.9
Total Phosphate as PO4	µg/l	Specific to Llyn Padarn: 6.5 ug/l (High status); <10 ug/l (Good status); <20 ug/l (Moderate status)	20	20.00	<20.00	No data	No data	22.00	65.00	23.00	<20.00	67.00	21.00	67.00	36.11	67	20
Ammoniacal Nitrogen as N	µg/l	0.2 mg/l (High status); 0.3 mg/l (Good status) (90^{th})	15	<15.00	97.00	<15.00	<15.00	<15.00	<15.00	160.00	<15.00	180	<15.00	< 15	54.20	180	15
Nitrate as N	mg/l	N/A	0.25	0.50	0.30	<0.30	0.40	0.30	0.40	0.21	0.36	0.23	0.28	0.29	0.32	0.5	0.21
Nitrite as N	µg/l	N/A	25	<25.00	<25.00	<25.00	34.00	28.00	2.00	19.00	7	48	53	37.00	27.55	53	2
Alkalinity	mg/l	N/A	3	110.00	110.00	82.00	88.00	78.00	73.00	93.00	68	100	86	89.00	88.82	110	68
Chemical Oxygen Demand (Total)	mg/l	N/A	2	5.90	<2.00	2.30	<2.00	6.50	2.90	3.80	3.1	5.1	3.1	< 2.0	3.67	6.5	2
BOD	mg/l	3 mg/l (High status); 4mg/l (Good status) (90^{th})	1	1.20	1.70	2.10	1.10	1.10	<1.00	1.10	1.4	<1.00	<1.00	< 1.0	1.27	2.1	1
Aluminium (dissolved)	mg/l	N/A	0.001	0.01	0.13	<0.001	0.00	<0.001	0.00	0.01	<0.001	0.0108	0.002	0.00	0.02	0.131	0.001
Antimony (dissolved)	µg/l	N/A	0.4	1.50	1.70	1.50	1.50	1.70	3.10	1.70	2	1.8	1.6	1.60	1.79	3.1	1.5
Arsenic (dissolved)	µg/l	Annual ave. 50 ug/l	0.15	5.52	3.81	3.18	3.52	2.68	3.70	3.24	3.47	3.36	3.08	3.25	3.53	5.52	2.68
Barium (dissolved)	µg/l	N/A	0.06	560.00	560.00	560.00	490.00	520.00	550.00	550.00	550	620	680	540.00	561.82	680	490
Boron (dissolved)	µg/l	N/A	10	23.00	21.00	15.00	16.00	15.00	14.00	16.00	18	12	64	18.00	21.09	64	12
Cadmium (dissolved)	µg/l	0.08 ug/l (annual ave.) & 0.45 ug/l MAC	0.02	<0.02	0.08	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.03	0.08	0.02
Chromium (dissolved)	µg/l	Annual ave. 3.4 (CrVI) and 4.7 (CrIII) & 32 ug/l MAC (95^{th}) for CrIII	0.2	1.00	1.40	1.10	1.30	1.10	1.10	1.10	1	1.2	2.6	1.90	1.35	2.6	1
Cobalt (dissolved)	µg/l	N/A	0.2	<0.20	<0.20	0.6	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0.24	0.6	0.2
Copper (dissolved)	µg/l	Annual ave. 1 ug/l bioavailable	0.5	5.70	9.00	6.40	7.70	5.80	8.00	6.50	3.8	7.4	4.8	6.50	6.51	9	3.8
Iron (dissolved)	ug/l	Annual ave. 1 ug/l bioavailable	4	20	120	10	20	30	10	10	<4	29	9	10	20	120	<4
Lead (dissolved)	µg/l	Annual ave. 1.2 ug/l & 14 ug/l MAC	0.2	<0.20	2.80	0.30	0.20	<0.20	0.60	<0.20	<0.20	0.3	<0.20	<0.20	0.49	2.8	0.2
Lithium (dissolved)	µg/l	N/A	1	6.90	6.30	3.70	2.00	1.80	2.30	2.50	1	2.7	3	3.20	3.22	6.9	1
Manganese (dissolved)	µg/l	Annual ave. 123 ug/l bioavailable	0.05	1.50	8.40	1.10	5.00	3.90	2.90	1.60	5.3	1.3		3.70	3.47	8.4	1.1
Mercury (dissolved)	µg/l	N/A	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.21	<0.05	0.06	0.21	0.05
Molybdenum (dissolved)	µg/l	N/A	0.05	0.09	0.89	0.36	0.17	0.26	0.74	0.61	0.56	0.6	0.48	0.49	0.48	0.89	0.09
Nickel (dissolved)	µg/l	Annual ave. 4 ug/l & 8.6 ug/l MAC	0.5	<0.50	1.10	<0.50	<0.50	1.00	<0.50	<0.50	<0.50	0.8	<0.50	<0.50	0.63	1.1	0.5
Phosphorus (dissolved)	µg/l	SRP Not relevant to lakes	30	<30.00	<30.00	<30.00	<30.00	<30.00	<30.00	<30.00	<30.00	<30.00	<30.00	<30.00	30.00	30	30
Selenium (dissolved)	µg/l	N/A	0.6	2.80	1.60	<0.60	<0.60	<0.60	<0.60	<0.60	0.7	<0.60	1	1.70	1.04	2.8	0.6
Strontium (dissolved)	µg/l	N/A	50	85.00	86.00	89.00	78.00	85.00	89.00	90.00	93	91	88	93.00	87.91	93	78
Zinc (dissolved)	µg/l	Annual ave. 10.9 ug/l+background (i.e. plus 1.4 ug/l)	0.5	2.50	6.60	2.20	2.60	2.60	2.60	1.60	2.5	2.9	1	2.10	2.65	6.6	1
Calcium (dissolved)	mg/l	N/A	0.012	21.00	21.00	21.00	19.00	20.00	20.00	21.00	21	21	20	20.00	20.45	21	19
Magnesium (dissolved)	mg/l	N/A	0.005	5.40	5.40	5.30	4.80	5.00	4.70	5.00	5.1	5.3	5.1	4.70	5.07	5.4	4.7
Potassium (dissolved)	mg/l	N/A	0.025	0.54	0.55	0.63	0.59	0.54	0.53	0.54	0.57	0.59	0.83	0.70	0.60	0.83	0.53
Sodium (dissolved)	mg/l	170 mg/l (f/w EQS)	0.01	5.70	5.60	5.80	5.20	5.70	6.10	6.40	5.7	5.2	5.8	5.30	5.68	6.4	5.2

Notes:

1) Results below the LOD have been included in the summary statistics as the LOD value.
2) 'f/w EQS refers to the former river EQS. Please refer to Section 2.4.2 for further details.
3) N/A refers to where no EQS exists. Underlined analytical parameters are those with WFD standard.

Appendix A 4
Laboratory Results of PWS Drinking Water Samples

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