Appendix 12D

Groundwater Yield Report

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FACTUAL REPORT ON RECONDITIONING AND TEST PUMPING OF PW1: DERRYGREENAGH, CO. OFFALY

Prepared for:

Fichtner / Bord Na Mona

Prepared by:

HYDRO-ENVIRONMENTAL SERVICES

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1. INTRODUCTION

1.1 BACKGROUND

Bord na Móna propose to develop as gas powered power station at Derrygreenagh Co. Offaly. The proposal requires a reliable and significant water supply.

The purpose of this investigation is to provide additional information on an existing groundwater borehole (subsequently referred to as PW1) onsite for purposes of replacing the existing onsite groundwater supply borehole, referred to as the "Hostel Well" and of meeting the water requirements of a proposed energy generation plant.

The borehole PW1 was completed, developed and test pumped in 2008 to determine the deployable yield, which was determined at the time of testing to be 630 m^3/day.

As outlined in this report contemporary investigation works have been completed in accordance with the specification document entitled: "*Reconditioning and Test Pumping: Derrygreenagh, Co. Offaly – Specification for Investigation Works, Rev B, dated 04th July 2023*".

The works included:

- Reconditioning of well PW1;
- Step pumping test in PW1;
- Constant rate pumping test in PW1;
- Monitoring of various observation wells during the step test and constant rate pumping test; and,
- Water sampling for laboratory analysis during the step test (2 no. samples), and during the constant rate pumping test (2 no).
- Factual reporting.

The main works proposed, and the purpose of this contract are the reconditioning, development and test pumping of borehole PW1, the impact on the groundwater levels across the Main Site and to identify any variations in the quality of the pumped groundwater.

1.2 SITE LOCATION

The Site is located in the townland of Derrygreenagh, Co. Offaly and is situated along the R400, 2.25km southeast of Junction 3, of the M6 motorway.

Elevation on the Site is ranges from 80mOD – 90mOD. The surrounding land is relatively flat, with elevation steadily remaining at 80mOD.

The centre of the site is given in the following coordinates: 649513.632, 738320.753 (ITM). A site location map is shown in **Figure A** below.

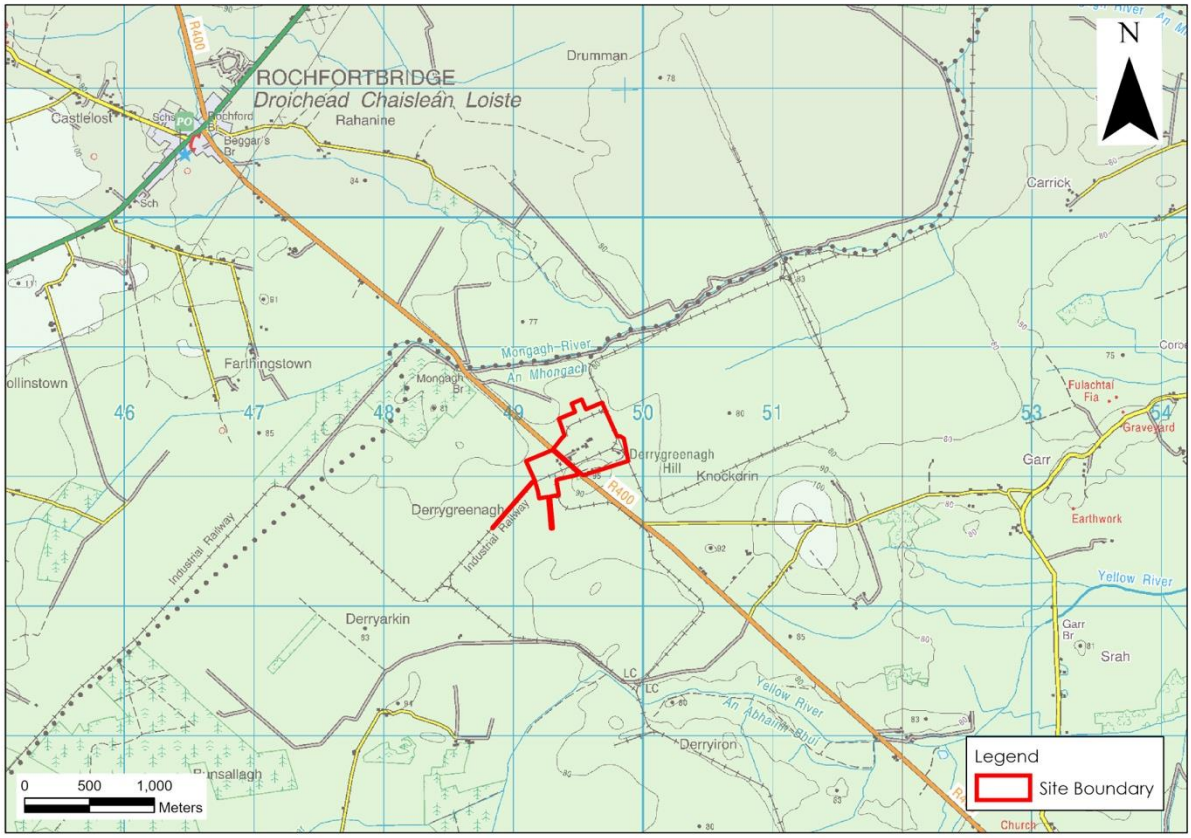


Figure A: Site Location Map

2. ENVIRONMENTAL SETTING

2.1 SITE GEOLOGY

The Site itself is a "mineral island", situated between an extensive area of peat bog on all sides. The GSI (www.gsi.ie) has mapped the soils underneath the Site to be till derived chiefly from limestone. These limestone tills are described as being deep basic mineral soils that are well drained (BminDW). The immediate surrounding land has been mapped by the GSI as consisting of Cut Peat, which is very poorly drained.

The Site is situated over the Lucan Formation, denoted by its dark limestone and shale (calp). The GSI maps this formation as ranging in thickness, from 300m – 800m. There are smaller areas of volcanic agglomerate to the southwest and northwest of the Site.

There are no faults directly beneath the Site, however there are a number of faults in the surrounding areas, some as close as 1.25km to the south.

2.2 SITE HYDROGEOLOGY

The Site is located over the Athboy GWB (IE_EA_G_001) which is shown by the EPA (www.epa.ie) to be of 'poorly productive bedrock' within the Dinantian Upper Impure Limestones. This groundwater body is also deemed to be at risk from agricultural activities.

The majority of the land around the Site, which consists of peat, will favour surface water runoff as the peat is very poorly drained, and this has an annual recharge coefficient of 4% or 22mm/year. The Site itself, the GSI has mapped has an annual recharge coefficient of 7.5% or 39mm/year. Made ground on the Site has been given an annual recharge coefficient of 20%.

Static groundwater level in pumping borehole PW1 is 6.72mbtoc (below top of casing).

A number of sand and gravel extractions pits have been excavated below the surrounding peat bogs. These areas of exposed subsoils will likely increase groundwater vulnerability, but will also increase recharge locally.

There are no Group Waster Schemes or Public Water Supply Schemes or any associated source protection areas located near the site. The Toberdaly PWS is located 5km southeast of the Site (GSI, 1996)[1].

2.3 PREVIOUS SITE INVESTIGATIONS

Previous site investigations works included:

- PW1 – drilled in 2008, well log attached in **Appendix I**;
- Current SI monitoring wells (IDL, 2023), including BH101, BH103, BH104, BH105, BH106, BH109, BH111A, BH112 , BH113, BH116C, BH116R, BH117, BHSS04, and BHSS07.

The Hostel Well supplies water to the existing works site. There are no details (drill date, depth, contractor, etc) available for this well.

We also used an existing monitoring well (which we have referred to as MW1) for water level monitoring during the pumping test. This older monitoring well is located beside BH104 and close to PW1.

A site map showing locations of the pumping well PW1, and all the other observation wells around the site is presented in **Figure B**.

[1] *Toberdaly Public Supply – Groundwater Source Protection Zones (draft), (GSI, 1996).*

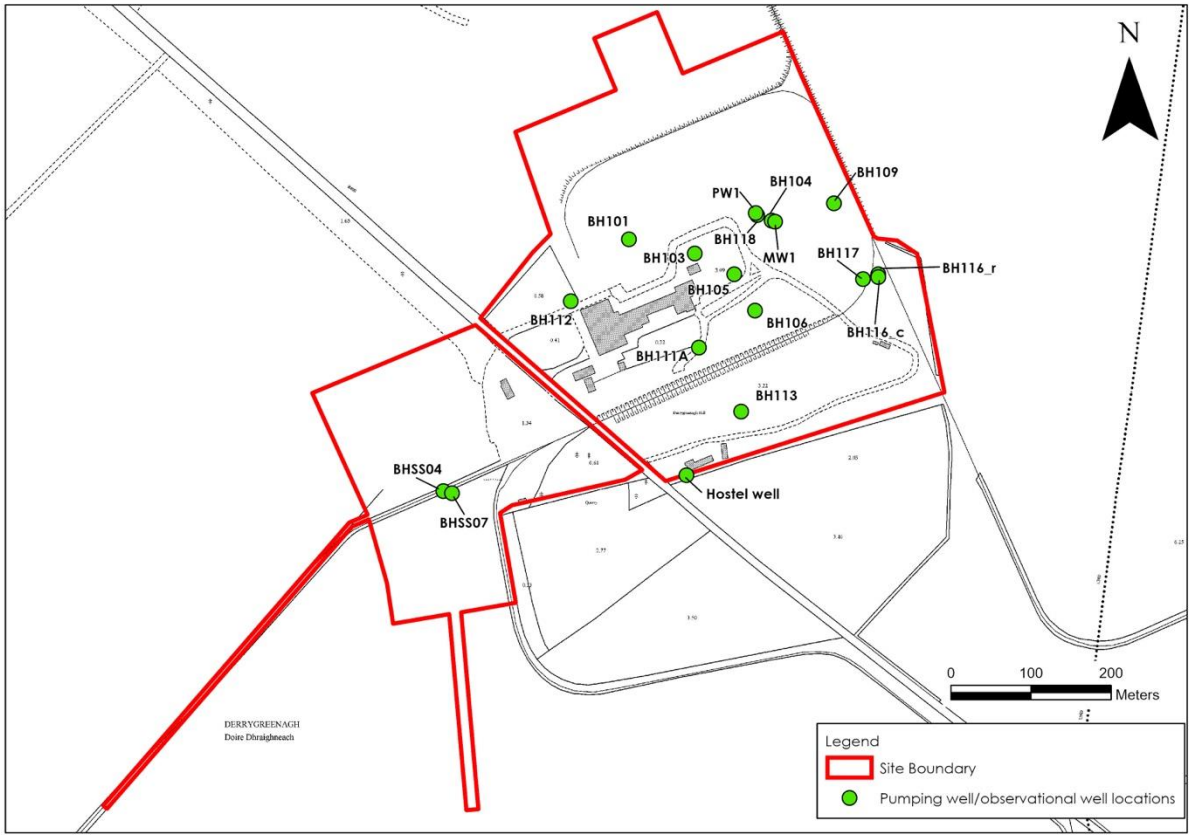


Figure B: Pumping Well and Observation Well Location Map

2.4 PREVIOUS PUMPING TEST IN PW1

A previous step test and constant rate pumping test was completed in PW1 in 2008 (Appendix H: Glover Site Investigation Ltd: Report Ref 08-0221). Drawdown curves for PW1 and observation wells during of those tests are included in **Figure C** and **Figure D**[2].

In 2008 records indicate that PW1 was pumped at 604.8 m^3/day, and a total drawdown of 4.7m was recorded.

[2] *We have no information on the distance and location of the observation wells used in the 2008 pumping test relative to PW1 (note one of the observation wells is MW1 as referenced in this report, but we can't confirm which one of the four observation MW1 is).*

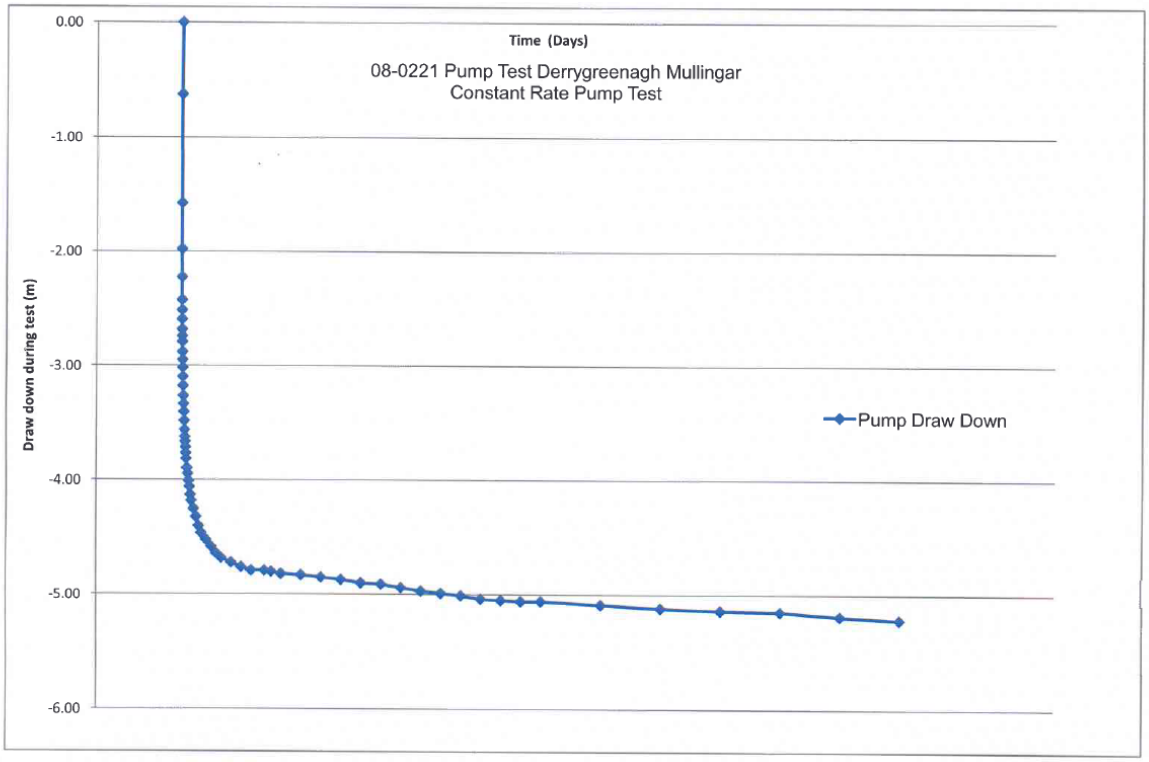


Figure C: 2008 CRT Pumping Test Plot – PW1

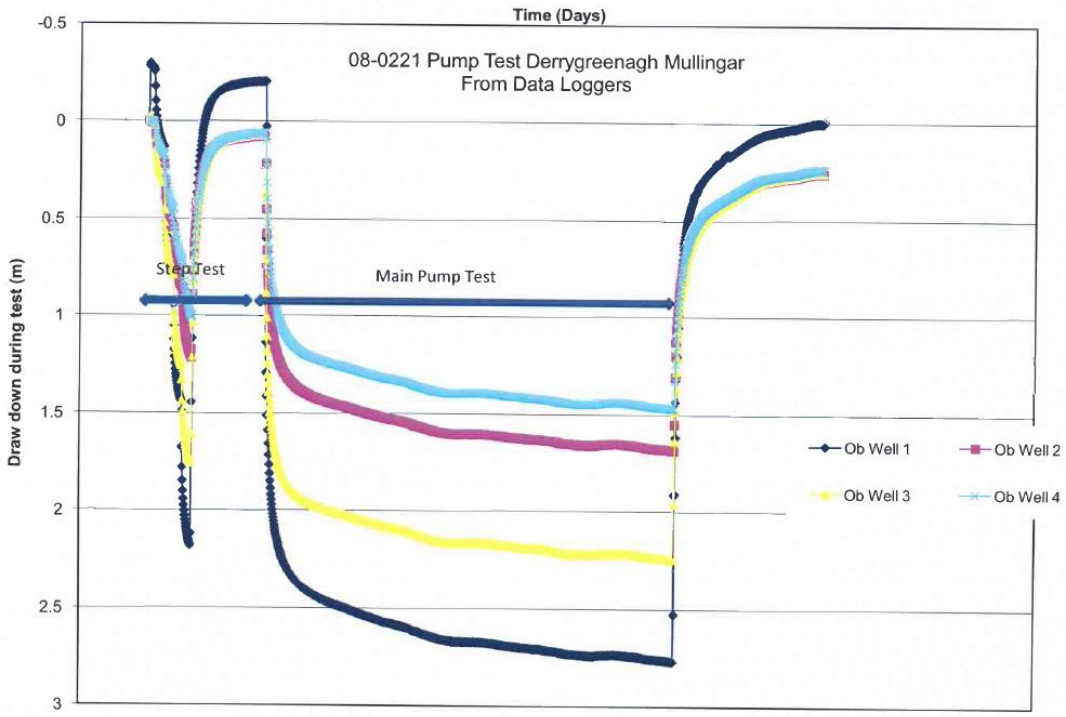


Figure D: 2008 ST and CRT Pumping Test Plot – Observation Wells

3. WELL REHABILITATION WORKS

Dempsey's well drilling completed the well rehabilitation works.

Rehabilitation works comprised the following:

- Day 1 setup drill rig over the well
- Day 1 and 2, slowly brushing the inside of the well (day 1 - 0-42m, Day 2 - 42-65m)
- Day 2 – airlifting the well using the compressor on the drill rig, slowly moving down and up in short intervals (<3m), and back down again within the well
- Day 3 – continued airlifting up and down and up the well

Of note the following was recorded:

- A short open drain (not connected to any other BnM drain) leading to an enclosed (no outfall) vegetated area was used for disposal of flush water during the rehabilitation works.
- Initial airlifting had a lower flow, and comprised dark orange water for 3-4 minutes following each movement of the drill rods down the well.
- The discoloration reduced, and also the time to clear reduced after each movement reduced, as airlifting progressed.
- The apparent yield of the well increased as the well rehabilitation works progressed. The apparent yield almost doubled from Day 1 to Day 3.
- Towards the end of the airlifting the flush water discoloration was minor at the beginning of each airlifting cycle.
- Surging airlifting of the well at that point made no difference in flush water colour or apparent yield.

On the morning of the day 4 a downhole camera survey of PW1 was completed to confirm:

1. The well screen and internal lining of the well were suitably clean; and,
2. No internal damage to the well lining and screen had occurred during the well rehabilitation works.

A section of photographs of the Rehabilitation Works are included in **Figure E**.

Figure E: Well Rehabilitation Works

4. PUMPING TEST METHODOLOGY

4.1 PUMPING TEST SETUP AND CALIBRATION TEST

Dempseys Drilling installed a 6" 15HP Franklin multistage submersible pump in PW1 to a depth of 31mbgl.

The pump section was placed 0.5m above the top of the screen, at a depth of 31mbgl. 4" rising main was installed, and an in-line flow meter, flow control valve, pressure gauge and a sample tap were all installed at ground level along the discharge line. The flow meter was connected to a digital display, and flow was also recorded continuously during the pumping tests.

A 5" discharge line was laid out over the bog surface, and a suitable discharge location was agreed with BnM, ~150m east of PW1. The discharge was routed to a peat drain within the cutover bog to the east.

2 no. 25mm dipping tubes were installed in the pumping well. One dipping tube housed a 50m range Diver datalogger and its direct read cable to ground level. The second dipping tube was used for manual measurement of water levels during the pumping tests.

The pumping rate was varied using a VSD drive. The VSD drive and display for the flow meter were housed in a trailer that was parked beside PW1.

A diesel generator was used to power the submersible pump. Dempsey Drilling was responsible for running and refuelling the generator.

Setup pictures of the pumping test are included in **Figure F**.

HES and Dempsy Drilling performed pre-test monitoring prior to the commencement of pumping works. A period of pump calibration was carried out prior to the pumping test. This was undertaken by Dempsey Drilling and supervised by HES.

A calibration test (set of pumping rates) was undertaken on PW1. During the calibration test the following was recorded:

- 4 L/s, 21.2 hertz, 19meters of water above pump.
- 6 L/s, 23.4 hertz, 18.2 meters of water above pump.
- 8.5 L/s, 25.8 hertz, 17.25 meters of water above the pump.
- 10 L/s, 29.4 hertz, 15.87 meter of water above pump
- 12 L/s, 33.9 hertz, 13.4 meters of water above pump.
- 19.64 L/s, 50 hertz, 9.75 meters of water above the pump.

Figure F: Pumping Test – Site Setup

Diver ® water level dataloggers were installed in the following monitoring wells (refer to **Figure B**):

- BH103 (could not be accessed initially as the gate to the tractor compound was locked)
- BH104
- BH105
- BH106
- BH109
- BH111A
- BH112
- BH113
- BH116C
- BH116R
- BH118
- Hostel Well
- BHSS07
- MW1
- PW1

All loggers were set to record water levels at 2 minute interval during the pumping tests. Manual dips in all monitoring wells were recorded to calibrate and validate the logger data.

4.2 STEP TEST METHODOLOGY

Based on the calibration test data the following step test pumping rates were proposed:

- 4 L/sec
- 8 L/sec
- 12 L/sec, and
- 16 L/sec.

The VSD drive was used to change the flow rates at the end of each step. The Step test was completed in 4 no. stages, each 100 minutes long. Each step will be 100 minutes in length. The step test was completed on 28th July 2023, and the well was allowed to recovery over the weekend, with the constant rate pumping test commencing on Tuesday 1st August 2023.

Manual dips during the step test were repeated at the following intervals for each step:

Time Interval	Monitoring Frequency
0-5 mins	Every 30 seconds
5-10 mins	Every 1 minute
10-20 mins	Every 2 minutes
20-60 mins	Every 5 minutes
60-100 mins	Every 10 minutes

4.3 CONSTANT RATE PUMPING TEST METHODOLOGY

The constant rate pumping test had the same setup as described above. A flow rate of 12 L/s was chosen based on review of the step test data.

5. PUMPING TEST DATA

5.1 STEP PUMPING TEST

5.1.1 ST – 28/07/2023

The step test in PW1 began at 09:20am on 28th July 2023. Each step was 100 minutes long. Summary data is presented in **Table A**, and a plot of the step test data is shown in **Figure G**.

Overall, the total drawdown for the 4 no. steps was 11.77m. After the pump was switched off it took the well 40 minutes to recovery to 8.92mbREF, from 19.27 mbRef. Full recovery to ~7.60mRef occurred after ~10 hours (note the well did not recovery past 7.60mbRef). [Please note the data logger in the pumping well was not installed until after the initial recovery of the Step test), as at that time we only had one dipping tube, and we needed that for manual dip measurements. A second dipping tube was installed for the CRT.]

Step test data are attached in **Appendix II**. An excel file with these data has been uploaded to sharefile.

Table A. Step Test Summary Results

Location	Step No	Pumping Rate (L/s)	Duration (mins)	Start time	End time	Drawdown per step (m)	Total Drawdown (m)
PW1	Step 1	4	100	09:20	11:00	2.01	2.01
PW1	Step 2	8	100	11:00	14:40	2.82	4.83
PW1	Step 3	12	100	12:40	14:20	3.36	8.19
PW1	Step 4	16	100	14:20	16:00	3.58	11.77

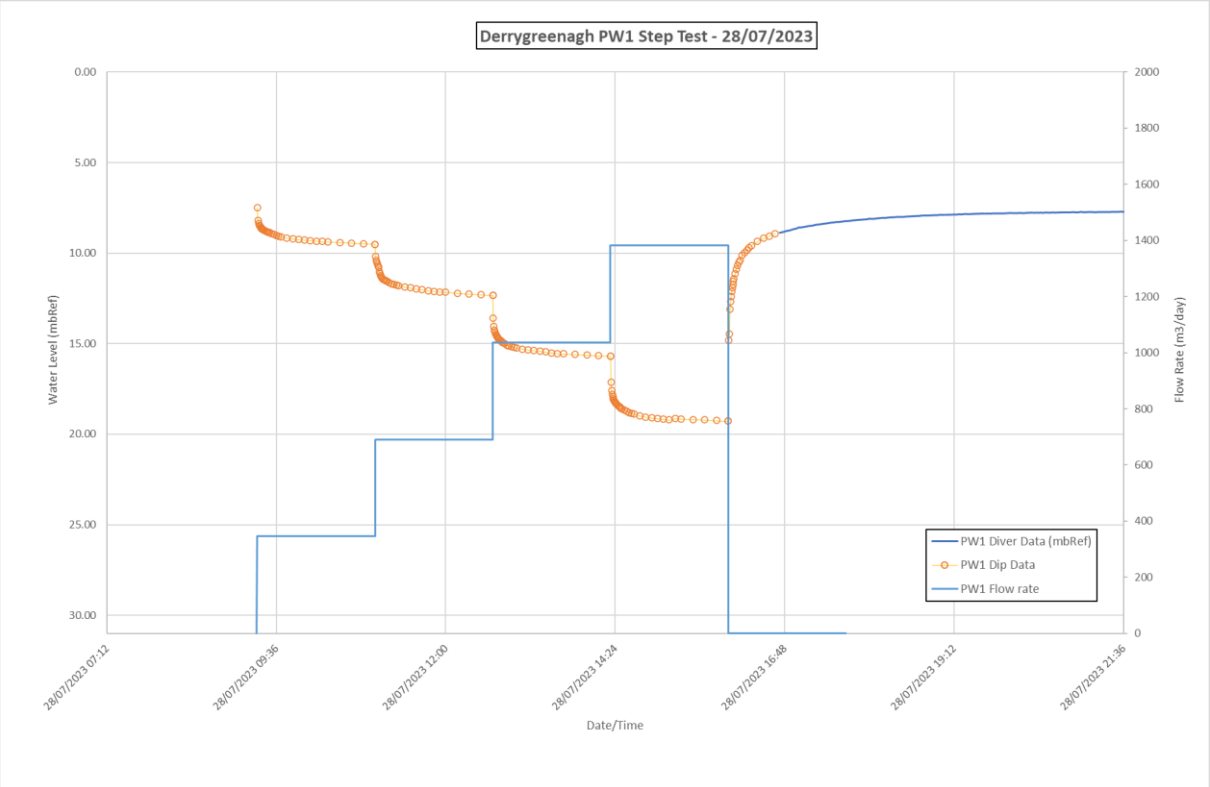


Figure G: Derrygreenagh PW1 Step Test

5.1.2 ST – Field Hydrochemistry

Field hydrochemistry was also monitored during the step test in the borehole. The results of this monitoring are shown below in **Table B**.

Table B. Field Hydrochemistry Measurements During Step Test

Location	Time (mins)	Total Time (mins)	Temp (°C)	EC (µS/cm)	pH [H+]	DO %	NTU
Step 1	20	20	10.6	645	7.05	22.4	2.16
Step 1	30	30	10.7	644	7.03	13.7	1.59
Step 1	50	50	11	644	7.03	9.1	1.13
Step 1	60	60	11	644	7.02	8.5	0.91
Step 1	70	70	10.8	641	7.02	7.9	0.88
Step 1	80	80	10.8	641	7.02	7.7	0.71
Step 1	90	90	10.8	640	7.02	7.3	0.38
Step 1	98	98	10.7	640	7.02	7.2	-
Step 2	5	103	10.5	636	7.01	6.4	-
Step 2	15	113	10.6	637	7.01	5.8	4.96
Step 2	30	128	10.7	638	7.03	5.6	4.21
Step 2	45	143	10.6	638	7.03	5.5	2.10
Step 2	60	158	10.8	639	7.05	5.4	1.47
Step 2	70	168	10.8	640	7.03	5.4	1.6
Step 2	80	178	10.8	639	7.03	5.4	1.18
Step 2	90	188	10.9	642	7.02	5.3	1.09
Step 3	20	198	10.5	635	7.05	5.3	7.10
Step 3	30	208	10.5	636	7.04	5.0	17.3
Step 3	45	213	10.6	637	7.04	4.9	5.26
Step 3	50	218	10.7	637	7.04	4.7	3.7
Step 3	60	228	10.6	636	7.04	4.6	3.63
Step 3	70	238	10.6	637	7.04	4.5	3.48
Step 3	80	248	10.6	637	7.04	4.5	3.01
Step 4	90	258	10.6	639	7.03	8.3	3.57
Step 4	10	268	10.5	636	7.06	4.9	24.6
Step 4	15	273	10.6	635	7.05	4.5	32.6
Step 4	30	288	10.6	636	7.05	4.1	23.2
Step 4	40	298	10.7	636	7.05	4.0	20.8
Step 4	50	308	10.6	635	7.05	3.9	17.2
Step 4	60	318	10.6	635	7.05	3.9	16.1
Step 4	70	328	10.6	635	7.05	3.9	12.4
Step 4	80	338	10.6	635	7.06	3.8	13.9
Step 4	90	348	10.6	634	7.06	3.8	11.7
Step 4	96	358	10.6	634	7.06	3.8	10.4

5.1.3 ST – Water Sampling

A water sample was taken for laboratory analysis at the end of Step 1, and at the end of Step 3. Original laboratory reports are attached in **Appendix III**, and the data is tabulated in **Table E.**

5.2 CONSTANT RATE PUMPING TEST

5.2.1 CRT – 01/08/2023 to 08/08/2023

A constant rate pumping test was performed on PW1 between 01st August and 8th August 2023. The pumping test setup was as described in Section 4.

The static water level in PW1 recorded at the beginning of the CRT was 7.47mbRef, and the final water level recorded 7 days later prior to pump turn-off was 16.25mbRef. The pumping rate varied slightly over the 7 days, but the average pumping rate was 42.1 m^3/hr (1,010.4 m^3/day).

Overall, the total drawdown in PW1 recorded during the CRT was 8.78m. After the pump was switched off it took the well 40 minutes to recovery to 9.12mbREF.

Summary drawdown data is presented in **Table A**, and a plot of the CRT data for PW1 is shown in **Figure H**Figure G.

Water level monitoring data recorded in all other observation wells during the CRT are provided in plot format in **Appendix IV**. Data for PW1,and 8 no. monitoring wells are provided (BH104, MW1, BH105, BH109, BH111A, BH112, BHSS07, and Hostel Well). Excel files with these data has been uploaded to sharefile.

[Note: continuous water level monitoring was attempted in shallow monitoring wells, i.e. BH118 and BH116C. Both wells were generally dry, other than after heavy rainfall].

Table C. Drawdown Constant Rate Pumping Test

Name	Location (ITM)		Distance to PW1 (m)	Total Drawdown @ end of CRT (m)
PW1	649589.68	738371.53	0	8.78
BH104	649609.48	738361.9	19.4	4.80
MW1	649613.78	738360.58	26	4.63
BH105	649562.57	738294.96	80	1.48
BH109	649687.45	738383.53	97.5	0.46
BH111A	649518.7	738203.24	183	1.19
BH112	649358.593	738261.141	256	0.05
BHSS07	649210.383	738021.446	516	None apparent
Hostel Well	649503.3	738043.65	340	None apparent

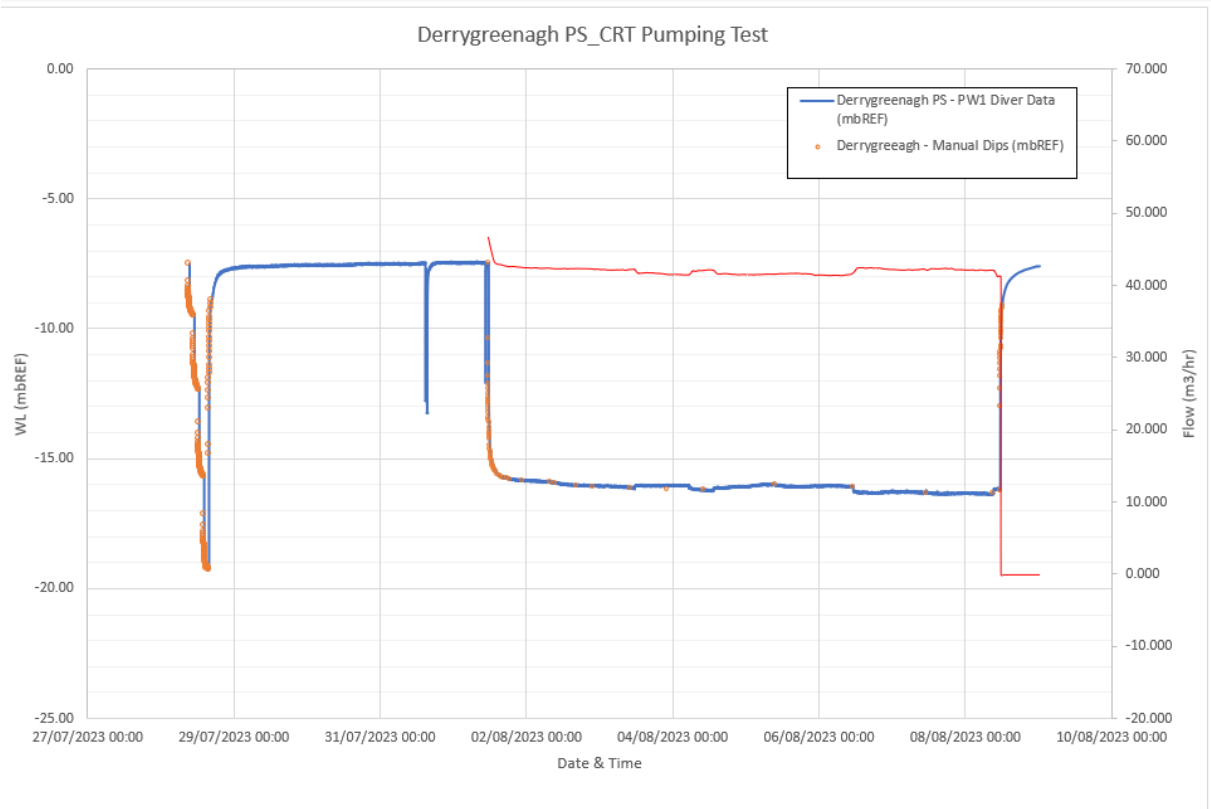


Figure H: Derrygreenagh PW1 CRT Pumping Test

5.2.2 CRT – Field Hydrochemistry

Field hydrochemistry was also monitored during the CRT in PW1. The results of this monitoring are shown below in
Table B.

Table D. Field Hydrochemistry Measurements During the CRT

Date	Time (hr:mins)	Total Time (mins)	Temp (°C)	EC (µS/cm)	pH [H+]	DO %	NTU
01/08/2023	11:15	0	11.1	653	7.08	12.5	11.8
01/08/2023	12:05	35	10.6	637	7.08	7.3	8.46
01/08/2023	12:30	60	10.7	638	7.08	4.8	6.95
01/08/2023	13:30	120	10.6	636	7.11	4.2	5.55
01/08/2023	14:30	180	10.7	637	7.06	4.0	3.99
01/08/2023	15:30	240	10.6	635	7.06	3.8	4.56
01/08/2023	16:30	300	10.5	634	7.06	3.7	1.83
01/08/2023	17:30	360	10.6	634	7.06	3.6	1.90
01/08/2023	18:30	420	10.6	633	7.07	3.6	1.02
02/08/2023	07:15	1,185	10.4	630	7.1	5.0	0.26
02/08/2023	09:30	1,320	10.4	629	7.08	3.3	0.35
02/08/2023	16:25	1,735	10.6	631	7.07	3.3	0.23
03/08/2023	10:00	2,790	10.5	628	7.1	4.1	0.61
04/08/2023	10:00	4,230	10.4	627	7.12	3.9	0.62
05/08/2023	09:30	5,640	10.4	625	7.09	3.6	0.65
06/08/2023	11:00	7,170	10.5	625	7.11	4.5	0.64
07/08/2023	11:00	8,610	10.5	625	7.09	4.9	0.71
08/08/2023	09:00	9,930	10.4	624	7.1	5.2	0.9
08/08/2023	11:35	10,085	10.4	623	7.09	3.6	0.61

5.2.3 CRT – Water Sampling

Water samples were taken for laboratory analysis on Day 2 and Day 7 of the CRT. Original laboratory reports are attached in **Appendix III**, and the data is tabulated in **Table E**.

Table E. Groundwater Laboratory Results

Parameter	PW 1 – Step 2	PW 1 – Step 3	PW1 – CRT Day 2	PW 1 – CRT Day 7
Total Coliforms (MPN/100ml)	<10	<10	<10	<10
Faecal Coliforms (MPN/100ml)	-	-	<10	-
pH	7.11	7.10	7.08	7.13
Conductivity (µS/cm @20°C)	633	635	638	625
Redox Potential (m/v)	228	235	214	228
Total Organic Carbon (mg/l)	1.5	1.6	1.7	1.5
Calcium (mg/l)	127.5	125.4	122.2	117.6
Chloride (mg/l)	17	18	18	19
Magnesium (mg/l)	9.1	9.4	9.2	92.4
Potassium (mg/l)	1.6	1.9	1.5	13.8
Sodium (mg/l)	9.8	11.2	9.7	96.4
Alkalinity (mg/l as $CaCO_3$)	355	361	371	372
Hardness Total (mg/l as $CaCO_3$)	379	381	-	366
Bicarbonate (mg/l as $CaCO_3$)	355.4	360.6	370.7	372.4
Sulphate (mg/l as SO_4)	20	19	21	21
Nitrite (mg/l as N)	1.13	<0.01	0.73	<0.01
Nitrate mg/L (as N)	<1	1	1	1
Boron (µg/l)	<16	<16	<16	<16
Dissolved Oxygen (mg/l)	5.8	5.3	7.5	6.6
Ammonia mg/L (as N)	0.44	0.51	0.40	0.35
Iron (mg/L)	1.864	2.014	1.608	1.095

Iron dissolved (mg/L)	0.1347	0.1123	0.0721	0.0121
Manganese (mg/L)	0.09	0.105	0.16	0.211
Manganese dissolved (mg/L)	0.09	0.104	0.160	0.132
TPH (mg/L)	<1	<1	<1	<1
BTEX Total (µg/l)	<1	<1	<1	<1
Polyaromatic Hydrocarbons (µg/l)	<0.1	<0.1	<0.1	<0.1
Arsenic (µg/l)	3	4	3.3	3
Cadmium (µg/l)	<1	<1	<1	<1
Chromium (µg/l)	<2	<2	<2	<2
Copper (µg/l)	1	1	<1	<1
Lead (µg/l)	<1	<1	<1	<1
Mercury (µg/l)	<0.08	0.09	<0.08	<0.08
Nickel (µg/l)	40	36	27	25
Zinc (µg/l)	20	19	21	20
Selenium (µg/l)	2	3	2	1

6. REPORT SUMMARY

- Well rehabilitation works have been undertaken in PW1, and these were successful.
- A step pumping test and a constant rate pumping tests were also completed in well PW1, and an output of 1,010.4 m^3/day was sustained over a 7 day period with 8.78m of drawdown recorded.
- PW1 is a high yielding well.
- Field hydrochemistry and laboratory data for waster samples taken during the pumping tests are also presented in this factual report.

* * * * * * * * * * *

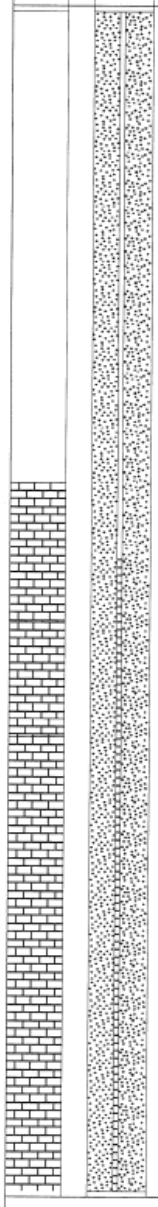
7. REFERENCES

Aecom / Fichtner	04th July 2023	Reconditioning and Test Pumping: Derrygreenagh, Co. Offaly – Specification for Investigation Works, Rev B
BS ISO 14686	2003	Pumping tests for water wells — Considerations and guidelines for design, performance and use.

APPENDIX I
PW1 – WELL LOG

Glover Site Investigations Ltd

Installation Type Standpipe	**Dimensions** Internal Diameter of Tube [A] = 150 mm; Diameter of Filter Zone = 200 mm	**Site** Derrygreenagh CCGT, Rochfortbridge	**Borehole Number** PW01
		Client Bord Na Mona	**Job Number** 08-0221
	Location 249653.762 E 238348.3 N; **Ground Level (mOD)** 82.79	**Engineer** Mott MacDonald Pettit Ltd	**Sheet** 1/1



Depth (m)	Description
30.00	Fine Gravel Filter
65.00	Well Screen

Groundwater Strikes During Drilling

Date	Time	Depth Struck (m)	Casing Depth (m)	Inflow Rate	Readings 5 min	Readings 10 min	Readings 15 min	Readings 20 min	Depth Sealed (m)

Groundwater Observations During Drilling

Date	Start of Shift Time	Start of Shift Depth Hole (m)	Start of Shift Casing Depth (m)	Start of Shift Water Depth (m)	Start of Shift Water Level (mOD)	End of Shift Time	End of Shift Depth Hole (m)	End of Shift Casing Depth (m)	End of Shift Water Depth (m)	End of Shift Water Level (mOD)
10/05/08							65.00			

Instrument Groundwater Observations

Inst. [A] Type :

Date	Instrument [A] Time	Instrument [A] Depth (m)	Instrument [A] Level (mOD)	Remarks

Remarks

Figure 3: Log of an existing abstraction borehole on the site.

Glover Site Investigations Ltd

Site Derrygreenagh CCGT, Rochfortbridge			**Borehole Number** PW01
Boring Method DTH Rotary	**Casing Diameter** 150mm cased to 65.00m	**Ground Level (mOD)** 82.79	**Client** Bord Na Mona	**Job Number** 08-0221
	Location 249653.762 E 238348.3 N	**Dates** 10/05/2008	**Engineer** Mott MacDonald Pettit Ltd	**Sheet** 2/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
							Moderately strong dark grey fine grained CARBONIFEROUS LIMESTONE		
						(25.00)			
				10/05/2008:	17.79	65.00	Complete at 65.00m		

Remarks

Scale (approx)	Logged By
1:200	DC/HH

Figure No. 08-0221.PW01

Glover Site Investigations Ltd

Site	Borehole Number
Derrygreenagh CCGT, Rochfortbridge	PW01

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
DTH Rotary	150mm cased to 65.00m	82.79	Bord Na Mona	08-0221
	Location	**Dates**	**Engineer**	**Sheet**
	249653.762 E 238348.3 N	10/05/2008	Mott MacDonald Pettit Ltd	1/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
						(26.00)	OVERBURDEN		
					56.79	26.00	Broken and jointed dark grey fine grained CARBONIFEROUS LIMESTONE		
						(7.70)			
					49.09	33.70	Moderately weak grey fine grained CARBONIFEROUS LIMESTONE		
						(5.30)			
					43.79	39.00			
					42.79	(1.00)	LIMESTONE (Full description as Sheet 2)		

Remarks
3000mm steel permanent liner installed to 28.00m
250mm steel liner installed from 0.0m - 39.00m.
250mm reinforced steel liner installed from 37.00m - 39.00m
200mm UPVC standpipe installed.

Scale (approx)	Logged By
1:200	DC/HH

Figure No.
08-0221.PW01

APPENDIX II
STEP TEST DATA

Date	Time (min)		PW1 WL (mbRef)	PW1 flow (m^3/hr)	Flow rate (m^3/day)
28/07/2023 09:19	-1	-1	7.5		0
28/07/2023 09:20	0	0.00	7.5	14.4	345.6
28/07/2023 09:20	00:00:30	0.50	8.18		345.6
28/07/2023 09:21	00:01:00	1.00	8.36		
28/07/2023 09:21	00:01:30	1.50	8.46		
28/07/2023 09:22	00:02:00	2.00	8.52		
28/07/2023 09:22	00:02:30	2.50	8.56		
28/07/2023 09:23	00:03:00	3.00	8.6		
28/07/2023 09:23	00:03:30	3.50	8.64		
28/07/2023 09:24	00:04:00	4.00	8.66		
28/07/2023 09:24	00:04:30	4.50	8.69		
28/07/2023 09:25	00:05:00	5.00	8.71		
28/07/2023 09:26	00:06:00	6.00	8.75		
28/07/2023 09:27	00:07:00	7.00	8.79		
28/07/2023 09:28	00:08:00	8.00	8.82		
28/07/2023 09:29	00:09:00	9.00	8.85		
28/07/2023 09:30	00:10:00	10.00	8.87		
28/07/2023 09:32	00:12:00	12.00	8.91		
28/07/2023 09:34	00:14:00	14.00	8.95		
28/07/2023 09:36	00:16:00	16.00	9.02		
28/07/2023 09:38	00:18:00	18.00	9.07		
28/07/2023 09:40	00:20:00	20.00	9.1		
28/07/2023 09:45	00:25:00	25.00	9.16		
28/07/2023 09:50	00:30:00	30.00	9.21		
28/07/2023 09:55	00:35:00	35.00	9.25		
28/07/2023 10:00	00:40:00	40.00	9.28		
28/07/2023 10:05	00:45:00	45.00	9.31		
28/07/2023 10:10	00:50:00	50.00	9.33		
28/07/2023 10:15	00:55:00	55.00	9.36		
28/07/2023 10:20	01:00:00	60.00	9.38		
28/07/2023 10:30	01:10:00	70.00	9.41		
28/07/2023 10:40	01:20:00	80.00	9.44		
28/07/2023 10:50	01:30:00	90.00	9.47		
28/07/2023 11:00	01:40:00	100.00	9.51	14.4	345.6
28/07/2023 11:00	0	100.00	9.51	28.8	691.2
28/07/2023 11:00	00:00:30	100.50	10.2		
28/07/2023 11:01	00:01:00	101.00	10.4		
28/07/2023 11:01	00:01:30	101.50	10.51		
28/07/2023 11:02	00:02:00	102.00	10.62		
28/07/2023 11:02	00:02:30	102.50	10.71		
28/07/2023 11:03	00:03:00	103.00	10.78		
28/07/2023 11:03	00:03:30	103.50	11.02		
28/07/2023 11:04	00:04:00	104.00	11.15		
28/07/2023 11:04	00:04:30	104.50	11.25		
28/07/2023 11:05	00:05:00	105.00	11.31		

28/07/2023 11:06	00:06:00	106.00	11.38		
28/07/2023 11:07	00:07:00	107.00	11.44		
28/07/2023 11:08	00:08:00	108.00	11.48		
28/07/2023 11:09	00:09:00	109.00	11.52		
28/07/2023 11:10	00:10:00	110.00	11.56		
28/07/2023 11:12	00:12:00	112.00	11.62		
28/07/2023 11:14	00:14:00	114.00	11.68		
28/07/2023 11:16	00:16:00	116.00	11.72		
28/07/2023 11:18	00:18:00	118.00	11.76		
28/07/2023 11:20	00:20:00	120.00	11.8		
28/07/2023 11:25	00:25:00	125.00	11.87		
28/07/2023 11:30	00:30:00	130.00	11.92		
28/07/2023 11:35	00:35:00	135.00	11.99		
28/07/2023 11:40	00:40:00	140.00	12.02		
28/07/2023 11:45	00:45:00	145.00	12.07		
28/07/2023 11:50	00:50:00	150.00	12.11		
28/07/2023 11:55	00:55:00	155.00	12.14		
28/07/2023 12:00	01:00:00	160.00	12.16		
28/07/2023 12:10	01:10:00	170.00	12.22		
28/07/2023 12:20	01:20:00	180.00	12.26		
28/07/2023 12:30	01:30:00	190.00	12.3		
28/07/2023 12:40	01:40:00	200.00	12.33	28.8	691.2
28/07/2023 12:40	0	200.00	12.33	43.2	1036.8
28/07/2023 12:40	00:00:30	200.50	13.6		
28/07/2023 12:41	00:01:00	201.00	14.03		
28/07/2023 12:41	00:01:30	201.50	14.24		
28/07/2023 12:42	00:02:00	202.00	14.37		
28/07/2023 12:42	00:02:30	202.50	14.46		
28/07/2023 12:43	00:03:00	203.00	14.54		
28/07/2023 12:43	00:03:30	203.50	14.6		
28/07/2023 12:44	00:04:00	204.00	14.64		
28/07/2023 12:44	00:04:30	204.50	14.71		
28/07/2023 12:45	00:05:00	205.00	14.75		
28/07/2023 12:46	00:06:00	206.00	14.81		
28/07/2023 12:47	00:07:00	207.00	14.85		
28/07/2023 12:48	00:08:00	208.00	14.91		
28/07/2023 12:49	00:09:00	209.00	14.95		
28/07/2023 12:50	00:10:00	210.00	15		
28/07/2023 12:52	00:12:00	212.00	15.08		
28/07/2023 12:54	00:14:00	214.00	15.12		
28/07/2023 12:56	00:16:00	216.00	15.16		
28/07/2023 12:58	00:18:00	218.00	15.21		
28/07/2023 13:00	00:20:00	220.00	15.24		
28/07/2023 13:05	00:25:00	225.00	15.29		
28/07/2023 13:10	00:30:00	230.00	15.34		
28/07/2023 13:15	00:35:00	235.00	15.38		
28/07/2023 13:20	00:40:00	240.00	15.41		

28/07/2023 13:25	00:45:00	245.00	15.46		
28/07/2023 13:30	00:50:00	250.00	15.51		
28/07/2023 13:35	00:55:00	255.00	15.54		
28/07/2023 13:40	01:00:00	260.00	15.56		
28/07/2023 13:50	01:10:00	270.00	15.6		
28/07/2023 14:00	01:20:00	280.00	15.63		
28/07/2023 14:10	01:30:00	290.00	15.66		
28/07/2023 14:20	01:40:00	300.00	15.69	43.2	1036.8
28/07/2023 14:20	0	300.00	15.69	57.6	1382.4
28/07/2023 14:20	00:00:30	300.50	17.13		
28/07/2023 14:21	00:01:00	301.00	17.58		
28/07/2023 14:21	00:01:30	301.50	17.81		
28/07/2023 14:22	00:02:00	302.00	17.92		
28/07/2023 14:22	00:02:30	302.50	18.03		
28/07/2023 14:23	00:03:00	303.00	18.1		
28/07/2023 14:23	00:03:30	303.50	18.18		
28/07/2023 14:24	00:04:00	304.00	18.22		
28/07/2023 14:24	00:04:30	304.50	18.27		
28/07/2023 14:25	00:05:00	305.00	18.32		
28/07/2023 14:26	00:06:00	306.00	18.4		
28/07/2023 14:27	00:07:00	307.00	18.46		
28/07/2023 14:28	00:08:00	308.00	18.51		
28/07/2023 14:29	00:09:00	309.00	18.56		
28/07/2023 14:30	00:10:00	310.00	18.6		
28/07/2023 14:32	00:12:00	312.00	18.66		
28/07/2023 14:34	00:14:00	314.00	18.74		
28/07/2023 14:36	00:16:00	316.00	18.8		
28/07/2023 14:38	00:18:00	318.00	18.84		
28/07/2023 14:40	00:20:00	320.00	18.88		
28/07/2023 14:45	00:25:00	325.00	18.98		
28/07/2023 14:50	00:30:00	330.00	19.04		
28/07/2023 14:55	00:35:00	335.00	19.1		
28/07/2023 15:00	00:40:00	340.00	19.13		
28/07/2023 15:05	00:45:00	345.00	19.17		
28/07/2023 15:10	00:50:00	350.00	19.21		
28/07/2023 15:15	00:55:00	355.00	19.13		
28/07/2023 15:20	01:00:00	360.00	19.15		
28/07/2023 15:30	01:10:00	370.00	19.18		
28/07/2023 15:40	01:20:00	380.00	19.21		
28/07/2023 15:50	01:30:00	390.00	19.25		
28/07/2023 16:00	01:40:00	400.00	19.27	57.6	1382.4
28/07/2023 16:00	0	400.00	19.27	0	0
28/07/2023 16:00	00:00:30	400.50	14.82		
28/07/2023 16:01	00:01:00	401.00	14.48		
28/07/2023 16:01	00:01:30	401.50	13.1		
28/07/2023 16:02	00:02:00	402.00	12.68		

28/07/2023 16:02	00:02:30	402.50	12.38		
28/07/2023 16:03	00:03:00	403.00	12.12		
28/07/2023 16:03	00:03:30	403.50	11.9		
28/07/2023 16:04	00:04:00	404.00	11.74		
28/07/2023 16:04	00:04:30	404.50	11.56		
28/07/2023 16:05	00:05:00	405.00	11.42		
28/07/2023 16:06	00:06:00	406.00	11.13		
28/07/2023 16:07	00:07:00	407.00	10.88		
28/07/2023 16:08	00:08:00	408.00	10.68		
28/07/2023 16:09	00:09:00	409.00	10.5		
28/07/2023 16:10	00:10:00	410.00	10.38		
28/07/2023 16:12	00:12:00	412.00	10.12		
28/07/2023 16:14	00:14:00	414.00	9.96		
28/07/2023 16:16	00:16:00	416.00	9.83		
28/07/2023 16:18	00:18:00	418.00	9.69		
28/07/2023 16:20	00:20:00	420.00	9.58		
28/07/2023 16:25	00:25:00	425.00	9.36		
28/07/2023 16:30	00:30:00	430.00	9.18		
28/07/2023 16:35	00:35:00	435.00	9.05		
28/07/2023 16:40	00:40:00	440.00	8.92		0
28/07/2023 16:45	00:45:00				
28/07/2023 16:50	00:50:00				
28/07/2023 16:55	00:55:00				
28/07/2023 17:00	01:00:00				
28/07/2023 17:10	01:10:00				
28/07/2023 17:20	01:20:00				
28/07/2023 17:30	01:30:00				
28/07/2023 17:40	01:40:00			0	0

APPENDIX III
ORIGINAL GROUNDWATER LABORATORY REPORTS

Fitz Scientific Webportal

Lab Ref	Client Ref	Client Ref 2	Client Ref 3	Sample Date	Report Date	Parameter	SOP	Technique	Value	Units
7820/044/01	P1655-PW1_CRT Day 7			08/08/2023		Coliforms (Total)	157	Filtration / Incubation	<10	cfu/100ml
7820/044/01	P1655-PW1_CRT Day 7			08/08/2023		pH (Ground Water)	110	Electrometry	7.13	pH Units
7820/044/01	P1655-PW1_CRT Day 7			08/08/2023		Conductivity (Ground Water at 20C)	112	Electrometry	625.0	µscm -1@20C
7820/044/01	P1655-PW1_CRT Day 7			08/08/2023		Redox Potential	232	Electrometry	228	m/v
7820/044/01	P1655-PW1_CRT Day 7			08/08/2023		Total Organic Carbon	316	TOC analyser (NPOC)	1.5	mg/L
7820/044/01	P1655-PW1_CRT Day 7			08/08/2023		Ammonia (Ground Water)	114	Colorimetry	0.35	mg/L as N
7820/044/01	P1655-PW1_CRT Day 7			08/08/2023		Calcium (Ground Water)	184	ICPMS	117.6	mg/L
7820/044/01	P1655-PW1_CRT Day 7			08/08/2023		Chloride (Ground Water)	100	Colorimetry	19	mg/L
7820/044/01	P1655-PW1_CRT Day 7			08/08/2023		Magnesium (Ground Water)	184	ICPMS	92.4	mg/L
7820/044/01	P1655-PW1_CRT Day 7			08/08/2023		Potassium (Ground Water)	184	ICPMS	13.8	mg/L
7820/044/01	P1655-PW1_CRT Day 7			08/08/2023		Sodium (Ground water)	184	ICPMS	96.4	mg/L
7820/044/01	P1655-PW1_CRT Day 7			08/08/2023		Alkalinity (Ground Water)	102	Colorimetry	372	mg/L CaCO3
7820/044/01	P1655-PW1_CRT Day 7			08/08/2023		Hardness Total (Ground Water)	111	Colorimetry	366.0	mg/L CaCO3
7820/044/01	P1655-PW1_CRT Day 7			08/08/2023		Bicarbonate (CaCO3)	102	Colorimetry	372.4	mg/L CaCO3
7820/044/01	P1655-PW1_CRT Day 7			08/08/2023		Sulphate (Ground Water)	119	Colorimetry	21	mg/L as SO4
7820/044/01	P1655-PW1_CRT Day 7			08/08/2023		Nitrate (Ground Water)	103	Colorimetry	1	mg/L as N
7820/044/01	P1655-PW1_CRT Day 7			08/08/2023		Nitrite (Ground Water)	118	Colorimetry	<0.01	mg/L as N
7820/044/	P1655-PW1_CRT			08/08/2023		Boron (Ground Water)	177	ICPMS	<16	ug/L

Lab Ref	Client Ref	Client Ref 2	Client Ref 3	Sample Date	Report Date	Parameter	SOP	Technique	Value	Units
01	Day 7									
7820/044/01	P1655-PW1_CRT Day 7			08/08/2023		Iron (Ground Water)	177	ICPMS	1095	ug/L
7820/044/01	P1655-PW1_CRT Day 7			08/08/2023		Manganese (Ground Water)	177	ICPMS	211	ug/L
7820/044/01	P1655-PW1_CRT Day 7			08/08/2023		Manganese (Dissolved)	177	ICPMS	132	ug/L
7820/044/01	P1655-PW1_CRT Day 7			08/08/2023		Iron (Dissolved)	177	ICPMS	12.1	ug/L
7820/044/01	P1655-PW1_CRT Day 7			08/08/2023		Dissolved oxygen (mg/l)	715	DO Meter	6.6	mg/L
7820/044/01	P1655-PW1_CRT Day 7			08/08/2023		BTEX Total (Ground Water)	154	GCMS	<1	ug/L
7820/044/01	P1655-PW1_CRT Day 7			08/08/2023		TPH (>C10-12)	188	GC-FID	<1	ug/L
7820/044/01	P1655-PW1_CRT Day 7			08/08/2023		TPH (>C10-40)	188	GC-FID	<1	ug/L
7820/044/01	P1655-PW1_CRT Day 7			08/08/2023		TPH (>C12-14)	188	GC-FID	<1	ug/L
7820/044/01	P1655-PW1_CRT Day 7			08/08/2023		TPH (>C14-16)	188	GC-FID	<1	ug/L
7820/044/01	P1655-PW1_CRT Day 7			08/08/2023		TPH (>C16-18)	188	GC-FID	<1	ug/L
7820/044/01	P1655-PW1_CRT Day 7			08/08/2023		TPH (>C18-20)	188	GC-FID	<1	ug/L
7820/044/01	P1655-PW1_CRT Day 7			08/08/2023		TPH (>C20-22)	188	GC-FID	<1	ug/L
7820/044/01	P1655-PW1_CRT Day 7			08/08/2023		TPH (>C22-24)	188	GC-FID	<1	ug/L
7820/044/01	P1655-PW1_CRT Day 7			08/08/2023		TPH (>C24-26)	188	GC-FID	<1	ug/L
7820/044/01	P1655-PW1_CRT Day 7			08/08/2023		TPH (>C26-28)	188	GC-FID	<1	ug/L
7820/044/01	P1655-PW1_CRT Day 7			08/08/2023		TPH (>C28-30)	188	GC-FID	<1	ug/L
7820/044/01	P1655-PW1_CRT Day 7			08/08/2023		TPH (>C30-32)	188	GC-FID	<1	ug/L

Lab Ref	Client Ref	Client Ref 2	Client Ref 3	Sample Date	Report Date	Parameter	SOP	Technique	Value	Units
7820/044/01	P1655-PW1_CRT Day 7			08/08/2023		TPH (>C32-34)	188	GC-FID	<1	ug/L
7820/044/01	P1655-PW1_CRT Day 7			08/08/2023		TPH (>C34-36)	188	GC-FID	<1	ug/L
7820/044/01	P1655-PW1_CRT Day 7			08/08/2023		TPH (>C36-38)	188	GC-FID	<1	ug/L
7820/044/01	P1655-PW1_CRT Day 7			08/08/2023		TPH (>C38-40)	188	GC-FID	<1	ug/L
7820/044/01	P1655-PW1_CRT Day 7			08/08/2023		Polyaromatic Hydrocarbons (GCMS)	200	GCMS	<0.1	ug/L
7820/044/01	P1655-PW1_CRT Day 7			08/08/2023		Arsenic (Ground Water)	177	ICPMS	3	ug/L
7820/044/01	P1655-PW1_CRT Day 7			08/08/2023		Cadmium (Ground Water)	177	ICPMS	<1	ug/L
7820/044/01	P1655-PW1_CRT Day 7			08/08/2023		Chromium (Ground Water)	177	ICPMS	<2	ug/L
7820/044/01	P1655-PW1_CRT Day 7			08/08/2023		Copper (Ground Water)	177	ICPMS	<1	ug/L
7820/044/01	P1655-PW1_CRT Day 7			08/08/2023		Lead (Ground Water)	177	ICPMS	<1	ug/L
7820/044/01	P1655-PW1_CRT Day 7			08/08/2023		Mercury (Ground water)	178	ICPMS	<0.08	ug/L
7820/044/01	P1655-PW1_CRT Day 7			08/08/2023		Nickel (Ground Water)	177	ICPMS	25	ug/L
7820/044/01	P1655-PW1_CRT Day 7			08/08/2023		Zinc (Ground Water)	177	ICPMS	20	ug/L
7820/044/01	P1655-PW1_CRT Day 7			08/08/2023		Selenium (Ground Water)	177	ICPMS	1	ug/L
7820/043/01	PW1-CRT Day 2			02/08/2023		Alkalinity (Ground Water)	102	Colorimetry	371	mg/L CaCO3
7820/043/01	PW1-CRT Day 2			02/08/2023		Ammonia (Ground Water)	114	Colorimetry	0.40	mg/L as N
7820/043/01	PW1-CRT Day 2			02/08/2023		Arsenic (Ground Water)	177	ICPMS	3	ug/L
7820/043/01	PW1-CRT Day 2			02/08/2023		Bicarbonate (CaCO3)	102	Colorimetry	370.7	mg/L CaCO3
7820/043/	PW1-CRT Day 2			02/08/2023		Boron (Ground Water)	177	ICPMS	<16	ug/L

Lab Ref	Client Ref	Client Ref 2	Client Ref 3	Sample Date	Report Date	Parameter	SOP	Technique	Value	Units
01										
7820/043/01	PW1-CRT Day 2			02/08/2023		BTEX Total (Ground Water)	154	GCMS	<1	ug/L
7820/043/01	PW1-CRT Day 2			02/08/2023		Cadmium (Ground Water)	177	ICPMS	<1	ug/L
7820/043/01	PW1-CRT Day 2			02/08/2023		Calcium (Ground Water)	184	ICPMS	122.2	mg/L
7820/043/01	PW1-CRT Day 2			02/08/2023		Chloride (Ground Water)	100	Colorimetry	18	mg/L
7820/043/01	PW1-CRT Day 2			02/08/2023		Chromium (Ground Water)	177	ICPMS	<2	ug/L
7820/043/01	PW1-CRT Day 2			02/08/2023		Coliforms (Faecal)	140	Filtration / Incubation	<10	cfu/100ml
7820/043/01	PW1-CRT Day 2			02/08/2023		Coliforms (Total)	157	Filtration / Incubation	<10	cfu/100ml
7820/043/01	PW1-CRT Day 2			02/08/2023		Conductivity (Ground Water at 20C)	112	Electrometry	638.0	µscm-1@20C
7820/043/01	PW1-CRT Day 2			02/08/2023		Copper (Ground Water)	177	ICPMS	<1	ug/L
7820/043/01	PW1-CRT Day 2			02/08/2023		Iron (Ground Water)	177	ICPMS	1608	ug/L
7820/043/01	PW1-CRT Day 2			02/08/2023		Lead (Ground Water)	177	ICPMS	<1	ug/L
7820/043/01	PW1-CRT Day 2			02/08/2023		Magnesium (Ground Water)	184	ICPMS	9.2	mg/L
7820/043/01	PW1-CRT Day 2			02/08/2023		Manganese (Ground Water)	177	ICPMS	160	ug/L
7820/043/01	PW1-CRT Day 2			02/08/2023		Mercury (Ground water)	178	ICPMS	<0.08	ug/L
7820/043/01	PW1-CRT Day 2			02/08/2023		Nickel (Ground Water)	177	ICPMS	27	ug/L
7820/043/01	PW1-CRT Day 2			02/08/2023		Nitrate (Ground Water)	103	Colorimetry	1	mg/L as N
7820/043/01	PW1-CRT Day 2			02/08/2023		Nitrite (Ground Water)	118	Colorimetry	0.73	mg/L as N
7820/043/01	PW1-CRT Day 2			02/08/2023		pH (Ground Water)	110	Electrometry	7.08	pH Units

Lab Ref	Client Ref	Client Ref 2	Client Ref 3	Sample Date	Report Date	Parameter	SOP	Technique	Value	Units
7820/043/01	PW1-CRT Day 2			02/08/2023		Polyaromatic Hydrocarbons (GCMS)	200	GCMS	<0.1	ug/L
7820/043/01	PW1-CRT Day 2			02/08/2023		Potassium (Ground Water)	184	ICPMS	1.5	mg/L
7820/043/01	PW1-CRT Day 2			02/08/2023		Redox Potential	232	Electrometry	214	m/v
7820/043/01	PW1-CRT Day 2			02/08/2023		Selenium (Ground Water)	177	ICPMS	2	ug/L
7820/043/01	PW1-CRT Day 2			02/08/2023		Sodium (Ground water)	184	ICPMS	9.7	mg/L
7820/043/01	PW1-CRT Day 2			02/08/2023		Sulphate (Ground Water)	119	Colorimetry	21	mg/L as SO4
7820/043/01	PW1-CRT Day 2			02/08/2023		Temperature (On site)*	0	By Subcontractor	10.4	degree C
7820/043/01	PW1-CRT Day 2			02/08/2023		Total Organic Carbon	316	TOC analyser (NPOC)	1.7	mg/L
7820/043/01	PW1-CRT Day 2			02/08/2023		Zinc (Ground Water)	177	ICPMS	21	ug/L
7820/043/01	PW1-CRT Day 2			02/08/2023		Dissolved oxygen (mg/l)	715	DO Meter	7.5	mg/L
7820/043/01	PW1-CRT Day 2			02/08/2023		TPH (>C10-12)	188	GC-FID	<1	ug/L
7820/043/01	PW1-CRT Day 2			02/08/2023		TPH (>C10-40)	188	GC-FID	<1	ug/L
7820/043/01	PW1-CRT Day 2			02/08/2023		TPH (>C12-14)	188	GC-FID	<1	ug/L
7820/043/01	PW1-CRT Day 2			02/08/2023		TPH (>C14-16)	188	GC-FID	<1	ug/L
7820/043/01	PW1-CRT Day 2			02/08/2023		TPH (>C16-18)	188	GC-FID	<1	ug/L
7820/043/01	PW1-CRT Day 2			02/08/2023		TPH (>C18-20)	188	GC-FID	<1	ug/L
7820/043/01	PW1-CRT Day 2			02/08/2023		TPH (>C20-22)	188	GC-FID	<1	ug/L
7820/043/01	PW1-CRT Day 2			02/08/2023		TPH (>C22-24)	188	GC-FID	<1	ug/L
7820/043/	PW1-CRT Day 2			02/08/2023		TPH (>C24-26)	188	GC-FID	<1	ug/L

Lab Ref	Client Ref	Client Ref 2	Client Ref 3	Sample Date	Report Date	Parameter	SOP	Technique	Value	Units
01										
7820/043/01	PW1-CRT Day 2			02/08/2023		TPH (>C26-28)	188	GC-FID	<1	ug/L
7820/043/01	PW1-CRT Day 2			02/08/2023		TPH (>C28-30)	188	GC-FID	<1	ug/L
7820/043/01	PW1-CRT Day 2			02/08/2023		TPH (>C30-32)	188	GC-FID	<1	ug/L
7820/043/01	PW1-CRT Day 2			02/08/2023		TPH (>C32-34)	188	GC-FID	<1	ug/L
7820/043/01	PW1-CRT Day 2			02/08/2023		TPH (>C34-36)	188	GC-FID	<1	ug/L
7820/043/01	PW1-CRT Day 2			02/08/2023		TPH (>C36-38)	188	GC-FID	<1	ug/L
7820/043/01	PW1-CRT Day 2			02/08/2023		TPH (>C38-40)	188	GC-FID	<1	ug/L
7820/043/01	PW1-CRT Day 2			02/08/2023		Arsenic (Dissolved)	177	ICPMS	3.3	ug/L
7820/043/01	PW1-CRT Day 2			02/08/2023		Lead (Dissolved)	177	ICPMS	<0.2	ug/L
7820/043/01	PW1-CRT Day 2			02/08/2023		Cadmium (Dissolved)	177	ICPMS	<0.5	ug/L
7820/043/01	PW1-CRT Day 2			02/08/2023		Copper (Dissolved)	177	ICPMS	0.1	ug/L
7820/043/01	PW1-CRT Day 2			02/08/2023		Iron (Dissolved)	177	ICPMS	72.1	ug/L
7820/043/01	PW1-CRT Day 2			02/08/2023		Zinc (Dissolved)	177	ICPMS	11.6	ug/L
7820/043/01	PW1-CRT Day 2			02/08/2023		Manganese (Dissolved)	177	ICPMS	159	ug/L
7820/043/01	PW1-CRT Day 2			02/08/2023		Nickel (Dissolved)	177	ICPMS	15.7	ug/L
7820/043/01	PW1-CRT Day 2			02/08/2023		Magnesium (Dissolved)	184	ICPMS	9.1	mg/L

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Customer	*Adam Keegan* *Hydro-Environmental Services* *22 Lower Main Street* *Dungarvan* *Co Waterford*	Lab Report Ref. No.	7820/042/02
		Date of Receipt	28/07/2023
		Sampled On	*28/07/2023*
		Date Testing Commenced	28/07/2023
		Received or Collected	By Fitz: Pick up Ross
		Condition on Receipt	Acceptable
Customer PO	*P1655*	Date of Report	17/08/2023
Customer Ref	*Derrygreenagh PW1 step2*	*Sample Type*	*Ground Water*
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Alkalinity (Ground Water)	102	Colorimetry	355	mg/L CaCO3	INAB
Ammonia (Ground Water)	114	Colorimetry	0.44	mg/L as N	INAB
Arsenic (Ground Water)	177	ICPMS	3	ug/L	INAB
Bicarbonate (CaCO3)	102	Colorimetry	355.4	mg/L CaCO3	
Boron (Ground Water)	177	ICPMS	<16	ug/L	INAB
BTEX Total (Ground Water)	154	GCMS	<1	ug/L	
Cadmium (Ground Water)	177	ICPMS	<1	ug/L	INAB
Calcium (Ground Water)	184	ICPMS	127.5	mg/L	INAB
Chloride (Ground Water)	100	Colorimetry	17	mg/L	INAB
Chromium (Ground Water)	177	ICPMS	<2	ug/L	INAB
Coliforms (Total)	157	Filtration / Incubation	<10	cfu/100ml	
Conductivity (Ground Water at 20C)	112	Electrometry	633.0	µscm -1@20C	INAB
Copper (Ground Water)	177	ICPMS	1	ug/L	INAB
Dissolved oxygen (mg/l)	715	DO Meter	5.8	mg/L	
Hardness Total (Ground Water)	111	Colorimetry	379.0	mg/L CaCO3	INAB
Iron (Dissolved)	177	ICPMS	134.7	ug/L	
Iron (Ground Water)	177	ICPMS	1864	ug/L	INAB
Lead (Ground Water)	177	ICPMS	<1	ug/L	INAB
Magnesium (Ground Water)	184	ICPMS	9.1	mg/L	INAB
Manganese (Dissolved)	177	ICPMS	90	ug/L	

Signed: A Harmon **Date: 17/08/2023**

Aoife Harmon - Laboratory Supervisor

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		Date of Receipt	28/07/2023
		Sampled On	*28/07/2023*
		Date Testing Commenced	28/07/2023
		Received or Collected	By Fitz: Pick up Ross
		Condition on Receipt	Acceptable
Customer PO	*P1655*	Date of Report	17/08/2023
Customer Ref	*Derrygreenagh PW1 step2*	*Sample Type*	*Ground Water*
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Manganese (Ground Water)	177	ICPMS	90	ug/L	INAB
Mercury (Ground water)	178	ICPMS	<0.08	ug/L	INAB
Nickel (Ground Water)	177	ICPMS	40	ug/L	INAB
Nitrate (Ground Water)	103	Colorimetry	<1	mg/L as N	INAB
Nitrite (Ground Water)	118	Colorimetry	1.13	mg/L as N	INAB
pH (Ground Water)	110	Electrometry	7.11	pH Units	INAB
Polyaromatic Hydrocarbons (GCMS)	200	GCMS	<0.1	ug/L	
Potassium (Ground Water)	184	ICPMS	1.6	mg/L	INAB
Redox Potential	232	Electrometry	228	m/v	
Selenium (Ground Water)	177	ICPMS	2	ug/L	
Sodium (Ground water)	184	ICPMS	9.8	mg/L	INAB
Sulphate (Ground Water)	119	Colorimetry	20	mg/L as SO4	INAB
Temperature (On site)	0	By Subcontractor	10.9	degree C	
Total Organic Carbon	316	TOC analyser (NPOC)	1.5	mg/L	
TPH (>C10-12)	188	GC-FID	<1	ug/L	
TPH (>C10-40)	188	GC-FID	<1	ug/L	
TPH (>C12-14)	188	GC-FID	<1	ug/L	
TPH (>C14-16)	188	GC-FID	<1	ug/L	
TPH (>C16-18)	188	GC-FID	<1	ug/L	
TPH (>C18-20)	188	GC-FID	<1	ug/L	

Signed: A Harmon **Date: 17/08/2023**

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		Date of Receipt	28/07/2023
		Sampled On	*28/07/2023*
		Date Testing Commenced	28/07/2023
		Received or Collected	By Fitz: Pick up Ross
		Condition on Receipt	Acceptable
Customer PO	*P1655*	Date of Report	17/08/2023
Customer Ref	*Derrygreenagh PW1 step2*	*Sample Type*	*Ground Water*
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
TPH (>C20-22)	188	GC-FID	<1	ug/L	
TPH (>C22-24)	188	GC-FID	<1	ug/L	
TPH (>C24-26)	188	GC-FID	<1	ug/L	
TPH (>C26-28)	188	GC-FID	<1	ug/L	
TPH (>C28-30)	188	GC-FID	<1	ug/L	
TPH (>C30-32)	188	GC-FID	<1	ug/L	
TPH (>C32-34)	188	GC-FID	<1	ug/L	
TPH (>C34-36)	188	GC-FID	<1	ug/L	
TPH (>C36-38)	188	GC-FID	<1	ug/L	
TPH (>C38-40)	188	GC-FID	<1	ug/L	
Zinc (Ground Water)	177	ICPMS	20	ug/L	INAB

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		Date of Receipt	28/07/2023
		Sampled On	*28/07/2023*
		Date Testing Commenced	28/07/2023
		Received or Collected	By Fitz: Pick up Ross
		Condition on Receipt	Acceptable
Customer PO	*P1655*	Date of Report	17/08/2023
Customer Ref	*Derrygreenagh PW1 step3*	*Sample Type*	*Groundwater*
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Alkalinity (Ground Water)	102	Colorimetry	361	mg/L CaCO3	INAB
Ammonia (Ground Water)	114	Colorimetry	0.51	mg/L as N	INAB
Arsenic (Ground Water)	177	ICPMS	4	ug/L	INAB
Bicarbonate (CaCO3)	102	Colorimetry	360.6	mg/L CaCO3	
Boron (Ground Water)	177	ICPMS	<16	ug/L	INAB
BTEX Total (Ground Water)	154	GCMS	<1	ug/L	
Cadmium (Ground Water)	177	ICPMS	<1	ug/L	INAB
Calcium (Ground Water)	184	ICPMS	125.4	mg/L	INAB
Chloride (Ground Water)	100	Colorimetry	18	mg/L	INAB
Chromium (Ground Water)	177	ICPMS	<2	ug/L	INAB
Coliforms (Total)	157	Filtration / Incubation	<10	cfu/100ml	
Conductivity (Ground Water at 20C)	112	Electrometry	635.0	µscm -1@20C	INAB
Copper (Ground Water)	177	ICPMS	1	ug/L	INAB
Dissolved oxygen (mg/l)	715	DO Meter	5.3	mg/L	
Hardness Total (Ground Water)	111	Colorimetry	381.0	mg/L CaCO3	INAB
Iron (Dissolved)	177	ICPMS	112.3	ug/L	
Iron (Ground Water)	177	ICPMS	2014	ug/L	INAB
Lead (Ground Water)	177	ICPMS	<1	ug/L	INAB
Magnesium (Ground Water)	184	ICPMS	9.4	mg/L	INAB
Manganese (Dissolved)	177	ICPMS	104	ug/L	

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		Sampled On	*28/07/2023*
		Date Testing Commenced	28/07/2023
		Received or Collected	By Fitz: Pick up Ross
		Condition on Receipt	Acceptable
Customer PO	*P1655*	Date of Report	17/08/2023
Customer Ref	*Derrygreenagh PW1 step3*	*Sample Type*	*Groundwater*
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Manganese (Ground Water)	177	ICPMS	105	ug/L	INAB
Mercury (Ground water)	178	ICPMS	0.09	ug/L	INAB
Nickel (Ground Water)	177	ICPMS	36	ug/L	INAB
Nitrate (Ground Water)	103	Colorimetry	1	mg/L as N	INAB
Nitrite (Ground Water)	118	Colorimetry	<0.01	mg/L as N	INAB
pH (Ground Water)	110	Electrometry	7.10	pH Units	INAB
Polyaromatic Hydrocarbons (GCMS)	200	GCMS	<0.1	ug/L	
Potassium (Ground Water)	184	ICPMS	1.9	mg/L	INAB
Redox Potential	232	Electrometry	235	m/v	
Selenium (Ground Water)	177	ICPMS	3	ug/L	
Sodium (Ground water)	184	ICPMS	11.2	mg/L	INAB
Sulphate (Ground Water)	119	Colorimetry	19	mg/L as SO4	INAB
Temperature (On site)	0	By Subcontractor	10.6	degree C	
Total Organic Carbon	316	TOC analyser (NPOC)	1.6	mg/L	
TPH (>C10-12)	188	GC-FID	<1	ug/L	
TPH (>C10-40)	188	GC-FID	<1	ug/L	
TPH (>C12-14)	188	GC-FID	<1	ug/L	
TPH (>C14-16)	188	GC-FID	<1	ug/L	
TPH (>C16-18)	188	GC-FID	<1	ug/L	
TPH (>C18-20)	188	GC-FID	<1	ug/L	

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		Sampled On	*28/07/2023*
		Date Testing Commenced	28/07/2023
		Received or Collected	By Fitz: Pick up Ross
		Condition on Receipt	Acceptable
Customer PO	*P1655*	Date of Report	17/08/2023
Customer Ref	*Derrygreenagh PW1 step3*	*Sample Type*	*Groundwater*
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
TPH (>C20-22)	188	GC-FID	<1	ug/L	
TPH (>C22-24)	188	GC-FID	<1	ug/L	
TPH (>C24-26)	188	GC-FID	<1	ug/L	
TPH (>C26-28)	188	GC-FID	<1	ug/L	
TPH (>C28-30)	188	GC-FID	<1	ug/L	
TPH (>C30-32)	188	GC-FID	<1	ug/L	
TPH (>C32-34)	188	GC-FID	<1	ug/L	
TPH (>C34-36)	188	GC-FID	<1	ug/L	
TPH (>C36-38)	188	GC-FID	<1	ug/L	
TPH (>C38-40)	188	GC-FID	<1	ug/L	
Zinc (Ground Water)	177	ICPMS	19	ug/L	INAB

Signed: A Harmon **Date: 17/08/2023**

Aoife Harmon - Laboratory Supervisor

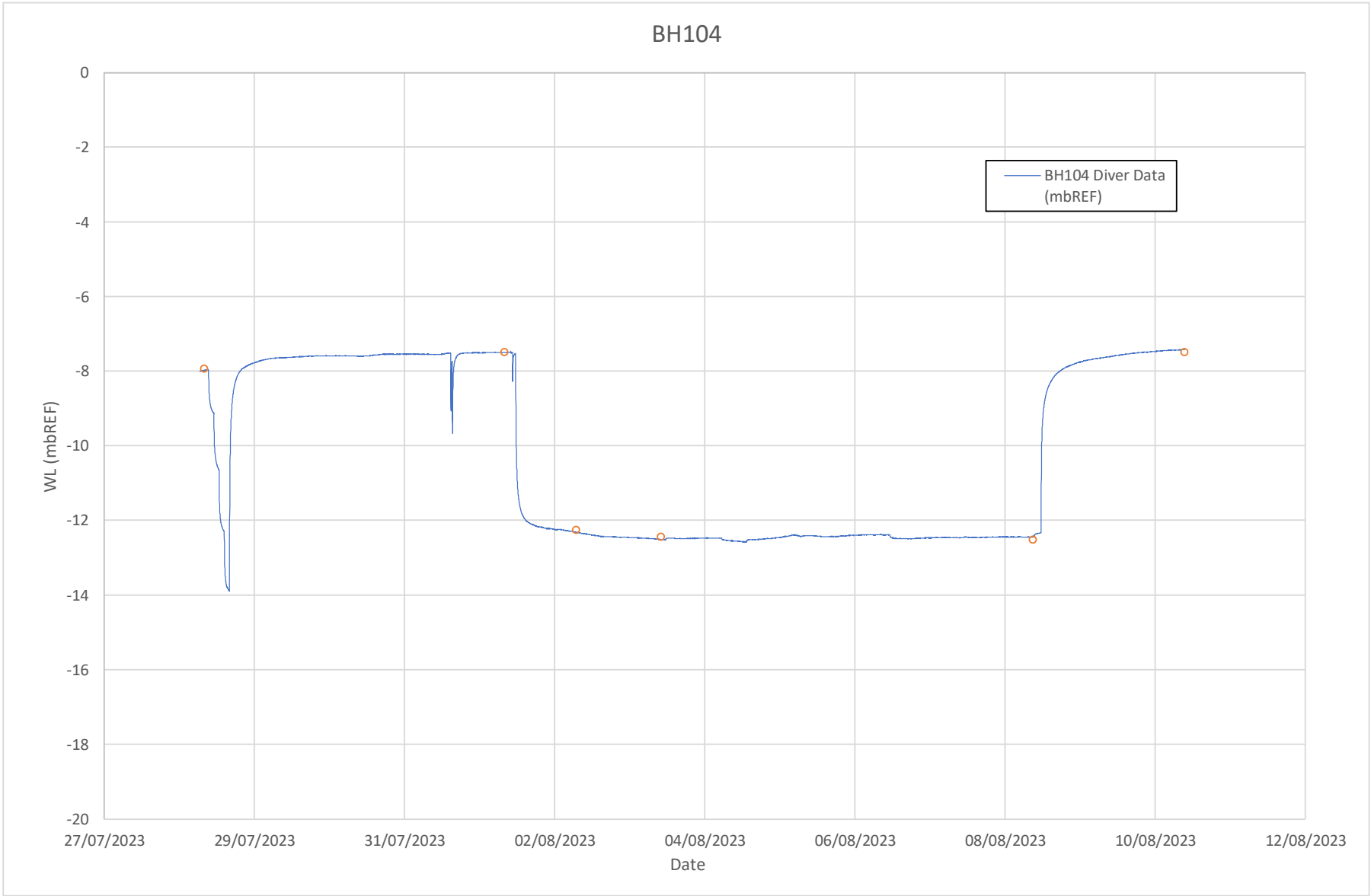
Acc. : Accredited Parameters by ISO/IEC 17025:2017

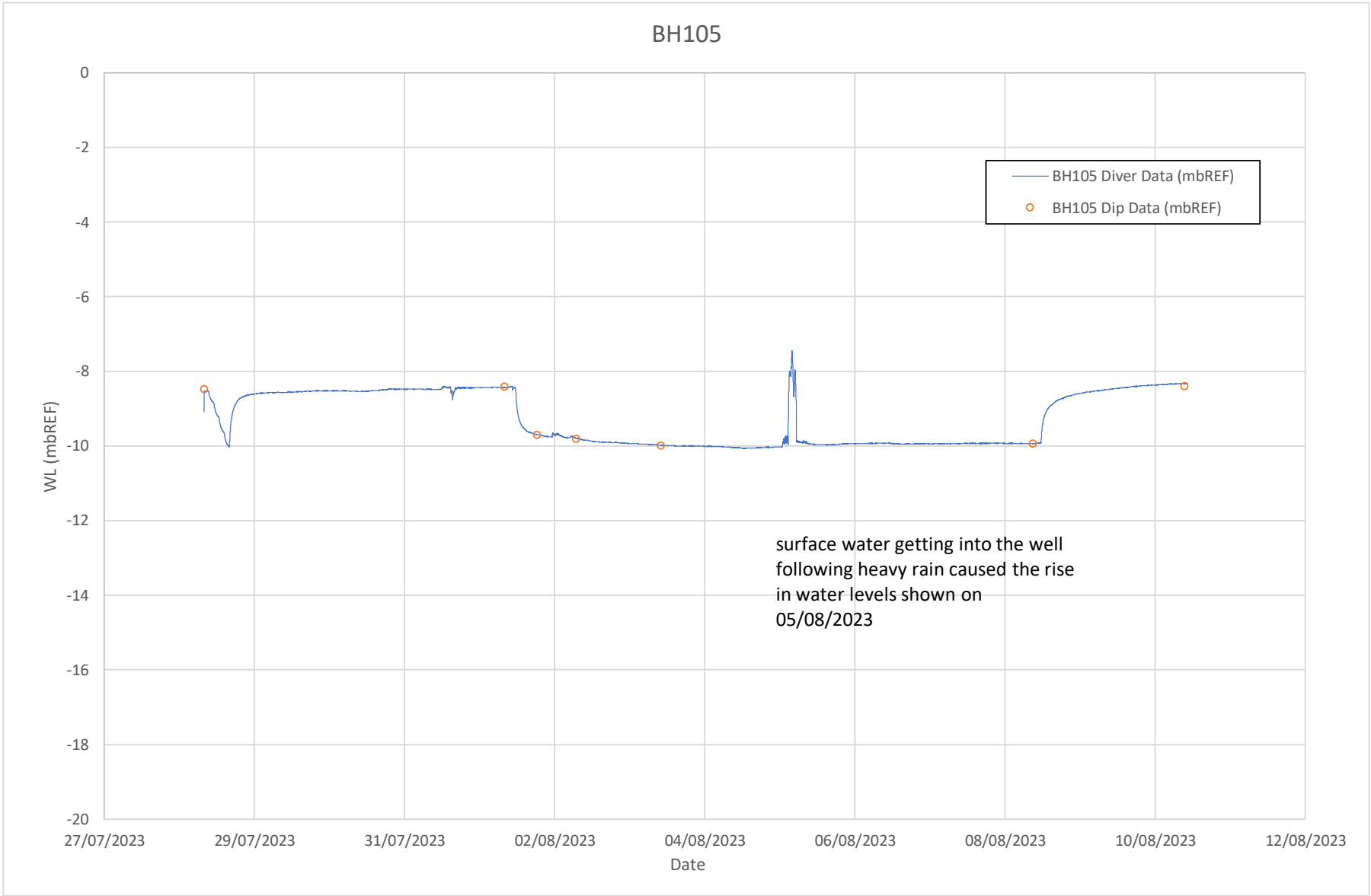
For bacterial analysis a result of 0 means none detected in volume examined
All organic results are analysed as received and all results are corrected for dry weight at 104 C
Results shall not be reproduced, except in full, without the approval of Fitz Scientific
Results contained in this report relate only to the samples tested (P) : Presumptive Results

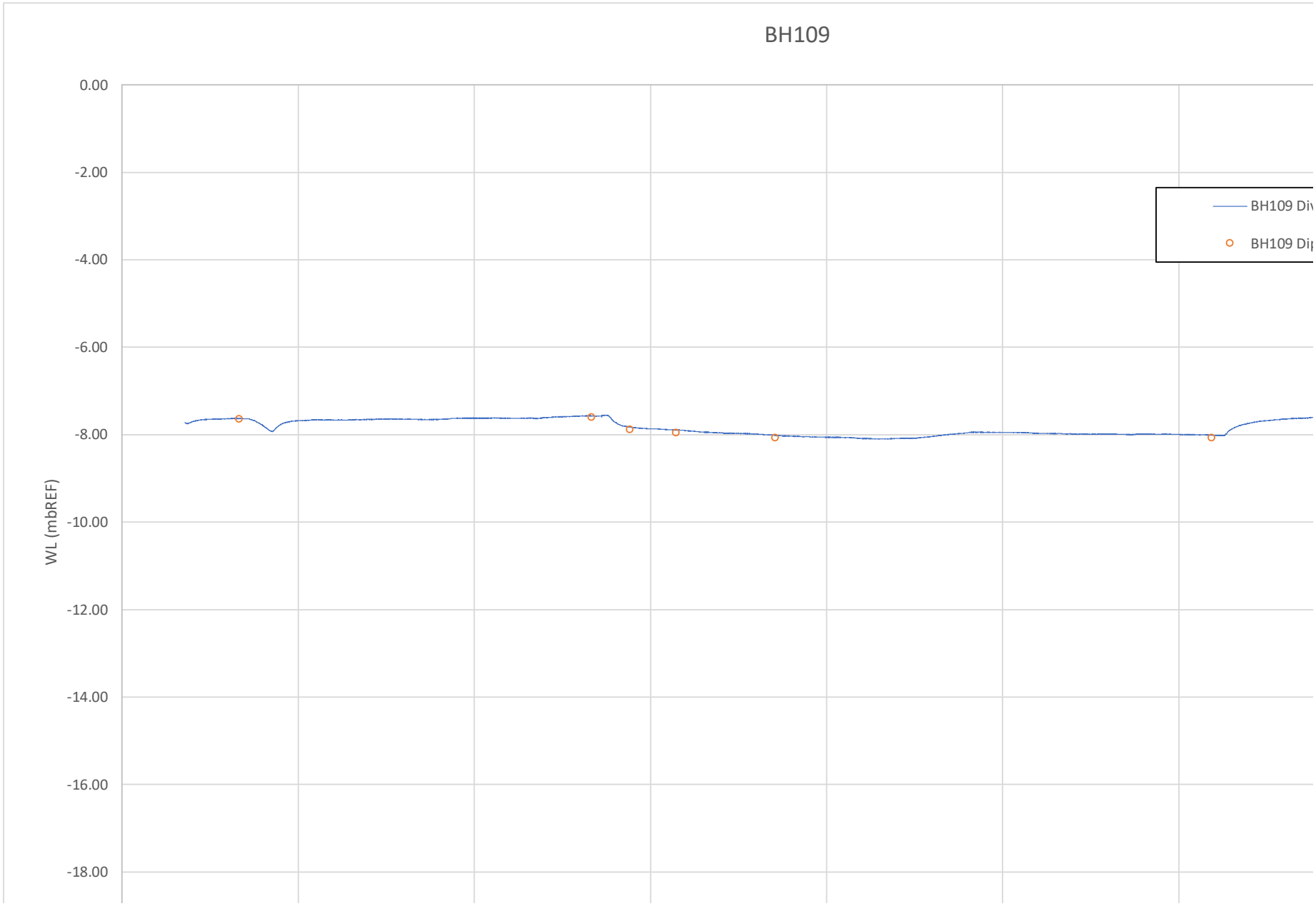
** : The test result for this parameter may be invalid as it has exceeded the recommended holding time (BS EN ISO 5667-3:2018)
* Subcontracted *

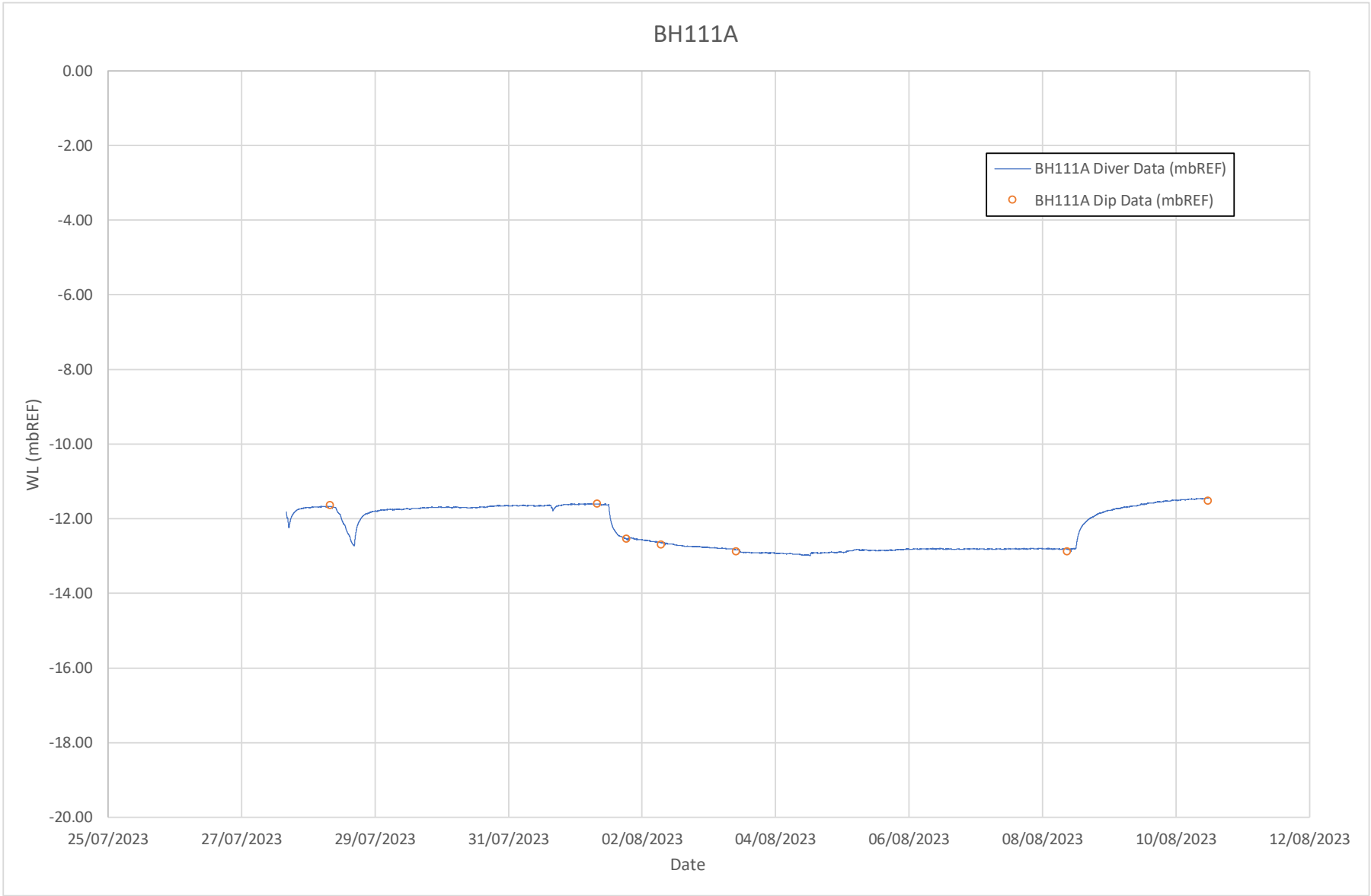
Final results will be issued without any estimated uncertainty of measurement being applied. This can be supplied on request.
Fitz Scientific maintain all customer information in the strictest confidence which is legally enforceable.

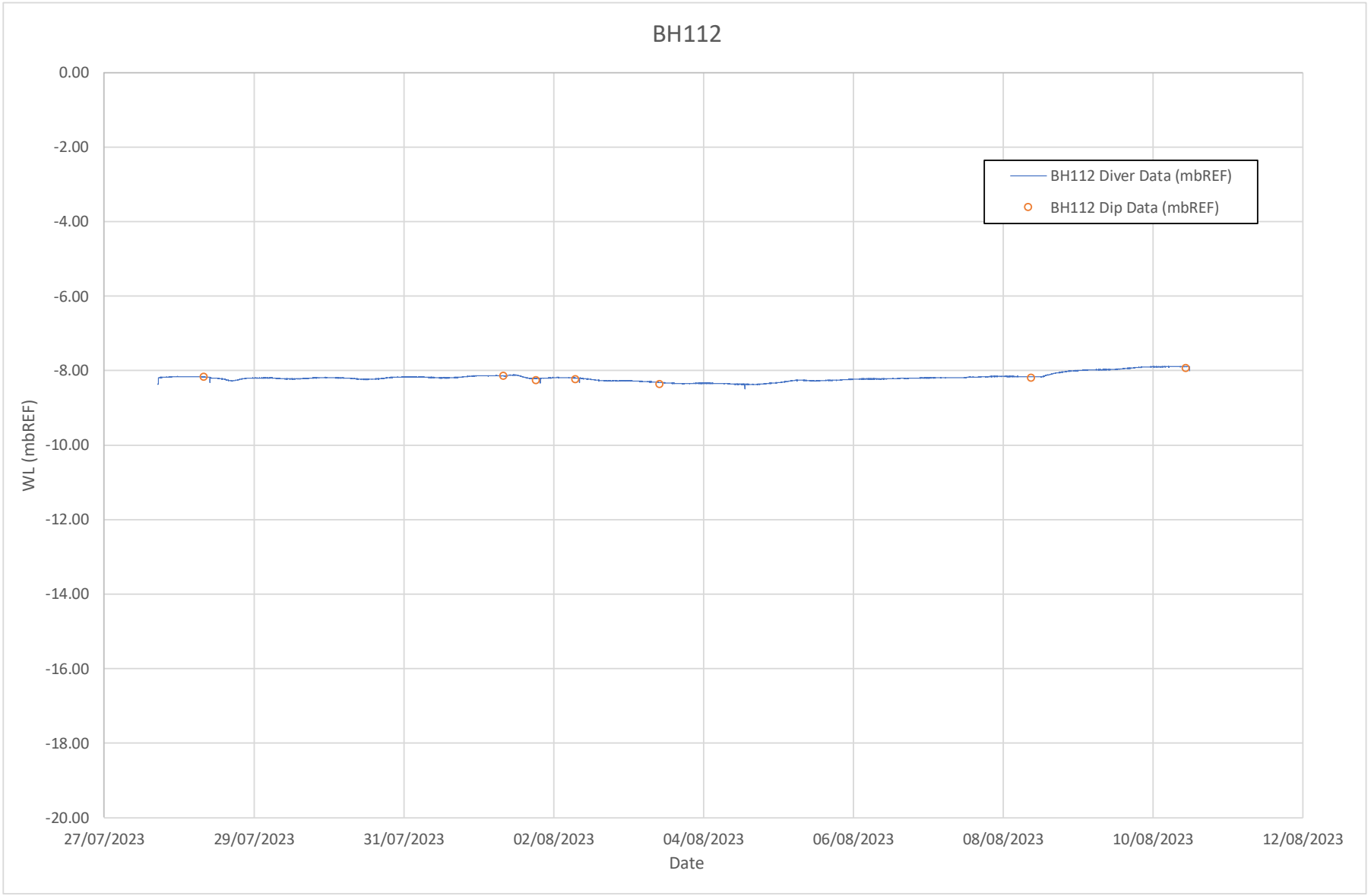
APPENDIX IV
CONSTANT RATE PUMPING TEST DATA PLOTS


BH104
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
WL (mbREF)
27/07/2023
29/07/2023
31/07/2023
02/08/2023
04/08/2023
06/08/2023
08/08/2023
10/08/2023
12/08/2023
Date
BH104 Diver Data (mbREF)


BH105
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
WL (mbREF)
27/07/2023
29/07/2023
31/07/2023
02/08/2023
04/08/2023
06/08/2023
08/08/2023
10/08/2023
12/08/2023
Date
BH105 Diver Data (mbREF)
BH105 Dip Data (mbREF)
surface water getting into the well following heavy rain caused the rise in water levels shown on 05/08/2023


BH109
0.00
-2.00
-4.00
-6.00
-8.00
-10.00
-12.00
-14.00
-16.00
-18.00
WL (mbREF)
BH109 Div
BH109 Dip


BH111A
0.00
-2.00
-4.00
-6.00
-8.00
-10.00
-12.00
-14.00
-16.00
-18.00
-20.00
WL (mbREF)
25/07/2023
27/07/2023
29/07/2023
31/07/2023
02/08/2023
04/08/2023
06/08/2023
08/08/2023
10/08/2023
12/08/2023
Date
BH111A Diver Data (mbREF)
BH111A Dip Data (mbREF)


BH112
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-2.00
-4.00
-6.00
-8.00
-10.00
-12.00
-14.00
-16.00
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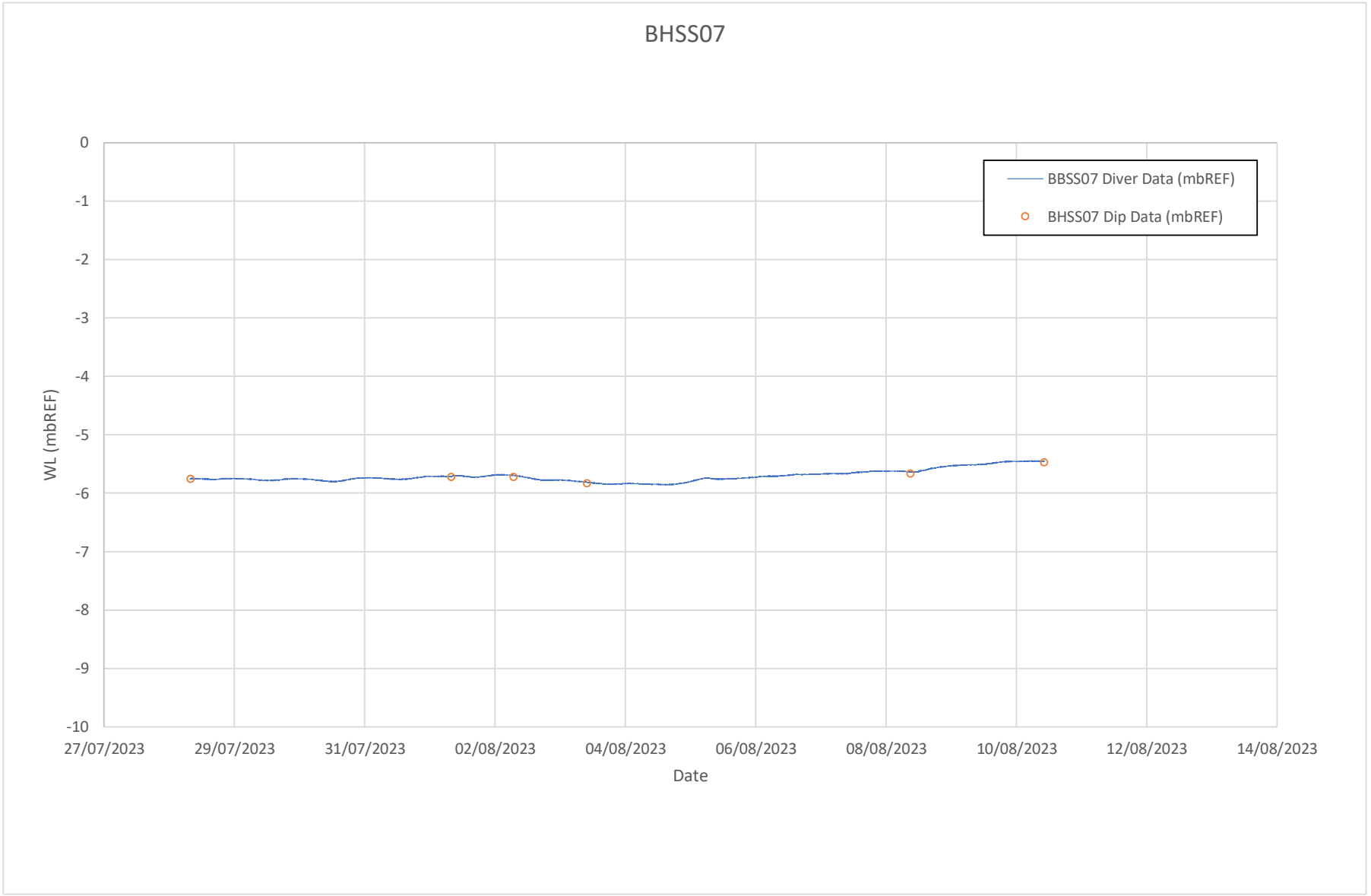
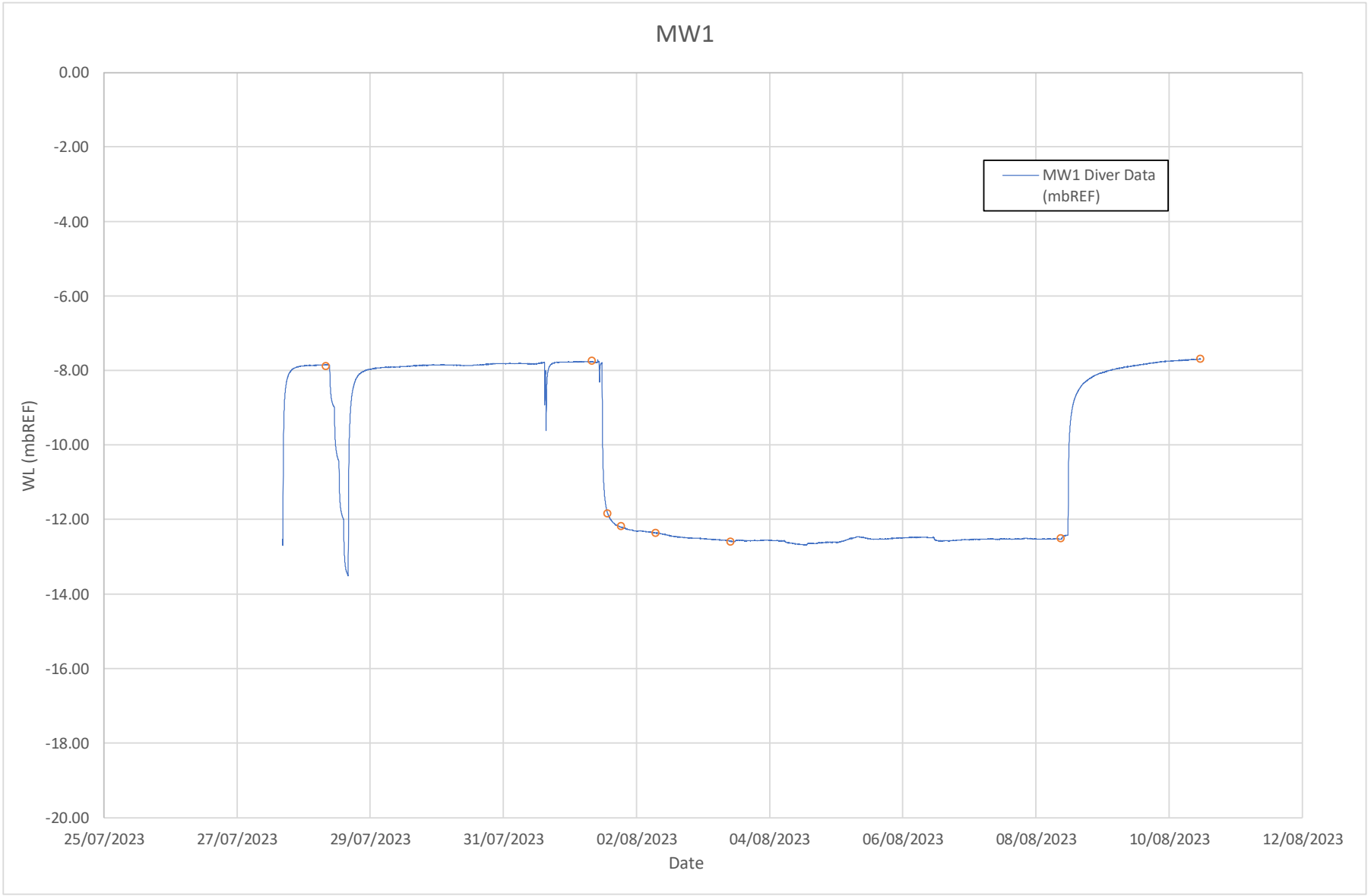
-20.00
WL (mbREF)
27/07/2023
29/07/2023
31/07/2023
02/08/2023
04/08/2023
06/08/2023
08/08/2023
10/08/2023
12/08/2023
Date
BH112 Diver Data (mbREF)
BH112 Dip Data (mbREF)


BHSS07
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
WL (mbREF)
27/07/2023
29/07/2023
31/07/2023
02/08/2023
04/08/2023
06/08/2023
08/08/2023
10/08/2023
12/08/2023
14/08/2023
Date
BBSS07 Diver Data (mbREF)
BHSS07 Dip Data (mbREF)


Hostel Well
0
-5
-10
-15
-20
-25
WL (mbREF)
BH Hostel Well Diver Data (mbREF)
27/07/2023
29/07/2023
31/07/2023
02/08/2023
04/08/2023
06/08/2023
08/08/2023
10/08/2023
12/08/2023
14/08/2023
Date


MW1
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-2.00
-4.00
-6.00
-8.00
-10.00
-12.00
-14.00
-16.00
-18.00
-20.00
WL (mbREF)
25/07/2023
27/07/2023
29/07/2023
31/07/2023
02/08/2023
04/08/2023
06/08/2023
08/08/2023
10/08/2023
12/08/2023
Date
MW1 Diver Data (mbREF)

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